Utttar Pradesh Rajarshi Tandon
Open University, Pragraj

UGHN-101
FUNDAMENTALS OF FOOD & NUTRITION

UTTAR PRADESH RAJARSHI TANDON OPEN UNIVERSITY
UGHN 101 - Fundamental of Food and Nutrition

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BLOCK
1

INTRODUCTION OF FOOD AND FOOD GROUPS

BLOCK I- INTRODUCTION

The most fundamental need for survival is food sources. Everyone consumes food, and most individuals do it with pleasure. Scientists have always been interested in the food people eat, how it moves through the body, and what consequences it has. The science of nutrition was developed as a result of this curiosity. The scientific study of food and its relationship to health is referred to as nutrition. It may also be described as the branch of science that studies how the body uses food for growth, energy, and health maintenance. Nutritional therapy has been widely practiced in our nation either alone or in combination with medication for centuries. Today, food plays a significant role in our lives. We now understand that the level of our physical wellness is influenced by the nutrition we provide our bodies. But a variety of circumstances affect our eating behaviors. This block is made up of seven units, which are listed following:

UNIT-I Introduction of Food and Functions of Food
UNIT II Selection, Nutritional Contribution and Changes During Cooking of Cereals
UNIT III Selection, Nutritional Contribution and Changes During Cooking of Pulses
UNIT IV Selection, Nutritional Contribution and Changes During Cooking of Fruits and Vegetables

UNIT-I INTRODUCTION OF FOOD AND FUNCTIONS OF FOOD

You will learn the definitions of nutrients, food science, food and nutrition in the current unit. You will additionally learn about the way we feel towards food are affected by societal and physiological variables.

Structure

1.0 SCOPE

You will be able to do the following after studying this unit:

- Discuss Basic concepts in food and nutrition
- Describe Understanding relationship between food Nutrition and Health
- Explain Functions of Food, food groups, food pyramid
- Definitions and terms used in Food Science and Nutrition Health, Food, Nutrition and Nutrients

1.1 OVERVIEW

Every living thing needs food. Food is what we consume to maintain our health, growth, and ability to work, play, and grow. Foods can be viewed as a composite mixture of different chemical components that, when consumed, satisfy both hunger and taste. One of our fundamental needs is food. Our existence has always depended on Nourishment. As you learn more about the science behind foods and nutrition, you must carefully evaluate your beliefs about food and choose either to accept or reject them. You should use whatever you study in the course in daily life.

1.2 INTRODUCTION OF FOOD

All of the food that is present in nature is not consumed by civilized people. Before eating,theychop, smashes, cools, prepares, and changes in a number of ways to provide diversity to the diet. You can determine the nutritional value of foods by studying dietary composition. You may have heard that some meals are essential for sustaining good health.We now have a plethora of knowledge about how to utilize food to guarantee kids and young people grow, in order to stay healthy throughout life, to meet the unique demands of nursing and motherhood, as well as for usage in using it to heal from illness.

1.2.1 BASIC CONCEPTS IN FOOD AND NUTRITION

Nutritional science investigates how food interacts with a person to maintain and improve health. All bodily parts obtain and utilize the nutrients necessary for their tasks, as well as for the growth and regeneration of every component (rejuvenation), through a series of processes known as nutrition. Food may be a substance which is consumed for the nutritional, growth, and reproductive purpose.The definition of optimal nutrition involves getting and using vital nutrients in the right amounts as needed by the body, but also maintaining a "reserve."

“State of complete physical, mental and social well being and not merely the absence of disease and infirmity" definition given by WHO (World Health Organization)

The following are some of the main requirements (or qualities) of "health":

- Obtaining optimal growth and development while fully expressing one's hereditary ability.
- Maintaining the structural uprightness and functional productivity of the body tissue required for a healthy and constructive life. The capacity to age with minimum disability and impairment in function, and
- The capacity to fight illness, including

  (a) The ability to fend off infections (immune competence),

  (b) The ability to halt the progression of cancer and degenerative diseases, and

  (c) The capacity to fend off the effects of environmental poisons and pollutants.
- Mental Health

- Happiness in society is the capacity to coexist peacefully with other people.

Vital nutrients are the component in food which might be provided to the physique in sufficient quantity such as Carbs, Fats, Proteins, Vitamins, and minerals as well as Water.

A person's nutritional status is their state of health as it relates to how well they use their nutrients. It can only be established by comparing the data gathered through a rigorous medical and nutritional history, a thorough physical examination, and the right scientific analysis.

Fig1.1 Essential Nutrients

1.2.2 LEARNING ABOUT THE RELATION BETWEEN NUTRITION, DIET, AND HEALTH

The foods we eat affect our health. Consuming a diet rich in the right nutrients in the right levels is crucial for maintaining good health. A balanced diet comprises various kinds of food in enough amounts as well as proportion which are a requirement for energy, fats, proteins, vitamins and minerals is sufficiently supplied, and a small amount of supplements prevent short-term weight gain.

In promoting health, diet has always had a vital role to play. The general welfare of human beings is strongly influenced by the quality of nutrition. The foods we eat have an influence on our state of health and wellness. Malnutrition occurs when there is a deficiency in the intake and use of nutrients. Lack of nutrition may have an impact on energy levels, alertness, mobility, stability, and healing.An imbalance in nutritional intake due to large quantities of one or more food types leading to obesity, protein energy malnutrition etc. or specific, i.e. excess nutrients that are possibly caused by poor eating habits or underlying disease such as vitamin C deficiency, iron deficiency anemia etc.

The deficiency in nutrients caused by the lack of food intake is called undernutrition. This has a major effect on how much of the nutrients in your body are balanced. Serious health and nutritional problems, like weakened immunity, recurrent infections, hormone changes, decreased body fat index, reduced efficiency of work, lower growth in children, higher costs for medical treatment or even a decline in quality of life can result from the absence of adequate nutrition when combined with an unhealthy diet.

Overnutrition is the opposite of undernutrition, which is caused by the frequent or habitual consumption of nutrients by eating too much food that is dangerous to health. Even if most nutrients are harmful in excess, the risk of overnutrition is mainly due to carbohydrates and fats. Obesity, which occurs because of the accumulation of an excessive amount of body fat, is a serious form of malnutrition.

Obesity increases the chance of developing chronic diseases that include high blood pressure Type 2 diabetes, cancer, stroke, coronary artery disease, joint pain, problems with the liver, breathing problems, and restricted movement. The health effects of these disorders vary from premature mortality to disability.

Consequently, correct eating choices that result in excellent nutrition might provide the following benefits:

- Promotion of children's optimum prospective growth and development
- The risk of developing chronic diseases like Heart disease, Cancer, Diabetes, Obesity, Osteoporosis, Iron deficiency, and Dental Caries (Cavities) has decreased.
- Have a healthy, productive life.

ASSESS THE PROGRESS OF YOUR SESSIONS 1

1) What do you understand about basic principles in Nutrition?

2) What are the basic relationships between Food, Nutrition and Health?

3) How do you understand the terms "Undernutrition" and "overnutrition"?

PHYSICAL ACTIVITY 1

1) Create a poster illustrating the signs and measures to prevent obesity.

1.3. FUNCTIONS OF FOOD

All living things require food to survive. Food may be categorized based on its functions in the body.

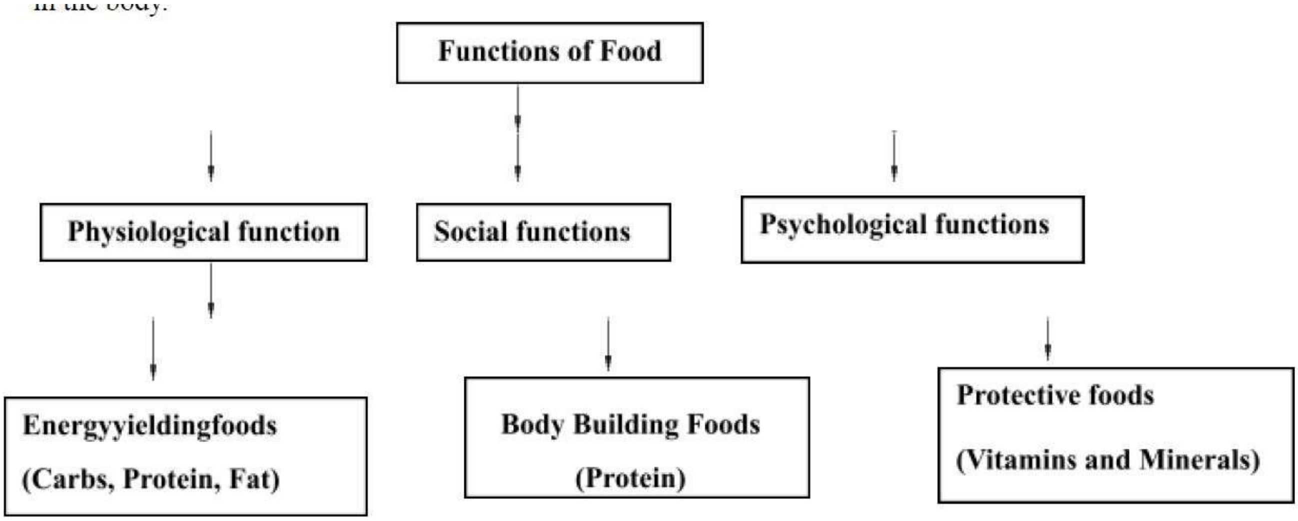

Fig 1.2 Functions of Food

What we consume, which nourishes our bodies, is referred to as "food." It consists of solids, semi-solids, and liquids.It should be palatable, or 'edible' and nourish our body also.The food we consume needs to be harmless and include all of the nutrients our bodies require. We must consume a broad range of meals and do so on a regular basis, throughout the day. Keep in mind that the food we eat must taste good and look, odor, and be enjoyable. Inadequate nutrition, kids as well as teenagers may not reach their full potential, and elderly struggle to perform at their best.

i. Energy yielding foods

That category contains foods overwhelming in carbohydrate, fats as well as protein. 1 gram of carbohydrate has 4 calories. 1 gram of protein has 4 calories. 1 gram of fat has 9 calories. These could be classified into two different categories such as:

- Cereals, Pulses, Roots, and tubers
- Carbohydrate like sugars, Oils and Fats

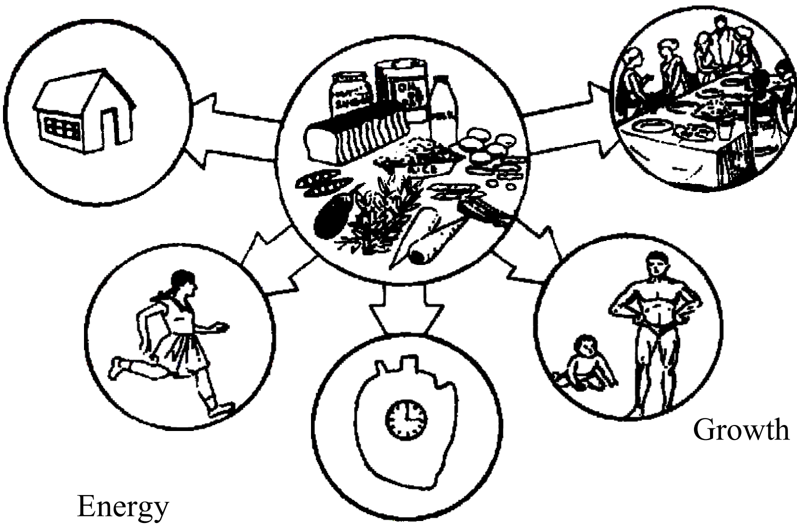

Fig 1.3Various functions of Food

Grains of cereals contribute good quantities of proteins, minerals, and vitamins to the food along with energy. Along with providing energy for the body, pulses also include protein and B vitamins. Despite the fact that roots and tubers primarily give energy, which also contribute less amount of minerals and vitamins. Simple carbohydrates, such as sugar, solely contain energy (i.e., empty calories) but fats also include concentrated energy sources.

ii)Body Building Foods

Protein-rich diets are known as "body building foods." These are divided into two categories.

- Milk, meat, eggs and seafood:

They include a lot of proteins with significant biological importance. These kinds of proteins contain all of the necessary proteins needed in the appropriate amounts towards the formation of body tissues.

- Pulses, nuts, and oil seeds:

Despite having high protein content, they are unable to supply the entire range of amino acids needed for the body of a person to function properly.

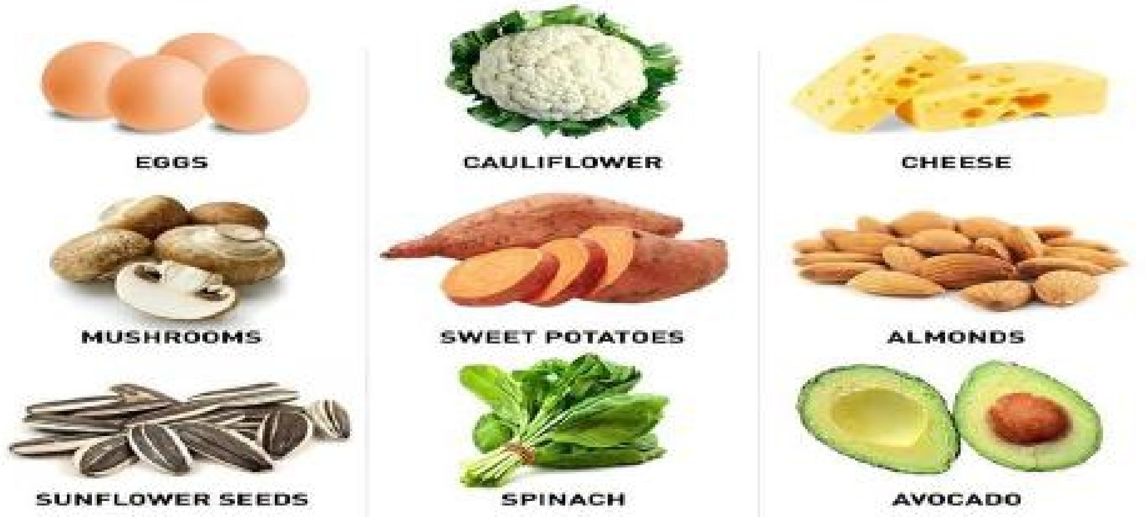

Fig 1.4 Energy giving foods

ASSESS THE PROGRESS OF YOUR SESSIONS 2

1) **Fill in the blanks.**
   a) Body building foods are those that are high in _______________.
   b) _____________are good proteins of high biological value.
   c) 1 gram of carbohydrate provides _____________ calories.
   d) 1 gram fat provides _____________ calories.
   e) Nuts and oilseeds are rich in ___________.

Fig 1.5 Body building foods

iii) Protective foods

Food that contains vitamins, protein as well as minerals serve as regulators in the body to keep the body's temperature, water balance, and heartbeat roughly divided into two categories.

- Vitamin and high in minerals foods, as well as high-biological-value proteins, such as milk, eggs, salmon, and liver.
- Foods that are particularly high in a certain vitamin or mineral, such as some fruits and green leafy vegetables.

Table 1.1 Function of foods

Food Groups	**Food sources**
Energy Giving Foods	Wheat, Rice, Millets, Potatoes, Yam, Sweet Potatoes
Body building foods	Lentils, Beans, Peas, Green grams, Meat, Eggs, Ground Nuts, Fish, Milk
Protective foods	Vegetables and fruits

ASSESS THE PROGRESS OF YOUR SESSIONS 3

1) Give the names of five foods that help us stay healthy.

a) __________
b) __________
c) __________
d) __________
e) __________

2) List five foods that give us energy.

a)_____________
b) ____________
c) ____________

1.3.1 PHYSIOLOGICAL, SOCIAL AND PSYCHOLOGICAL FUNCTIONS

- **Physiological Functions Of Food.**

The body's initial purpose is to give you energy. The body requires energy to support the natural functions required for life to continue, to perform professional, home, and leisure activities, to transform food taken into usable nutrients in the body, to develop, and to remain warm. The process of oxidation of the nutrients ingested provides the required energy. What we eat becomes a part of us. Thus, one of the more significant roles of eating is body formation. If the proper types and quantities of food are consumed via birth until adulthood, a newborn infant weighing 2.7-3.2 kg may grow to its full adult size of 50-60 kg. Daily dietary intake contributes to the maintenance of the adult body's composition and the replacement of the body's worn-out cells.

The key role of food is to control bodily activity. It governs a wide range of activities, including:

- Heart beating
- Keeping the body temperature stable
- contraction of muscle
- water balance controls
- blood clotting
- Elimination of waste through the body
- The 4th purpose of eating is to increase our body's ability to fight against illness.

- **Social Functions of Food**

Our social existence has consistently been focused on food. Our community's social, cultural, and religious lifestyle has included it. At religious events held in homes, temples, and churches, special delicacies are given out as *prasad* or a blessing. Celebrations are held at particular life's stages, including birth, naming ceremony, anniversaries, marriages, etc. The majority of religious occasions require that certain groups of people be fed at feasts. Most of these feasts are connected with specific cuisine in each location.

Food has long been used to communicate affection, camaraderie, and acceptance by society. *Pedha* are given out for a successful exam or the birth of a child, *laddus are* connected with Deepavali festivals and weddings, desserts are mostly served in birthday parties, and *tilgud* is linked to the occasion of happiness.Sankranti Also celebrates friendship and happiness.

Because food is such a crucial component of our societal existence and its role is essential in routine lifestyle. A comfortable mood is produced by the provision of refreshments during gatherings. The food for such a gathering should draw people together rather than separate them. This fundamental component must be addressed while creating menus for such events.

- **Psychological Functions of Food**

Foods help people with their emotional demands in addition to their bodily and social needs. They consist of acceptance, affection, and a feeling of security. Making delectable meals for family members, for instance, is a sign of care as well as affection.

Each of us has emotional needs, such as the desire for safety and love. Food can be crucial in satisfying these demands. Making the child's favorite food is one way a mother may show her child how much she cares. Giving food away as a kind of punishment for bad behavior is also an option. When given food they are accustomed to eating, people feel confident and at ease. Many people utilize food as a way to relieve stress and irritation, whereas others who are sad and lonely may eat less or refuse meals. Sago *kheer* and *Khichdi* are two dishes that may be connected to illness, whereas *Pedha* is connected to good news. As a result, eating is closely related to feeling and mood.

ASSESS THE PROGRESS OF YOUR SESSIONS 4

1) Explain the body-building function of food.

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2) Mention the societal significance of food.

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PHYSICAL ACTIVITY 1

1) Which foods are commonly linked with the following types of events/situations that are made in your family's house?
   a) Birthday party
   b) Marriage
   c) Holi, Deepawali, Makar Sankranti

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   ____
   ____
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   ____

1.3.2 FOOD GROUPS

Because they contain equivalent amounts of the necessary nutrients, foods are arranged together in order to meet your body's dietary needs for optimum health. You must eat a variety of foods through each of the five categories of food each day in the given quantities.

For the convenience of preparing meals, foods have been divided into distinct groups based on their nutritional content. Meals can be planned according to convenience using food groupings like "Basic Four," "Basic Five," or "Basic Seven."

Fig 1.6 Five Basic Food Groups

- **BASIC FOUR**

S.No.	Group	Nutrients
1.	Cereals, Millets And Pulses	Energy, Protein, B-Vitamins
2.	Vegetables and Fruits	Vitamins, Minerals and Fibre
3.	Milk, Milk products, and animal foods	Protein, Calcium B-vitamins
4.	Oils,Fats, Nuts and Oilseeds	Energy,Protein (Nuts and oil seeds)

II Basic Five: ICMR

Group	Nutrients
Cereals, Grains and Products: Rice,Wheat,Ragi,Maize, Bajra,Jowar, Rice flakes, puffed rice	Energy, Protein, Invisible Fat,Thiamine, Folic Acid,Riboflavin, Iron and Fibre

Pulses and Legumes: Bengal gram, Black gram, Cow pea, peas(dry) Rajma, Soya,Beans	Energy, Protein, Invisible Fat,Thiamine, Folic Acid,Riboflavin, Calcium, Iron and Fibre
Milk and Meat Products i) Milk,Curd, Skimmed Milk, Cheese ii) Chicken,Liver,Fish,Egg And Meat	Protein, Fat, Riboflavin, Calcium,Protein, Fat, Riboflavin
Fruits and Vegetables: **Fruits:** Mango, Guava, Tomato Ripe,Papaya, Orange. Sweet Lime,Watermelon. **Vegetables (Green Leafy)**: Amaranth, Spinach, Gogu,Drumstick Leaves, Coriander leaves, Mustard leaves, Fenugreek leaves. **Other Vegetables**:Carrots, Brinjal, Ladies finger, Capsicum, Beans, Onion,Drumstick, Cauliflower.	Carotenoids, Vitamin –C, Riboflavin,Folic Acid, Iron, Fibre. Riboflavin,Folic Acid, Calcium,Fiber,Iron, Carotenoids, Carotenoids,Folic Acid, Calcium andFibre
Fats and Sugars: Fats**:**Butter, Ghee, Hydrogenated Oils,Cooking Oils like Groundnut,Mustard, Coconut. Sugars**:**Sugar, Jaggery	Energy, Fat, EssentialfattyAcids and Fat-Soluble Vitamins Energy, Iron (From Jaggery)

III. BASIC SEVEN

Groups	**Nutrients**
Green and Yellow Vegetables	Carotenoids,Ascorbic acid, and Iron
Oranges, Grapefruit, Tomatoes or Raw Cabbage	Ascorbic acid
Potatoes,Other Vegetables And Fruits	Vitamins and Minerals in general and Fiber of Cellulose
Milk and Milk Products	Calcium, Phosphorus, Protein and Vitamins
Meat, Poultry, Fish and Eggs	Proteins, Phosphorus, Iron and B Vitamins

Bread, Flour and Cereals	Thiamine,Niacin,Riboflavin,Iron,Carbohydrate and Fibre
Butter or Fortified Margarine	Vitamin A and Fat

While planning a balanced diet, include dishes from each category in sufficient amounts. You should consume enough grains and pulses, various fruits and vegetables, good amounts of animal products, and little to no oils and sweets.

PRACTICAL ACTIVITY 2

1) You group foods and discuss their nutritional value.

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ASSESS THE PROGRESS OF YOUR SESSIONS 5

2) Which nutrients do cereals, millets, and pulses give us when we eat them?

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Nutrient Density

It is the amount of a variety of nutrients provided by a food in relation to its actual amount of calories. When comparing the proteins content of isocaloric servings of dhal, bread, and dairy products, you will find that dhal has the greatest nutritional density for protein, followed by milk, while bread has the lowest.Therefore, nutritional density should be taken into account while choosing foods that are suitable for the diets of youngsters, pregnant women, nursing mothers, and patients on diets for therapeutic purposes.

Function of Nutrients

We consume a variety of foods on a regular basis, including grains such as wheat and rice, dal, fruits and vegetables, eggs, dairy products, meat, fish, sugar, fat, and oils. These various foods include various types of chemical substances referred to as nutrients. These nutrients are categorized referring to their chemical constituents. Although every component category serves a distinct purpose, every nutrient requires cooperation together to be successful. Carbohydrates, proteins, lipids, minerals, vitamins as well as water are the nutrients that are present in food. Another crucial element of our daily meals is fiber.

Carbohydrates: Foods that include carbs include the starch from grains and sugar from sugarcane and fruits. The major function of carbohydrates' is to give energy to our body. Those which are not used immediately for this reason are retained as glycogen or converted to fat and preserved, to be used for supply of energy whenever required.

Fat: Examples of fats that may be present in diet include lard by beef, cream from milk as well as the oils contained in seeds. In addition to serving as transporters for vitamins that are fat-soluble and being a supplier of important fatty acids, fats constitute significant as suppliers of energy. Excessive fats in foods are retained as fat accumulated within the body. Extra energy consumed than the body requires becomes deposited as fat.

Protein: Casein from dairy products, albumin from eggs, globulins from legumes, while gluten from wheat are all kinds of proteins that are present in the diet. Proteins are mostly used in the growth novel tissues in addition to maintaining and making repairs of previously established tissues. Additionally, the manufacture of regulatory and defense-related molecules including enzymes, hormones and antibodies involves the use of dietary proteins. ten percent of the total amount of energy utilized by the diet comes from proteins. Protein that is taken in surplus of what the body needs is converted into fats and carbohydrates and retained as fat in the body.

Minerals: Minerals such as phosphorus, iron, calcium, iodine, salt, potassium, and many more can be identified in a range of foods that include both inorganic and organic ingredients. Minerals are necessary for the development of the muscles, bones, teeth, and structural elements of tissues that are soft. It also helps to regulate a variety of biological processes, such as blood clotting, neuron activation, contractions of muscles, and several more.

Vitamins: Diet Includes both water-soluble vitamins C and B group and fat-soluble vitamins A, D, E, and K. These are essential for development, healthy bodily operation, and regular bodily functions.

Water: We obtain water via the meals and drinks we consume, as well as from the water we drink directly. Our bodies are mostly made up of water, which makes up around 60% of our total body weight. Water is required for the body to utilize nutrients as well as to eliminate wasted food. It regulates biological activities such as controlling temperatures.

Everyone needs similar nutrients to live a life of wellness. The sole difference is the amount of every nutrient required based on characteristics such as age, size, activity level, and so on.Everyone needs energy for work, although a man who carries goods may need more than a man who sits at a desk in a work environment.You probably already know that we get our nutrients from the food and drinks that we consume. The majority of diets contain the nutrients at various levels.

ASSESS THE PROGRESS OF YOUR SESSIONS 6

1) Why are nutrients crucial to maintaining our health?

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1.3.3 FOOD PYRAMID

The food pyramid is designed to be used by the majority of healthy people as a reference for the kinds of foods and their proportions to be present in a routine diet. The food pyramid has been created to help with choosing foods from each dietary group. To maintain excellent health, the food pyramid makes it very explicit that we should eat something from all five food categories.In addition, it advises us to take fewer of the foods at the high of the food pyramid, like as sugars and lipids, in comparison to the cereals and pulses at the base of the pyramid. The food pyramid may be used to design a balanced diet and make it easier to choose substitute foods. It also promotes optimum health.

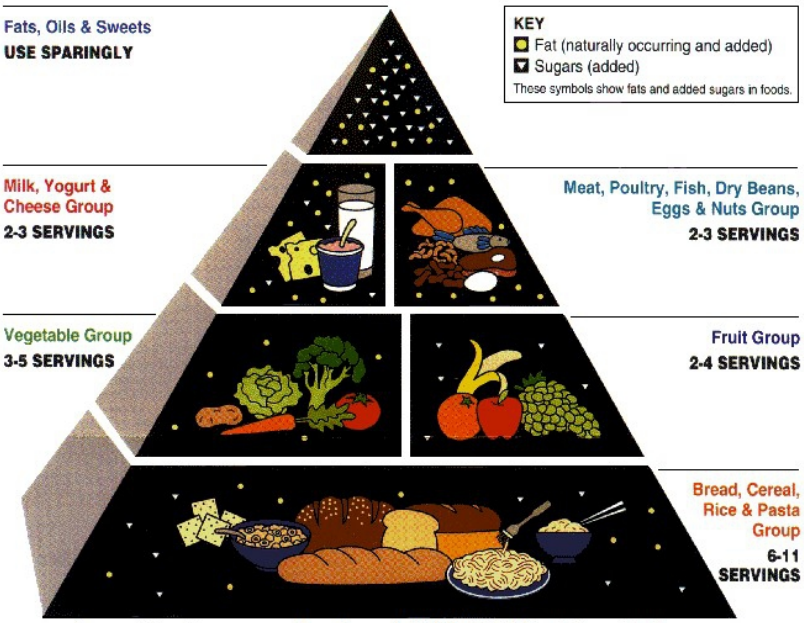
The US Department of Agriculture produced the Food Guide Pyramid in 1992. It has six food categories and was created to reflect changing consumer eating patterns and to provide the department's official advice on what is healthy for humans. The pattern gradually becomes narrower as it ascends from a wide base. The six food categories are arranged in the pyramid according to their daily portions and importance:

1. 6-11 servings of bread, cereal and pasta
2. 3-5 portion of vegetables
3. 2 -4 servings of fruits
4. 2-3 servings of milk, yogurt, and cheese
5. 2- 3 servings of meat,poultry,fish,beans,eggs nuts
6. Oils, fats, and sugars are at the top of the pyramid and take up the least amount of space.

The "my pyramid" version, which was revised in 2005, helped people pick the proper foods and servings to balance their physical activity. Any healthy person over the age of two is intended to use it.

1.3.4 DEFINITIONS AND TERMS USED IN FOOD SCIENCE AND NUTRITION HEALTH, FOOD, NUTRITION AND NUTRIENTS

Food Science: Food science is a synthesis of several distinct chemical substances. Food science is the study of the changes that present in these nutrients while preparing food which are organic or produced through handling processes. When food is prepared, numerous physical and chemical reactions take place. Understanding the nutritional content of various foods and how to preserve them during cooking are also important aspects of food science studies.



Source: https://commons.wikimedia.org/wiki/File:USDA_Food_Pyramid.gif

Fig 1.7 Food Pyramid (Source: Food guide pyramid, USD)

Nutrition: The process through which living beings obtain the nourishment they need to be healthy is known as nutrition. The study of all bodily functions that depend on the breakdown and assimilation of food, as well as the analysis of that food, is known as nutrition.

Health: The WHO defines health as "a state of complete physical, mental, and social well-being, rather than merely the absence of disease or infirmity."

Food: The substance consumed through food helps the body satisfy its demands for growth, energy, maintenance of health, and reproduction.

Nutrients: Nutrients are essential for the body to grow, reproduce and live a healthy life. Nutrients are dietary ingredients. Proteins, water, lipids, carbs, vitamins and minerals comprise the nutrients.

Food Technology: Food technology refers to the science and engineering of processing and preserving large quantities of food using food science principles.

ASSESS THE PROGRESS OF YOUR SESSIONS 7

1) What do you understand by the term nutrients?

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2) What is a food pyramid?

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3) How do you apply your understanding of nutrition?

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1.4 LET US SUMMARISE

The most fundamental requirement for existence is food. Everyone eats, and the majority of people prefer it. Today, nutrition plays a crucial role in our daily lives. We now understand that how well the cells in our bodies are nourished determines the quality of our health. Many people eat what they want or because it is the norm or out of habit. The fact that they are aware of a food's nutritional content has no impact on their choice of food. Few individuals are aware of how the body uses food. It's also important to understand that tasty food doesn't always mean this is healthy.

Having a healthy diet is a goal that every person can achieve. The secret to success is to adopt moderation in all we consume. It is important to make accurate choices while choosing among the many meals on the market. Convenience meals come in a wide range and are designed to make life easier for modern housewives who might also be using them. They can only be used to supplement the daily diet. Never forget that no single meal can supply all the nutrients needed for a healthy lifestyle. Choose natural meals and eat things that will meet your dietary requirements.

1.5GLOSSARY

Food: Foods are materials that are ingested by humans for food, sustenance, and enjoyment in their naturally occurring, processed, or prepared forms.

Nutrition: People get the nutrients they need to develop and maintain their health through the processes that occur when they eat certain foods.

Culture: A community-accepted activity

Fruits: Fruits represent the part of plants' delicious soft, and edible components.

Cereals: Any kind of grain which may be consumed or turned into flour

Legumes: Any plant that produces elongated seed pods. Beans and peas

Meat: The edible portions of animals or birds that are consumed by humans.

Bajra: Pearl millet is a variety of millet that is widely cultivated in the northwestern region of India and can be processed into flour.

1.6 EXERCISES TO CHECK YOUR PROGRESS ANSWERS

Assess the progress of Your Sessions 1

1. The following information should be in your response:

- Fundamental requirements (or qualities) of "health"
- Basic concepts in food and nutrition

2.The following information should be in your response:

- Understanding relationship between food, Nutrition and Health

3. The following information should be in your response:

- Undernutrition and overnutrition

Assess the progress of Your Sessions 2

a)Protein
b) Milk, Egg,Meat
c) 4 calories

d) 9 calories

e) energy

Assess the progress of Your Sessions 3

1) Milk, egg, Cereals, and millets

2) Rice, Potatoes, Wheat

Assess the progress of Your Sessions 4

- Protein-rich food is referred to as "body building foods. "High-quality proteins are abundant in dairy products, meat, eggs, and seafood. Considering the fact that nuts and pulses are rich in protein while the protein is of inferior quality. That foods support growth and support life. They also provide energy.

- Social Functions of Food

Assess the progress of Your Sessions 5

1) Energy, Protein, B-Vitamins, fiber, carbohydrates

Assess the progress of Your Sessions 6

All humans need the same nutrients for their bodies to function properly. The amount of each nutrient required based on variables like age, size, activity level, etc. is the sole variation. Everyone requires energy for work, but men who move heavy objects may need more than men who sit at desks all day.

Assess the progress of Your Sessions 7

1) Nutrients are essential for the body to develop, reproduce and live an active life. Nutrients are dietary ingredients. Proteins, water, lipids, carbs, vitamins and minerals comprise the nutrients.
2) The food pyramid is designed to be used by the majority of healthy people as a reference for the kinds of meals and their proportions to be present in a routine diet.
3) The metabolic reactions that occur when people consume certain foods provide them with the nutrients they require to grow and sustain their health.

UNIT II SELECTION, NUTRITIONAL CONTRIBUTION AND CHANGES DURING COOKING OF CEREALS

The major dietary items in our regular diet are cereals and millets. You will learn about the appropriate selection, nutritional composition and what modifications occur when grains are cooked within this unit. Students will also learn of different kinds of grains and millet that are eaten in our nation, how they are used in our diets.

Structure

2.0 SCOPE

After the students complete this course, they will be capable of:

- To know the factors to consider while choosing cereals
- list the nutrients given by grains
- Describe the changes that occur on the grains while cooking.

2.1 OVERVIEW

The seeds of the grass family are cereal grains. The term "cereal" originates from Ceres, a Roman grain goddess. The second-biggest producer of wheat, rice, and other commodities in the world is India. Rice, maize, wheat, sorghum, jowar, ragi, and the bajra are the principal cereal crops. According to The Ministry of Agriculture of India's preliminary estimate for the year 2020-21, output of main grains such as the grain rice, maize, and bajra production was 102.36 million tons, 19.88 million tons, as well as 9.23 million tons, respectively. The most recent information on wheat production is available for the years 2022 and 2023. During those years, the country is predicted to produce a record amount of rice, 1308.37 lakh tons, and wheat, 1121.82 lakh tons. Along with this, cereals include flour, snacks, breads and rolls, or alimentary pastes or pasta. Cereal meals are consumed widely because they are simple to prepare and store, they are inexpensive, and they provide important nutrients. The majority of people use them as a staple in their diets. Magnesium, which is abundant in millet and is crucial for decreasing blood pressure as well as the risk of heart attacks and strokes, particularly in cases of atherosclerosis, is also a key component. Additionally, millet is a fantastic source of potassium, a vasodilator that reduces blood pressure.

Fig 2.1 Cereal grains

2.2 SELECTION OF CEREALS

The primary foods of the Indian diet include cereals, millets, and their derivatives. Foods must be selected with care as they provide a significant portion of our requirements for calories, iron, protein, and thiamin. There are two factors to grain quality. Physical quality is the first, and it pertains to things like cleanliness, grain soundness, and the absence of extraneous objects. The second factor is processing quality, which refers to usability. For instance, thin long grain rice that does not form clumps during heating is said to be excellent for creating *Pulao*, while *Puran poli* needs a certain variety of wheat. Let's think about the exact selection criteria for these dishes.

- All the factors stated above are taken into consideration while choosing wheat. The households grind whole wheat for their personal consumption. In India, bread that is unleavened (*chapatti*,*Puri*,*parantha*, etc.) is often made with whole wheat flour. There is a virtually minimal nutritional loss in these food preparations. Buyers often purchase the variant that best meets its performance demands. Little is known about how different cultivars function in native wheat preparations. As a result, consumer choice depends on their unique expertise and experience.

Prior to purchasing the cereals, it is important to make the right decision. The following recommendations must be considered in mind while selecting grains:

- Clean grains should be free of impurities like grit and pebbles etc.
- They should not have any fungus, insects, or mold growing on them.
- It is preferable to purchase grains or flour from cooperative stores.
- To guarantee high-quality materials, contact *Grahak Sangh* or any other cooperative organizations.
- In order for families to use whole wheat, it is often ground. This aids in avoiding market purchases of infected flour.
- Insects, lumps, and mold should not be present in maida.
- Crisp, free of grit, gravel, or sand, C*hirwa* and puff rice should be served.
- Mold and bad smell are not present in high-quality Dhalia.
- Indians desire that after cooking, each rice grain maintains its own identity. This quality in the grain seems to be developed with age. It has been shown that when cooking, older grains tend to absorb more water than their initial volume, but fresher grains only absorb slightly more. As there are currently no defined visual indicators of aging to help consumers, it is challenging to determine how much rice has aged based only on how it looks.
- Choose based on your requirements. Short types of rice perform well for *Khichri*, idli, dosa, and other dishes, whereas long, thin varieties are used to make pulao. Suji in fine forms suits adequately for *Halwas*, whereas upma requires larger Suji particles.
- Fresh bread should be packaged in a manner that is clean. Good quality is soft and has a baked taste.
- Bajra, jowar, ragi, corn, and various other millets are other grains that are utilized as staples. The standards for selection are similar among all grains: soundness of grain, cleanliness, lack of mingling with different grains, and absence of garbage.

ASSESS THE PROGRESS OF YOUR SESSIONS 1

1) List the elements to take into account while choosing both rice and wheat grains.

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2.3 NUTRITIONAL CONTRIBUTION OF THE CEREALS

- **Energy:** With a contribution of 70–80%, cereals constitute the primary source of energy.
- **Carbohydrate:** In grains, carbohydrates constitute about 80% of the dry matter. Both soluble and crude fibers are types of the two types of carbohydrates that are present. Cellulose, hemicellulose, and pentosans are the constituents of fiber. Starch is the most significant soluble carbohydrate in all grains, and it is also the most numerous. Also present are small amounts of sugar and dextrin. Simple sugars such as glucose as well as disaccharides like sucrose and maltose are among the free sugars that are present. Among all the grains, whole wheat, ragi, and bajra have the highest fiber content.
- **Protein:** Different cereals have varying amounts of protein. Compared to other cereals, rice has lower protein content. Rice has lower protein content than other grains. The protein composition of various cereal kinds differs as well. Proteins are present in all tissues of cereal grains. Protein in cereals ranges from 6–12%, however it commonly lacks lysine. Due to their extensive consumption, they meet more than 50% of the daily protein requirements. Rice protein is of higher quality than the other grain proteins. Due to reciprocal replenishment, when cereals are eaten with pulses, the protein quality is increased. Methionine is abundant and lysine is lacking in cereals. Pulses are high in lysine and low in methionine. As a result, the quality of the protein of both proteins improves.
- **Lipids:** The amount of lipids in wheat, rice, and maize is 1-2% and 3%, respectively. In comparison to other grain components, germ and bran contain more lipids. Lipids make about 6–11% of the wheat germ, together with bran at 3-5% and endosperm at 0.8–1.5%. Maize germ has 35% lipid content, whereas bran has l% lipid content. The main lipids are triglycerides of palmitic, oleic, and linoleic acids. Phospholipids and lecithin can also be found in cereals.

  According to estimates based on cereal consumption, our diet's fat content can provide more than 50% of our demands for critical fatty acids. Legumes and cereals together can satisfy an adult's need for critical fatty acids.
- **Minerals:** Approximately 95 percent of all minerals are made up of magnesium phosphates and sulphates, potassium, along with calcium. In cereals, phytin makes up a sizable amount of the phosphorus content. In phytin, there is calcium but not phosphorus, which makes them unavailable for absorption. Cereals' phytate content hinders the absorption of iron. Phytate levels in unrefined grains are higher than in refined or polished cereal. The phytate level is decreased during seed germination owing to enzymatic breakdown, while iron availability is

increased. Additionally, grains contain extremely trace levels of elements which include zinc, copper, and manganese.

Cereals are weak suppliers of calcium and iron, with rice perhaps being a particularly inadequate source of those two minerals. The level of polishing affects the content. Calcium and iron may be abundant in ragi. Millets (ragi, bajra, and jowar) are full of fiber and nutrients. Wheat is milled using iron rollers, which increases the iron content of the grain.

- **Vitamins:** Whole grain is a key component of B vitamins that we need in our daily meals. B vitamins are reduced when grains are refined or polished since the outer bran contains almost all of such vitamins. The vitamins in the bran's outer layer penetrate into the grain during parboiling, which involves soaking in water and heating paddy. So, a large portion of the B vitamins are retained in milled and polished parboiled rice. Whole wheat flour has more B vitamins than Maida. All cereals, with the exception of maize, lack vitamin A or C. Vitamin E is abundant in oils derived from cereals grains.
- **Enzymes:** Theoxido-reductases, lipases, amylases, and proteases are among the numerous enzymes found in certain grains, and they are significant. An increase in amylase activity occurs with germination. In comparison, the germ has more proteases. The fatty acids that develop during grain storage and their derivatives are caused by cereal lipases.

Table 2.1 Nutritional composition of Cereals and millets

Food	**Energy (Kcal)**	**Protein (g)**	**Fat (g)**	**CHO (g)**	**Calcium (mg)**	**Phos-phorus (mg)**	**Iron (mg)**	**Thiamin (mg)**
Wheat flour (Whole)	341	12.1	1.7	69.4	48	355	4.9	0.49
Wheat flour(refined)	348	11	0.9	73.9	23	121	2.7	0.12
Rice raw (milled)	345	6.8	0.5	78.2	10	160	0.7	0.06
Maize (dry)	342	11.1	3.6	66.2	10	348	2.30	0.42
Bajra	361	11.6	5.0	67.5	42	296	8.0	0.33

Ragi	328	7.3	1.3	72.0	344	283	3.9	0.42

Source: Gopalan et *al.* (2004)

ASSESS THE PROGRESS OF YOUR SESSIONS 2

1) Name the vitamins and minerals are present in the whole-grain cereal?

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2.4 COMMON CEREAL GRAINS

WHEAT

One of the oldest and most significant cereal crops is wheat. There are 30,000 species of this kind of plant, which is part of the genus Triticum. The average wheat kernel is between 1/8 and 1/4 of an inch in size. Some varieties of wheat have stiff hairs called "brushes" covering the tips of each kernel. Wheat grains have rounded in both ends and an ovoid shape. Aleurone is folded in half, and all of the covering layers are creased along one side of the grain.

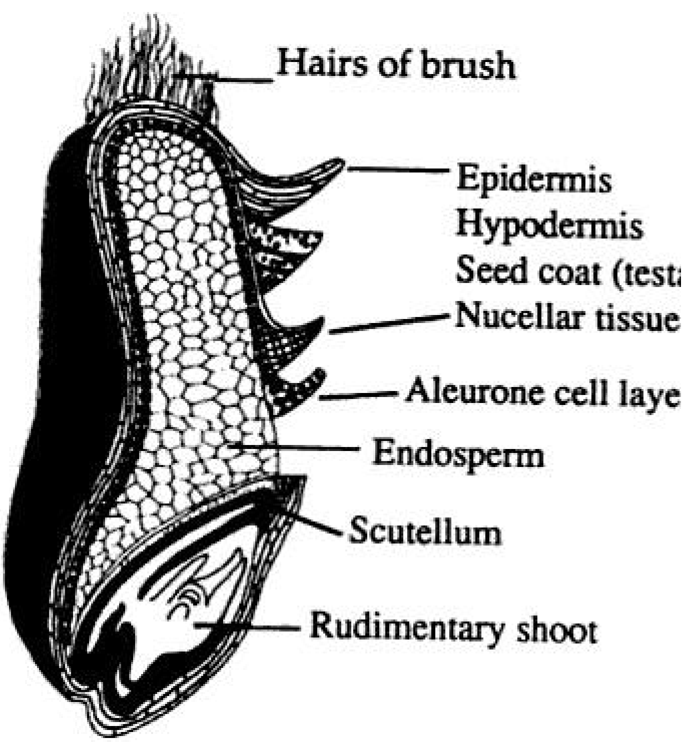

Fig 2.2 Structure of Wheat

Climate and soil variations have some impact on the nutritive value of wheat grains. Protein composition is influenced by the variety cultivated, the climate, and the soil. The percentages of various proteins relative to the total protein in wheat grains are Albumin: 5-10,Globulin : 5-10,Prolamine: 40-50 and Glutelin :40-50.Proteins which are present in wheat have a low tryptophan content and a high glutamic acid content. As glutamine and asparagine, glutamic acid and aspartic acid both are found in the amide form. The feature of the gluten is greatly affected by the high concentration of amide. The proteins in the bran and germ contain more essential amino acids compared to the proteins in the inner endosperm. Therefore, endosperm proteins have substantially lower biological value than whole wheat proteins. Wheat flour includes the proteins glutenin and gliadin, which are generally referred to as gluten. The grade of the gluten utilized determines the strength of the wheat flour.

Most wheat that is used for food must be treated. The grain is initially cleaned in order to condition it and ensure that the kernel separates correctly. The grain is cracked after which it passes through a series of rollers during the milling process. The bigger particles are transported across rollers for additional reduction while the smaller fragments get sorted. Approximately 72% of milled grain may generate white flour. The germ-oil content of flour, which is formed from the whole kernel, causes it to grow rancid when stored for a long period. Since it has no germ in white flour, it persists for longer. Animal food is made from inadequate and extra wheat, as well as different milling leftovers.

When combined with water, only wheat flour among cereal flours makes viscous-elastic dough. Wheat has a protein called gluten that is responsible for viscoelasticity. Because the gluten proteins are water soluble, they will interact and swell. High extraction wheat flour, often known as *Atta*, is used to make *chapatis.* The capacity of the flour to absorb water is one of the main elements that determine how *chapaties* are soft and fluffy.

PHYSICAL ACTIVITY 1

1) Prepare any two recipes by the utilization of wheat flour.

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ASSESS THE PROGRESS OF YOUR SESSIONS 3

1) What happens when wheat and water come into contact?

RICE

Over 50% of people on the planet eat rice as a staple food. Asia is where it is mostly consumed. There are three types of rice: milled, hand-pounded, and parboiled. The milling and polishing levels have an impact on the nutritional content. Compared to high polished milled rice, which has

Fig 2.3 Rice Grain

few amounts of thiamin, rice that has been parboiled and hand-pounded rice both have large levels.The grains of rice are known as paddy after they are harvested. They have a tough outer layer or husk that is not edible. By hand hammering or milling, this can be removed. In India, paddy is milled either by hand or in streamlined rice mills. More broken rice is found when pounding at home. The lipid in bran develops rancidity during storage, reducing the shelf life. The outer husk of the rice is removed and cleaned during milling. Then it is polished and sieved. The mineral and vitamin content of the grains is decreased during polishing. Most types of coarse rice are not polished to a high level. According to Indian government standards, polishing shouldn't go over 5 per cent. The majority of the thiamin is lost. Parboiled rice came from India originally. Parboiled rice comprises up half of the crop in India. Parboiling is especially beneficial for coarse and medium grains of soft rice since they smash excessively when handled raw. Paddy is parboiled by short soaking it in water, heating it once or twice in steam, and then drying it before milling. When compared to raw rice, parboiling increases protein efficiency ratio and enhances digestibility. The resistance of milled parboiled rice to fungi and insects is higher. When rice is washed, parboiled rice loses less water-soluble nutrients than uncooked rice. Processed rice products consist of puffed rice and rice flakes.

In India, rice products including parched rice, parched paddy, and rice flakes make up about 4-5 percent of the country's total rice supplies. Rice that has been parboiled is used to make flakes. Paddy is soaked in water for two to three days to soften the kernel, and then the water is boiled for a short period of time before being drained. The paddy is cooked until the husks split open in a shallow clay vessel or iron pan. The husk is removed and the kernel is flattened by using an iron roller or pestle. Winnowing is used to separate the husk. Rice that has been flaked is white and paper-thin. A rice product that is ready to eat is called *Murmura*or puffed rice. In order to raise the moisture content of parboiled rice to roughly 20%, salt water is added. Rice that has been parched is created by tossing it in hot, iron or clay-coated sand. As you stir the rice, it begins to bubble out and crackle. The dried rice and sand are then separated using a sieve once the pan's contents have been removed. Making parched rice requires the usage of parboiled rice. Parched rice is a crisp food that ranges in color from bright white to gray. It can be purchased salted or unsalted. It can be drunk either plain or after being combined with buttermilk. In an earthen jar, sun-ripened paddy is filled and then moistened with hot water. The water is removed from the jars after two to three minutes, and they are then left upside down for eight to ten hours. The paddy is briefly exposed to the sun before being dried in hot sand (190–210°C) for 40–45 seconds. The grains swell and burst into a delicate, white product when they are parched. The dried grains are winnowed to separate the husk and sieved to eliminate sand.

PHYSICAL ACTIVITY 2

1) Prepare five traditional food products with the utilization of the rice flour.

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ASSESS THE PROGRESS OF YOUR SESSIONS 4

1) How do you describe parboiled rice?

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RICE BRAN OIL

A low-cost chemical process has been established by the Central Food Technological Research Institute in Mysore to extract edible oil from rice bran. This oil is safe to consume for humans, according to the National Institute of Nutrition in Hyderabad. It contains a lot of vitamin E, which prevents oxidation. It also lowers cholesterol more effectively than other oils. When compared to other oils, this oil has an excellent keeping quality. When compared to food fried in groundnut oil, deep-fried foods made using rice bran oil demonstrated that this oil is less absorbed or eaten in fried dishes.

Rice can be used to make a number of dishes, including *pulaos, khichri*, idli, dosa, sweet rice, *kheer*, and *Phirni*, among others. *Poha, bhelpuri*, and other dishes are frequently made with rice flakes and puffed rice.

Environmental and genetic variables both have an impact on the nutritional composition of the rice. The husk and germ of the grain are removed during milling along with the pericarp and aleurone layers that contain the highest amount of nutrients like protein, minerals, and vitamins in comparison to the endosperm. The type of grain used determines the amylose content of the starch. The outstanding and longer grain varieties contain up to 17.5% amylose, whereas other coarse varieties are entirely absent of it. Amylopectin constitutes the majority of glutinous rice. The free sugars glucose, sucrose, dextrin, fructose, and raffinose are also found in rice. The fibre of rice contains hemicellulose, which is composed of pentoses, arabinose, and xylose. Rice has 72–75°/o starch, which is the main carbohydrate. Rice has a significantly lower protein level (7%) than wheat. The main protein in rice is glutelin, also called oryzenin. Albumin, globulin, and prolamiries are also found in rice in trace amounts. Compared to rice bran and rice polishing, the proteins in polished rice have a reduced biological value but a higher digestibility. Parboiling has no effect on the biological value or digestibility of the proteins. When compared to wheat and other cereal products, rice protein has a higher nutritional value. In comparison to other cereal proteins, rice proteins are higher in arginine. Lysine and threonine are lacking in rice. The pericarp and germ of the rice are where the majority of the minerals are found. Iron and calcium are deficient in polished rice. Compared to white rice, colored rice has higher iron content. Amylases, proteases, lipases, oxidases, peroxidases, and phenol uses are all enzymes present in rice. Anthocyanins and carotenoid pigments can be found in colored rice.

PHYSICAL ACTIVITY 3

a) Give the wheat and rice-based meals you ate for breakfast today.

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PHYSICAL ACTIVITY 4

b) Prepare five dishes that you make using five different types of rice.

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ASSESS THE PROGRESS OF YOUR SESSIONS 5

1) What considerations will you take when making *chapattis*?

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2) How can you think about rice bran oil being excellent for your health?

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MAIZE OR CORN

In India, maize is eaten as popcorn that has been cooked or roasted. It is transformed into food products in regions like South America, Central America, and Africa through grinding, alkali processing, boiling, heating, and fermentation. Protein makes for about 11% of maize. Tryptophan and lysine are lacking in the protein from maize. Produced in nations like America are new kinds with high lysine levels. Carotene can be found in abundance in maize. Insignificant levels of thiamine and folic acid are also present. Like all cereals, maize is high in calories and utilized in Integrated Child Development Services programs and supplemental nutrition programs to feed malnourished children. Similar to all cereals, maize contains a lot of calories and is used in Integrated Child Development Services initiatives and supplemental nutrition programs to feed malnourished kids.

PHYSICAL ACTIVITY 5

1) Make a list of the foods that are often cooked by using maize and Jowar in your area.

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JOWAR

Fig 2.4 Jowar

Tamil Nadu, Maharashtra, Karnataka, Madhya Pradesh, Gujarat, and Uttar Pradesh all cultivate sorghum millet, popularly known as jowar. To create roti or bhakri, it is utilized. Jowar has a high protein content compared to rice, however the rice protein's quality is higher. Low concentrations of lysine, methionine, and cystine are found in jowar. Leucine, an amino acid, is present in high proportions in some Jowar varieties. Niacin deficiency is caused by the consequent imbalance between leucine and isoleucine, which prevents the conversion of tryptophan to niacin. Since the proteins in grains and legumes complement one another, Jowar and any legume will provide superior nutritional value when they are combined in a 70:30 ratio. Jowar contains carbohydrates and B-complex vitamins. It has little vitamin A and a lot of nutritional fiber. The parched form of some jowar is eaten. According to research conducted at the Andhra Pradesh Agricultural University in Rajendra Nagar, Hyderabad, Jowar that has been popped or flaked has a five-fold increase in starch digestibility but a decrease in protein digestibility. In non-insulin dependent diabetics, whole jowar recipes significantly decreased plasma glucose levels compared to dehulled jowar recipes. Commercially, malted Jowar is used to produce a variety of baby meals.

RAGI

Fig 2.5 Ragi

Ragi is often referred to as finger millet. It comprises slightly more than 25% of the food grains farmed in India. Its nutritional value is comparable to or even superior to that of rice or wheat. In rural areas, finger millet or Ragi is frequently consumed unprocessed. Although low in thiamine, it is abundant in B vitamins. Calcium is especially abundant in Ragi. It is also full of fiber and a good source of iron.

PEARL MILLET (BAJRA):

Fig 2.6 Pearl millet

In India, pearl millet is the most common kind of millet. Protein content is equivalent with that of wheat. Prolamine makes up a significant amount of the protein, which is followed by globulin and albumin. Tryptophan level is excessive and lysine concentration is inadequate among the amino acids. Iron, thiamine, riboflavin, and niacin are abundant in bajra. Bajra may retain the majority of its germs after around 80% of the polish is removed, and its nutritional value is not much diminished. Pearling enhances the items' look and flavor.It is prepared similarly to rice after being dehusked. *Bhakri* is a flour-based dish.

PHYSICAL ACTIVITY 6

1) Make three dishes with the incorporation of Pearl millet (*Bajra*).

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FOXTAIL MILLET:

Fig 2.7 Foxtail millet

Foxtail millets possess a bittersweet flavor. It's a healthy meal for diabetics. It lowers the body's natural cholesterol levels. It contains lots of antioxidants. They are healthy for children as well as expectant mothers because they include a lot of fiber, protein, calcium, iron, manganese, phosphorus, magnesium, and vitamins. It functions as medicine for persons suffering from diarrhea, feelings of burning when urination, stomachaches, and an absence of appetite. It is an effective treatment for anemia since it is high in proteins and iron. Foxtail millet is also beneficial in the treatment of skin illnesses, oral cancer, lung cancer, stomach cancer, Parkinson's disease, and asthma.

BARNYARD MILLET (*SAWA*):

Fig 2.8 Barnyard Millet

The flavor of barnyard millets is pleasant. Millet is used to make cuisine that is filling and simple for digestion. As a result, in North India, it's utilized in religious fasting. It contains a high amount of iron. Pregnant women and newborns in Uttarakhand and Nepal consume food made from barnyard millet. They think that anemia is minimized in neonatal women, and lots of breast milk will be produced by them. The diet keeps the body temperature steady. It increases the body's ability for resistance. For individuals who spend a lot of time in a fixed posture at work without doing much physical exertion, this is a really nice meal. Due to the high fibre content of this millet, it is beneficial for both diabetes and constipation. This millet-based diet guards against the development of small intestine ulcers as well as large intestine cancer.

ASSESS THE PROGRESS OF YOUR SESSIONS 3

ASSESS THE PROGRESS OF YOUR SESSIONS 6

1) Why diabetic sufferers should eat barnyard millet?

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LITTLE MILLET:

They have a sweet flavor. Many health problems are resolved by eating little amounts of millet. This works as medicine if you get a burning feeling in your chest after eating, sour belching, or tightening in your stomach as a result of a gastrointestinal condition, etc. This is beneficial for people with sexually transmitted infections, diarrhea, and indigestion, as well as to increase sperm count in men and resolve period issues in women. It contains plenty of fiber content; it is also beneficial for people who have constipation. This is a nourishing dish for people with cardiac issues, obesity, and joint discomfort.Nature has blessed us with little millets including foxtail millet, tiny millet, barnyard millet, and kodo millet. Those constitute the cereal grains with therapeutic qualities. It contaminates health supplements. All ailments can be cured by consuming them regularly for six to two years. Small grains not just offer nutrition but also help to detoxify the body and eliminate impurities that might cause sickness. Consequently, they guarantee our well-being.They aid in the treatment of reproductive system problems among men and women. It also helps women with PCOD. By consuming a little millet, men's sperm counts can be enhanced. They also help to clear out the lymph nodal system and manage cancers of the brain, throat, blood, the thyroid, and pancreas.

KODO MILLET:

Fig 2.9 Kodo millet

Kodo millet has a sweet, bitter, and acerbic flavor. It is abundant in nutrients and is thus a healthy diet for children. It has a lot of vitamins and minerals. It is helpful for digestion. It prevents deadly diseases like cancer, has excellent antioxidant activity, regulates blood sugar and cholesterol levels, gives sprinters good energy, and provides the body with the nutrients it needs. You can receive all the nutrients your body needs if you combine them with other legumes like Bengal gram or cowpea. It is also good for weight loss because of its high fiber content. This is beneficial for blood purification, bone marrow function, and the treatment of asthma, renal difficulties, prostate, blood cancer, and tumors of the gut, thyroid, throat, pancreas, or liver.Kodo millet is beneficial for diabetic people.They are also beneficial in the recovery of individuals who have been weakened due to dengue fever, Typhoid fever or viral fevers.

ASSESS THE PROGRESS OF YOUR SESSIONS 7

1) What kind of millets ought to be consumed for health issues?

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PHYSICAL ACTIVITY 7

2) Specify four excellent nutrients of millets that you regularly utilize.

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2.5 CHANGES DURING COOKING OF CEREALS

Cereals exhibit significant changes throughout the cooking process.

Lump prevention

Unwanted lumps may form if dry starch or flour is added immediately to a hot liquid. When dry flour is mixed with hot liquid, the outside flour particles gelatinize and become sticky; the inside flour particles are unable to gelatinize and remain dry, resulting in lump formation. Gelatinization is slowed down because the lump's starch is not available for thickening.

Agitation: Slowly adding the flour and thoroughly combining it will help prevent lumps by ensuring that the flour is equally distributed before it gelatinizes.

Flakes and granules: When flakes and granules are utilized instead of flour, formation of lump is reduced. No lumps develop because the particles are bigger and do not instantly gelatinize when submerged in hot water.

Paste: Before adding hot water, flour is used to make a cold water paste. All particles are surrounded by water, which has already begun to gelatinize each particle.

Below the boiling point: Before gelatinizing, cereal flour should be mixed to below the boiling point in order to disperse all of the particles.

Fat Addition: When the particles are fried in oil, they all get a fat coating that keeps them from sticking together and forming lumps.

Adding Sugar: Sugar reduces gelatinization and lump formation by mixing with water.

Through dry roasting: Dextrinization occurs when starch granules are heated, which prevents gelatinization of external particles and prevents lump formation.

2.5.1 EFFECT OF COOKING ON NUTRITIONAL COMPOSITION OF THE CEREALS

B vitamins are lost through the baking technique by 30%, although this loss can be made up for by fortification. Baking biscuits and cakes leads to vitamin losses of around 10-15%. Thiamin, riboflavin, and niacin losses during rice washing are around 20-40%, 10-30%, and 15-25%, respectively. Excessive washing is avoided. Cooking losses are usually less serious than washing losses. The method of cooking that promotes moist depletion is one in which extra water is used and excess water is discarded. This can result in the loss of around 30% of the remaining thiamin. This water can be consumed or used to prevent cooking in big volumes of water.

PHYSICAL ACTIVITY 8

1) How can you evaluate the factors that prevent lump formation?

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ASSESS THE PROGRESS OF YOUR SESSIONS 8

1) Describe the effect of cooking on the nutritive value of the cereals.

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2.6 THE UTILIZATION OF CEREALS IN COOKING

Due to their relative low cost, cereals comprising the primary food source help to satisfy majority of the energy and fifty percent of the dietary protein needs.Foods such as cereal enhance the protein content of pulses.The main food item has been made by utilizing cereal grains.Cereal is a need for all of our meals.

- Foods such as cereal are employed as a thickening substance in a variety of dishes, including desserts and sauces.
- Cereals are utilized as a covering agent, such as crumbs of bread.
- Cereals grains are utilized to make drinks, such malted beverages.
- Cereals are utilized in sweets, such as Kheer and Halwa.
- Cereals are employed for the development of ready-to-eat food products like macaroni, corn flakes, and puffed rice.
- Cereals can be utilized to make filling for *parathas* and puran poli.
- Fermented cereal products, including dosa and idli, are eaten for breakfast as well as refreshments.
- For making unleavened bread (roti), the majority of nutritious millets such as bajra, Ragi, maize are crushed, and the whole grain flour is then utilized. Minor nutritional loss occurs since flour made from whole grains is used in the majority of recipes.

2.6.1.CEREALS PROVIDE BENEFITS FOR HEALTH

- Cereal is the main supplier of energy in the human diet.
- Significant levels of minerals present millets like ragi, jowar, and *Bajra*.Ragi and *Bajra*are excellent sources of calcium and iron
- Foods made from whole grains may lower the risk of developing breast cancer.
- Insoluble and soluble fibers including pectin, cellulose, and hemicellulose are found in cereals that reduce constipation.
- Cereals contain a good amount of B vitamins.
- The fiber content present in cereal slows down the food's release of glucose, keeping blood sugar levels balanced.

ASSESS THE PROGRESS OF YOUR SESSIONS 9

1) TRUE/FALSE

i) Ragi is a good source of fat. __________

ii) The most significant cereals in the human diet are wheat, rice, and maize ______

iii) Cereals are rich sources of fiber, vitamins and minerals. _______

iv) Rice is a good source of minerals, especially iron and calcium. ________

v) The key rice grain constituents that influence cooking and eating quality are starch, protein, and lipids. __________

vi) Maize is a low-cost starch that is an important source of energy for animal feed. _________

vii) Whole grains are not good for fiber. ________

2.7 LET US SUMMARISE

In Indian diets, cereals constitute the major source of energy contributing to 70-80% of the majority of Indians' daily calorie consumption. Rice, wheat, jowar, bajra, and ragi are the most widely consumed grains in India. The nutritional content of cereals varies depending on the particular portion of the grain utilized. Since all whole grain foods include carbohydrate, iron, protein, phosphorus, thiamin, and fiber, the milling process removes a few of these elements. A balanced diet that includes a variety of cereals may assist you meet your nutritional needs. Rice-based foods may be replaced with wheat dosa, rice flakes payasam, ragi-based cheela, and broken wheat upama. A blend of cereal flours may be utilized to make idli and dosa batters as well as *Chapatis* dough. This will add different nutrients to the day's diet. Beverages and weaning meals can be made with malted grains.

2.8 GLOSSARY

Idli and Dosa: Common South Indian dishes developed with fermented rice and pulse.

Poha: Rice flakes are mixed with other items such as vegetables and nuts to make this dish.

***Chapatis*:** a flat, circular, unleavened bread from India that is often baked with whole wheat flour and griddle-cooked.

Parboiling: By steaming and soaking paddy, it is possible to ensure that the nutrients from the outer layers are absorbed by the grains and are not lost during milling.

Gelatinization: When starch is cooked in water, a transitional process called gelatinization takes place. The granules split into a mixture of polymers-in-solution during this process.

Broth:A thin, unclarified soup

Batter: combination of wheat flour, fluid, and more substances that is sufficiently soft to be beaten or "battered. “utilized to cover meals during fried to make a pancake, dessert etc.

Thickening agents:A culinary ingredient employed to give a drink or food item a thicker consistency.

UNIT III SELECTION, NUTRITIONAL CONTRIBUTION AND CHANGES DURING COOKING OF PULSES

You previously learned about the numerous essential functions which vital nutrients play in the functioning of our bodies in Unit 1. Students will learn about pulse selection, nutritional contribution, and changes during cooking in this unit.

Structure

3.0 SCOPE

Student will be able to do the following after completing this unit:

- Identify the various types of pulse
- purchase high-quality pulses;
- list the nutrients contribution by pulses
- discuss several methods in which these foods may be incorporated in our daily diet; and
- effect of cooking on pulses

3.1 OVERVIEW

Pod-bearing plants in the leguminous family produce edible fruits or seeds that are known as pulses. You have already read in Unit I that pulses are a good source of protein. The fruit is a pod that holds two to ten seeds. Red gram dhal, bengal gram dhal, black gram dhal, green gram dhal, and masoor dhal are the key pulses that play a significant role in our diets. Certain are cooked in the form of whole grams. Rajma, dry peas, and cowpeas are all members of the leguminous family. Oilseeds and nuts are also incredibly nutrient-dense foods. Because these foods are expensive, we might not be consuming them in large quantities. However, groundnut consumption is widespread and they give more nutrients. The main pulses farmed in the nation are chickpea, pigeonpea (tur), mungbean, urdbean, fieldpea, and lentil, which together make up around 80.7% of the nation's pulse production. Furthermore, there are pulses that are prevalent in a certain region, such as horsegram in Karnataka, Orissa, and Bihar, moth bean in Rajasthan, and lathyrus in Bihar, Madhya Pradesh, and West Bengal.Rajma is grown in hilly areas, and cowpea is grown in Rajasthan and Karnataka.Madhya Pradesh, Uttar Pradesh, Maharashtra, Rajasthan, Karnataka, and Andhra Pradesh are the primary pulse producing states, accounting for 80% of total land and 81.1% of total pulse output. Other major pulse-producing states are Orissa, Bihar, Tamil Nadu, Gujarat, and Haryana.

Pulses are regarded as a superfood since they are rich in protein, minerals and B vitamins, less in fat, gluten free and rich in dietary fiber.

3.2 SELECTION OF PULSES:

Your study of the dietary categories in Unit 1 was covered.Pulses come in a huge range of varieties. You may add different dhals in your diet depending on your preferences and budget. In grocery shops, pulses can be found in a variety of packages, including canned, plastic bags, and/or bulk. When purchasing pulses, check to see that the dhal is clean, free of pebbles or twigs, and insect-free. The pulse needs to be dry so as to prevent fungus from growing on it. Many times, sale-purchased pulses are contaminated with khesari (Lathyrus) dhal or other inexpensive dhals, or they are dyed with unfavorable colors to enhance their look, both of which are harmful for the consumer's health.

The most popular kinds of dhal include *Urad, Tur, Mung, Chana* and lentil. In order to prevent deterioration, storage must be free from moisture. Dhals with shattered parts are less expensive than ones that are not. These more affordable ones may be used to make dishes like vadas, idlis, dhoklas, pakodas, and other things that are created after grinding (either wet or dry).

Fig 3.1 Different types of Pulses

Table 3.1 Popular Legumes with Their Hindi and Scientific Name

Legumes	Hindi Name	Scientific Name
Bengal Gram (Chick pea)	Chana	*Cicer arietinum*
Soybean	Soybean	*Glycine max* (L.) Merrill
Rajmah (Kidney bean)	Rajmah	*Phaseolus vulgaris*
Horse Gram	Kulthi	*Dolichos biflorus*
Cowpea	Lobia	*Vigna catjang*
Field Bean	Sem	*Dolichos lablab*
Red Gram (Pigeon pea)	Arhar	*Cajanus cajan* (L.) Millsp.
Moth Beans	Moth	*Vigna aconitifolia* (Jacq.) Marechal
Khesari	Khesari	*Lathyrus sativus*
Lentil	Masoor	*Lens esculenta*
Black Gram	Urd dhal	*Phaseolus mungo Roxb.*
Peas	Matar	*Pisum sativum*
Green Gram	Mung	*Phaseolus aureus Roxb.*

(Gopalan, *et al.*, 1989; Pueppke and Broughton (1999)

ASSESS THE PROGRESS OF YOUR SESSIONS 1

1) What aspects would you consider while purchasing pulses?

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2) List the most common pulses consumed in India.

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3.3 NUTRITIONAL CONTRIBUTION OF THE PULSES:

Pulses are abundant in vitamin A and vitamin E. On a moisture-free basis, pulses have a fat content of 1.5%. They have a high concentration of polyunsaturated fatty acids. They include calcium, magnesium, zinc, iron, potassium, and phosphorus; 80 per cent of the phosphorus is found as phytate phosphorus. Prolonged cooking time, a lack of sulphur, amino acids, and inadequate protein digestibility are examples of antinutritional characteristics like protease inhibitors, hemagglutinins, phytates, flatus factors, tannins, etc. that hinder the complete utilization of dietary legumes. Processing techniques including heating, soaking, germination, and fermentation can significantly reduce or remove antinutritional factors like phytin content. Processed pulses have a higher nutritional value. The B complex vitamins thiamin, folic acid, and pantothenic acid are especially abundant in legume seeds. Although they lack vitamin A and C, like cereals, they do contain vitamin C in small amounts in germinating beans.

Energy: Pulse has 340 calories per 100g, which is approximately the same as cereal.

Protein: Pulses are an important source of protein in vegetarian diets. Pulses have 20-25 per cent protein. They provide two times as much protein than grains. They mainly consist of globulins. Albumins can be found in pulses too. Their nutritional value is determined not only by the quantity of protein but also by its quality, which is determined by the amino acid composition. Sulphur-containing amino acids, especially methionine and tryptophan, are low in legume proteins. All pulses include enough amounts of leucine and phenylalanine. Only groundnuts have low lysine and threonine content.Bengal gram has a greater concentration of arginine and an adequate level of tyrosine. Pulses, on the other hand, are high in lysine. As a result, they can be used to enhance cereal protein. The best diet is one that includes both cereals, grains and pulses.

The essential amino acids isoleucine, leucine, phenylalanine, threonine, and valine are better found in legumes compared to cereal grains.

Table 3.2 The Biological Value of Certain Legume Proteins

Legumes	Biological values
Peanut	54.5
Pigeon pea	60.0
Soyabean	65.0
Green gram	70.0
Chick pea	79.5
Pea	81.7
Cow pea	89.2

Source :B. Srilakshmi,2011

Carbohydrates: Pulses comprise between 55 - 60 per cent starch.Additionally, there are soluble sugars, fiber, and unusable carbs. Pulses contain significant amounts of oligosaccharides of the raffinose family, which cause flatulence in humans.

Lipids: On a dry basis, pulses have a 1.5% lipid content. They have a high concentration of polyunsaturated fatty acids. They fulfill the necessary fatty acid needs of an adult, together with cereal grains. In addition to linoleic acid, most legume seed oils also contain substantial levels of linolenic acid. During storage, they become oxidatively rancid, losing their nutritional value, solubility of the proteins, and developing an unpleasant odor. There is also oleic, stearic, and palmitic acid.

Minerals: They are high in minerals such as calcium, magnesium, zinc, iron, potassium, and phosphorus. Phytate phosphorus accounts for about 80 per cent of the phosphorus available. Phytin forms complexes with proteins and minerals, rendering them physiologically inaccessible to both humans and animals. Processing methods including heating, soaking, germination, and fermentation may remove or reduce significant phytin levels. Pulses cannot significantly increase the overall quantity of minerals consumed in the amounts that are utilized.

Vitamin: Legume seeds are high in B vitamins, including thiamin, folic acid, and pantothenic acid. Although they lack vitamin A and C, like cereals, they do contain vitamin C in small amounts in germinating beans.

Table 3.3 Nutritional composition of pulses

Pulses	Energy (Kcal)	Moisture (g)	Protein (g)	Fat (g)	Mineral (g)	Carbo-hydrates (g)	Fibre (g)	Calcium (mg)	Phos-phorus (mg)	Iron (mg)
Bengal gram (whole)	360	10	17	5	3	4	4	202	312	5
Bengal gram (dhal)	372	10	21	6	3	1	1	56	331	5
Bengal gram, (roasted)	369	11	22	5	2	1	1	58	340	9
Black gram (dhal)	347	11	24	1	3	1	1	154	385	4
Cow pea	323	13	24	1	3	3	4	77	414	9
Field bean (dry)	347	10	25	1	3	1	1	60	433	3
Green gram(whole)	334	10	24	1	3	4	4	124	326	4
Green gram (dhal)	348	10	24	1	3	1	1	75	405	4
Horse gram, (whole)	321	12	22	0	3	5	5	287	311	7
Kherasi dhal	345	10	28	1	2	57	2	90	317	6
Lentil	343	12	25	1	2	59	1	69	293	7
Moth beans	330	11	24	1	3	56	4	202	230	9
Peas green	93	73	7	0	1	16	4	20	139	1
Peas (dry)	315	16	20	1	2	56	4	75	298	7
Peas (roasted)	340	10	23	1	2	59	4	81	345	6
Rajmah	346	12	23	1	3	61	5	260	410	5

Redgram, (dhal)	335	13	22	2	3	58	1	73	304	3
Redgram(tender)	116	65	10	1	1	17	6	57	164	1
Soyabean	432	8	43	19	4	21	4	240	690	10

Source: Gopalan. C, Rama Sastri B.V. and Balasubramanian, S.C., 2004, Nutritive Value of Indian Foods, National Institute of Nutrition, ICMR, Hyderabad.

ASSESS THE PROGRESS OF YOUR SESSIONS 2

1) Consider the nutritional advantages of including pulses in your diet.

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2) List the important vitamins and minerals present in pulse.

a) ________________

b) ________________

c) _______________

d) _______________

3.3.1 DIGESTIBILITY OF PULSES

Pulses maintain their quality well and do not degrade quickly. They are highly well-liked since they are simple to prepare, offer a wide range of foods, and are simple to digest. Chick pea protein among legumes has a high level of digestion. Other forms of legumes, such as lentils and Phaseolus, are less digestible.

3.3.2 GERMINATION

After soaking whole pulses for the recommended amount of time, the water needs to be drained, and the seeds of the pulses must be knotted in a loosely woven fabric and hung. Twice or three times every day, water should be sprayed. The process of germination happens in a day or two.

The benefits of germination

- Sprouting increases nutritional value. During sprouting, minerals including zinc, calcium, and iron get released from their binding condition. Vitamin C is produced through germination.
- Starch loses some of its ability to thicken when it is turned to sugar.

- Germination enhances flavor and texture.
- Germinated pulses provide diet diversity.
- Cooking time is reduced by sprouting.

ASSESS THE PROGRESS OF YOUR SESSIONS 3

1) Summarize the dietary benefit of pulses in terms of nutrition.

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2) What benefits does fermentation provide?

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3.4 TYPES OF PULSES

India is home to a variety of grains, including Bengal gram (chana, chickpea), tuvar dal (red gram, pigeonpea), mung dal (green gram), masur dal (lentil), urad or mash dal (black gram), kulith (horse gram), and kala tur (Indian soybean). Rajma (kidney, haricot, or French bean), agave (field bean), chastang (broad bean), matar (green pea), babril (pink bean), lobia (cowpea), kheri (moth beans), safari (rice bean), sim (scarlet inner bean), guar (cluster beans), and bora sim (sword bean) are some additional less popular varieties. A portion of the harvested grain is processed at home, while the remainder is done in *chakkis.*

a) **Bengal gram:**

Fig 3.2 Bengal gram

Bengal gram, which makes about 40% of all pulse production in India, is a very extensively planted pulse crop. Bengal gram is often known as chickpea. About 10 to 11 million tons are produced in India, making up around 70 percent of global output. It is utilized for both human consumption and animal feed.

Freshly leafy greens are consumed as food, whereas chickpea straw is an excellent livestock fodder. Grain can be utilized as a vegetable. Gram growing nations include India, Pakistan, Ethiopia, Burma, and Turkey. In terms of output and acreage, India leads the globe, followed by Pakistan. Major gram producing states in India are Madhya Pradesh, Rajasthan, Uttar Pradesh, Haryana, Maharashtra, and Punjab.

Based upon grain size, color, and form, gram is divided into two classes

i. Desi (also known as brown gram)

ii. Kabuli, also known as white gram.Kabuli has a lower yield potential than Desi gram.

Bengal gram is a popular substitute for animal or meat protein since it is a protein-rich dietary supplement. Consuming bengal gram on a regular basis helps to reduce protein deficiency. It also aids in the reduction of blood cholesterol levels. Chickpeas are abundant in fiber, protein,antioxidants and healthy fats, and they have a low glycemic index (GI). As a consequence, chickpeas aid in the management of triglycerides, cholesterol, blood sugar, and blood pressure levels; sustaining of an appropriate weight; and helping to maintain gastrointestinal health.It may assist to strengthen bones. It is possible that this will aid in the improvement of brain health. It may aid in the prevention of iron deficiency. The grains are prepared in a variety of ways, including dhal, roasted grains, and fried grains. Its flour is used to make *chappatti*, soups, and other desserts such as "Beasan*Ladoos*" and "*Gajak*." Grains and flour are both utilized as milch and draught animal concentrates. Chickpeas may be used to make dough for cookies, chocolate brownies, dark chocolate truffles and bark, fudge, pudding, dessert hummus and other snacks and sweets.

b) Red gram:

Fig 3.3 Red gram

The pigeon pea, Cajanus cajan. (L) Millsp., is a perennial legume of the Fabaceae family. It is a tolerant of drought perennial that is generally grown as a yearly tall shrub.India's second-most significant pulse crop after gram (channa) is redgram, also known as *Tur* or Arhar in local parlance. Redgram's propensity to generate high economic yields amid soil moisture deficits makes it an essential crop in both rainfed and dry land agriculture. India (42.80 lakh tonnes), Malawi (4.24 lakh tons), Myanmar (3.39 lakh tonnes), Tanzania (1.36 lakh tonnes), and Haiti (1.23 lakh tons) are the world's top redgramproducers. Pigeon peas are an excellent supplier of nutritional fibre, carbs, and proteins, all of which are required for development and growth. Incorporating *Tur* dhal in your daily meals serves to fulfill your calcium and iron needs, while providing an excellent supplier of folic acids stimulates foetal development and prevents congenital birth problems in the foetus. *Tur* dhal contains dietary fibre and protein, which help to reduce appetite, delay digestion, assist weight reduction, regulate diabetes, and lower cholesterol levels. Furthermore, abundant vitamin and mineral reserves such as magnesium, manganese, phosphorus, potassium, sodium, and zinc help to improve physical and mental health. In accordance to the USDA (United States Department of Agriculture), a serving or cup of *Tur*dhal has the following nutrients: Calories(343 kcal), Total Fat (1.5g),Total Carbohydrate (63g),Protein (22g),Sodium (17mg),Potassium (1392 mg),Calcium (0.13mg).In Ayurveda, it is utilized as a volerant to treat injuries and sores. It also can be utilized as an astringent to prevent bleeding. It also is additionally utilized to treat lung and chest problems and get rid of internal parasitic worms. It aids in the treatment of jaundice, cough, and pneumonia. Inflammation of the throat, diarrhea, and chlorosis is all treated with the roots. Pigeon pea flour may be used to make protein-rich breads and biscuits with higher levels of important amino acids. Pigeon pea flour can assist governments in meeting the second sustainability development objective of achieving zero hunger. Researchers are also investigating the feasibility of creating pasta with this flour.

ASSESS THE PROGRESS OF YOUR SESSIONS 4

1) Give an overview of the nutritional benefits of Bengal gram.

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2) Mention the health benefits of Red gram.

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c) **Green gram:**

Fig 3.4 Green gram

Mungbean (Vigna radiata L. Wilczek), commonly called green gram, is a legume plant which is considered as a native food of India. It is a small green bean with a shape that is circular that is mostly cultivated in the southeast, east, and South Asian countries. It may be used as an ingredient in both savory and dessert recipes. Mungbean is a superior protein (20-24%) supplier with greater digestibility that can be ingested as whole grains, dhal, or sprouted form, and serves as an excellent addition to rice as a source of adequate nutrition for humans. In addition to being a good supplier of dietary fiber, carbs, and calories, it is also a great source of flavonoids, phenolics, and other antioxidants. Other vitamins and minerals found in it include copper, magnesium, phosphorus, potassium, and vitamin B6.It also has a low cholesterol and saturated fat content, making it ideal for medicinal and new food compositions. It is the primary source for both human food and animal feed.

Mungbean is a high fibre carbohydrate source that may aid in the reduction of blood glucose levels. The soluble fibre and resistant starch in mung beans promote healthy digestion. In comparison to other legume proteins, mung bean protein is also simpler to digest.Mung bean elements such as potassium, magnesium, and fibre have been related to a decreased risk of high blood pressure. In India, green gram is mostly consumed as dhal. Mung dal may be used in a variety of ways, including sprouts, processed grains, fried beans, bean paste, and incorporation into pasta, cakes, bread, cold jellies, and sweets.

PHYSICAL ACTIVITY 1

1) Make a list of the foods that can be cooked with green gram.

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d) Lentil:

Fig 3.5 Lentil

Red lentils, often referred to as Masoor dal in India, are a highly demanded lentil. They are cultivated throughout the nation and eaten for their many health advantages. Red lentils are incredibly beneficial to your skin and can help you avoid problems like premature ageing and acne. They may also be utilized to brighten skin and remove tans.Red lentils, due to their high fibre content, aid in weight reduction and digestion. Red lentils (Masoor Dal) are beneficial to diabetics because they moderate the erratic spikes and decreases in blood glucose levels. It is high in proteins and mineral substances, which serve to support your body's numerous functions.Lentil is the most sought legume in many countries due to its high average protein content and quick cooking qualities. Lentil seeds provide 1-2% fat, 24-32% protein, and minerals (iron, cobalt, and iodine) as well as vitamins (lysine and arginine). Lentils can be cooked in a variety of ways, including soaking, boiling, sprouting/germination, fermentation, frying, and dry-heating. Processed lentils are utilized in the preparation of the lentil snacks, and medical applications.

e) Blackgram:

Fig 3.6 Black gram

Black gram is most significant pulse crops farmed in India. It is consumed as 'dhal' (whole or split, husked and un-husked) or perched. It is utilized as a nutritious fodder, particularly for dairy cows. It is also a green manuring crop. In terms of balanced human nutrition, urdbean is a great complement to rice due to its high lysine content. Urad dal having a low glycemic index (it slowly raises blood glucose levels). It contains a high quantity of indigestible fibre and a low glycemic index, making it a great alternative for managing blood sugar levels in diabetics. Consuming urad dal on a regular basis in conjunction with a low-fat diet may aid in the maintenance of lipid homeostasis (balancing). As a result, it may aid in lowering the risk of heart disease. There are various methods to incorporate urad dal into your diet. Urad dry seeds may be boiled and used in a variety of dishes. Urad may also be processed into flour and used to add protein to bread. Urad dal may also be the major component in meals such as idli and dosa. These are fermented rice and dhal cakes.

ASSESS THE PROGRESS OF YOUR SESSIONS 5

1) In what ways is black gram utilized in Indian cuisine?

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PHYSICAL ACTIVITY 2

1) Create a graph to show the nutritional profile of lentils.

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3.4.1 TOXIC ELEMENTS IN PULSES

Several chemical components in pulses have hazardous qualities**.** Prolonged cooking time, a lack of sulphur, amino acids, and low protein digestibility are some of the variables that prevent the complete utilization of legumes.

Lathyrogens: A crippling nerve condition known as lathyrism affects men. It is well known that it is brought on by consuming too much kesari dhal (Lathyrissativus), a pulse. Muscular stiffness, weakness, and paralysis of the leg muscle are signs of lathyrism.

Trypsin inhibitors: These may be found in dried peas, red gram, Bengal gram, cowpea, *lathyus sativus*, double beans, and soyabean. Trypsin inhibiting substances are proteins that restrict the activity of trypsin in the stomach, obstruct protein digestion, and reduce protein absorption.

Hemagglutinins: In nature, they are proteins that are abundant in leguminous seeds. Hemagglutinins reduce nutrient absorption, impairing growth.

Goitrogens: These chemicals prevent the thyroid gland from absorbing iodine. They can be found in soyabeans and groundnuts. Excessive consumption of these foods may precipitate goiter.

Saponins: Saponins, which are found in soyabeans, produce nausea and vomiting. Toxins can be removed through soaking before cooking.

Tannins: The majority of legumes have a substantial quantity of seed coat. Tannins form irreversible bonds with iron, interfering with iron absorption. Furthermore, proteins are bound by tannins, which makes them less available.

ASSESS THE PROGRESS OF YOUR SESSIONS 6

1) What are the Toxic elements in pulses and how may they be removed?

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3.4.2 PRODUCTS MADE FROM PULSES:

Bengal gram flour, often known as besan, is made from chickpea. The flour is commonly used in batters and doughs, which can be salted and spiced and utilized in extruded dishes such as crisp *sev, murakku* or *chakli, thengole*. It is also used to make *pakoras, bhajias,* and potato *vadas*. These snacks are made using Bengal gram and black gram, which have an unusual sticky quality that leads to great moulding, extruding, and binding capabilities.

- **Puffed Grains:**

Puffed peas and Bengal gram are popular. These are consumed as snacks and also used as part of the preparation of other foods. With jaggery syrup, Bengal gram rolled into *laddus*. Puffed Bengal gram and peas have a high nutritional content and can be easily digestible. Moist conditioning before roasting aids in most effective puffing. Continuous gram roasting facilities are used in the commercial puffing process. As the roasted grains are subjected to mild impact between a knurled roller and a hot plate, they are dehusked, puffed, and split. For homogeneous heat transmission and smooth discharging of sand and puffed grain, the manually driven puffing machine created by Suryanath and Srivastava (1982) was modified.

- **Ready to Use Mixes**

Dals are used to make rasam (a thin soup), dal dhanshakh (a thicker dal), and sambhar (a thicker dal). Dals are commonly utilized in the production of commercial instant mixes. Dals are the core of the Indian protein diet. They are less expensive than meat. Lysine is found in abundance in all dal products. Many pulses have anti-nutritional properties such as hemagglutinins, goitrogens, and trypsin inhibitors. They are also present in trace levels but are eliminated during the cooking process. The protein value of papad, which is the crisp, textural addition to an Indian diet, is roughly 22% when roasted dals such as black gram dal (urad), green gram dal (mung), red gram dal (tur), and Bengal gram dal (chana) are used.

- *Papads*, the crisp, textural component of the Indian cuisine, can be deep-fried or roasted.The protein content of papad is about 22% because dals like black gram dal (urad), green gram dal (mung), red gram dal (tur), and Bengal gram dal (chana) are utilized. If deep-fried, the nutritional content of a single 10 g papad can be as high as 50 calories.
- In order to make fermented meals like idli, dosa, and dhokla, we can ground soaked dhals. The dhal is allowed to ferment all night. The dishes are light and simple to process.

- Cereals and pulses can be mixed to create a variety of delicious dishes. In order to produce khichri, dhal-stuffed *Paratha*, puris, etc., you may combine pulses with atta and rice.The combination of grains and pulses is more nutrient-dense, as you have already read.
- Puranpolis can be made with dhals that have been cooked to a soft consistency, well-mashed, or crushed and cooked with jaggery.
- Sprouted pulses are occasionally used in traditional legume dishes. Starch and proteins undergo a partial breakdown during sprouting, which improves digestibility. An extra benefit is the distinctive taste that sprouted legumes have. It is necessary to spread the sprouting method and use more sprouted legumes. It could also be offered as a commercial, ready-to-use product.

PRACTICAL ACTIVITY 3

1) Make dishes using whole grains, sprouting pulses, split dhals, parched pulses, and pulse flours.

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PRACTICAL ACTIVITY 4

2) Make recipes with the combination of cereal and pulses.

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PRACTICAL ACTIVITY 5

3) Prepare dishes utilizing items made from fermented pulses.

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ASSESS THE PROGRESS OF YOUR SESSIONS 7

1) What are the different healthy foods items developed from pulses?

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2) Plan and make two snacks acceptable for malnourished children using chickpea flour.

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3.5 CHANGES DURING COOKING OF PULSES

Legume seeds that have not been roasted contain antinutritional elements that, if taken in sufficient quantities, can be harmful. Bean protein loses quality when it is overheated. As more lysine is present in roasted pulses than in boiled or pressure-cooked ones, roasting pulses brings about more improvements in the protein quality of pulses than dry heat treatment. Methionine loss occurs during heat treatment. On the contents of calcium, magnesium, and total iron, cooking has little impact. Heat application may cause thiamine loss.Sodium metabisulphite is present to be effective in marinating the colour of lentils, other seeds acquire a darker color during processing.

ASSESS THE PROGRESS OF YOUR SESSIONS 8

1) What are the factors affecting cooking of pulses?

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3.6LET US SUMMARISE

Indian meals are not complete without pulses. We all consume a variety of pulse in our diet. Pulses such as Urad, Masoor, rajmah, chana, besan, moong, and Arhar are widespread. They are abundant in minerals and vitamins, in addition to being high in protein.All pulses have enough lysine, which is lacking in cereals, and hence can augment cereal protein. A combination of grains and pulses outperforms each one. As a result, a cereal-and-pulse combination is suitable for human eating.

3.7 GLOSSARY

Sprouted: to begin growing or producing new growth

Redgram dhal: Pulse of 'Cajanus cajan,' commonly known as arhar dal, tur dal, tuver dal, or pigeon pea.

Rajma: Dry French bean; legume of the plant Phaseolus vulgaris.

Moth bean: Phaseolus aconitifolus, Jacq., legume and also called Dew Gramme and Aconite bean.

Khichri: A dish produced by cooking a combination of rice and pulse with seasoning, spices, and other ingredients.

Jaggery: A kind of non-centrifugal cane sugar popular in Asia. It is a concentrated product of date, cane juice, or palm sap that does not separate the molasses and crystals and ranges in colour from golden brown to dark brown.

Papad: *Papad,* the crunchy, textural element of Indian food, can be roasted or deep-fried.

Dosa: A snack made with a fermented batter of rice and urad dal.

Extrusion: In the food industry, extrusion involves pushing soft and combined materials by a hole in a perforated surface or die intended to create the desired form.

UNIT IV SELECTION, NUTRITIONAL CONTRIBUTION AND CHANGES DURING COOKING OF FRUITS AND VEGETABLES

You learned regarding pulses and their dietary significance in Unit 3. You will learn how to choose fruits and vegetables as well as their beneficial nutrients in this unit.

Structure

4.0 SCOPE

The information given in this lesson will help you understand the significance, dietary benefits, and nutritional value of fruits and vegetables. This section also goes into a lot of detail regarding the alterations that take place when vegetables and fruits are cooked. The major objectives of this unit are:

- describe the significance of fruits and vegetables in our diet;
- state the dietary beneficial of various fruits and vegetables;
- choose excellent fruits and vegetables from the marketplace;

- clarify the numerous forms in which the fruits may be consumed other than uncooked

4.1 OVERVIEW

Consuming different types of vegetables and fruits is a key component of keeping up a nutritious diet. The World Health Organization (WHO) suggests that we take 400 grammes of vegetables and fruit every day, or five meals. This suggested daily intake may help lower the chance of developing significant health disorders such as type 2 diabetes, obesity, heart disease, and stroke. Vegetables and fruits include phytochemicals. Vegetables and fruits that are yellow, orange, red, blue, purple, and green in color comprise phytochemicals. The wide variety of plant-based substances that plants naturally produce is referred to as phytochemicals. Plant pigments and flavor agents are among them. Fruits and vegetables both have medical benefits.

4.1.1 HEALTH BENEFITS OF FRUITS AND VEGETABLES:

- Fruits and vegetables are abundant in fiber. Because fiber makes you feel full, you eat less. Fiber is beneficial to the heart and the intestines. It lowers the probability of cancer of the colon, regulates bowel motions, and aids in maintaining an optimal digestive system. Fiber lowers the risk of stroke and lowers blood cholesterol levels, which together help avoid cardiovascular illnesses.
- Folate protects birth defects of the neural tube and is found in spinach, beans, melons, and oranges.
- White potatoes, and white beans, lima beans, cooked greens, carrot juice, and prune juice all lower blood pressure.
- Infections might be avoided with vitamin A, which also supports healthy skin and eyes. Excellent sources of vitamin A in fruits and vegetables include the following: Pumpkin, sweet potatoes, pumpkin, carrots, and green vegetables such as turnip greens, mustard leaves, kale, collard greens, seasonal squash, cantaloupe, and red peppers.
- Vitamin C supports gum and tooth health and aids in the healing of cuts and wounds. The following are excellent resources of vitamin C in vegetables and fruits: red and green peppers, kiwifruit berries, sweet potatoes, kale, cantaloupe, broccoli, pineapple, cabbage, Brussels sprouts, oranges, lemons, and mangoes.
- Olives, the flesh of avocados and coconut are the only naturally fat-free foods that are not found in vegetables and fruits.

- Every healthy diet and weight loss plan should include substituting fruits and vegetables for foods with a higher caloric content.
- Each fruit and vegetable deliver a unique combination of nutrients, flavors, and textures. We must select a range of fruits and vegetables for the best overall nourishment.

ASSESS THE PROGRESS OF YOUR SESSIONS 1

1) Mention any two health advantages of consuming folate and vitamin C rich fruits and vegetables.

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2) What role doesphotochemical play in fruits and vegetables?

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4.2 FRUITS

Fruits play a significant role in a healthy diet and are a great source of several essential nutrients, such as potassium, folic acid, and antioxidants like polyphenols.

Fig 4.1Fruits

You will learn about their nutritional worth in this section along with how to buy them and how they change when cooked.

Table 4.1 Some Examples of different types of fruits

S.No.	Groups	Examples
1.	The delicate fruits and berries	grapes, strawberries, and all other berries
2.	segmented fruits or citrus fruits	Mandarins, grapefruits, oranges, pomelos, delicious limes, and tangerines
3.	Stone fruits or drupes	apricots, cherries, peaches, plums, and
4.	Melons	Muskmelon and Watermelon
5.	Pomes and hard fruits	pears and Apple
6.	Fruits from the tropics and subtropics	fruits include bananas, guavas, papayas, jackfruits, dragon fruits, custard apples, and kiwis

a) **APPLE (*Malus domestica):***

Apples are divided into four major groups based on their maturity time (summer, winter, or autumn), color, size, and flavor, among other factors, such as cooking apples, eating apples, cider apples, and drying apples.It is a cold-weather crop. It requires a span of time with temperatures ranging from -2 to 6°C and an annual rainfall of 60 to 75 cm for two to three months. Apples flourish on rich, well-aerated, wet soil with very little lime. Apples are grown in orchards by grafting or clonal propagation.It is mainly eaten fresh, however it is also utilized in processed foods such as apple butter, jam, canned applesauce, and apple juice (sweet cider). Sweet cider can be fermented longer with controlled bacterial inoculation to produce alcohol (hard cider) or acetic acid (vinegar). Apple pomace, a byproduct of the cider press, is a source of pectin that is used in the manufacture of jellies, jams, and marmalades.Apple is also used to make murabba, an Indian preserved meal that is thought to be a cardiac stimulant.The apple is the only fruit with a well-known phrase "An apple a day keeps the doctor away".

b) **BANANA (*Musa paradisiaca)*:**

It is an herbaceous plant with a tree-like look. The wrapping spiral leaf bases form the stem. The leaves are around 4 feet long and 1 foot wide, with a pronounced midrib.The banana was first cultivated in South East Asia's humid tropical areas.Bananas were first mentioned in 500 BC Hindu literature and epics.It can be cultivated in practically all warm climates across the world, although tropical lowlands provide the best growing conditions. It grows well in fertile alluvial soil with a pH of 4.5-7.5. For banana growth, 100-250 cm of rainfall and an average temperature of 270°C are ideal, and the plantation should be shielded from strong winds.The greatest and fastest way to get energy is from ripe bananas, which are rich in vitamins, minerals, and a high proportion of carbs along with some oil and protein. It is eaten raw, and it is used to make a variety of products such as banana purée, banana chips, and banana figs. Fermentation of bananas produces alcohol and vinegar. Following the removal of the fibrous outer bracts, the male buds are sometimes consumed as a boiled vegetable in parts of Southeast Asia. In banana growing areas, even the inner core of the pseudostem is cooked like a curry. It has been observed that ingesting banana peel or smoking dried peel causes hallucinations. 5-hydroxytryptamine (5-HT) is known to induce these effects.

c) MANGO (*Mangifera indica)*:

Evergreen mango trees may grow up to 90 feet tall. It features dense panicles of tiny pink blooms. The meaty drupe has a thick yellowish-red surface and a big seed. The fruit comes in a variety of sizes, shapes, and qualities. The fruit's pulp is orange or yellow in colour, and when fully matured, it has a rich, delectable, fragrant flavor with a great balance of sweetness and acidity. Fruits that are not ripe are fibrous and extremely acidic.It comes originally from SouthEast Asia and has been grown in India for over 4,000 years. It is significant in Hindu mythology, religion, ritual, and traditions. In almost all Hindu festivals, garlands of mango leaves are tied on doors as decoration.The colder regions of India are the only ones where mangoes are not grown. It thrives on well-drained soils with a pH of 5.5 to 6.0. An annual rainfall of 75–190 cm and an average temperature of 24–27 °C are needed for mango growing. Ripe mangoes are eaten as a dessert fruit and used to create jams, jellies, and squash. Pickles, chutneys, aam panna, aam papad, and amchur are all made from mangoes. The kernel within the stone is also roasted, pulverized, and boiled into gruel.

d) CITRUS FRUITS:

Citrus fruits are from the genus citrus, which has roughly evergreen 16 species fragrant trees and shrubs, typically through thorny branches, that are found across the world's tropical and subtropical climates. Orange, lemon, and lime are the three most common citrus fruits. They are a beloved fruit because of their vibrant shade, tempting flavour, and sweetness.

Fig 4.2Citrus Fruits

They can be consumed raw and are served as juice. They are rich in vitamin C content.

e) DRUPES:

Drupes are delicious fruits with a thin shell and luscious meat that contain a single seed (Stone). This category includes apricots, cherries, peaches, and plums.

Fig 4.3 Drupes Fruit

f) MELONS:

Cucumbers and melons are both members of the Cucurbitaceae family. Melons are typically consumed uncooked. Their flesh is composed of 94% water and only 5% sugars. The seeds may be eaten after being peeled of their hard coverings, and they also produce edible oil.

g) BERRIES:

Berries are fruits having layers of pericarp (fruit coat) that, except from the skin on the exterior, are frequently homogeneous. The pulpous and luscious pericarp layers contain seeds embedded in the pulp mass. The fruits' cell structure is delicate and might be destroyed by hard handling or freezing.

Fig 4.4 Berries

h) **YELLOW FRUITS:** Yellow fruits include mangos, apricots, gooseberries, and papayas. These kinds of fruit are high in beta-carotene, which is a precursor of vitamin A. They guard the eyes from night blindness and other vitamin A deficiencies.

ASSESS THE PROGRESS OF YOUR SESSIONS 2

1) List the top five fruits that are most popular in India.

a) ________________
b) ________________
c) ________________
d) ________________
e) ________________

2) Mention any five vitamin C rich fruits.

a) ________________
b) ________________
c) ________________
d) ________________
e) ________________

3) What kinds of foodstuffs are made from mangoes?

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4.2.1 SELECTION OF FRUITS

Size, grade, and diversity are all important factors in the selection of fruits. Knowledge of the ripening process in fruits is essential in order to choose fruits suitable for preservation. Fruits that are just ripe, crisp, fine, and bruise-free are considered to be of good quality. They should not have any symptoms of deterioration, such as the presence of mold, shrinking and limpness, discoloration and mushy texture, the appearance of insects and worms, overripe vegetables, or bruised or damaged skin.

Bananas: When buying bananas, it should not have any black spots on the skin, be free of bruising, and be slightly hard. As completely ripe fruit is readily crushed even as you carry it home from the market, they should then be allowed to ripen at room temperature.

Apples:A good apple is firm, crisp, colorful, and weighty. Each kind has its own distinct hue and form. When apples are kept for an extended period of time, they get spongy texture and lose flavor and aroma. As a result, it is best to buy apples only when they are in season. Small, tart fruits can be used to make jelly, sauce, and other preserved foods.

Grapes: Grapes must be full, lustrous, color-coordinated, securely connected to stem, and devoid of bruising and discoloration. They should not leak since it indicates spoiling.

Citrus Fruits: Oranges, sweet limes (mausambi), grape fruits, lemons, and other citrus fruits are examples. These are organized by size, and the price decreases as the size increases. In some markets, lemons are sold by weight in addition to being sold by the dozen or basket. Citrus fruits with bright and thin skins, firmness, rich colour, and weight in relation to size are favored since they are more likely to contain juice. A spongy texture and dull, dry skin are signs of aging and poor eating habits. Additionally, keep an eye out for signs of decay, such as cuts or skin punctures, soft spots, surface mold, skin punctures, and discoloured, weakened areas of skin near the stem end or button.

Pears: Pears ought to be picked when they are firm and have already begun to soften to ensure that they will mature accurately. They should not be droopy or shriveled, with dull-looking skin and little weakening of the flesh around the stem, since these pears will not ripen. Avoid stains on the pear's sides or blossom ends, which indicate corky tissue below.

Plums and prunes: Choose plums and prunes that are the right colour for the kind and at the right stage of ripeness—from moderately firm to slightly soft.

Pineapples: Choose pineapples with a firm, plump, and hefty for their size appearance, with a vibrant golden yellow, orange-yellow, or reddish brown colour that covers 15% to 20% of the fruit, a fragrant perfume, and a very tiny separation of the eyes or pips. These colours may be found on pineapples of different varieties. The proportion of edible flesh increases with fruit size. They are supposed to be a lack of bruises, microbial growth, soft or discoloured patches, and bruising.

Peaches: These should be fairly firm, not too soft, with yellowish or at least creamy skin between the red areas.

ASSESS THE PROGRESS OF YOUR SESSIONS 3

1) When buying fruits, list any three selection criteria.

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PRACTICAL ACTIVITY 1

1. Prepare the following recipes with fruits:

   a) Salads
   b) Desserts

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4.2.2 NUTRITIONAL CONTRIBUTION OF FRUITS

Fruits are extremely low sources of both fat and protein. The exception is the avocado, which has 28% fat. Fruits are very perishable since they contain a significant amount of moisture. They are also an excellent source of fibre. Fruits are often a poor source of iron. Mangoes are a great source of carotene. Beta-carotene is found in abundance in Indian dates and papaya. Fruits high in vitamin C include guavas and citrus fruits. Large levels of vitamin C may be oxidized in fruits if they are damaged, peeled, cooked, or exposed to air, alkali, or copper. Flavonoids, which act as antioxidants, are present in a variety of fruits including apples, pears, cherries, grapes, and citrus. Vitamin C is abundant in fruits, particularly citrus and guava. Yellow fruits, such as mango and papaya, contain beta-carotene. Bananas are high in carbohydrate and hence high in energy. With the exception of avocado, the protein and fat content of fruits is low.

Fruits also provide fibre as well as minerals including salt, potassium along with magnesium. Fruits do not provide a good amount of calcium. Iron is present in significant proportions in dry fruits, *seethaphal*, and watermelon.

Table 4.2 Nutritional composition of fruits

Species	Fiber (mg/g)	Vit. A (IU/g)	Vit. C (μg/g)	Vit. E (μg/g)	Vit. B_1 (μg/g)	Vit. B_2 (μg/g)	Ca (μg/g)	Fe (μg/g)	K (mg/g)
Apple	24–27	0.53	46–58	1.81	0.14	0.14	72	1.45	1.15
Apricot	20–23	26.11	100–114	8.90	0.29	0.29	143	5.71	2.97
Avocado	50–62	6.21	71–173	20–27	1.07	1.07	107	10.71	6.43
Banana	24–26	0.81	87–93	1.02	0.42	1.02	59	3.39	3.96
Blackberry	53	1.65	210	11.70	0.28	0.42	319	5.56	1.96
Blueberry	24–27	1.00	97–131	5.72	0.48	0.48	62	1.38	0.89
Cherry	21–23	2.15	71–73	0.73	0.44	0.59	147	4.41	2.24
Cucumber	7	0.74	25–32	0.29	0.17	0.08	143	1.68	1.48
Grapefruit	11–16	0.1–2.6	312–382	1.28	0.33	0.16	116	0.83	1.38
Kiwi	30–34	1.75	928–974	14.6	0.26	0.53	263	3.95	3.32
Lemon	28	0.29	529–534	1.55	0.34	0.17	259	5.17	1.38
Mango	18	38.94	278	11.21	0.61	0.55	103	1.21	1.56
Melon Cantaloupe	8	32.24	367–425	–	0.38	0.19	112	1.88	3.09
Nectarine	17	7.36	51–54	7.72	0.15	0.44	51	1.47	2.12
Orange	24	2.05	533	1.83	0.84	0.38	397	0.76	1.81
Papaya	18	2.84	620	7.30	0.29	0.29	243	0.71	2.57
Pear	24–36	0.20	38–42	1.21	0.18	0.42	108	2.41	1.25
Pineapple	13	0.23	155–362	0.19	0.90	0.39	71	3.87	1.13
Plum	15	3.23	91–95	2.57	0.45	0.91	45	1.52	1.73
Pumpkin	11	10.82	49	–	0.33	0.78	151	5.71	2.30
Squash	11–19	1.96	150–170	1.24	0.62	0.35	203	4.42	1.95
Strawberry	22	0.27	566–592	2.78	0.18	0.66	138	3.61	1.66
Sweet pepper	17–20	6.3–57	804–1900	5.92–15.8	0.67	0.27	87	4.70	1.77
Tomato	12	6.23	125–189	5.32	0.61	0.50	50	4.44	2.22
Watermelon	4–5	3.66	81–99	0.49	0.79	0.20	79	1.97	1.16

Adapted from Dorais and Ehret (2008); data are from the USDA database

ASSESS THE PROGRESS OF YOUR SESSIONS 4

1) Give a list of the main nutrients that can be found in fruits.

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2) Bring attention to the value of fiber-rich fruits and vegetables in a healthy lifestyle.

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4.2.3 CHANGES DURING COOKING OF FRUITS:

- During ripening and cooking, the fruits go through a number of changes. These consist of modifications to the product's appearance, flavour, juiciness, soluble solids, colour, texture, and flavour.

- The food becomes soft, tasty, and digestible after cooking. Cooked apple, guava, and mango chunks are examples of fruits that become soft because to softening cellulose found between the cell walls.
- High temperature causes gelatinization and thickening of starch.
- The fruit tissue's pectin is extracted during cooking, aiding in the synthesis of gel. This may be seen while jam or jelly is being made.
- Because vitamin C is lost during cooking, fruits should be eaten raw whenever possible.
- Because of the high temperature while cooking, colour pigments in fruits often oxidise, darken, and become bland. Anthocyanins leach in water, giving the preparation a bluish purple hue owing to oxidation, as in adding black grapes to apple jam, orange, marmalade, and other similar preparations.
- Cooking improves the flavour of fruits, but overcooking might result in flavour loss; consequently, optimal cooking should be done.

Scientists and producers all across the world are working hard to fulfill customer demand for high-quality products. Initial sales are influenced by appearance and freshness, but flavour satisfaction is critical for frequent purchases.Most researchers previously considered that physicochemical characteristics including TSS, TA, hardness, and volatile chemicals were good predictors of fruit ripeness and flavour.Scientists, on the other hand, are becoming increasingly conscious of the relevance of sensory analysis with skilled groups or consumers, particularly for measuring variables that are difficult to assess with normal scientific studies. The effect of thermal treatments on the sensory attributes of fruit has received little attention, but contemporary postharvest research is giving these investigations considerable attention.

ASSESS THE PROGRESS OF YOUR SESSIONS 5

1) What effect does cooking have on the nutritive value of fruits?

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4.3 VEGETABLES

Plants or plant components that are consumed as vegetables. Vegetables provide various nutrients in addition to adding variety to the diet. They make the dish more appealing due to its colour, texture, and flavour. According to their nutritious content, vegetables may be divided into three types.

Fig 4.5 Vegetables

1. Green leafy vegetables

Green leafy veggies are high in fibre and low in calories, have high water content, and are crisp and fresh. Fenugreek, spinach, Colocasia, amaranth, radish, cabbage, celery, coriander, and dill (shepu) leaves are among examples.

2. Roots, tubers, and bulbs:

These veggies are an excellent supplier of carbohydrates. The inclusion of carbohydrate (starch) makes them a good source of calories. They may be kept for a long time because of their less moisture value. Among them are beetroot, carrot, colocasia, turnip, potato, sweet potato, yam, tapioca, onion, and garlic.

3. OTHER VEGETABLES

They provide food diversity and are a great provider of dietary fiber. They provide a respectable amount of vitamins and minerals. Variations of (for instance) brinjal, ladies finger, cauliflower, cucumber, and gourd.

Table 4.3 Vegetable classification based on commonly eaten plant sections

Group	**Examples**
Roots	Carrot, beet root, radish, turnip, colocasia
Tubers	Potatoes, sweet potatoes, tapioca
Bulb	Onion, garlic, leeks

Leaves	Cabbage, lettuce, spinach, amaranth, fenugreek leaves, coriander leaves, mint leaves, greens
Flowers	Plantain flower, Cauliflower, broccoli
Fruits	Tomatoes, brinjal, lady's finger, pumpkin, cucumber, gourds (ash gourd, bottle gourd), capsicum, drumstick, plantain
Legumes (Pods and seed)	Peas, beans, chowli, broad beans, French beans, double beans, Bengal gram tender, red gram tender.
Stems	Plantain stem, ginger, amaranth stem, celery stem, lotus stem

ASSESS THE PROGRESS OF YOUR SESSIONS 6

1) Give some examples of roots and tubers.

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4.3.1 SOME VEGETABLES

a) Spinach

FIG 4.6 Spinach

Spinach (Spinacia oleracea) is a green leafy vegetable that is high in iron. It contains more than 13 flavonoids, which fight cancer and function as antioxidants. Spinach contains vitamin K as well as carotenoids that are good for heart and bone health and for preventing age-related macular degeneration and cataracts in the eyes. Due to its low calorie content and high vitamin content, spinach constitutes a few of the numerous necessary nutritious vegetables. More than enough vitamin K and A, manganese, folic acid, and around 40% of the magnesium the body needs are present in a cup of spinach leaves. Nearly 20 elements, including dietary fibre, calcium, and protein, are present in it in excellent amounts. Even yet, a cup only has 40 calories.

b) Amaranth Leaves:

FIG 4.7 Amaranth leaves

Amaranthus (L.) is a genus with around 60 species that belongs to the Amaranthaceae family. The plants have a wide range of kinds and morphologies, and the green sections of certain species are eaten as vegetables. Due to its nutritional value, amaranth is still incorporated in the human diet today. Amaranth is regarded as a "superfood" due to its high nutraceutical value, which includes high-quality protein, unsaturated oils, dietary fibre, tocopherols, tocotrienols, phenolic compounds, flavonoids, vitamins, and minerals. Amaranth has a greater protein, dietary fibre, calcium, iron, and magnesium content than other grains; hence, although being an old crop today, it is regarded a millennium crop or superfood with important nutraceutical qualities and agronomic adaptability.These are employed in human nutrition in the form of whole-meal amaranth flour, crackers, eggless pasta, gluten-free brown bread, biscuits, cookies, and so on.

c) Broccoli:

Fig 4.8 Broccoli

Brassica oleraceae var. italica is a variety of brassica that resembles cauliflower and comes in two varieties: the heading or calabrese variety and the sprouting variety. Among the veggies addressed are kale, cauliflower, Brussels sprouts, bokchoy, cabbage, collard greens, rutabaga and turnips. The sprouting type, collected in the spring following a dormant winter, is made up of small immature purple or green compact clusters of miniature blooms that branch from a thick 1 m tall main stem.

They are regularly cut to be utilized as a vegetable or salad ingredient unless they have become hardly usable. It can be consumed fresh, cooked, steamed, cool, or heated. These nutrient-dense meals give plenty of nutrients for a low calorie count.

d) Potatoes:

Fig 4.9Potatoes

The plant *Solanum tuberosum*, among the most frequently cultivated and productive crops, uses the swollen tip of a stem that grows underground as a starch store to encourage the formation of new stems from the eyes. The two primary varieties are waxy and floury, characterized by the tissue integrity.

ASSESS THE PROGRESS OF YOUR SESSIONS 7

1) Enumerate the advantages of spinach and amaranth for health.

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4.3.2 SELECTION OF VEGETABLES

When vegetables remain in the sun or for an extended period of time, they normally wither.Purchase vegetables that are fresh. When purchasing root and tuber crops make assured that they are of the exact same variety, well-shaped, smooth, and nearly the same in size. The following are the qualities of different vegetables that are desirable:

- **Beans:** Seeds should be less than half grown and should break readily with a sharp sound to be considered tender, fresh, crisp, clean, firm, and velvety to the touch.
- **Cabbage:**No yellow or withered leaves, should be compact, and be fresh.
- **Carrots:** There should be no wilted, soft, or flabby portions. They should be firm, fresh, smooth, and yellow orange in colour.

- **Cauliflower**: It should be compact with no insect, fine heads, soft leaves, should not be rough, and flowers should not be spread out. Yellow flowers should not be used. The colour yellow signifies over maturity.
- **Brinjal**:Firm,bright,uniform dark rich purple or green colour, free of marks or decay, should not be wilted, flabby or soft, no bug holes.
- **Greens:**Tender, fresh dark bright green, no holes in the leaves, no wilted leaves, not with too much water, no soft portion of leaves. The leaves should be crisp, and the stems should be slender.
- **Tomatoes:**Bright red in colour, firm, should not be soft, plump body with uniform red colour, any holes, softness, black, overripe, or cracks.

ASSESS THE PROGRESS OF YOUR SESSIONS 8

1) Give any two selection standards you use while buying vegetables.

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PRACTICAL ACTIVITY 2

1) Go to a local market and describe how you plan to buy any five veggies that are high in iron and vitamin C.

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4.3.3 NUTRITIONAL CONTRIBUTION OF VEGETABLES

Due to their high mineral and vitamin content, vegetables are regarded as foods that provide protection. Green leafy vegetables, roots and tubers, and other vegetables are divided into three categories based on their nutritional value.

a) Green leafy vegetables

Green leafy vegetables are high in vitamins and minerals. They are composed of a high carotenoid content, which converts to vitamin A. They contain vitamin C. Drumstick leaves, and Spinach leaves are high in vitamin C and iron content. Fenugreek, drumstick leaves, and colocasia leaves all contribute calcium and fibre to our diet which help in preventing degenerative diseases.Greens are high in B vitamins, including riboflavin and folic acid.B-Vitamin levels decline with drying and withering.

Iron is abundant in green leafy vegetables.Iron is abundant in leaves of plants that are generally discarded, such as the beetroot and cauliflower leaves.It is necessary to understand how to include such types of leaves into your normal diet.Mint and mayalu (red bacchali) are high in iron.

Calcium is provided by Agathi, Colocasia leaves, Drumstick leaves, and Fenugreek leaves in our diet.Oxalic acid, another component of greens, limits the body's ability to absorb calcium and iron.Greens are often rich in moisture therefore they must be well preserved.

The energy content of foods is not increased by greens since they are not a rich source of proteins, lipids, or carbohydrates.

b) Roots and Tubers

- Roots and tubers provide more calories than green-leafy vegetables because they contain more carbohydrates.
- Carrots contain a high percentage of carotene;however, it is less than that found in green leafy vegetables.
- They contain a fair amount of vitamin C content.
- Calcium, iron, protein, and B-vitamins are scarce in roots and tubers.
- They contain a poor source of protein.

c) Other Vegetables

- Vitamin C is found in capsicum. Small bitter gourds are more nutrient-dense than regular ones.
- They are particularly perishable due to their high moisture content.
- They are frequently deficient in every nutrient.
- They are a good supply of vitamin C.
- They help to increase fiber intake of the diet.Iron is abundant in plantain green.

Table 4.4 Nutritive value of some common vegetables

Nutrients	**Mint**	**Amaranth**	**Spinach**	**Coriander leaves**	**Gogu**	**Drumstick Leaves**
Calories	4.8	45	26	44	56	92
Protein (g)	4.8	4	2	3.3	1.7	6.7
Calcium (mg)	200	397	73	184	172	440
Iron (mg)	5.6	3.49	1.14	1.12	2.28	0.85
Carotene (μg)	620	5520	5580	6918	2898	6780

Thiamine (mg)	0.05	0.03	0.03	0.05	0.07	0.06
Riboflavin (mg)	0.26	0.30	0.26	0.06	0.39	0.05
Vitamin C (mg)	27	99	28	135	20	220

Source: National institution of Nutrition, 2013

ASSESS THE PROGRESS OF YOUR SESSIONS 9

1) List some examples of vegetables that are an excellent source of vitamins A and C.

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4.3.4 CHANGES DURING COOKING OF VEGETABLES

The colour, flavor, and texture of vegetables are increased with cooking, which also increases their overall palatability.Digestibility is also improved. A softening of the fibre occurs.Protein coagulates and gelatinizes starch. Cooking vegetables provides variety to your diet.Microorganisms are eliminated during cooking. If the vegetables are cooked submerged in water or steam, water may be absorbed. The cooking process softens cellulose and hemicelluloses. The pectic substances go through several chemical modifications.Cooked vegetable cutting and chewing are made simpler by pectic compounds.Boiling induces the gelatinization of starch, as is the case with boiled potatoes. When potatoes are fried, dextrinization of starch occurs.Caramelization of sugar occurs when vegetables, such as onions, become scorched or burnt.During cooking, some nutrients are lost as the food is exposed to various variables.Vegetables lose nutrients beginning with their preparation and particularly when getting cooked.

- Ascorbic acid and carotene are lost during dehydration.
- The addition of soda causes a significant loss of B-vitamins during cooking.To maintain the natural colour of the veggies, keep them away from alkaline items like soda and acidic meals like tomatoes and lime juice for green leafy vegetables and green leafy vegetables respectively.
- To avoid overcooking, vegetables should only be cooked until tender-crisp.Raw veggies may be used in salads and *Raitas* to provide colour and texture to meals while also preventing nutritional loss while cooking.
- Since many vitamins, including thiamine and vitamin C, are heat-sensitive, cooking can partially destroy these nutrients.To reduce nutritional loss, cook all veggies except those with strong flavours in a closed pan.
- When using the moist heat method of cooking, the vegetables absorb water.

- Dryness is an adverse effect of dry heat techniques like baking because some water is lost.
- Water is released from the cells of high moisture plants like tomatoes and leafy greens as a result of cell breakdown.If sulphur-containing vegetables are kept uncovered for a few minutes after cooking, the development of a strong taste and discoloration of green leafy vegetables can be avoided.
- According to the variety of vegetables used, the flavour of the veggies may change throughout cooking.
- To preserve the colour, flavour, and nutrition, cook tubers and roots like potatoes, sweet potatoes, and beets with the skin on as well.
- Cook veggies as quickly as possible after they have been prepared. They should not be soaked. When cut areas are exposed, vitamin C is degraded. Water soluble vitamins B and C are lost during soaking.
- If the vegetables have been thoroughly washed, do not discard the cooking water; it can be used to make soups or gravies.

ASSESS THE PROGRESS OF YOUR SESSIONS 10

1) What is the best way to prepare greens so that their colour and nutrients are preserved?

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4.3.5 SIGNIFICANCE AND DIETARY APPLICATIONS OF VEGETABLES

One of the most important reasons to include veggies in your meal is to offer a naturally rich in vitamins, fiber, and minerals. Vegetables are essential nutrients for preventing disease and are excellent for maintaining health. They contain vital nutrients that may be used for bodybuilding and repair. Their high fiber content adds diversity to the diet, increases palatability, and prevents constipation.

4.3.6 VEGETABLE PREPARATION

Vegetables can be utilized as garnishing agents in curry dishes, salads, and sambhar, as thickening substances in gravies and soups, in chutneys (onion) and pickles (tomato, onion), in the making of recipes such as *pulao*, Avial, and non-vegetarian meals, and as preserved foods.

Vegetable preparations include filled vegetables, dried vegetables, vegetable curries, and kofta curries, as well as vegetable salad and also stuffing in *paranthas*.Various food ingredients such as pulses and cereals can be used to prepare vegetables. For example, *Chana* dhal with gourd (ghia) and dhal puri will be healthier as well as taste better as a result of this. When making sambhar, vegetables such as brinjals, drumsticks, and potatoes are cooked with arhar dhal. In addition, you may prepare veggies in a few different manners.

a) Vegetables Soups and Vegetables Juices:Vegetables add flavour and appeal to the dish. Vegetables such as drumstick, beetroot, Spinach, carrots, peas, beans, tomatoes and Cabbage can be used to produce a different variety of soups. Tomatoes, carrots, and other vegetables can be juiced. They enhance the flavour of the food. Vegetable based drinks and soups and are particularly beneficial to newborns and the elderly.

b) Vegetable based snacks: Vegetables can be used to make snacks such as cheela, pakoras, cutlets, vegetable burger, and stuffed kachories.

c) Vegetables as Desserts: Vegetables can be used to make *Kheers*, *Halwas*, and desserts.

d) Vegetables as Pickles and Chutneys: You're probably aware that greens in season are inexpensive. You may preserve them by producing pickles, chutneys, murrabas, and other condiments.

e) Salads: Salads made of vegetables are a significant way to meet some of your needs for fibre

PRACTICAL ACTIVITY 3

1) Prepare a nutritious raw snack using vegetables.

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BROWNING: Induced by the activity of enzymes, the surface of fruits and vegetables including apple, banana, potato, and brinjal develops a brown colour when they are chopped. Enzymatic browning is the name given to this process. When tissue is injured or cut and subjected to air, phenol oxidizing enzymes being generated. They interact with the polyphenols in the fruit to oxidize them into orthoquinones, which gives cut tissues their characteristic brown colour.Following techniques can be used to stop browning:

- By using heat, polyphenols become inactive by oxidation.
- Vacuum packing to remove oxygen.

- A pH changes to inhibit enzyme activity.
- Submerging veggies in salt and sugar solutions.
- Antioxidants like ascorbic acid are used to delay oxidation.

Salads can be made with both fruits and vegetables.Dietary vitamins and minerals are added by the vegetables used to make salads. Fruit salad is a vibrant, energizing, and healthy meal.Some of the fruits that may be used in a salad are pineapple, orange segments, apple and papaya cubes, grapes, bananas, sapotas, mangoes, and pomegranates.

4.4 LET US SUMMARISE

For a healthy diet and balanced diet, fruits and vegetables are necessary. In addition to giving the diet colour and diversity, they also contain significant quantities of vitamins, minerals, and carbs, including roughage (fibre). Choose fresh produce that is firm, crisp, and brightly coloured, free of evident bruising or rotting and wilting indications, when you are making your purchase. Water-soluble nutrients like thiamine, riboflavin, pantothenic acid, nicotinic acid, pyridoxine, folic acid, and vitamin C can dissolve in the cooking water and be lost while boiling vegetables. In order to reduce nutritional loss, attention must be made to adopt suitable cooking practices. The sparkling and unique colours of fruits and vegetables, which are caused by pigments present in plant cell plastids, add to their attractiveness. Cholorophyll, anthocyanins, anthoxanthins, and carotenoids are the main pigments found in fruits and vegetables. Enzymatic browning causes particular veggies and fruits cutting edges to become brown or black, this may be avoided by blanching or adding lemon juice. Eating a wide range of vegetables and fruits is an important part of a balanced diet and reduces the risk of heart disease and type 2 diabetes.

4.5 GLOSSARY

Gooseberries:Rasbari

Dates: Khajur

Figs: Anjeer

Grape-fruit: Chakotra

Grapes: Angoor

Peaches: Aarhoo

Pear: Nashpati

Sweet lime:Mausambi

Dietary fiber: The elements of plant foods which the human body is unable to absorb or digest are referred to as roughage or bulk.

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UGHN-101
FUNDAMENTALS OF FOOD & NUTRITION

BLOCK
2

INTRODUCTION OF MILK, POULTRY PRODUCTS AND FATS AND OILS

Block II: Introduction-Introduction To Milk, Poultry Products And Fats And Oils

Let's talk about milk, eggs, meat, poultry, fish, fats, and oils, which are all important foods in our diet. Each of these foods has something special to offer.

Milk and milk products like yogurt, cheese, and butter are packed with high-quality protein, calcium, and vitamins. These nutrients are essential for building strong bones and keeping our bodies healthy. When we drink milk or eat its products, we're fueling our body with energy and nutrients needed for growth and development.

Next, we have eggs, meat, poultry, and fish. These foods are excellent sources of protein, which is the building block of our muscles and tissues. They also provide healthy fats, vitamins, and minerals that support our body's functions, from maintaining strong muscles to keeping our immune system working well.

Finally, we come to fats and oils. Although fats sometimes get a bad reputation, they are important for our body. Fats give us energy, help in the production of hormones, and allow us to absorb vitamins like A, D, E, and K. Not all fats are the same, so it's important to choose healthy fats, like those found in nuts, seeds, and olive oil.

Understanding these food groups helps us make smarter choices about what to eat and how to maintain a balanced and nutritious diet.

UNIT V Milk and Milk Products

UNIT-VI Eggs, Meat, Poultry and Fish

UNIT VII Fats and Oils

UNIT V -MILK AND MILK PRODUCTS

Milk is an excellent source of minerals, vitamins, and proteins. Paneer, Khoya, cheese, curds, and other dairy products are not only simple to include in our diets but also contribute to the flavour of our food. In this section, you will learn about the nutritional makeup of milk and dairy products, methods to select and utilize them, and the changes that occur during the cooking of milk as well as milk products.

Structure

5.0 Scope
5.1 Overview
5.2 Selection of Milk and Milk Products
    5.2.1 Milk Products
5.3 Nutritional composition of Milk and Milk-Based Products
    5.3.1 Types of Processed Milk
5.4 Changes during cooking of milk and milk products
    5.4.1 Utilization of milk and milk products
5.5 LET US SUMMARISE
5.6 GLOSSARY
5.7 EXERCISES TO CHECK YOUR PROGRESS ANSWERS (Not Given)

5.0 SCOPE

You will be enabled to do the following after complete this chapter:

- To know about the selection criteria for milk and milk products.
- To learn nutritional contribution of milk and milk products;
- Changes that occur when milk and milk products are cooked

5.1 OVERVIEW

Milk has been consumed since the beginning of humanity. Even in the prehistoric period, cattle were domesticated, and milk was among the staple meals. Milk is among the most complete natural foods that are in nature for fostering development and health. You may have noticed that milk is the initial nourishment for the young of most animal species, including humans. You might be shocked to learn that a newborn can survive on only mother's milk for the first few months of its existence. No commercial milk product can ever fully replace mother's milk. All mammals produce milk after giving birth, and man consumes milk from many different species. The cow is the most prominent of these species as a food source. Additionally, milk from goats and buffalo is used.

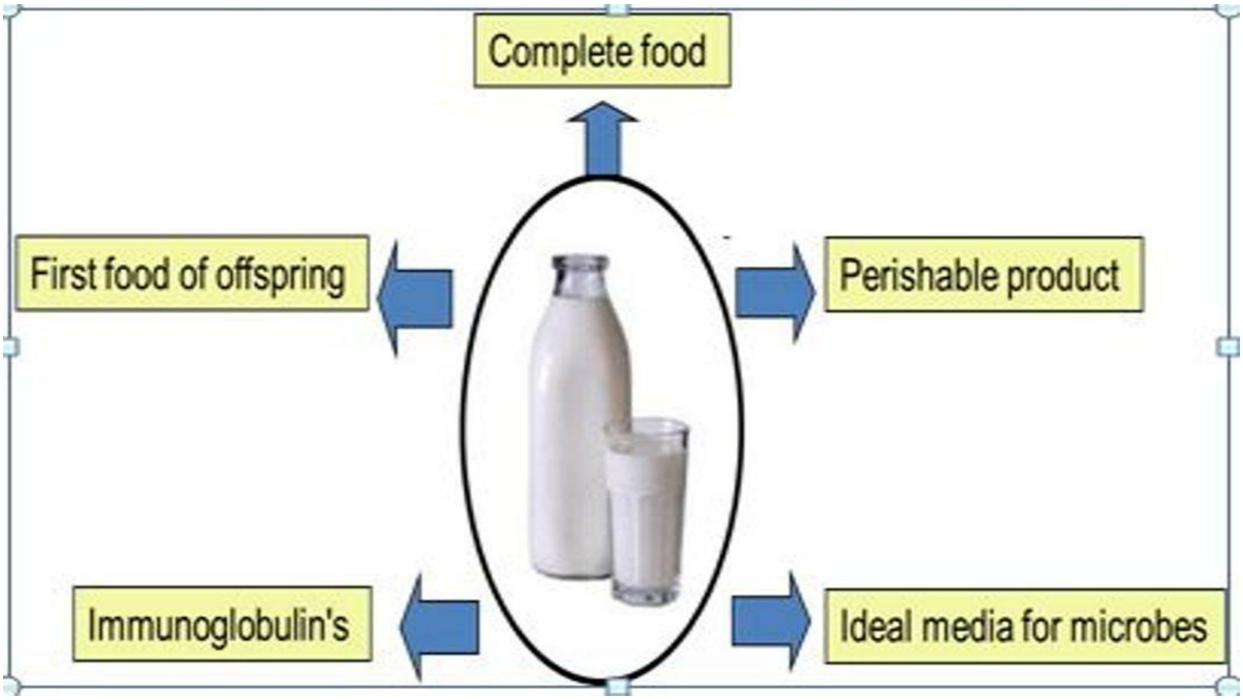

Fig 5.1 Benefits of milk

5.2SELECTION OF MILK AND MILK PRODUCTS

Government Dairies as well as milk dealers provide milk that is available to us on the market. There are two ways to get government supplies: from the booth, which is homogenized milk, or in polypacks as full cream milk. A large amount of fat that separates as *Malai* on top makes polypack milk pricey. *Malai* can be used as is or turned into butter and ghee. The fat in milk that has been homogenized is reduced to very little particles so they don't float on top of the milk. This is why homogenized milk does not contain malai. Always get your milk from an authorized vendor. Keep the following in mind while purchasing milk:

- It is better to purchase milk from government organizations since it has been pasteurized. Pasteurized milk never spoils and is always safe for consumption.

- Do not buy milk from sellers since there is a possibility that it may be contaminated. For the purpose of increasing their profits, milk retailers may add any type of water to the milk. Drinking such milk is also not very hygienic and might result in issues with your health.
- Curds are best prepared at home as they are hygienic and far less expensive than curds purchased from the market.
- Always ensure that the paneer is free of fungus and offensive aroma before purchasing. If possible, buy paneer that has been wrapped in a hygienic packaging.
- The khoya must be firm and smell well. Fresh cream should not have a sour flavour or odour.

PRACTICAL ACTIVITY 1

1) Examine the various types of milk as well as milk products on the market and observe the nutritional information given on the labels.

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ASSESS THE PROGRESS OF YOUR SESSIONS 1

1) Make a list of the associated criteria you will consider before buying the following:
   a) Paneer
   b) Khoya

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5.2.1 MILK PRODUCTS:

i) **Cream:**

Fig 5.2Cream

Cream, which comes from milk fat, is used to make desserts. A thick layer of fat from milk and a coagulated protein formed on top of large volumes of simmering milk. You may consume it whatever you choose, sugar-free or not.

ii) **Khoya:**

Fig 5.3 Khoya

Whole milk is used to make khoya by swirling it repeatedly in order to evaporate in an exposed cast iron skillet until it solidifies. This is frequently used to make Indian sweets.

iii) **Butter:**

Fig 5.4 Butter

Cream is converted into butter by churning. Butter and the milk's aqueous state separates from the cream when the fat globules in the cream are destabilized and agglomerate. The butter is taken out and cleaned. Numerous Indian recipes call for the use of butter as a cooking medium. It is a key component in bread, icing, cakes, and biscuits.

iv) **Ghee:** Butter oil is ghee. It is made by heating butter until the moisture is removed, then melting butter. It is used to make Indian sweets, savoury dishes, curries, and several kinds of rice, including pulav and biryani.

v) **Paneer and Cheese:**

Fig 5.5 Paneer and Cheese

You have seen that when milk is heated with a little lemon juice or tartar added, the milk's particles separate into lumps and a thin liquid is left behind. Cottage cheese, or paneer, is this lumpy solid mass that contains all the proteins, fats, and vitamin A found in milk. Whey is the liquid that is left over after paneer has been separated. It includes beneficial vitamins and minerals including calcium, phosphorus, and B-complex vitamins. Therefore, it is not advisable to discard this priceless liquid. It is simple to include into breads, curries, beans, and other dishes. You can also provide this drink to a family member's child who may be experiencing diarrhoea.The produced paneer can be ripened further to produce several types of cheese. This is accomplished by introducing various microorganisms under various circumstances; the resulting cheese has a strong taste and is far more costly than paneer. Under several brand names, it is offered in tiny cubes and tins.

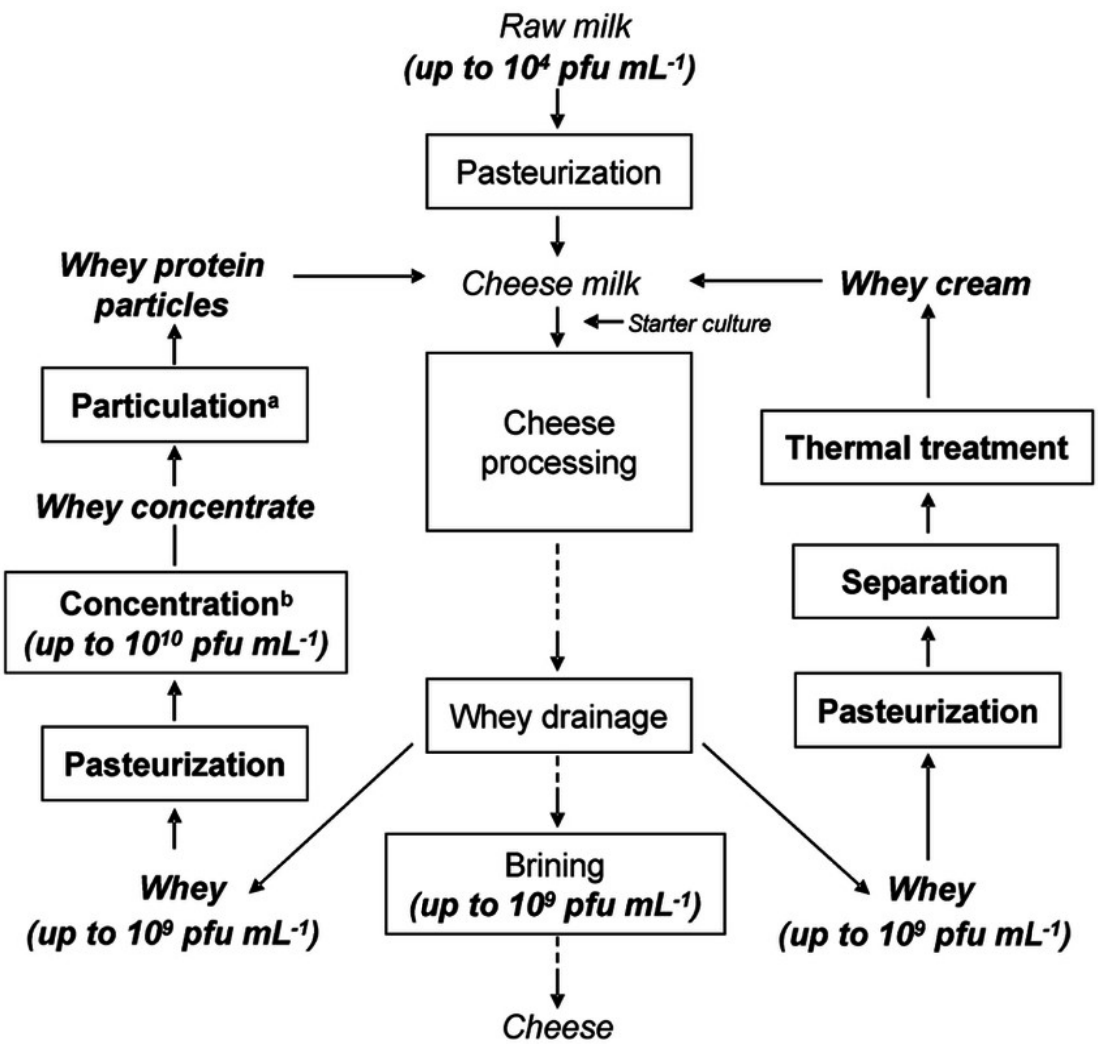

Fig 5.6 The production of Cheese

(Source: Atamer*et al.*, 2012)

vi) **Curd:** It is a vital product made from milk. You must mix a small amount of curd with warm milk and let it rest for five to six hours in order to make curd. What happens when a little curd is added to milk? Certain bacteria in the curd convert lactose into lactic acid, turning milk into curds as a result. The solid curd and sour flavour are a result of the lactic acid generated. We need milk that is just right for creating curds—not too hot or too cold. This explains why it's challenging for you to manufacture curds in the winter. To get around this, we need to flip a big pan over it to keep it warm. The nutritional content of milk and curd is similar. As a result, some people who cannot drink milk can accept it when it is in the form of curds. Curd is preferable to milk because it is more readily digested, particularly in diseases like diarrhea and dysentery.

vii) **Yoghurt:**

Fig 5.7 Yoghurt

This is a milk product that has been coagulated and has a curd-like texture. It has a little acidic flavour and is created with whole or partly skim milk. Pasteurized milk is combined with a mixture of Streptococcus thermophilus, Lactobacillus bulgaricus, and Lactobacillus acidophilus to make yoghurt, which is then incubated at 42°C to 46°C.

Fig 5.8 Milk based Products (source:https://www.thecompletenatural.ie/real-talk/nutrients-in-milk-dairy-products**)**

viii) **Ice Cream:**

Fig 5.9 Ice cream

Whole milk, skim milk, cream, butter, condensed milk products, or dry milk products are all included in this frozen dairy product. About 60% of the total solids in ice cream are made up of nonfat milk solids and milk fat. These ingredients increase the body, texture, and richness of ice cream. Ice cream also includes dairy products, sugar, an emulsifier, a stabilizer, flavouring, water, and air.

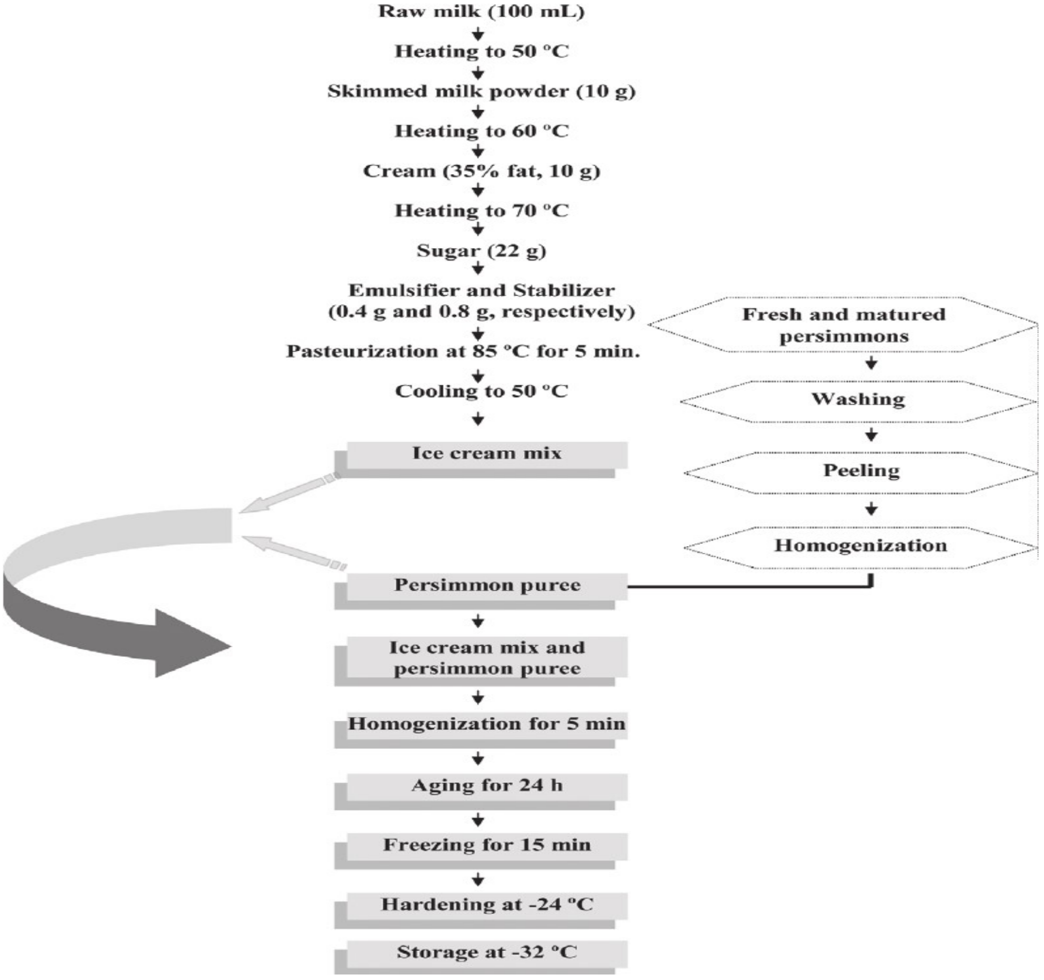

Fig 5.10 Manufacture of Ice cream

(Source: Karaman S., et al., 2013)

PHYSICAL ACTIVITY 2

1) Make a poster highlighting the value of milk consumption.

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PHYSICAL ACTIVITY 3

1) Make a meal with cheese and khoya that you will eat.

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PHYSICAL ACTIVITY 4

1) Make a flowchart showing how ice cream is made.

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ASSESS THE PROGRESS OF YOUR SESSIONS 2

1) Name four examples of milk products that are popular in India.

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2) How would you characterize Yoghurt?

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5.3. NUTRITIONAL COMPOSITION OF MILK AND MILK-BASED PRODUCTS

A Complex combination of lipids, carbohydrates, proteins, and several other organic and inorganic substances that have been dissolved in milk. Fat, followed by protein, is the milk component that varies the most. Milk composition varies according to species, breed, food, lactation time, and milking interval. There is also individual variance.

- **Milk fat:**

The fat content of buffalo milk contains 6.5 per cent. Cow's milk has 4.1 percent fat. Milk fat or butter fat has a high nutritional and economic value. Milk fat is responsible for its taste. Milk is an oil-in-water emulsion. Milk fat is a complex combination of glycerides. Milk includes a high concentration of short chain fatty acids, which contribute to its distinct taste and off flavour. They provide butter with a soft, firm consistency because of their low melting point of -10 to 12^{o}C. Phospholipids, sterols, free fatty acids, carotenoids, and vitamins that are fat-soluble are also present in milk. The colouring that gives milk fat its yellow hue is carotenes. Strong smells should never be present around milk, butter, or cream. Milk fat is easily digested. It has 2.1 per cent linoleic acid, 0.5 percent linolenic acid, and 0.14 percent arachidonic acid. There is no fat in skimmed milk. Buffalo milk has a high fat content.

- **Milk proteins:**

Milk has a high biological value and high-quality protein.Lysine is an important amino acid found in high concentrations in milk proteins.Cheese, khoya, and dried milk powders are concentrated forms with a high nutritional density per unit.

Casein accounts for 80% of the nitrogen in milk. It forms during the process of acidifying milk to pH 4.6 at 20°C. Lactoglobulin and lactalbumin make up the remaining whey protein. Proteoses, peptones, and milk enzymes are all found in milk protein. Casein is a phosphoprotein due to the presence of phosphoric acid in its molecular structure. Casein contains a considerable amount of essential amino acids. Casein has a calcium content of 8.2 per cent and a carbohydrate content of 5.7 percent. Since it is a significant source of high-quality protein, it is a crucial food for young children and infants. It is the primary source of animal protein for vegetarians.

- **Minerals**

Calcium, phosphorus, salt, and potassium are key minerals found in milk. Calcium is required for the action of rennin to produce curd from milk. Because of the high mineral content, dairy products contain a good amount of calcium. The calcium-phosphorus ratio (1.2:1) in milk is thought to be optimal for bone growth. Additionally, dairy products contain nutrients as vitamin D as well as lactose that help the body absorb calcium. The calcium need cannot be readily reached without the consumption of milk. Milk is deficient in iron content. However, any iron that is present is used by the body. Khoya includes more iron since it is extracted from containers during the making process.

- **Enzymes**

Milk enzymes that are relevant to food scientists are alkaline phosphatase, lipase, and xanthine oxidase.

- **Vitamins**

Both fat-soluble and water-soluble vitamins are frequently found in milk. Milk has a relatively modest quantity of niacin and ascorbic acid. Milk contains just a good quantity of thiamine, which is present in generally stationary amounts. Milk is a reliable source of riboflavin since it contains higher levels of it compared to the other B vitamins and is resistant to heat. Riboflavin is found in whey water during the cheese making process. Because it is light sensitive, milk loses 50 per cent of its riboflavin when exposed to sunlight.

- **Carbohydrate:**

Milk is the single food that includes lactose, which contains galactose, which is required for the production of the myelin sheath. Lactose, since it is not easily soluble, promotes the formation of lactic acid bacilli in the colon, lowering pH. This decrease in pH promotes calcium absorption. Lactose also enhances calcium ion permeability in the small intestine. Milk sugar is recommended as a carbohydrate source due to its regulated glycemic effect. Lactose sugar is the main carbohydrate found in milk. The infant can digest it without difficulty.

Milk has a lot of tryptophan but just a small amount of niacin. Milk has relatively little vitamin C. Vitamin A and D content are influenced by the animal's diet.

Assess the progress of Your Sessions 3

Table 5.1 Nutritive value of milk

Constituents	Unit	Cow Milk	Buffalo Milk	Goat Milk	Sheep Milk
Water	g	87.8	81.1	88.9	83
Protein	g	3.2	4.5	3.1	5.4
Fat	g	3.9	8	3.5	6
Carbohydrate	g	4.8	4.9	4.4	5.1
Energy	kcal	66	110	60	95
	kJ	275	463	253	396
Sugars (Lactose)	g	4.8	4.9	4.4	5.1
Fatty Acids					
Saturated	g	2.4	4.2	2.3	3.8
Monounsaturated	g	1.1	1.7	0.8	1.5
Polyunsaturated	g	0.1	0.2	0.1	0.3
Cholesterol	mg	14	8	10	11
Calcium	IU	120	195	100	170

Source: International Laboratory Services.

Source: *Dai li and PenguZhou , 2016*

ASSESS THE PROGRESS OF YOUR SESSIONS 3

1) In terms of nutrition, what function do milk and milk products play in the diet?

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2) List the five important nutrients found in milk.

a) ____________

b) ____________

c) ____________

d) ____________

e) ____________

5.3.1 TYPES OF PROCESSED MILK

Skim milk: The Whole milk is converted to skim milk by having the cream separator remove the fat.The percentage of fat is typically between 0.05 and 0.2. Fat-soluble vitamins like Vitamin A and Vitamin D are also decreased when fat is removed from milk, in addition to taste and flavour. Inorder to make milk more nutrient-dense, these vitamins are added during fortification. Raw milk is used to make the following types of milk. A low-calorie diet and youngsters that require high protein levels utilize skim milk.

Dry milk: Dry milk can be made from whole or skim milk; milk powder can be dehydrated to about 97% by spray drying and vacuum drying; it can be reconstituted into fluid milk; and it has a good shelf life without refrigeration. Whole milk powder can only be stored for six months due to the tendency of the fat to oxidize.

Toned milk: In order to make toned milk, skim milk powder is reconstituted with milk.Skimmed milk is produced by removing milk fat in a cream separator. After mechanically drying, skim milk is produced as powder. It is combined with buffalo milk, which has 7% fat.Toned milk should have a 3 percent fat content.

Standardized Milk: Standardized milk contains fat 4.5 percent and solid non-fat 8.5 percent. It is made using a combination of skim milk and buffalo milk.

Homogenized Milk: The mechanical process of homogenization involves pushing milk through tiny openings at high pressure and speed to minimize fat globules size. Fat globules size after milk has been homogenized will typically be 2 micrometers. The quantity and fat globule surface area rise as their size decreases. The freshly generated fat droplets stabilize the milk emulsion and stop the cream from rising by stabilizing the milk emulsion. The texture, flavour, and colour of homogenized milk are all whiter and creamier.

Evaporated Milk: More than half of the water in milk is evaporated under vacuum, between 74 and 77 degrees Celsius, to create it. Following homogenization, it is fortified to vitamin D and packed into cans.

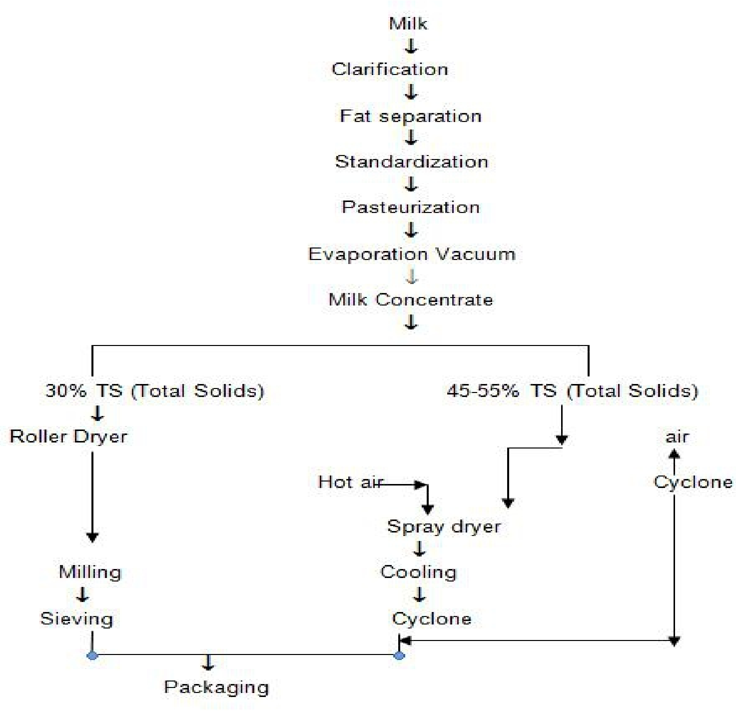

Fig 5.11 Manufacture of milk powder (Source: B. Srilakshmi, 2010)

ASSESS THE PROGRESS OF YOUR SESSIONS4

1) What is the importance of skim milk?

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2) Define Toned milk and Dry milk.

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PASTEURISATION OF MILK:

Pasteurisation was named after the French scientist Louis Pasteur, who found that heating some liquids to a high level of temperature increased their storage quality. In general, it is the heating of milk to a temperature that eliminates the organisms responsible for TB and fever, as well as practically all of the other microbes found in that product, without significantly changing its composition or qualities. Following pasteurization, the product should be immediately cooled to a temperature low enough to prevent the growth of microorganisms resistant to the temperature used. Pasteurisation is now regarded to be a crucial aspect in the production of butter, ice cream, and cheese. Pasteurisation also inactivates several natural enzymes, such as lipase.

Nowadays, three general approaches are in use.

a) **Holding method or Batch process:**The holding procedure involves heating the milk or cream to a temperature of around 65°C and keeping it there for at least 30 minutes before rapidly cooling it. A greater temperature is occasionally employed, in which case the holding period is reduced. For instance, hold at 68.3ºC for 20 minutes. Temperature and heating time must be carefully controlled.
b) **High temperature short time method or continuous process (HTST):**The system is known as a "continuous flow or flash pasteuriser" because the machines are built in a way that allows for continuous operation. The technology requires that the milk be heated to at least 72ºC for 15 seconds while it is being processed through the machine. Immediately after that, cooling occurs. The cream line is unaffected and no cooked flavour is imparted by this technique.
c) **Ultra-High temperature method:**The UHTS technology causes milk to be completely pasteurized. Milk is kept in this method for 3 seconds at 93.4ºC or for 1 second at 149ºC. In the dairy industry, this technique is also often used to process milk or cream. When compared to

milk pasteurized using other methods, this product has a longer shelf life. Following pasteurization, the milk is quickly cooled to 7ºC or less.

After the heat treatment described above, milk should be quickly chilled to stop the growth of any remaining germs. The nutritious content of milk is not changed after pasteurization. No undesirable cooked flavour results from it. Pathogens that are harmful, notably TB bacteria, are eliminated. The overall bacterial count has significantly decreased, lengthening the shelf life of milk.

ASSESS THE PROGRESS OF YOUR SESSIONS 5

1) Why is milk pasteurized?

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5.4 CHANGES DURING COOKING OF MILK AND MILK PRODUCTS

- **Protein**

Lactalbumin and lactoglobulin become insoluble or precipitate when heated. At a temperature of 66°C, lactalbumin starts to coagulate. With higher heating temperatures and longer heating times, the amount of coagulum increases. The coagulum that develops gathers on the bottom of the pan in which the milk is heated and appears as little particles rather than a hard mass. Casein, the most abundant protein in milk, does not coagulate at the temperatures and times used for food preparation. Casein coagulates at l00°C for 12 hours, 135°C for one hour, or 155°C for three minutes. Casein is heat resistant because it is combined with certain quantities of calcium, magnesium, phosphorus, and citrate in milk. When the concentration of casein is raised above that of the normal fluid milk, the heating times that cause casein coagulation are reduced. For instance, it is required to take certain precautions to prevent casein coagulation while sterilizing canned evaporated milk. One such step is to pre-warm the milk before sterilizing it. When milk is heated, albumin congeals as a precipitate that drops on the container's sides. The coagulation of milk proteins by heat is enhanced by an increase in acidity. Additionally, the type and quantity of salts present have an impact. Heat accelerates the response of salts and tannins on casein coagulation.

- **Fat**

When milk is boiled, the proteins that cover the fat globules in the unheated mille are broken, which causes a coating of fat to occasionally develop on the surface. The coalescence of fat globules is made possible by the shattering of emulsifying agent film layers.

- **Sugar-protein mixtures**

Milk that has evaporated observes Maillard type nonenzymatic browning. Maillard (1912) was the first to explain how combinations with reducing sugars and amino acids developed a brown colour. Lysine has the greatest impact, followed by tryptophan and arginine. Lysine has a stronger reaction to glucose than fructose or lactose, while tryptophan and lactose interact most fast. The processes of the Maillard reaction, which involves reducing carbohydrates and proteins or amino acids, are as follows:

a) Condensation of an amino group with an aldehyde or ketone group
b) Organizing condensation by-products
c) The rearranged products are dehydrated
d) Additional degradation
e) polymerization to create dark pigments

Because it lacks a reactive group, sucrose is inactive, but its hydrolytic byproducts, such as glucose and fructose, do interact with amino acids. Proline can cause a response that might have an unpleasant taste. The rate of browning accelerates with rising temperature. Products made from concentrated milk, such as evaporated milk and sweetened condensed milk, have high quantities of lactose sugar and protein and become black when heated. Dried milk that has been stored for a long period may also experience this response.

- **Acid**

Whenever milk undergoes heating, the acidity drops first owing to the discharge of soluble carbon dioxide and then rises due to the precipitation of hydrogen ions as calcium and phosphate combine to create insoluble compounds. Significant pH changes while heating are avoided by balancing these conflicting factors.

- **Minerals**

Iodine is a volatile chemical that evaporates from milk when heated. Heating reduces the dispersion of calcium phosphate in milk, and some of it precipitates. Most of it forms albumin coagulum in the bottom of the pan, and some of it is probably entangled in the scum on the milk's surface.

- **Colour, flavour and digestibility:**

Milk is pasteurized, however this has no major impact on the taste or look of the milk. The cooked flavour of boiling milk is caused by the loss of dissolved gasses such as carbon dioxide and oxygen, as well as changes in protein. Digestibility may be improved slightly. In comparison to raw milk, heated milk produces smaller and tenderer curds in the stomach.

5.4.1 UTILIZATION OF MILK AND MILK PRODUCTS:

- Curds can be consumed on their own or in combination with other dishes. Add greens like cucumber, carrot, mint, coriander etc. or pulses like pa*k*ori or *vadas* to turn it into *Raitas*. You may also enjoy sweet *Raitas* by combining curds with sugar and fruits like bananas, mangos, etc. Curds are also used to make Shrikand. Curds may be made into *lassi* by adding water, which is delicious in the heat.
- It adds to the nutritional content of the diet, for example, shakes, normal milk, flavoured milk, and cheese sandwiches.
- Milk enhances the flavour and taste of a food, such as payasam, coffee or tea.
- It functions as a thickening agent in conjunction via starch, as in white sauce or creamy soup.
- Desserts like fruit cream, custard and ice cream also include milk as an ingredient.
- Khoya acts as a binding agent in dishes such as carrot halwa.
- As a garnish, cheese is used.
- A popular beverage for quenching thirst is salted butter milk.

ASSESS THE PROGRESS OF YOUR SESSIONS 6

1) Identify two cooking techniques that involve milk or milk products.

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PRACTICAL ACTIVITY 5

1) Students come up with a list of ten foods that contain milk.

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5.5 LET US SUMMARISE

In addition to being excellent sources of animal proteins, milk and dairy products also give the body the essential amino acids it needs to support healthy body growth and maintenance. In addition to improving the capacity of the animals most suitable to serve as his milk sources to produce more milk, man has perfected the skill of using milk and milk products as nourishment for his well-being. The cow is the primary producer of milk for human consumption in many parts of the world; other animals that offer milk to humans include the buffalo, goat, sheep, camel, and mare. In India, the buffalo produces more milk than the cow. Goat milk is also used in modest amounts. Milk, a multi-nutrient beverage, contains protein, fat, carbohydrates, vitamins, and minerals. The main protein contained in milk is casein.

5.6 GLOSSARY

Homogenized: High pressure is applied to milk to break down the fat into extremely tiny particles.
Malai: The tiny size of the particles prevents them from rising to the top of the milk as *malai*.
Curd: The method of sequentially coagulating milk to produce curd is known as curdling.
Yoghurt: Yoghurt is a manufactured food that may have been sweetened.
Paneer:A form of curdled milk cheese utilized in Afghan, Iranian, and Indian cuisine.
Khoya:A common dairy ingredient in many recipes

UNIT-VI- EGGS, MEAT, POULTRY AND FISH

Eggs, meat, poultry, and fish are not nutritional necessities, although they serve as an excellent supply of nutrition. In this unit, you will learn about their nutritional significance, the varieties that are accessible on the market, how to choose them, in addition to the various ways that they may be included into our regular meals.

Structure

6.0 SCOPE

The aim of the course is to learn the following:

- Understand the Selection criteria of eggs, meat, poultry and fish
- Purchase excellent quality eggs and flesh foods from the market and list the many possible uses of eggs and flesh foods in the making of different dishes.
- To know about the role of eggs, meat, poultry and fish in our diet; and
- To understand about the changes that occur when eggs, meat, poultry, and fish are cooked

6.1 OVERVIEW

We will study the usage of eggs, which is comparable to that of milk, in this unit. To properly understand the significance of eggs in the diet, it is necessary to know their genuine nature. Although eggs are occasionally selected for use at home, hen eggs are the most commonly consumed, hence this section focuses on hen eggs. An egg of hen is similar to an undeveloped chicken since it has all of the necessary nutrients required to build the chick's body and give it the energy it requires to traverse the outside world.

Following that, let's go deep into the poultry used in restaurants. The poultry refers to tamed birds which have been brought under man's control for two reasons: the eggs that they ought to develop and the flesh meal that they offer. Most popular domestic fowl species are considered poultry, including chickens, ducks, geese, turkeys, guinea fowls, and pigeons. But only if they are raised for at least one of the two aforementioned goals are any of these species considered to fall under this category. Poultry, as used in this the Section, refers to all kinds of native birds slain for their meat to be cooked and consumed by humans. Poultry is unlikely to be a need in the average diet, and when costs are high, it is clearly a luxury. But it makes a big difference in offering that "a thing different from the normal" for special occasions and breaking up the repetitive process of traditional animal protein dishes. This chapter will instruct students on how to use poultry and game birds in restaurant cuisine.

We will learn about meat in the final portion of the unit. Meat is composed of tissue from muscles. It is produced from the meat of both animals that are domesticated (like pigs, cattle, and sheep) and wild hunting animals (e.g. deer). As a culinary professional, the chef, or supervisor of a catering business, meat will take up more of your time and money than another kind of dish. Therefore, if you want to cook meat properly and effectively, it is essential to have a thorough understanding of them.

PHYSICAL ACTIVITY 1

1) Design and prepare two snacks that are healthy for students by utilizing eggs.

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6.2 EGG

As you learned in Unit 1, eggs and flesh items such as meat, fish, and so on are high in protein and belong to the fundamental food category. As a result, they are a vital element of the diet. Eggs are extremely healthy due to their high protein, mineral, and vitamin content. Eggs are a high-protein component in human beings' meals. By itself, an egg is a great and complete food. All types of birds' eggs are edible, however in India, hen and duck eggs are mostly used for human consumption. Due to the presence of essential amino acids that are significant, it is the perfect preventive food. So, the reference protein is known as egg protein. Lysine and methionine are mostly missing in our Indian diets. Egg is a dietary supplement since it is a rich source of these amino acids. An egg is made to provide food and shelter to a growing chick. Therefore, it is a very nourishing meal. The shell, the white, and the egg yolk are its three essential components.

Table 6.1Distribution of egg components as a percentage (g)

Part	Weight
Shell	8-11
White	56-61
Yolk	27-32

Egg rewards are determined by size rather than flavour because all eggs have the same flavour. Winter-reared eggs are said to be superior to summer-reared eggs.An inner and outer membrane located inside the shell also serves to preserve the egg's quality. Both membranes are permeable and made up of fibres. The broader outer membrane (48µm) than the thinner inner membrane (22 µm) is securely linked to the shell. The outside membrane has six layers of fibres, whereas the inner membrane has three. The inner membrane is linked to the outer membrane, and the two membranes are loosely tethered to one another, generally towards the egg's wide end. Protein and carbohydrate make up the membranes.

The egg's white is made up of three layers, with two thin portions enclosing a thick area. Some chickens excrete more thick to thin white in comparison to other hens. The thickness of albumin and the ratio of thick to thin egg white are also affected by storage conditions.

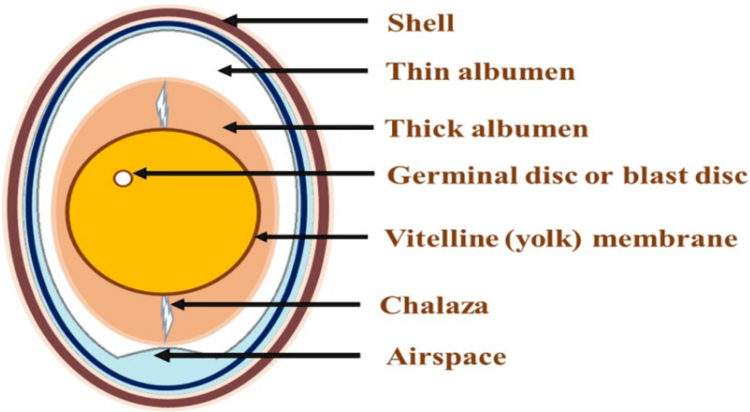

Fig 6.1Structure of the Egg

The yolk of the egg is encased in a sac known as the vitelline membrane. Chalaziferous, or the inner layer of solid white, lies next to the vitelline membrane, the thin membrane that encloses the egg yolk. This chalaziferous layer, which penetrates the chalazae, strengthens the vitelline membrane.The chalazae are two tiny, twisted strands of thickened white that are attached to either end of the yolk and serve to secure the yolks in the egg's middle. Ovomucin and chalazae appear to have very identical molecular structures. The female reproductive nucleus in infertile eggs is not fertilized by association with cock sperm. Because they are incapable of generating chicks, they are referred to as lifeless or vegetarian eggs. When a male bird is not maintained with the laying hens, infertile eggs are generated.

The market offers eggs in the following ways:

a) Brown eggs: A large number of consumers prefer to purchase eggs with a dark shell and will even spend more on products as their value is likely to be healthier, tastier, or most authentic. The egg's flavor, purity, or nutritional content are unrelated to the shell color, which is determined by the breed of hen.

b) Fresh eggs or shell eggs: These are the major topic of this section and are most frequently utilized in morning cooking.

c) Frozen eggs: The majority of the time, frozen eggs are produced from premium fresh eggs and are fantastic in baked goods, omelets, French toast, and scrambled eggs. They are pasteurized. These defrost at refrigerator temperatures over the course of at least two days. The entire eggs, Whites, Yolks, and whole eggs that contain extra yolks are types of frozen eggs.

d) Dried Eggs: Bake is the most common use for dried eggs. These shouldn't be suggested for use during the preparation of a morning meal. Dried eggs must be kept chilled or frozen, properly wrapped, as opposed to the majority of dehydrated items, which are shelf-stable. It can be whole eggs, yolks, and whites.

6.2.1 SELECTION OF EGGS

The selection of eggs can be based on the following parameters.

- Buy only what you need to last one or two weeks.
- Always buy eggs from a reputable store, *Grahak Sangh*, or a government cooperative group.
- Purchase farm organic or refrigerated eggs.
- An egg typically weighs between 52 and 55 g. Every egg's thickness is inversely proportional with their dimensions.
- The shell should be clean and not cracked.
- There is a little air cell in fresh eggs. This may be assessed by holding the egg up to the light.
- When held up to the light, the yolk ought to appear in the middle with no dark spots.
- The quality of the eggs is not affected by colour, which might be either brown or white.
- When submerged in water, a high-quality egg will sink. Because of the expanded air cell and moisture loss, low-quality eggs will float.
- When an egg is broken in a dish, it will stand up in a spherical shape, similar to a hard round yolk. A stale egg has a propensity to spread across the plate, and it is often impossible to separate the egg white from the yolk (yellow component of the egg).

PRACTICAL ACTIVITY 2

1) Using a few quick tests you can perform at home, you can determine the grade of an egg.

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ASSESS THE PROGRESS OF YOUR SESSIONS 1

1) Make an outline with the factors you'll take into account when buying eggs.

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- **EGG QUALITIES INCLUDES:**

The proteins in eggs have three major characteristics that make them suitable for so many various cooking applications.

1. When heated, egg proteins coagulate.
2. When beaten, egg proteins expand and maintain air within the structure.
3. Proteins in egg yolks work well as emulsifiers.

Table 6.2 Characteristics of fresh and deteriorated eggs

Characteristics	**Fresh egg**	**Deteriorated egg**
Consistency of egg white	Firm and viscous	Thin and runny
Position of the yolk	Center of the white	Yplk moves towards the shell
Air cell	small	Large
Chalazae	strong	Weakens
Vitelline membrane	Intact and strong	Weak, Ruptures-white mixes with the yolk

6.2.2 NUTRITIONAL COMPOSITION OF EGGS

Eggs are inexpensive and packed with many of the vital nutrients. Except for ascorbic acid, eggs are a good source of all nutrients. Table 6.3 shows the nutritional value of eggs.

Protein:

Eggs contain 12-14 per cent proteins that are well balanced in terms of all necessary amino acids. As a result, it serves as a standard for the chemical score of other proteins.Nearly 25% of an adult man's daily protein needs are covered by the contents of two eggs. Aside from egg proteins, all other plant protein diets provide a high supplemental value. Cereal proteins, for example, are low in the amino acid lysine. The sulphur-containing amino acid cysteine is deficient in pulses and oilseed proteins. As a result, combining an egg with any cereal or cereal pulse combination will improve the protein content of the dish.Among the proteins found in many foods, egg protein has the highest biological value i.e 96.

Fat:

Egg represents one of the most abundant supplies of lecithin, a phospholipid that is found in the construction of every cell wall in the body. Aside from providing energy, it also contains important fatty acids such as linoleic acid and arachidonic fatty acids. The yolk contains vitamins A, D, and E, and egg fat serves as a carrier for these fat-soluble vitamins. Because egg fat is highly emulsified, it is easily digested and absorbed.

Each egg contains around 250 mg of cholesterol, and the daily limit is 300 mg of cholesterol. Normal people can consume between three and four eggs each week without ill effect.

Minerals and Vitamins:

The percentage of minerals in an egg is strongly correlated with the mineral composition of the hen's diet. The egg's calcium content is highest in the shell, where it is also concentrated. The egg contains significant minerals including phosphorus, iron, zinc, and other trace components. Zinc that is physiologically accessible is abundant in eggs. Conalbumin-bound egg iron is ineffectively absorbed by men.

The egg contains significant levels of both water-soluble and fat-soluble vitamins, with the exception of vitamin C, which is completely lacking.

Vitamins A, riboflavin, folic acid, and B12 are especially abundant in eggs. The amount of each of these vitamins in an egg depends on the amount of these elements in the bird's nutrition.

The egg white's constitution is very different compared to the yolk's. Yolk which has a low percentage of fluid (49.5%) as well as a high percentage of egg lipid (33.3%), the white has a large amount of water (87%) and zero fat.

The yolk contains fat, soluble in water, mineral compounds, and nutrients that are fat-soluble, while the white contains albumin proteins. With a 13.3% protein content and excellent quality that includes all of the key amino acids needed by humans, the eggs are particularly crucial during childhood, teenage years, gestation, and nursing.

By changing the hen's diet, one may alter the nutritional value of the egg. Although it is difficult to significantly alter the protein level, adding liquid oils to the hens' food can raise the egg's fat content. The vitamin D content of the egg is increased by either exposing the birds to sunlight or adding vitamin D to their meal. Egg production is reduced in hens who are vitamin D deficient. By adding fish oil to the food of the hens, even the cholesterol level of egg yolks may be decreased. Comparing infertile and fertilized eggs, there is no discernible difference in nutritional content.

Table 6.3 Nutritive Value of Egg

Nutrients	Whole Egg	Egg white	Egg Yolk
Energy (Kcal)	149	50	358
Water (%)	75.33	87.81	48.81
Protein (g)	12.49	10.52	16.76
Fat (g)	10.02	0	30.87
Cholesterol (mg)	425	-	1.3
Carbohydrate (g)	1.22	1.03	1.78
Vitamin A, IU	635	-	1.95
Riboflavin (mg)	0.508	0.452	0.639
Calcium (mg)	49	6	137
Phosphorus (mg)	178	13	488

Source: Britannica 2000

6.2.3 PIGMENT

Shell: In almost all of breeds, the shell is white in hue. According on the breed, it can be in various colours of brown. The Quality or nutritional value is not determined by colour.

Egg white: Egg white includes trace levels of ovoflavin, which gives it a greenish tint. The more riboflavin there is in the egg white, the greener the colouring.

Egg Yolk: A number of factors, including the kind and quantity of pigment contained in the hen's diet, the colour of the egg yolk can range from a pale yellow to a vivid orange. Xanthophylls and carotenoids are what give the colour. The body may turn the carotenoids into vitamin A. The majority of yolks with a deep tint are high in vitamin A. The yellow coloration is caused by xanthophylls, which are not converted into vitamin A. The yolk may be rich in vitamin A but may not be coloured if the hen is fed only pure vitamin A.

6.2.4 HEALTH BENEFITS OF EGG

Eggs are a fantastic and fairly priced source of protein with excellent biological value. Several different kinds of plant protein diets benefit greatly from the inclusion of the proteins contained in eggs. Therefore, adding eggs to any grain or grain-pulse combo will raise the dish's protein level. Additionally, these substances are rich in riboflavin, the A, D, and E vitamins. The yolk of an egg is rich in iron and beta-carotene. Lecithin, a phospholipid present in all of the body's cell walls, may be found in eggs, one of the finest food resources for it. Important fatty acids like linoleic acid and arachidonic acid are also found in eggs.

ASSESS THE PROGRESS OF YOUR SESSIONS 2

1) Egg provides significant amounts of certain nutrients, as follows:
   a) ______________
   b) ______________
   c) ______________
   d) ______________
2) Write about the nutritional importance of egg.

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6.2.5 CHANGES DURING COOKING EGG

Egg boiling has little to no impact on the nutritional content of the protein, minerals, or fat-soluble vitamins, with the exception of a little reduction in thiamine and riboflavin. The retention of thiamine and riboflavin in hard-cooked, fried, poached, and scrambled eggs is more than 85 percent. As avidin is denatured by heating egg white, biotin availability is improved.

Temperature and Time Effects: When cooking eggs, it is necessary to maintain the ambient temperature down or the duration of cooking shorter. Heated eggs with excessive temperatures or over prolonged periods of duration degrades their appearance, taste, even colour. Overheated proteins become hard and sticky, and reduce due to water loss, that's why overcooked egg scrambles seem curled and seem hard and stretchy.

Temperatures of Coagulation: Egg whites and yolks coagulate at various degrees. Around 60°C is when egg whites start to coagulate; they are completely coagulated between 165°C and 70°C. Temperatures ranging from 62°C to 70°C are necessary for the egg yolks to begin coagulating. Because of this contrast, eggs may be cooked so that the whites become firm while the yolks stay soft. An egg can be cooked for an hour at 142°F (61°C) and still have a soft yolk. Furthermore, eggs that have been beaten coagulate at a little more elevated temperature (about 69°C).

Colour Variations: Unwanted colour changes in eggs might occur during processing. The sulphur with the egg white may combine to iron from the yolk, boiling fluid, or different iron elements to create ferrous sulphide, an algae-like substance with a unique smell as well as fragrance, when eggs are excessively cooked or subjected to heat to extreme temperatures. Utilize high-quality cooking utensils, cook meals at moderate temperatures to minimize excessive cooking, quickly cool hard-cooked eggs in chilled water, and serve food right away to prevent green yolk issues. The modest browning of cooked eggs brought on through the Maillard process, as the egg proteins interact with the quite a limited carbohydrates in the egg, is a different one, more difficult to avoid, change.

6.2.6 UTILIZATION OF EGGS IN COOKING

In the kitchen, eggs may be utilized in a variety of ways. When eaten purely or in conjunction alongside other meals, eggs constitute the primary source of animal protein in a plate of food. Boiling, scrambling, frying (omelettes), or poaching eggs are all options. Eggs are frequently baked and fried using dry heat. Fried eggs are commonly served in the form of scrambled eggs and omelettes. Baked egg dishes include shirred eggs, the meringues (that is, spongy and hard), and soufflés. When cooking eggs, using a frying pan, a sauté pan (Omelets pan), or maybe a pancake. Eggs are best cooked in cast iron pans that have been primed or seasoned. Preparation is accomplished by scraping a tiny amount of vegetable oil into a clean frying pan and heating it on medium, then briefly raising to high. By cleaning the frying pan with detergent or cooking anything other than eggs in it, the coated top is eliminated. Nonstick pans require no seasoning or preparation. Frying is used in the preparation of fries and eggs that have been scrambled, as well as omeletes.

Eggs can be used for:

- Diced eggs that have been hard-boiled are used to decorate meals like biryani.
- Eggs generate elastic sheets that may trap air when they are pounded. While baking, this air increases, resulting in an airy soft product. Cakes, foamy omelettes, soufflés, and meringue may all be made with them.
- In culinary combinations, eggs can be utilized to taste and colour foods like pastries and desserts such as pudding
- It's advantageous to add an egg to clear soups. The albumin coagulates and moves suspended particles when a minute bit of egg white is cooked and poured to the watery soup. It turns into a clear soup after given time to settle.
- Egg proteins aid to maintain the structure of the products that they are found in by coagulating between 65 and 70°C. You may use them to make samosa, toasted bread, and mango fritters.

- Because the proteins in eggs aggregate when cooked, they may be used to thicken stirred and bake desserts, beverages, and desserts such as pudding.
- Eggs or yolks from eggs, milk and/or cream mixtures, sugar substitutes (sugar, nectar), and flavours (vanilla, nuts, etc.) are the main ingredients in custards. Custards are thickened by the coagulation of protein from eggs after cooking. These egg proteins destroy during cooking and reassemble to form a network, which coagulates or sets at the correct temperature to create the firm custard gel. Custard dishes should be covered and chilled immediately as feasible after being made since they are extremely susceptible to microbial contamination.

PHYSICAL ACTIVITY 3

1) List five pulse-based dishes that you have consumed in the last two days.

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ASSESS THE PROGRESS OF YOUR SESSIONS 3

1) Describe the role that eggs play in the typical diet.

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2) List five egg-based dishes that are popular in your area.

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6.3 MEAT

Fig 6.2 Meat

Meat is the term for the flesh of warm-blooded, four-legged animals, typically cattle, sheep, and swine. Lamb is the flesh of young sheep, usually under a year old. It can be referred to as mutton after 12 months of age. Pork is the flesh of a pig that has been harvested between the ages of 5 and 12 months. Cattle slaughtered between three and fourteen weeks after birth are used to make meat from them. Calf meat is produced when a calf is slaughtered between the ages of 14 and 52 weeks. Beef is the name for meat taken from cattle that have been slaughtered a year after birth.

6.3.1 SELECTION OF MEAT

The freshness of the food you purchase is essential. Our bodies can be harmed by eating stale meat or the flesh of elderly animals. Our health is also harmed by the presence of disease-causing organisms in these diets. As a result, always buy such foods from clean, trustworthy stores. The quality of the meat may be determined by looking at how it appears.

Consider the following while purchasing meat foods:

- The flesh of a calf or veal is firm and light pink. The sliced surface is wet, and the flesh is mushy and flabby.
- The bone is pinkish white and has some blood in it. No indications of fat are seen. Young lambs younger than a year old have flesh that is tender, pink, red, and smooth.
- The skeletons are spongy and brown in colour in appearance. A slick fat layer and a deep crimson hue characterize excellent-quality lamb. White and sturdy is the bone.
- Animal products of lower quality contain darker flesh and fibrous, coarse grain. The fat layers are delicious and thick.

ASSESS THE PROGRESS OF YOUR SESSIONS 4

1) Describe the factors to take into account while buying mutton.

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6.3.2 NUTRITIONAL COMPOSITION OF MEAT

Meat is a very nourishing meal. It can be absorbed almost entirely. The quantity of high-quality proteins, essential fatty acids, numerous crucial minerals, and the B complex vitamin family (thiamine, niacin, riboflavin, pantothenic acid, B6, folic acids, biotin as well and B12) are all factors in the nutritional value of meat. The amount of fat in meat affects how many calories it contains. Various meats include organs including tongue, the brain, thymus (sweet breads), the liver, heart, and spleen. A great source of nutrients, they are also. A, B, C, D, E, and K vitamins are abundant in various meat (organ flesh), notably the kidneys and liver.

Table 6.4 Nutritional composition of meat

Food	Moisture (%)	Energy (Kcal)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Phosphorus (mg)
Beef Muscle	74.3	114	22.6	2.6	10	0.8	190
Buffalo Meat	78.7	86	19.4	0.9	3		189
Fowl	72.2	109	25.9	0.6	25		245
Goat meat	74.2	118	21.4	3.6	12		193
Liver Goat	76.3	107	20.0	3.0	17		279
Liver Sheep	70.4	150	19.3	7.5	10	6.3	380
Mutton Muscle	71.5	194	18.5	13.3	150	2.5	150
Pork (muscle)	77.4	114	18.7	4.4	30	2.2	200

Source: Gopalan C., Rama Sastri, B.V. and Balasubramanian, S.C., 2004 (NIN,ICMR, Hyderabad)

ASSESS THE PROGRESS OF YOUR SESSIONS 5

1) Which nutrients are plentiful in meat?

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6.3.3 CHANGES DURING COOKING MEAT

When meat is cooked, numerous alterations occur that make it appear appealing, smell good, and taste well. Meat is cooked to eliminate any potentially hazardous bacteria and enhance its flavour. In addition to changes in colour, weight, volume, flavour, and fatty tissue, meat experiences morphological alterations to the protein structure, tendons, ligaments, as well as muscle fibre.

a) **Change in Colour:** Myoglobin is transformed into brown or dull red globin hemochromogen during cooking, which causes a change in colour. Some myoglobin undergoes oxidation during a particular period to become brown metamyoglobin. Metmyoglobin contains ferric-state iron. Thus, the colour of cooked meat changes from a drab red to a brown colour.
b) **Reduction in weight and volume:** Cooking has an impact on the pace and volume of shrinkage that results from shrinkage. The meat's pH appears to be the key component in influencing the loss during cooking. The flesh will shrink the most if its pH is 5.8, which correlates to the isoelectric point of the major muscle protein. When pH is 4.0 or 7.0, there is less shrinking.
c) **Changes in fatty tissue:**Collagenous tissue destruction as well as the release of fat that has melted is responsible for changes in fatty tissue. The oxidation of fat may be the factor that causes the surface browning of fat. Depending on the quantity of fat in the meat, different amounts of drip include fat.
d) **Intracellular protein and fibres in muscles alterations:** Muscle protoplasmic proteins have been modified and are no longer water soluble. Muscle fibres get shorter and thinner.
e) **Flavour:** Cooked meat has a different flavour and aroma than raw meat because of the release of volatile compounds created during cooking as well as the presence of water and fat-soluble components in raw meat. On heating, a meaty taste emerges from a raw beef water extract. However, it is less intense than the flavour of the water used to boil the meat.
f) **Juiciness:** Juiciness is determined by the capacity of meat proteins to retain cooked water.

ASSESS THE PROGRESS OF YOUR SESSIONS 6

1) What occurs following the meat's cooking?

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6.3.4 MEAT PREPARATION

Flesh meals may be cooked in a variety of ways at home. It is relatively simple to incorporate some food from this category in one's daily diet because there are so many various kinds of meat meals accessible on the market. Cleaning and cutting the outside of the meat are prerequisites before cooking. Remove any internal organs that will not be consumed. There are several methods to prepare meat items, including:

- Our dinners would not be complete without curry. A variety of curries may be made using any meat food.
- Meat, chicken, and other ingredients can also be utilized as stuffing for a variety of snacks and cuisines, including pies, bread rolls, samosas, and sandwiches.
- You can make soups and broths with flesh-based ingredients. These are simple to digest and extremely helpful for growing kids and people getting well after a protracted illness.
- The 'tandoori' dish is highly popular in India. On an open tandoor, food such as mutton tikkas, seekh kababs, tandoori chicken, fish, etc. can be made.
- Cutlets and rolls can be made with fish, chicken, or mutton along with additional components like potatoes, etc.
- To create particularly delicious meals, meat products can be fried, roasted, or baked.
- Popular dishes include fried chicken and roasted mutton.

PRACTICAL ACTIVITY 4

1) Specify the names of five dishes you've made using various types of rice.

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6.4 POULTRY

Fig 6.3 Poultry farming

These birds come in a wide range of varieties, including chicken, turkey, goose, and duck. Our diet includes poultry as an option of animal protein. There are several chicken items available on the market, including whole live birds and prepared birds. A bird's tenderness increases with age. The juvenile bird's skin is easily removed from the flesh since it is delicate. Young birds' breast bones and other bones are delicate and easily removed.

Age-based classifications are used for poultry. The softness and fat content of the chicken are influenced by age. The categorization, as determined by Indian criteria, is as follows:

Broiler or fryer: All types of chicken between the ages of 8 and 10 weeks have flexible cartilage in the breastbone, soft flesh, and smooth, supple skin.

Roaster: An immature bird, usually between three and five months old, of any gender, with delicate flesh and skin that is so elastic and smooth-textured, however the cartilage of the breastbone may be slightly less elastic as a result of the grill or fryer.

Stag: An adult male chicken, usually under ten months old, with skin that is rough, relatively stiffened with darker flesh, a noticeable hardening of the bone in the breastbone.

Stewing chicken or fowl: A fully grown bird, frequently older than the age of ten, with less pliable meat than that of a roaster and breastbone points that are strangely fastened.

Cock: with hardened, darker, and coarser skin, and a mature male chicken, usually older than ten months, possesses all of these traits, including a hard breastbone tip.

6.4.1 SELECTION OF POULTRY

Young birds (under 9 months old) are better for cooking since their meat is more delicate.

Signs of a young bird:

- The feathers and particularly the quills attached to the wings, should be easy to lift.
- The body has no lengthy hair.
- Skin should be smooth and either white or clean.
- Scales on the feet should be level, smooth, and overlying.

The distinctive indications that a bird is fresh:

- Soft and fluffy feathers, clear and clean eyes, no unpleasant aroma, and soft, not stiff and dry feet.
- Skin that is clear and free of any dark or greenish tones.

6.4.2 NUTRITIONAL COMPOSITION OF POULTRY

Poultry has a comparable composition to meat (muscle tissue, connective tissue). With a high protein content of around 25%, fowl flesh resembles in quality and nutrient content to other types of meats. Water makes up over 75% of muscle tissue, followed by protein at 20% and fat at 5%.It contains each essential amino acid required to build biological tissues. Young birds' flesh has a little amount of fat, although the amount depends on the species and age of the bird. Compared to red meat, chicken fat is more unsaturated, which is good for your health. Poultry meat is beneficial to people who must limit their fat consumption as a result of a great protein to lipid proportion. Meat of the poultry, like other animal tissues, is high in B vitamins and minerals. All four birds contain black flesh; however the connective tissue is different in duck, goose, and squab. Dark meat has a dark colour because of a protein called myoglobin. In order for muscles to function during moments of intense exercise, this protein stores oxygen.

ASSESS THE PROGRESS OF YOUR SESSIONS 7

1) Name the three nutrients that are found within poultry.

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6.4.3 CHANGES DURING COOKING

Similar to other types of meat, changes occur during the cooking of chicken. Low to moderate heat should be used to cook poultry so that it is moist, tender, and cooked evenly. Proteins become tougher, shrink, and lose their juiciness with extreme heat. The chicken must be fully cooked before being dipped in flour, egg, and bread crumbs then slowly fried if deep-frying it. The time required for browning in deep fat is insufficient to allow for complete meat cooking. When roasting a whole chicken, delicate sections like the breast may overcook prior to the legs and thigh being done. Stuffed birds should be cooked until the filling achieves an internal temperature of 74°C. This eliminates the possibility of food poisoning caused by bacteria.

PRACTICAL ACTIVITY 5

1) Write down five different ways that meat food is prepared, and then examine the methods that are used.

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6.5 FISH

India has a coastline of 5,100 km.More than 200 edible fish varieties are known, including sardines, mackerel, tuna, catfish, and scombroides.

Fig 6.4 Fish

Fin fish as well as shellfish are two distinct types of fish. Shellfish are mollusks and crustaceans with shells, whereas fin fish are bony-skeleton fish. Animal proteins, minerals, and vitamins abound in these fish and shellfish.

Marine fish include sardines, mackerel, tuna, catfish, brown duck, ribbon fish, prawns, and cattle. Freshwater fish include carps, catla, rohu, murrels, and hilsa. Fish contains complete proteins and may be substituted for meat in the diet; nevertheless, overall fish consumption is much lower than meat consumption.

6.5.1 CLASSIFICATION OF FISH

The two varieties of edible fish are finfish and shellfish. Fin fish are fish that have a bony skeleton. The name "shellfish" encompasses mollusks and crustaceans. Shellfish is highly perishable. Crustacea have legs that are partially linked to their outer shells. Among them are crabs, lobsters, prawns, and prawns. Mollusks have more durable outer shells but no legs. They have hinged shells as mussels, oysters, and scallops.

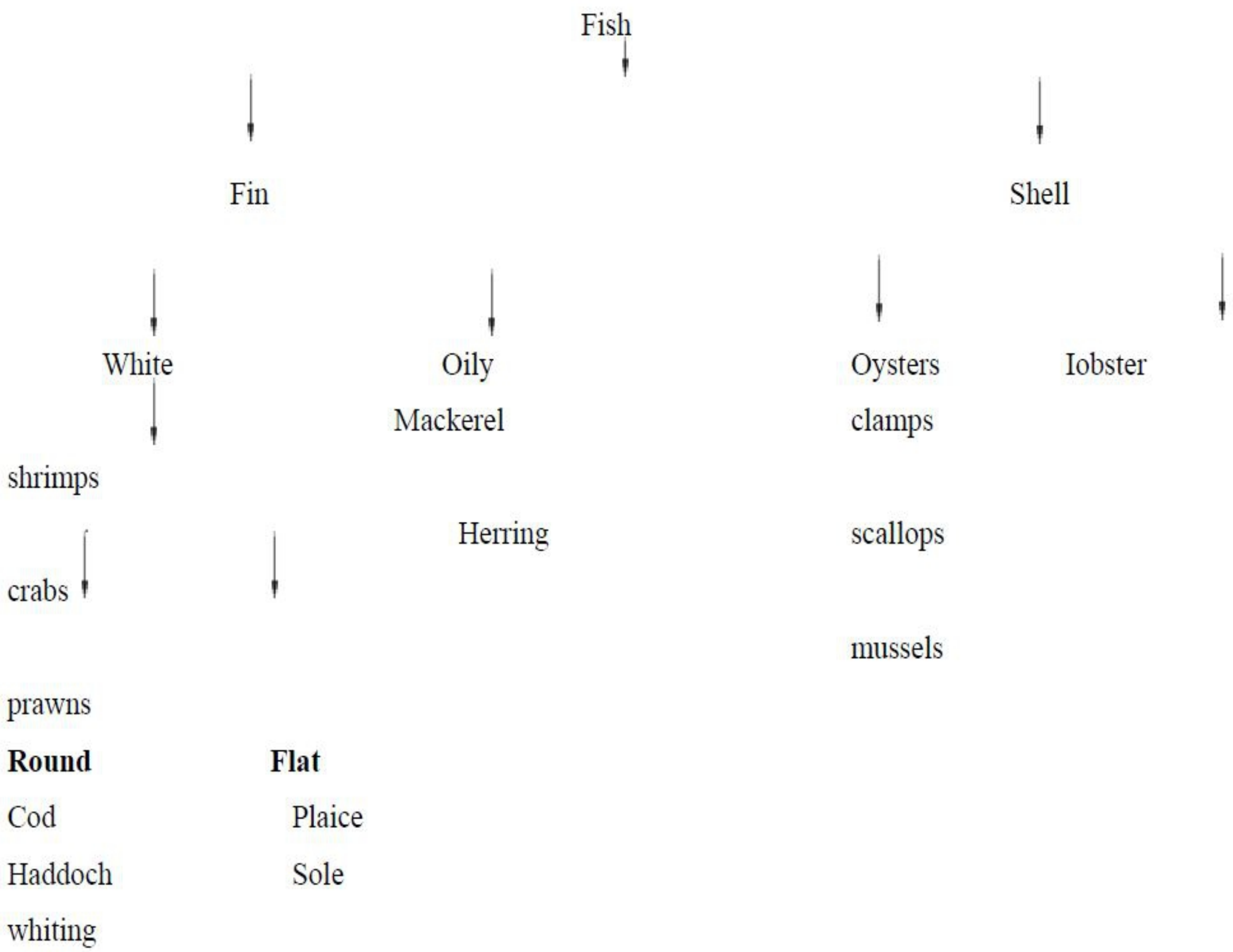

Fig 6.5 Classification of fish

6.5.2 SELECTION OF FISH

When choosing fish, keep the following things in mind:

- Bright eyes that are not sunken are preferable.
- • The gills have to be red.
- The flesh of the animal has to be solid and not flabby, and the tail of the animal must be sturdy with the scales well fastened to the skin.

• No objectionable scents should be present.
• If an indentation is left after pressing a cut piece with a finger, the fish is stale.
• The mere fact that the uncooked flesh is beginning to peel clear of the bone is dangerous.

ASSESS THE PROGRESS OF YOUR SESSIONS 8

1) List the points have to keep in mind while buying fish.

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6.5.3 NUTRITIONAL COMPOSITION OF FISH

High amount of protein Present in fish. According to species as well as period of the year, the fish fat percentage varies between 0.2 to 20 percent. The bulk of the fish have minimal amounts of fat. Herring may have a fat proportion of 8-20%, but sardines may have a fat percentage of 1.9-14.66%. The protein amount in fish varies from 9 to 20 per cent based on its fluid level. Bombay duck contains a protein amount of 9.1 percent, which is because of its high level of moisture.

Shellfish is lower in fat and higher in carbs than finfish. Glycogen is found in the muscle tissues of fish, just like it is in meat. In live fish, glycogen is a form of energy stored.

Fish, especially little fish with bones, are high in calcium. Iodine, selenium, and fluoride are abundant in marine fish. Selenium is an extremely potent antioxidant. Oysters are high in copper and iron. Freshwater fish has a lower sodium level than beef. The best supply of zinc in nature is oysters, for instance. Fish meals have a higher bioavailability of iron and zinc than plant meals. Foods from the sea, especially shellfish, are rich in vitamin B12. Vitamins that are fat-soluble are abundant in fish liver oils. Shark liver oil contains 10,000–24,000 IU of vitamin A per gramme of oil. Vitamin C is abundant in rohu. Fish is a great source of niacin and vitamin D. Seafood contains a sizable amount of vitamin B12.

6.5.4 HEALTH BENEFITS:

Both the Greenlandic Eskimos and the Japanese fishing population are completely free of cardiac diseases. The fatty acid makeup of fish is thought to be responsible for the positive effect of eating fish. The brain's growth and function, as well as arthritic pain and inflammation, are all prevented by omega-3 fatty acids, which also guard against cardiovascular disease.

PRACTICAL ACTIVITY 6

1) Make a list of the different menu items that fish may be utilized in.

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6.5.5 CHANGES DURING COOKING FISH

Fish cooks considerably more rapidly than beef and poultry because it has less connective tissue and shorter muscle fibers. When checked with a fork, fish is considered properly cooked when the flesh readily falls into clamps of pure white flakes. While cooking fish for an extended amount of time or at an extreme heat, the muscle protein contracts, making the fish tough, dry and flavorless. Fish requires cautious handling when cooking and serving since, compared to meat and poultry, cooked fish tends to break apart readily.

ASSESS THE PROGRESS OF YOUR SESSIONS 9

1) What is happening with frying fish?

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6.6 LET US SUMMARISE

Eggs are a crucial component of our diet since they are rich in protein, iron, vitamin A, and B-complex vitamins as discussed in this section. A few quick tests can help us identify how fresh eggs are before we buy them. Eggs are simple to incorporate into our regular meals, and many preparations, such as omeletes, custards, etc., may be done at home. Meat from various animals, birds, and fish are considered flesh meals. These are abundant in B-complex vitamins, iron, and protein. We can tell the quality of meat items by their texture and outward look. With these flesh foods, a variety of food preparations can be developed. Long before they domesticated animals or learned to grow plants, humans subsisted on fish, shellfish, alongside aquatic mammals. The top beaks of birds were used to make fishnets, spears, and fishing hooks that were discovered during the excavation of Stone Age sites. The only significant food source still sought nowadays is seafood. Compared to moderately fat beef, several fish are lower in cholesterol and fat. Regular consumption of fish has an extra nutritional benefit. Most fish fat is highly unsaturated.

6.7 GLOSSARY

Fin fish: It covers sharks, certain rays, and bony fish.

Shellfish: refers to molluscs

Mutton: the flesh of an adult goat or sheep

Lamb: The meat from a young sheep is referred to as lamb

Meat: animal meat that is consumed as food

Omelet: a meal composed with fried eggs that have been rapidly combined together (beating)

Custard: a milk, egg, and sugar sauce that is sweet and yellow.

Young birds: Birds in their infancy

Thaw- brings anything from frozen state to room temperature.

Marine mammals: Porpoises, whales, seals, walruses, and polar bears are examples of ocean-dwelling or ocean-dependent animals.

UNIT VII- FATS AND OILS

You will learn about the selection, nutritional composition and changes during cooking and significance of fats and oils in our diets in this unit. Additionally, Students discover the numerous kinds of often used fats and oils, as well as how they work to prepare our meals.

Structure

7.0 SCOPE

You will be able to learn the following after finishing this unit:

• To learn the standards for choosing oils and fats;

• Emphasize the importance of oils and fats as part of diets; and

• enumerate the uses of various kinds of oils and fats during preparation and the alterations that occur during frying.

7.1 OVERVIEW

Since many years ago, man has employed oils and fats in the production of food. In the past, butter or ghee was used to prepare food because it gave richness to the flavour and colour. In addition to butter, humans now consume a wide variety of oils, fats, and products made from both animal and plant sources. In previous units, you learned about various foods such as grains, pulses, vegetables, meat, eggs, and milk and milk products. We require fats and oils to produce a range of appetizing and delicious dishes such as stuffed *paratha*, omelet, cutlets, *chakli*, mathri,cake, biscuits,*Dum Aloo, Sweet* and dhal. Oils and fats are used in cooking and frying, as well as to add richness and taste to meals. They are also a good source of concentrated energy and several key elements. Numerous foods contain significant levels of fat that are not readily visible, such as the 16 per cent fat found in avocados, 31 per cent fat in egg yolks, 35 per cent fat in chocolate, 41 percent fat in specific cuts of beef, 58% fat in almonds, and 32 percent fat in cheese.

Fig 7.1 Fats and Oils

7.1.1 CLASSIFICATION OF FAT:

According to their chemical composition, lipids may be divided into three groups:

i. Both oils and fats are examples of simple lipids.
ii. Phospholipids and lipoproteins are components of complex lipids, in addition to
iii. Derived lipids like fatty acids and sterols.

The biological tissues and meals include about twenty fatty acids. Chain length, saturation, and essential fatty acids are three significant properties of fatty acids. The length of a fatty acid chain is determined by the number of carbon atoms in the acid. Milk, lard, acetic acid, and coconut products all contain short-chain fatty acids while the vast majority regarding vegetable oils and fats from animals consist of fatty acids with long chains. Extra-long chain fatty acids are found in fish oils.

Cholesterol is a vital sterol. It is a waxy material. It is the most well-known sterol and has gained popularity because of the link between high blood cholesterol levels and heart disease. It is a vitamin D, hormone, and bile acid precursor. Corticosteroids, estrogens, testosterone, and calcitriol (the active vitamin D hormone) are all hormones derived from cholesterol. Bile acids, which are required for fat breakdown, are generated from cholesterol.

Table7.1: Fats sources

Meal	g/100g	Calories/100g
VisibleFats		
Vegetables and oil	100.0	900
Vanaspati	100.0	900
Ghee,cow's	99.5	895
Butter	81.0	729
InvisibleFats		
nut and seed oils	37.0–64.5	537–681
Lamb, muscles	13.3	194
hen, eggs	13.3	173
Lamb, liver	7.5	150
dairy, cow	4.1	67

Source: Madhbani S.R. and Rajagopal M.V.,2007 *Fundamentals of Foods and Nutrition* and added *Diet Therapy*

ASSESS THE PROGRESS OF YOUR SESSIONS 1

1) Give a list of the three types of fat.

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2) What kind of substance is cholesterol?

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7.2 CHOOSING THE RIGHT OILS AND FATS

Choose your oils and fats based on what you need and what you can afford. When choosing fats, keep the following in mind:

- Natural flavour and colour should be present in oils and fats.
- They should be spotless and devoid of any debris, filth, dust, or offensive odours.
- Purchase the oil or fat from a reputable supplier
- .Avoid buying oils and fats loose since they could be tampered with. Purchase in polyjars or sealed tins.
- Butter needs to be packaged in a sanitary manner. It needs to be flavorful and firm.
- Ghee ought to retain its delicate, natural flavour.

ASSESS THE PROGRESS OF YOUR SESSIONS 2

1) Which parameters would you possibly use to select oils and fats?

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7.2.1 SOURCES

- Oils from nuts and seeds are extracted to make vegetable oils, which are utilized in cooking. Animal fats made from milk include butter and ghee.
- Oils from plants are processed in order to produce vanaspati, a nearly solid fat. Because vanaspati is used in place of ghee, it is usually fortified with vitamins A and D.
- The visible fats in the Indian diet are provided through oils, butter, ghee, and vanaspati. The proportion of oils and fats in the diet varies by geography. Because these are expensive foods, the amount and type used in the diet vary according to the family's socioeconomic status.
- Animal fat-containing foods such as milk, eggs, meat, and liver Several dietary sources of submerged lipids.
- In addition to providing fat, nuts, seeds for oil production, eggs, dairy products, and livestock also include protein, minerals, and B-complex vitamins. Vitamin A is found in ghee, butter, eggs, and liver. Vitamin A is added to some refined oils and vanaspati.

Table 7.2.Some Common Fatty Acids' Names, Formulas, and Melting Points

Carbon Atom Count	Fatty Acids	Specifications	Melting Point (in degrees Celsius)
Saturated			
4	Butyric	C3H7COOH	–7.9
6	Caproic	C5H11COOH	–3.4
10	Capric	C9H19COOH	31.6
16	Palmitic	C15H31COOH	62.9
18	Stearic	C17H35COOH	69.6
Unsaturated			
18	Oleic	CH3(CH2)7CH=CH(CH2)7COOH	16.3
18	Linoleic	CH3(CH2)4CH=CHCH2CH=CH(CH2)7COOH	–5.0
18	Linolenic	CH3CH2CH=CHCH2CH=CHCH2CH=CH$(CH_2)_7$COOH	–11.0
20	Arachidonic	CH3(CH2)4(CH=CHCH2)4(CH2)2COOH	–49.5

Source: Madhbani S.R. and Rajagopal M.V.,2007 *Fundamentals of Foods and Nutrition* and added *Diet Therapy*

- The Vanaspati, enriched oil that is refined, ghee, and the butter can all be used to meet some of the daily vitamin A requirements.
- Controlling visible fats in the diet is easier than controlling hidden fats. One may keep an eye on how much butter, ghee, and other liquid oil is being utilized, for instance. The cream in dairy products and milk, nuts utilized in making food, the yolk of an egg, and grease employed to season veggies, lentils and lettuce are examples of invisible fats. Although dairy milk with no fat has 3 per cent fat in it. 10% or more of the total energy in the diet is made up of undetectable lipids.

ASSESS THE PROGRESS OF YOUR SESSIONS 3

1) Where can you get fats and oils?

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7.3 NUTRITIONAL CONTRIBUTION OF OILS AND FATS

Oils and fats are significant sources of energy for us. Compared to proteins and carbs, lipids offer 2.25 periods' higher levels of calories in terms of weight. They aid in reducing the quantity of food we consume. Oils and fats are crucial sources of energy, good sources of the A, D, E, and K, which are fat-soluble vitamins as well as they participate in the synthesis of a number of long-chain alcohols. Fats reduce the bulk of our diet since they are high in energy. However, you should avoid eating too much fat because it causes the body to store it as fat, which makes you gain weight. Ghee and butter, two animal-based fats, are particularly high in vitamin A. Both the A and D vitamins are added to vanaspati. Strong bones and teeth require sunshine while as you may have read in the first unit of Block 1, a form of vitamin A keeps our eyes healthy.Linoleic acid, an important fatty acid that is necessary for human health, is provided by oils. Over consumption of saturated fatty acids increases lipids in the blood levels as well as the danger of heart disease and arteriosclerosis. Thus, a large intake of unsaturated acids is required for normal health. They provide concentrated energy. Fat has nine calories per gram whereas protein and carbs only have four.

Ghee, a common cooking method generated by clarifying butter, is very useful when making desserts like *Mawa Laddu* and Mysore pak. It is consumed on a regular basis. Sesame oil is more widely utilized in the other southern states, whereas coconut oil is more popular in Kerala. In Bengal, Uttar Pradesh, Punjab, and Haryana, mustard oil is frequently utilized. Sesame oil and safflower oil, both of which are high in lenoleic acid, are present in vanaspati, or hydrogenated vegetable oil, to a minimum of 5% each. It takes the acid to stop atherosclerosis. Additionally, palm oil is now used in Indian cuisine. It has roughly 10% linoleic acid, while palmolein has about 12%. Essential fatty acids included in oils help to maintain the health of the surfaces of our bodies as well as heart healthy.They protect against dermatitis and reduce chances of cardiac arrest in older people.

Table 7.3 Percentage of fatty acids in specific oils and fats

Oils /Fats	**Total Saturates**	**Total mono unsaturated**	**Linoleic n-6**	**Total Poly unsaturated**
Coconut oil	89.5	7.8	2.0	2.0
Corn oil	12.7	29.6	57.4	57.4
Cotton-seed oil	25.9	22.9	50.9	50.9
Groundnut oil	20.9	49.3	29.9	29.9
Mustard or Rapeseed oil	10.7	56.0	18.1	32.6
Olive oil	14.8	74.5	10.0	10.0
Palm oil	46.3	43.7	10.0	10.6
Rice bran oil	22.1	41.0	34.3	35.7
Soyabean oil	13.1	28.9	50.7	57.2
Butter	69.4	28.0	2.5	2.5
Lard	46.2	45.2	11.0	11.0
Tallow	54.9	40.9	4.2	4.2

Source: Gopalan et al., 2004 (NIN, Hyderabad)

Other fats like margarine or bakery fats get utilized occasionally in the everyday diet. Acts like leavening components in cakes, pastries and cookies; in cakes, incorporating oil into the flour forms walls around each little bubble. Because fat is insoluble in water in foods that are baked, it interferes with gluten hydration and the gluten strand cohesion during combining them and making the product tender. They are typically used to make biscuits, bread, and cakes. Although table butter has been replaced by margarine in other nations, margarine is still not a significant part of the diet in India.

ASSESS THE PROGRESS OF YOUR SESSIONS 4

1) Fats have high levels of a few specific dietary components.

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2) What is the function of fat in baked products?

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7.3.1 EFAs (Essential fatty acids)

- Linoleic acid (omega-6 PUFA) and linolenic acid (omega-3 PUFA) are considered vital fatty acids as these substances are not made in the human body, are required for important physiological processes, and can only be received from diet.
- EFAs serve various key purposes. They are necessary for early growth and the preservation of typical healthy skin.DocosaHexaenoic Acid and EicosaPentaenoic are omega-3 fatty acids that play a crucial being involved in development of the embryo's brain and eyes. Additionally, such acids help to prevent Rheumatoid Arthritis as well as heart problems.
- The finest sources of these fatty acids are certain types of seafood. Through certain places, containing modified eggs higher quantities containing omega-3 fatty acids have been generated through incorporating high in DHA algae into food for chickens.
- The majority of natural fats, including only the case of coconut, are rich in linoleic acid.
- Omega-3 fatty acids may be present in greens, cabbage, as well as lettuce. Soybeans are also high in omega-3 fatty acids. A weekly serving of any fatty fish, including tuna, sardines, and salmon, can assist you satisfy the requirement. Fatty fish are rich providers of omega-3 fatty acids.
- Certain prostaglandins are synthesized using EFAs. Prostaglandins slow bleeding, reduce platelet thickness and stickiness, and lower triglyceride and very low density lipoprotein

(VLDL) levels in the blood. As a result, arterial obstruction is minimised. Prostaglandins also lower inflammation and consequently discomfort in certain conditions.

- Lack of EFAs causes growth retardation, dry skin, and itchy head patches.
- Diarrhoea and other symptoms may appear. These deficiency symptoms arise in low-birth-weight newborns fed fat-free formulas and in people nourished for lengthy periods of time on intravenous solutions containing no lipid.(like rheumatoid arthritis)

ASSESS THE PROGRESS OF YOUR SESSIONS 5

1) Write about foods that contain Omega-3 fatty acids.

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7.3.2 RECOMMENDED DIETARY ALLOWANCES

The demand for fat is dependent on two things: the need for energy and the need for necessary fatty acids. Invisible fat in the diet provides around 10% of overall energy requirements. A minimum of 5% of total energy must be delivered in the diet as visible fat. This equates to around 12 g of fat each day. For healthy people, a greater amount of consumption of 20 g/day is preferred to give energy density and palatability.

Given the potential difficulties associated with high fat consumption, a maximum limit of 20 g/day for adults and 25 g/day for young children is recommended. To meet the essential fatty acid requirements, the diet should include at least 10 g of vegetable oil, which is a good source of linoleic acid.

7.4 TYPES OF FATS AND OILS

7.4.1BUTTER: This is manufactured from separated cream through milk. The milk product may become vinegary on its own as well as after adding curds. The butter separates when it is churned. Butter prepared curd is now incorporated into cream, which provides better flavour and lasts longer. You may manufacture at your place and consume it plain, alternatively you may make ghee out of it. It may be an excellent resource of vitamin A and more costly than other fats since it is derived from milk. You can create sandwiches, cakes, cookies, and pastries using butter and chapatis and parantha. It is smooth and easy to digest. As a result, it is more suited to small kids, the elderly, and the sick.

7.4.2 GHEE: This originates from butter that has been heated until all of the fluid has been removed. It may be produced at home using homemade butter. Heat the butter until a light brown colour develops on the residual butter particles. Avoid overheating since this would make the ghee heat and essential nutrients to be demolished. A component for frying and cooking is ghee that is also used to produce desserts. However, given that it is made of butter, it is expensive to buy.

7.4.3 MARGARINE: Margarine is a butter replacement manufactured from vegetable oils such as soya bean, cotton seed, and others, as well as a hydrogenated blend of vegetable and animal fat. Developed with whey or cultured pasteurized skim milk (SM) and one or more optional fat components. Vitamins A and D can also be added to boost nutritional value. Other ingredients that can be used as emulsifiers include lecithin, monoglycerides, and/or fat producing fatty acids, artificial colours, salt, citric acid or specific citrates, and sodium benzoate as a preservative to the level of 0.1 per cent.

7.4.4 LARD:

Fig 7.2 Lard

Lard is a kind of pig fat. Lard is made by rendering fatty tissues with heat. The amount of lard used is determined by the location of the fatty tissues in the animal and the technique of cooking. To avoid the beginning of rancidity, an antioxidant is added. Lard is sometimes changed to increase its baking performance.

7.4.5 COTTONSEED OIL:

Fig 7.4 Cotton seed oil

It is eaten as a salad dressing or as a cooking oil.It has a neutral flavour that does not overwhelm other foodstuffs.

7.4.6 RICE BRAN OIL:

It is strong in unsaponifiable components such tocotrienols and oryzanol. These have antioxidant properties. This oil is high in vitamin E, which provides it oxidative stability. Furthermore, it has a greater cholesterol-lowering effect than other oils. When compared to other oils, it has a high keeping quality. Foods deep fried in rice bran oil were less absorbed or eaten in fried foods than meals fried in groundnut oil.

Fig 7.5 Rice bran oil

PHYSICALACTIVITY1

1) Mention the foods that you usually prepare using rice bran oil.

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ASSESS THE PROGRESS OF YOUR SESSIONS 6

1) State the preparations for which you utilize cotton seed oil in the food you prepare.

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7.4.7 REFINED OIL

Vegetable oils are made from oil-containing seeds, fruits, or nuts by using different pressing techniques, solvent-based extraction, or a combination of these. A seed cake with a fair amount of protein is still present, and the fat is also utilized to make animal feed.

OIL SEEDS OR NUTS

↓

COOKED IN STEAM

Cell Structure breaks ↓ Fat melts

SCREW PRESSED

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ADDITION OF FOOD GRADE HEXANE

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OIL IS EXTRACTED SOLVENT IS REMOVED

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DEGUMMED

↓

REFINED

↓

BLEACHED AND DEODORIZED

↓

REFINED OIL

Fig 7.6 Flowchart of the production of refined oil

(Source: B. Srilakshmi,2011)

7.4.8 Vanaspathi

In India, hydrogenated oil is referred to as "Vanaspathi." It is produced by hydrogenating groundnut oil that has been refined or a combination of groundnut oil and other edible vegetable oils. In Vanaspati, both beneficial and harmful fatty acids may be detected.Vanaspathi must have a melting point between 31°C and 37°C, contain 5% sesame oil, and be fortified with vitamin A in accordance with the Vanaspathi Control Order.

7.4.9 GROUNDNUT OIL:

Fig 7.7 Groundnut

Groundnut oil accounts for over half of all oils produced in India.The protein and fat content of groundnuts is fairly high. The B-complex vitamin niacin is particularly abundant in them. The 'king' of oilseeds is groundnut. It is a crucial component of our nation's food supply and a major source of income. Aside from being a valuable source of all nutrients, it is also a low-cost product. The term "wonder nut" and "poor man's cashew nut" are also used for the groundnut.Compared to eggs and meat; groundnuts provide two times the amount of protein.Groundnuts are high in calcium, phosphorus, iron, and zinc, in addition to protein. It is a clear amber liquid that is widely used in cooking and as a salad dressing. It is one of the most essential fats used in the production of margarine. It has high oxidative stability. It is also employed in the preservation of fish.

7.4.10 SOYBEAN OIL: In terms of both production and use, soybean oil is the world's top vegetable oil. It is extracted from raw beans using a solvent. It is a component in cake mixes, non-dairy creamers, cooking oil, Mayonnaise, sandwich spreads, and vanaspati.

7.4.11 MUSTARD OIL:

Fig 7.8 Mustard oil

It is a member of the *Brassica campestris* family. Mustard is a member of the same family. It is also known as *Sarson*. Mustard oil has a strong flavour and aroma and is somewhat more viscous than other common vegetable oils. Mustard oil has antibacterial properties and can help to protect the skin. It can also prevent cold, cough and skin problems. Mustard oil contains strong antioxidant activity.

PHYSICAL ACTIVITY 2

1) Name five dishes that you develop with mustard oil along with their names.

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7.4.12 OLIVE OIL:

Fig 7.9 Olive Oil

The conventional plant fruit known as the olive is used to make olive oil, which is fruit oil. The wild olive tree, which has its roots in southern Asia, has been extensively grown in the Mediterranean area. The substance that is extracted from the olive fruits can be divided through different categories for commercial usage, including virgin, extra virgin, pure, and processed oils. Olive oil is extensively used in food preparation in the modern world. Pure and refined olive oils are both used for deep frying. For daily cooking, virgin olive oil is preferred, while extra virgin olive oil is used in dressings for salads. The risk of heart disease is significantly decreased by the monounsaturated fats found in olive oil. Additionally, it contains plenty of polyunsaturated fats, which help to lower cholesterol.

7.4.13 PALM OIL:

Elaeis Guineensis palm fruit is used to make palm oil.It is used all over the world as a cooking oil, a component in margarines and shortening, as well as in a broad range of culinary products and fat blends.Both saturated and unsaturated fatty acids are present in equal amounts.It contains 5 per cent stearic acid and 44 percent palmitic acid. The liver contains 10% linoleic and terol and 39% oleic acid (MUF). Due to its high content of carotenoids (500–700 ppm), crude palm oil is one of the most abundant natural plant sources of carotenoids.

7.5 UTILIZATION OF FATS AND OILS IN FOOD PREPARATION

Cooking is carried out with fats and oils. You can do this by deep-frying, pan-frying, or doing shallow frying. Pan-frying is the process of cooking food in a skillet that has been lightly greased. Examples include frying *Puri,Pakora*, Dhokla, Dosa,omelets, fried eggs, pancakes, andpapad. In this way, food is cooked in minute pieces or a thin layer. To finish cooking, the meal must be rotated from one side to the other.

To cook the meal when deep frying, it is submerged in fat. The ingredient is used to prepare a variety of foods. The technique used seems similar to the boiling process. The food cooks very rapidly because lipids can be heated to temperatures that are far higher than boiling water. In order to prevent food from burning, it requires regular care and attention.

Fats are employed as a shortening agent. It gives baked and fried goods a crisp texture thanks to the shortening action. This occurs in wheat goods because the gluten strands are cut shorter, which prevents the product from becoming tough.

ASSESS THE PROGRESS OF YOUR SESSIONS 7

1) How do we use fats and oils in our daily diet?

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7.6 CHANGES IN FATS AND OILS DURING COOKING

Since they do not have a distinct melting point, fats gradually get softer when heated.

Smoke point, Flash point, and fire point: When fats and oils are burned to high temperatures, fat breakdown takes place and finally a point is reached when visible vapors are released. This is known as the smoking point, and the temperature is known as smoking temperatures of fat. When heated above the smoke point, they flash and burn. The terms "flash point" and "fire point" refer to the temperatures at which these take place.

Pyrolysis (Thermal breakdown): Whether or not the oil comes into contact with food, heating results in a breakdown in its molecular structure.When fat starts to smoke, its chemical breakdown begins, and glycerol is converted to free fatty acids and acrolein.The acrolein in the fat could cause irritation to the eyes and nose if it is allowed to smoke for any duration of time.

Oxidation: The development of rancidity is the result of molecular breakdown carried on by the oil surface's reaction with airborne oxygen.Every time the oil is heated, this change will take place.

Reaction with food residues: In particular, if the oil is heated again without the residues being removed, any food pieces left in it after frying will undergo chemical reaction.After usage, straining the oil can aid in preventing this kind of degradation.

They provide essential fatty acids, which are parts of the membranes of living cells, are a good source of A, D, E, and K vitamins,and add a distinctive flavour and texture to our food, making it more palatable. They are also used by the body to produce prostaglandins and have a role in many important physiological functions.

7.7 OUR HEALTH AND FATS AND OILS:

Saturated fat and unsaturated oil are common terms used to describe the fats and oils derived from meals. Saturated fats have a high percentage of saturated fatty acids, whereas unsaturated oils have a high percentage of unsaturated fatty acids. Excessive saturated fat consumption, together with excessive cholesterol consumption, contributes to an increased risk of heart disease. Increases in unsaturated lipids (either mono- or polyunsaturated) on the other hand, have been associated with a decreased prevalence of certain disorders.

Cholesterol levels are relatively high in the heart, liver, kidney, and egg (embryonic stage of life). New tissues are created throughout infancy and toddlerhood, particularly the brain, which requires cholesterol. As a result, fat should not be reduced in the diet of children under the age of five. Physical exercise, in addition to food, is a key component in the regulation of obesity, plasma cholesterol levels, and the prevention of CHD. Even during periods of increasing caloric intake, exercise reduces fasting plasma TRG levels. It is also known to raise HDL levels, which safeguard the health of blood arteries. As a result, we can avoid crippling heart disease and maintain our heart's health.

As a result, there have been an increasing number of recommendations from government authorities and health groups to reduce the quantity of saturated fat in the diet and raise the proportion of unsaturated fat. The majority of these organizations also advise reducing the total quantity of fat in the diet.

Since 1992, the US Department of Agriculture has promoted a food pyramid that provides a clear, visual representation of how much of what types of foods comprises a healthy, balanced diet. It advises consuming as little fat as possible. Although nutritionists acknowledge that some fat is necessary (and, in most cases, unavoidable, even for rigid vegetarians), they highlight that a large proportion of any fat, saturated or unsaturated, in the diet is not healthy. Despite at this point a small distinction between a single and double carbon-carbon bond can have a major influence on health.

- Consume foods high in healthy fats, such as nuts (such as walnuts and almonds), seeds (such as sunflower and pumpkin), olives, and so on.
- Instead of frying, try baking, steaming, grilling, or broiling.
- Pick lean meat and poultry cuts, low-fat or fat-free dairy products.
- Consume a lot of naturally low-fat foods like whole grains, fruits, and vegetables.
- Remember to inquire about the types of fats used in the production of the meals you are ordering while dining out. In many fast food or chain restaurants, you may also request to examine the nutrition information, and then select a lower-fat dish.

PHYSICAL ACTIVITY 3

1) Write an article about how fat affects people.

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7.7.1 IMPORTANCE OF FATS AND OILS

Fat improves texture: Acts as a leavening agent in cakes, biscuits, and cookies; in cakes, integrating oil into the flour produces walls surrounding each small bubble.

Fat acts as a shortening agent: Because fat is insoluble in water in baked goods, it interferes with the hydration of gluten and the cohesion of gluten strands during mixing, shortening them and making the product tender.

Fats for smoothness: In ice cream and frozen desserts, it reduces crystal size and provides a smooth texture. Fats obstruct sugar crystallization like halwa, candies. Upma Forms emulsion in mayonnaise providing smooth texture and prevents lump formation.

Fats enhance flavor: Aromatic aroma compounds dissolve in fat and enhance flavour, such as onion, ginger, garlic, pepper, and so on. Fats, such as Ghee, increase taste, flavour, and palatability. Fats are colouring agents. Turmeric added to oil, for example, is dispersed equally in meals.

Synergists: Compounds that delay auto-oxidation by reinforcing the action of antioxidants. Citric acid, phosphoric acid, ascorbic acid, lecithin, EDA – They combine with the pro oxidant metals like copper and iron and make them ineffective.

ASSESS THE PROGRESS OF YOUR SESSIONS 8

1) What is the importance of fats and oils

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7.7 LET US SUMMARISE

People eat fat in both visible and invisible forms. Fats shorten the strands of gluten, making the items delicate.Fats transport fat-soluble vitamins A,D,E, and K. Fats are an essential component of all salad dressings. Some types of foods cannot be cooked without fat.The food we eat is rich in flavour and texture as a result of fats and oils. Additionally, they enhance the flavour of meals and are a fantastic source of vitamins and energy. For frying and preparing meals, various fats and oils including ghee, butter, vanaspati, and vegetable oils are frequently used. In order to prevent heart disease and maintain our health, it is preferable to utilize more oils than fats. To avoid unfavourable changes, we should choose wisely, refrain from overusing them, and treat fats and oils with care while frying and storing them.

7.8 GLOSSARY

Fats and oil: Fats and oils are conventional names for fatty acid esters with glycerol.

Smoke point: The point of smoke indicates the level of heat that causes fats and oils begin to release visible fumes when heated.

Emulsion:A dispersion of colloidal particles consisting of two incompatible liquids is an emulsion.

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UGHN-101
FUNDAMENTALS OF FOOD & NUTRITION

BLOCK
3

NUTRIENT, FUNCTIONS, VITAMINS AND MINERALS

Block III : Introduction-Nutrient, Functions, Vitamins And Minerals

Let's dive into Nutrients, Vitamins, and Minerals, three key elements that keep our bodies functioning well every day.

In Unit VIII: Nutrient Functions, we explore how different nutrients—like carbohydrates, proteins, fats, vitamins, and minerals—work in our bodies. Each nutrient has a unique role: carbohydrates give us energy, proteins help build and repair tissues, and fats support cell growth and hormone production. All nutrients work together to keep us healthy and strong.

In Unit IX: Vitamins, we'll learn about the various vitamins that our body needs, such as vitamins A, B, C, D, E, and K. These vitamins help our body perform critical tasks like strengthening our immune system, improving vision, and supporting skin health. Since our body can't produce most vitamins on its own, we must get them from the foods we eat.

Finally, in Unit X: Minerals, we focus on essential minerals like calcium, iron, magnesium, and zinc. These minerals are like the building blocks of our body, helping with bone formation, muscle function, and overall growth. Just like vitamins, minerals come from the food we eat, and understanding their importance helps us maintain a balanced and nutritious diet.

These units are all about understanding how nutrients, vitamins, and minerals are the foundation of a healthy body!

UNIT VIII: NUTRIENT FUNCTIONS

Structure

8.1 INTRODUCTION:

Nutrition is the one of the streams of science which deals with foods, the nutrients and other components they contain, their action, metabolism, absorption and interrelation with health and disease. It is the collaboration of science and art wherein, we study the different processes by which all organisms ingest, digests, absorbs, transports & utilizes nutrients & disposes of their end products.

In addition, nutrition can be influenced by different aspects of food and eating behaviors like for eg. Social, Economic, Cultural and Psychological. In short, nutrition science is the area of knowledge regarding the role of food in the maintenance of health.

FOOD: Any edible substance that we can consume or drink is called Food. Food provides us nourishment, takes care of wear and tear, heals our body and protects us from infections and diseases. Thus, food helps us to maintain good health. The major function of foods is the life support function. In addition to that, foods satisfy hunger & create pleasure & happiness, when we consume foods of our choice.

The primary functions of food are to take care of physiological function & maintain health by providing body building & regulatory functions. It also provides psychological satisfaction by relieving hunger when we relish food made by our loved ones.

With these aspects we shall study nutrients & their functions under the following subtopics •

NUTRIENT: Nutrients are the chemical substances which are obtained from the food we eat and they are used in our body to provide energy, to support our growth & development, maintenance & repair of the body's tissues. Some of these nutrients are meant for reducing the risks of degenerative diseases and deficiency disorders.

ESSENTIAL NUTRIENT: An essential nutrient is a nutrient that our body cannot synthesize on its own or also not to an adequate amount & must be provided by dietary sources. These nutrients are necessary for the body to function properly. The six essential nutrients include carbohydrates, protein, fat, vitamins, minerals and water.

8.2 CLASSIFICATION: The nutrients are classified on the specific basis, based on which they have been grouped under different terminologies.

1. Classification based on the need and requirements in our body:

a) Macronutrients

b) Micronutrients

2. Classification based on the function they perform in our body:

a) Energy giving nutrients (GO Nutrients)

b) Body building nutrients (GROW Nutrients)

c) Protective nutrients (GLOW Nutrients)

Let us know more about them.

8.2.1 MACRONUTRIENTS : Macronutrients provide the bulk to the diet and they are needed in large quantities by our body. They supply energy as well as the essential nutrients needed for growth, maintenance, & activity. They include carbohydrates, proteins and fats. Water is also included in macronutrients.

8.2.2 MICRONUTRIENTS: Nutrients which are just essential in small quantities for the proper functioning of our body are referred to as micronutrients. Minerals and vitamins are grouped under the micronutrient category.

8.2.3 ENERGY GIVING NUTRIENTS : Those nutrients which provide energy to the body are called Energy giving nutrients. For Eg., Carbohydrate, Fats

8.2.4 BODY BUILDING NUTRIENTS: Those nutrients which help to build up muscle and tissues, help in growth and development of the body and maintain repair are called Body building nutrients. For Eg., Protein.

8.2.5 PROTECTIVE NUTRIENTS: Those nutrients which are effective in providing protection to the body from various infections are called Protective nutrients. For Eg., Vitamins and Minerals.

Water is considered as a regulatory nutrient which does not provide above mentioned functions, still is very vital for life. One cannot survive without water for more than a few days.

8.3 BASAL METABOLIC RATE (BMR)

The amount of energy required to carry on the involuntary work of the body is known as basal metabolic rate. It includes the functional activities of the various vital organs such as brain, heart, liver, kidney & lungs & also the secretory activities of glands, peristaltic movements of gastrointestinal tract, oxidation occurring in resting tissue, maintenance of muscle tone & body temperature. In general terms, it is the amount of the energy expenditure required when the body is at rest and no physical movements are taking place. For Eg., When we are lying on bed or at sleep.

Determinants of BMR

Many factors affect the BMR of an individual, they are as follows;

1) **Body composition**

2) **Gender:** males have higher muscle mass & lower body weight therefore they have high BMR. Females have higher fat mass & thus have lower BMR.

3) **Age:** BMR decreases with advancing age.

4) **Hereditary factors:** some people are bone with faster metabolism & some with slower metabolism.

5) **Body surface area:** surface area depends on height & weight. Greater the surface area higher the BMR & vice versa.

6) **Hormones:** some of the endocrine hormones like thyroid, catecholamine, adrenaline, growth hormone all of them increase.

7) **Pregnancy:** BMR increases by 5% during the first & second trimesters. During the last trimester it increased by 12%.

8) **State of nutrition:** BMR is lowered during starvation, malnutrition & wasting diseases.

8.4 BODY MASS INDEX (BMI)

Body mass index (BMI) is a measure of relative size based on the mass and height of an individual. BMI is defined as the ratio of weight (kgs) to height^2 (meter) of an individual (Fig:1).

BMI is used as a screening tool to indicate whether a person is underweight, overweight, and obese or a healthy weight for their height. It is a simple, inexpensive and noninvasive measure of body fat. BMI values are age-independent and the same for both genders. However, BMI may not correspond to the same degree of fatness in different populations due to different body proportions. BMI Range :(Table 1) gives the range of BMI. Fig.2 (BMI ranges for men & women)

Imperial System:

$$BMI = 703 \times \frac{\text{Weight (in pounds)}}{\text{Height}^2 \text{ (in inches)}}$$

Metric System:

$$BMI = \frac{\text{Weight (in kilograms)}}{\text{Height}^2 \text{ (in meters)}}$$

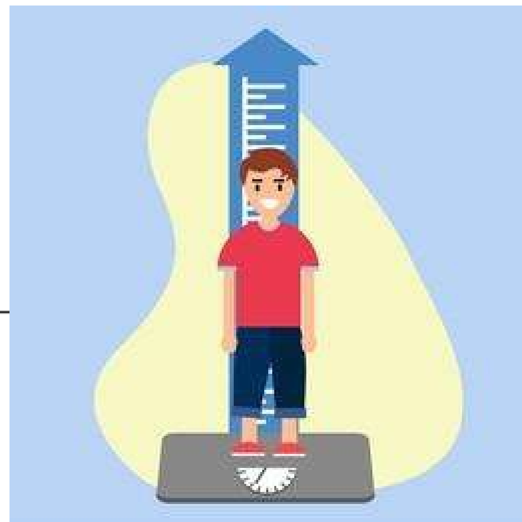


Fig.1: Formula for calculation of Body Mass Index (BMI)

Table 1: BMI standard ranges, their relationship to the nutritional status & obesity.

BMI (kg/m^2)	**Nutritional status**
Below 18.5	Underweight
18.5–24.9	Normal weight
25.0–29.9	Pre-obesity
30.0–34.9	Obesity class I
35.0–39.9	Obesity class II
Above 40	Obesity class III

Raised BMI is a major risk factor for non-communicable diseases such as- cardiovascular diseases (mainly heart disease and stroke), which were the leading cause of death all round the world; Type II

Diabetes Mellitus; Musculoskeletal disorders (especially osteoarthritis – a highly disabling degenerative disease of the joints); Some cancers (including endometrial, breast, ovarian, prostate, liver, gallbladder, kidney, and colon). The risk for these non-communicable diseases increases, with increases in BMI. As the high BMI is the sign of higher levels of adiposity and obesity which the root cause of various deadly lifestyle disorders.

Fig.2: BMI ranges for the men and women.

8.5 DIETARY REFERENCE INTAKES

The results of research studies in the field of nutrition are used by Scientists/Researchers to derive standards. These standards explain the amounts of individual nutrients required by healthy individuals of all age groups for supporting health. Such standards are collectively called as ***'Dietary Reference Intakes'*** which is an umbrella term for the following individual values:

1. **Estimated average requirements(EAR)**

The estimated nutrient requirement that is adequate in 50% of the population studied and is used to develop the recommended dietary allowances.

2. **Recommended dietary allowances (RDA)**

RDAs are estimates of nutrients to be consumed daily to ensure the requirements of all individuals in a given population. RDA is adequate for 97-98% of the healthy population and is separate for physiological groups such as infants, preschoolers, children, adolescents, pregnant women, lactating mothers, and adult men and women, taking into account their physical activity. RDA also includes a margin of safety to cover variation between individuals, dietary traditions and practices.

3. **Adequate intakes (AI)**

For some nutrients, there is insufficient knowledge to determine an Estimated Average Requirement (which is needed to set an RDA). In these cases, an AI is used which reflects the average amount of a nutrient that a group of healthy people consume.

4. **Tolerable upper intake levels (UL)**

It is the maximum intake of a nutrient that is not associated with adverse side effects in most individuals of the healthy population. Overall, these recommendations apply to healthy people and may not be appropriate for people with diseases who have altered nutrient needs. Care should be taken to consider country specific recommendations while deciding the nutrient requirements

Let us study RDA in detail.

8.6 RECOMMENDED DIETARY ALLOWANCES (RDA)

RDA is defined as "the average daily dietary intake level that is sufficient to meet the nutrient requirement of nearly all healthy individuals (97-98%) in a particular life stage & gender group". RDA is revised periodically by the Expert Group of Indian Council of Medical Research (ICMR)& updated with newer concepts & emerging knowledge concerning human nutrient requirements. RDA is based on Indian reference man & reference woman.

Reference Man and Reference Woman

For the purpose of computing the total nutrient needs of the population at the national level, the concept of reference man and woman is used.

- ❖ Reference men and women are defined on the basis of body weight of well-nourished healthy adults in each country, who have satisfactory growth during their childhood and are currently leading a healthy and active life.

- ❖ **The Referenced man** is between 18-29 years of age, and weighs 60 kg with a height of 1.73m with a BMI of 20.3. He is free from disease and physically fit for active work. On each working day, he is employed for 8 hours in an occupation that usually involves moderate activity. While not working, he spends 8 hours in bed, 4-6 hours in sitting and moving about and 2-4 hours in walking and in active recreation or household duties.

- **Reference woman is** between 18-29 years of age, non- pregnant, non-lactating and weighs 55 kg with a height of 1.61 m and a BMI of 21.1 is free from disease and physically fit for active work; on each working day, she is engaged in 8 hours of occupation which usually involves moderate activity, while when not at work she spends 8 hours in walking or active recreation or household chores.

RDA can also be defined as follows:

Recommended Dietary Allowances-*The Recommended Dietary Allowances (RDA) are the levels of intake of the essential nutrients that are judged to be adequate or sufficient to meet the nutrient requirement of nearly all (97 to 98 percent) healthy individuals in a particular life stage and gender group.*

A safety factor is considered while deciding the RDA for all nutrients except for energy. Thus, RDAs provide safe and adequate levels of nutrients needed by different age groups. A diet composed of a variety of foods from diverse food groups will be adequate in meeting the RDA for all nutrients.

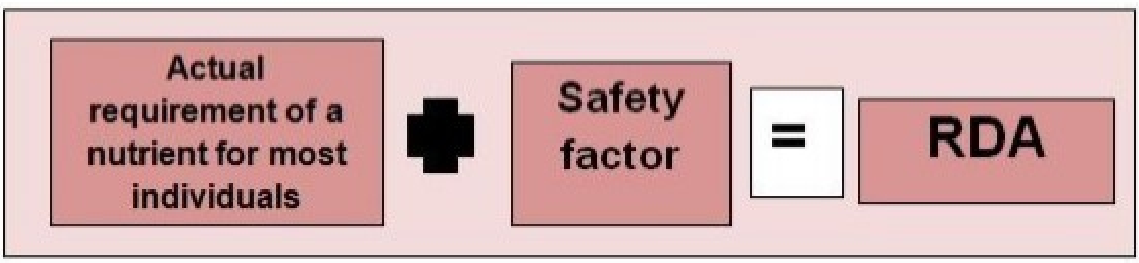


Fig.3: Simplification of RDA definition.

The latest RDA was revised in 2020 & recommendations for different age groups with nutrient requirement are shown below:

Age Group	Category of work	Body Wt	Protein	CHO	Cal cium	Magne sium	Iron	Zinc	Iodine	Thiamine	Ribo flavin	Niacin	Vit B6	Folate	Vit B12	Vit C	Vit A	Vit D
		(kg)	(g/d)	(g/d)	(mg/d)	(mg/d)	(mg/d)	(mg/d)	(µg/day)	(mg/d)	(mg/d)	(mg/d)	(mg/d)	(µg/d)	(µg/d)	(mg/d)	(µg/d)	(IU/d)
Men	Sedentary									1.4	2.0	14	1.9					
	Moderate	65	54.0	130	1000	385	19	17	150	1.8	2.5	18	2.4	300	2.5	80	1000	600
	Heavy									2.3	3.2	23	3.1					
Women	Sedentary									1.4	1.9	11	1.9					
	Moderate	55	45.7	130	1000	325	29	13.2	150	1.7	2.4	14	1.9	220	2.5	65	840	600
	Heavy									2.2	3.1	18	2.4					
	Pregnant woman	55 + 10	+9.5 (2nd trimester) +22.0 (3rd trimester)	175	1000	385	40	14.5	250	2.0	2.7	+2.5	2.3	570	+0.25	+15	900	600
	Lactation 0-6m		+16.9	200	1200	325	23	14	280	2.1	3.0	+5	+0.26	330	+1.0	+50	950	600
	7-12m		+13.2	200						2.1	2.9	+5	+0.17	330				
Infants	0-6 m*	5.8	8.1	55	300	30	-	-	100	0.2	0.4	2	0.1	25	1.2	20	350	400
	6-12m	8.5	10.5	95	300	75	3	2.5	130	0.4	0.6	5	0.6	85	1.2	27	350	400
Children	1-3y	11.7	11.3	130	500	135	8	3.0	90	0.7	0.9	7	0.9	110	1.2	27	390	
	4-6y	18.3	15.9	130	550	155	11	4.5	120	0.9	1.3	9	1.2	135	1.2	32	510	600
	7-9 y	25.3	23.3	130	650	215	15	5.9	120	1.1	1.6	11	1.5	170	2.5	43	630	
Boys	10-12y	34.9	31.8	130	850	270	16	8.5	150	1.5	2.1	15	2.0	220	2.5	54	770	600
Girls	10-12y	36.4	32.8	130	850	255	28	8.5	150	1.4	1.9	14	1.9	225	2.5	52	790	600
Boys	13-15y	50.5	44.9	130	1000	355	22	14.3	150	1.9	2.7	19	2.6	285	2.5	72	930	600
Girls	13-15y	49.6	43.2	130	1000	325	30	12.8	150	1.6	2.2	16	2.2	245	2.5	66	890	600
Boys	16-18y	64.4	55.4	130	1050	405	26	17.6	150	2.2	3.1	22	3.0	340	2.5	82	1000	600
Girls	16-18y	55.7	46.2	130	1050	335	32	14.2	150	1.7	2.3	17	2.3	270	2.5	68	860	600

* AI

(Source:Summary Of Recommendations, Recommended Dietary Allowances & Estimated Average Requirements For Indians – 2020, A Short Report Of Expert Group, ICMR-NIN.)

Fig.4: SUMMARY OF R.D.A. FOR INDIANS-2020.

The various applications of RDA include:

- Comparison of individual intakes to the RDA allows an estimate to be made about the probable risk of deficiency among individuals.
- Modifying nutrient requirements in clinical management of diseases,
- To help public health nutritionists to compose diets for schools, hospitals, prisons etc.
- For health care policy makers and public health nutritionists to design, develop nutrition intervention programmes and policies,
- For planning and procuring food supplies for population groups,
- For evaluating the adequacy of food supplies in meeting national nutritional needs.
- For interpreting food consumption records of individuals and populations,
- For establishing Standards for the national feeding programmes implemented by the Governments for its vulnerable population,
- For designing nutrition education programmes for the masses,
- For developing new food products and dietary supplements by the industry,
- Establishing guidelines for the national labeling of packaged foods (by Food Standards Safety Authority of India (FSSAI).

Factors on which RDA depends:

I. **Age of the individual:** RDAs increase with age in young children and after adulthood during old age they gradually decrease.

II. **Physical activity:** On the basis of physical activity, individuals have been classified as follows:
    - Sedentary worker – with least physical activity like lawyer, teacher, doctor
    - Moderate worker – with moderate physical activity like carpenter, tailor, plumber
    - Heavy worker- with vigorous physical activity like coal miner, steel worker, army man.

III. **Sex:** Male has higher values than females

IV. **Body Composition**

V. **Vulnerable:** pregnant and lactating mothers, infants and elderly people.

Why Is RDA Important?

- Maintenance of a state of positive health and optimal performance in populations at large by maintaining ideal body weight.
- Ensuring adequate nutritional status for pregnant women and lactating mothers.
- Improvement of birth weights and promotion of growth of infants, children and adolescents to achieve their full genetic potential.
- Achievement of adequacy in all nutrients and prevention of deficiency diseases.
- Prevention of chronic diet-related disorders.
- Maintenance of the health of the elderly and increasing life expectancy.

General Principles of Deriving RDA

Number of methods have been employed for determining the human nutrient requirements.

I. **Dietary intake**: This approach has been used in arriving at the energy requirements of children. Energy intakes of normally growing healthy children are utilized for this purpose.

II. **Growth:** The requirements of any particular nutrient or the breast milk intake, for satisfactory growth has been utilized for defining requirements in early infancy.

III. **Nutrient balance:** The minimum intake of nutrients for equilibrium (intake=output) in adults and nutrient retention consistent with satisfactory growth in children have been used widely for arriving at the protein requirement.

IV. **Obligatory loss of nutrients:** The minimal loss of any nutrient or of its metabolic products (namely nitrogenous end products in the case of proteins) through normal routes of elimination- urine, feces and sweat- is determined on a diet devoid of or very low in the nutrient.This information is used to determine the amount of nutrient to be consumed daily through the diet to replace the obligatory loss.

V. **Factorial approach:**In this approach, the requirements for different functions are assessed separately and added to arrive at the total daily requirements.

VI. **Nutrient turnover:** Data from turnover of nutrients in healthy persons, using isotopically labeled nutrients have been employed in arriving at requirements of certain nutrients. Requirements of Vitamin A and Vitamin C, iron and Vitamin B_{12} have been determined on this basis.

Practical Application of RDA

- To assess the adequacy of national food supplies and to plan for food production both in terms of quantity and quality e.g., agriculture planning
- To provide dietary guidelines for healthy living individuals and groups and to formulate balanced diets.
- RDA can also be used for judging the adequacy of intake of individuals or groups in a preliminary way. In the case of adult individuals, RDA has to be adjusted for the actual body weight while assessing the adequacy of intake.
- RDAs are used for formulating diet plans for patients in various illnesses and nutrient deficiency diseases after specific modifications related to the subject.

8.7 ENERGY METABOLISM

Energy is the ability to do work. The energy contained within the chemical constituents of food can be either trapped within the chemical constituents of the body or used to produce heat. Energy is a defined property of chemical compounds & other physical systems. Carbohydrates, fats, proteins in the diet are responsible for its energy content & are made available to the body when these compounds are oxidized in the energy releasing reaction of respiration.

Units of energy

All forms of energy are interconvertible. The energy value of food is expressed in **"kilocalories"** which have been used in nutrition for a long time. One kilocalorie is defined as "*the amount of heat energy required to raise the temperature of 1 kg of water by 1°C at normal atmospheric pressure*".

However, recently the International Union of Science & the International Union of Nutritional Science (IUNS) has adopted 'Joule' as the unit of energy instead of kcal.

A joule is defined as *"the energy required to move 1 kg mass by 1 meter by force of 1 Newton acting on it"*.

1 kcal = 4.184 kJ

1 kJ = 0.239kcal

1000 kcal = 4184 kJ

1mJ = 239 kcal

Energy value of food

The energy value of a food indicates its value to the body as a fuel. After a food is ingested, some of its energy may be 'lost' during digestion and metabolism. Only three food classes release energy & they are carbohydrates, proteins & lipids. Carbohydrates give 4 calories/g, proteins 4 calories/g & fat 9 calories/g calories (Fig:5) the energy released from food is measured in calories.

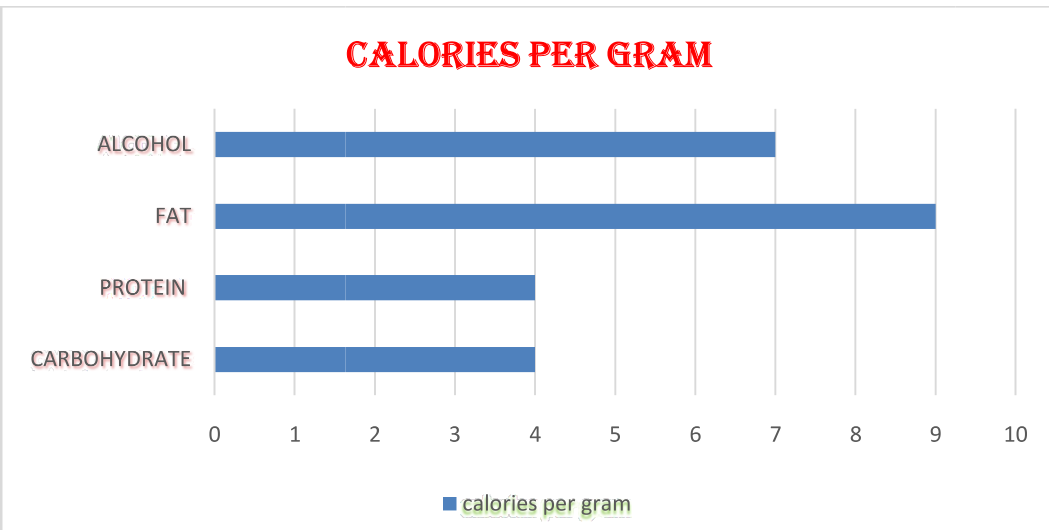


Fig. 5: Calorie content of molecules

Determination of energy value of foods

The first system for giving energy values to the macronutrients was described by Dr. W. O. Atwater in 1899. The amount of energy released from foods & the amount of energy expended by an individual can be obtained by direct & indirect calorimetry.

The principle of direct calorimetry includes the chemical changes that occur when carbohydrates or fat are oxidized during respiration in the body & the chemicals are burnt in the air. The amount of energy released or expended is measured by the heat produced.

Indirect calorimetry is based on the principle that when an organic substance is completely combusted either in calorimetry or in the human body. Oxygen consumed in amounts is directly related to the energy liberated as heat.

Although the energy value of some foods has been found by combustion in a bomb calorimeter, the amounts of the macronutrients - fat, protein, carbohydrate - in a food are taken into account when assessing the total energy value of the food.

Physiological fuel value

The amount of energy available to the body from a given amount of nutrients is called physiological fuel value. In the human body the process of digestion does not proceed with 100% efficiency as carbohydrates, fats & proteins are not completely oxidized.

Therefore, the entire amount of any ingested nutrient does not eventually become available to the body. The efficiency with which nutrient is digested must be taken into account. The coefficient of digestibility is used to express the proportion of an ingested nutrient that ultimately becomes available to the body's cells.

Table 2: Equipment used & purpose in direct & indirect calorimetry

Principle	**Equipment**	**Purpose**
Direct calorimetry	Bomb calorimeter	Energy value of food
	At water Rose respiration calorimeter	Energy expenditure during BMR/RMR
Indirect calorimetry	Benedict's oxy calorimeter	Energy value of food
	Eenedict-Roth respiration	Determination of BMR
	Douglas bag	Energy expenditure respirometer during work
	Max Plank	

The coefficients of digestibility for carbohydrate, fat & protein are 0.98, 0.95 & 0.92 respectively. There is no loss in metabolism of carbohydrate & fat. But in the case of protein, a part of energy is lost as urea due to incomplete oxidation. The loss has been estimated to be 1.3 kcal/g of protein oxidized.

The physiological energy values of carbohydrates, fats & proteins are 4, 9 & 4 respectively after making changes for losses of food energy in digestion & metabolism. These values are called Atwater Bryant factors or physiological fuel values.

Energy requirement

The energy requirement of an individual is based on the level of energy intake from food that will balance energy expenditure. The human body's total energy needs can be divided into three important components as follows- (Fig. 6)

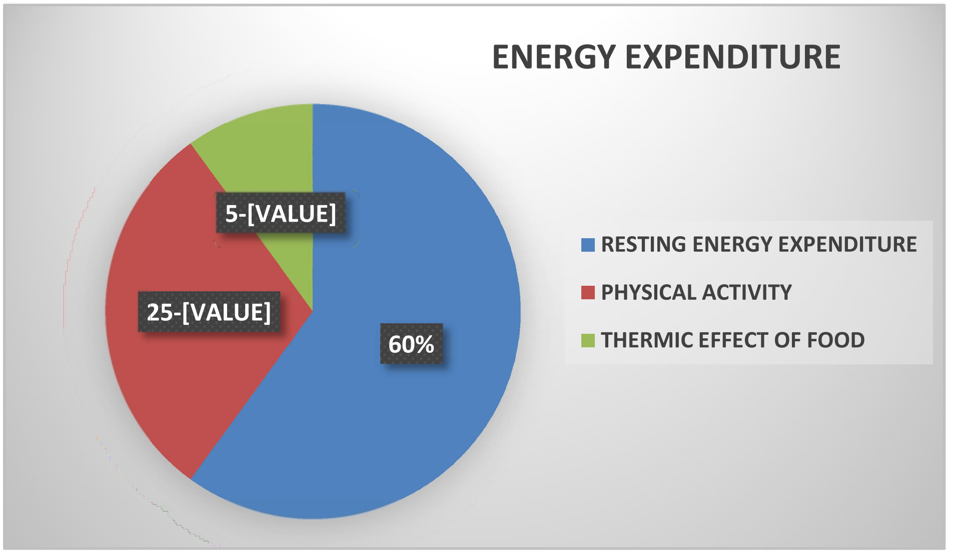


Fig. 6: Components of energy expenditure

1) Energy required to maintain basal metabolism (60%)

2) Energy required for the muscle movements or physical activity (25-30%)

3) The energy that is released as a result of the thermic effect of food (5-10%).

RDAs for Energy: The total energy requirement or the total energy expenditure (TEE) is calculated based on multiplication of basal metabolic rate (BMR) to physical activity level(PAL): TEE = BMR X PAL.

Now, in this unit we will study our macronutrients (Carbohydrates, Lipids and Proteins) in details under the sub-heading of Definition, Classification, Dietary Sources, Functions, Recommended Dietary Allowances, Clinical signs and symptoms of Deficiency diseases and Excess.

8.8 CARBOHYDRATES:

Carbohydrates are a major source of energy for humans, providing approximately 45 percent to 80 percent of the total caloric intake in different income groups.They are mainly present in food in the form of sugars, starches, and fibers.

Definition: Carbohydrates may be defined as polyhydroxy aldehydes or ketones or compounds which produce them on hydrolysis.Carbohydrates are primarily composed of carbon, hydrogen and oxygen. They have general an empirical formula-CnH2nOn

Table 3a. Summary of recommended energy requirement for Indians

Age group	Category	ICMR 2020	ICMR 2010	Difference
		Kcal/d		
Adult Men	Sedentary work	2110	2320	**-210**
	Moderate work	2710	2730	**-20**
	Heavy work	3470	3490	**-20**
Adult Women	Sedentary work	1660	1900	**-240**
	Moderate work	2130	2230	**-100**
	Heavy work	2720	2850	**-130**
	Pregnant	+ 350	+ 350	**--**
	Lactating (0-6m)	+600	+600	**--**
	Lactating (7-12m)	+520	+520	**--**
Infants	0-6 months	530	520	**+10**
	6-12 months	660	670	**-10**
Children*	1-3 y	1070	1060	**+10**
	4-6 y	1360	1350	**+10**
	7-9 y	1700	1690	**+10**
Boys	10-12 y	2220	2190	**+30**
Girls	10-12 y	2060	2010	**+50**
Boys	13-15 y	2860	2750	**+110**
Girls	13-15 y	2400	2330	**+70**
Boys	16-18 y	3320	3020	**+300**
Girls	16-18 y	2500	2440	**+60**

*For children 1% increase over the previous recommendations.

Table 3b. Energy Requirement*

Age Group	Category	Body weights	(kcal/d)[a]	(kcal/kg/day)
Men	Sedentary work	65.0	2110	**32**
	Moderate work	65.0	2710	**42**
	Heavy work	65.0	3470	**53**
Women	Sedentary work	55.0	1660	**30**
	Moderate work	55.0	2130	**39**
	Heavy work	55.0	2720	**49**
	Pregnant	55.0 + GWG[b]	+ 350	
	Lactating	55.0+	+600 +520	
Infants	0-6 m	5.8	530	**90**
	6-12m	8.5	660	**80**
Children[c]	1-3y 4-6y 7-9 y	12.9 18.3 25.3	1110 1360 1700	**83** **74** **67**
Boys	10-12y	34.9	2220	**64**
Girls	10-12y	36.4	2060	**57**
Boys	13-15y	50.5	2860	**57**
Girls	13-15y	49.6	2400	**49**
Boys	16-18y	64.4	3320	**52**
Girls	16-18y	55.7	2500	**45**

[a] Rounded off to the nearest 10 kcal/d

[b] GWG: Energy need in pregnancy should be adjusted for actual bodyweight, observed weight gain and activity pattern for the population

[c] Energy needs of children and adolescents have been computed for reference children and adolescents; with a moderate daily physical activity level.

*The actual requirement in specific population groups should be adjusted for the actual weight and physical activity of that population

(Source: A Brief Note on Nutrient Requirements for Indians, the Recommended Dietary Allowances (RDA) and the Estimated Average Requirements (EAR), ICMR - NIN, 2020)

Classification:

Carbohydrates, which are of immense importance in the diet, are classified on the basis of the sugar units present in them as simple carbohydrates and complex carbohydrates.

Monosaccharides and disaccharides make up simple carbohydrates, called simple sugars, which contain one and two sugar units, respectively. **Polysaccharides,** called complex carbohydrates, are structurally larger and more complex than simple sugars. They include starch, dietary fiber, and glycogen. There are two main classes of monosaccharides based on the carbonyl group present in them. They are aldoses and ketoses, aldoses (e.g., glucose) containing the aldehyde group (CHO) and ketoses (e.g., fructose) containing the ketone group (C=O).

Aldoses are further divided into trioses, tetroses, pentoses, and hexoses based on the number of carbon atoms.

The common disaccharides are maltose, lactose, and sucrose, which, upon hydrolysis, yield two monosaccharide units.

Polysaccharides have a high molecular weight and are insoluble in water. They are in the form of long chains, either branched or unbranched. The polysaccharides are further classified into groups depending upon the products they yield on hydrolysis. Homopolysaccharides yield only one type of monosaccharide unit on hydrolysis, e.g., starch, dextrin, cellulose, and glycogen.

Heteropolysaccharides yield more than one type of monosaccharide unit on hydrolysis, e.g., heparin and hyaluronic acid. Heparin is an anticoagulant found in the liver, spleen, lungs, and blood. Hyaluronic acid is found in the umbilical cord, synovial fluid, and vitreous humor. It has a lubricating action. In tissues, it forms an important part of the cementing ground substance.

The sugars are also classified as reducing and nonreducing sugars. The reducing property is attributed to the free aldehyde or keto group. They may also be classified as available and unavailable carbohydrates.

Available carbohydrates: carbohydrates that can be digested in the human body and yield energy when they are oxidized in the body.

Unavailable carbohydrates: carbohydrates that cannot be digested because the human body does not contain the enzymes necessary for their breakdown. Unavailable carbohydrates do not provide any energy to the body but are necessary as they perform some important functions in the body, such as the elimination of fecal waste.

Dietary Sources:

Daily diet should provide up to 50–70 percent kcal of energy from carbohydrate.Carbohydrates are not only an economical source of energy but are also readily available and easy to store as they have a long shelf life.The important sources of carbohydrates in the diets of Indians are cereals and millets, roots, tubers, pulses, sugar and jaggery.All sugars provide 4 kcal/g of energy.The carbohydrate and calorie content of a food can be reduced by using sugars which are sweeter than sucrose so that the quantity of sugar required will be less.

Functions:

- The chief function of carbohydrate is to provide energy to the body so that it can carry out day to day work to maintain body temperature. All carbohydrates except fiber provide 4 kcal/g of energy. It is the cheapest source of energy available.
- Glucose is the only form of energy used by the central nervous system. When blood glucose levels fall, the brain does not receive energy and convulsions may occur.
- Carbohydrates spare proteins from being broken down for energy and are used for body building and repair. In carbohydrate deficient diets, proteins meant for body building and repair are oxidized to meet the most important and primary need of the body, i.e., energy.
- They are required for complete oxidation of fat. In the deficiency, fats are broken down rapidly for energy and intermediate products such as ketones are formed in large amounts resulting in a condition called ketosis.
- Carbohydrates can be converted into non-essential amino acids, provided a source of nitrogen is available.
- The sugar lactose helps in the absorption of minerals calcium and phosphorus.
- Lactose helps certain bacteria to grow in the intestine. This bacterial flora is capable of synthesizing B complex vitamins in the gut
- Dietary fiber plays an important role in increasing fecal mass by absorbing and holding water, stimulating peristalsis, and eliminating fecal waste.
- Fibre also helps in lowering blood cholesterol levels by binding bile acids and cholesterol.

RDAs:

Table 4: RDA (2020) for Carbohydrate

Age Group	Category Of Work	Body Weight (kg)	Carbohydrate (g/d)
Men	Sedentary	65	130
	Moderate		
	Heavy		
Women	Sedentary	55	130
	Moderate		
	Heavy		
	Pregnant	55+10	175
	Lactation (0-6m)		200
	Lactation (7-12m)		200
Infant	0-6m	5.8	55
	6-12m	8.5	95
Children	1-3y	11.7	130
	4-6y	18.3	130
	7-9y	25.3	130
Boys	10-12y	34.9	130
Girls	10-12y	36.4	130
Boys	13-15y	50.5	130
Girls	13-15y	49.6	130
Boys	16-18y	64.4	130
Girls	16-18y	55.7	130

***AI**

Deficiency:

The daily diet should not contain less than 100 gram of carbohydrate. A deficiency of carbohydrate in the diet results in utilization of fat for energy. In severe deficiency, incomplete oxidation of fats causes ketone bodies to accumulate in the blood.

Excess:

- Excessive consumption of refined sugars could be one of the causes of dental caries or tooth decay.
- Excessive sugar depresses the appetite, provides hollow calories,and could result in malnutrition.

- High intake of sugar and refined carbohydrates increase the blood triglyceride levels leading to heart diseases.
- When excessive carbohydrates are consumed, they are converted into fat and deposited in the adipose tissue, which could lead to obesity, i.e., body weight of 20 per cent or more than the desirable weight.
- Excessive fibre could irritate the intestinal lining, causing cramps or bloating due to gas formation.
- Excessive fibre interferes with the absorption and availability of minerals elements such as iron and calcium

8.9 LIPIDS:

Definition: Lipids consist of a group of compounds containing fats and oils, which are insoluble in water but soluble in fat solvents. Similar to carbohydrates, they are mainly made up of carbon, hydrogen and oxygen. They contain much smaller proportions of oxygen than carbohydrates and larger proportions of carbon and hydrogen. They are a more concentrated source of energy, providing two and a quarter times more energy than carbohydrates and proteins.The lipids of importance to our health are fatty acids, fats, oil, phospholipids, lipoproteins, and sterols.

Classification:

A. **Classification Based On Structure:**Based on their structure lipids are classified into simple lipids, compound lipids, derived lipids, sterols

i. **Simple lipids:**They constitute more than 98 per cent of food and body fats. Simple lipids are made up of three fatty acids attached to glycerol. They are mixed triglycerides which means that more than one type of fatty acid is present in the fat, e.g., cooking oils and butter.

ii. **Compound lipids:**They are fats in which at least one fatty acid is replaced by carbohydrates, protein, or phosphorous, i.e., they are fats + non fat molecules, e.g., phospholipids, glycolipids, and lipoprotein.

iv. **Derived lipids:** They are the breakdown products of fats and include diglycerides, monoglycerides, glycerol and fatty acids.

v. **Sterols:** They are not made up of fatty acids and glycerol but have a benzene ring structure. These fat-like substances include cholesterol and fat soluble vitamin A, D, E, K.

Fatty Acids: Fatty acids consist of a chain of carbon atoms with a methyl (CH3) group at one end and a carboxyl (COOH) group at the other end. Fatty acids may have short chains or they may have long chains (12-22 carbon chains).They may be saturated or unsaturated.Saturated fats have single bonds between carbon atoms, while unsaturated fats have one or more double bonds between the carbon atoms. Fatty acids with two or more double bonds are called polyunsaturated.

Fatty acids are classified as saturated fatty acids and unsaturated fatty acids. Unsaturated fatty acids are further classified as monounsaturated fatty acids and polyunsaturated fatty acids.

Monounsaturated Fatty Acid: Oleic acid is a monounsaturated fatty acid and has one double bond. It is found in groundnut, olive oil, corn oil, etc. It may help lower blood cholesterol levels. It is an omega-9 fatty acid.

Polyunsaturated Fatty Acid: The polyunsaturated fatty acids are those with two or more double bonds. They include linoleic acid (two double bonds) linolenic acid (three double bonds), and arachidonic acid (four double bonds). They help in lowering blood cholesterol levels and prevent atherosclerosis and coronary heart disease.

Essential Fatty Acids: Two of the PUFA cannot be synthesized by the body. They have to be provided in the required amount by our diet and are called essential fatty acids. They are linoleic acid (an omega-6 fatty acid), and linolenic acid (an omega-3 fatty acid). Omega is the last letter of the Greek alphabet used by scientists for naming fatty acids.

Omega-6 Fatty Acids: Omega-6 fatty acids have the last double bond located on the sixth carbon from the methyl or omega end.Essential fatty acid linoleic acid (18:2 omega 6) and arachidonic acid (20:4 omega 6) are omega-6 fatty acids. And are present in number of foods.Omega-6 rich oils include safflower, sunflower, cottonseed, corn, sesame, and groundnut.When consumption of omega-6 goes up, need for omega-3 increases.Omega-3 and omega-6 in the correct ratio helps in reducing blood cholesterol levels.

Saturated Fatty Acids: These are found in animal food such as meat, butter, cheese, and egg yolk and in plant food such as coconut oil, palm oil, and cocoa butter.Hydrogenated fats used in bakery products and confectionaries have high percentage of saturated fatty acids.Stearic acid, palmitic acid, myristic acid and butyric acid are some of the saturated fatty acids.A maximum 10 percent of our total calories should come from saturated fats

Phospholipids: They are composed of fats, phosphoric acid, and a nitrogenous base, e.g., lecithin and cephalins.They are required for cell permeability and for the formation of brain and nervous tissue.They help in transporting fats throughout the body as they form a part of the lipoproteins.

Glycolipids: They contain glucose or galactose in place of one of the fatty acids in the triglyceride.

Lipoproteins: They include chylomicrons, very low-density lipoproteins (VLDL), low density lipoproteins (LDL), and high-density lipoprotein (HDL).They are composed of lipids (triglycerides, cholesterol, and phospholipids) and proteins in varying proportions with percentage of proteins being least in chylomicrons and most in HDL. Lipoproteins are required for transporting triglycerides to various tissues in the body via blood circulation.Triglycerides are encased by a covering of water-soluble proteins which help them to circulate in water-based blood. These lipid protein complexes are called lipoproteins.Since LDL are the main carriers of cholesterol, an increase in LDL increases the risk of heart disease. High density lipoproteins help in lowering cholesterol levels. An LDL/HDL ratio of less than 3 is desirable.

Cholesterol: It is a fatlike substance present in food. It is different in structure from triglycerides, as it has a ring structure. It is present in all cells of the body and in large amounts in brain and nerve tissueCholesterol if consumed in excess is responsible for disease of the cardiovascular system.The normal blood cholesterol level for adults should be below 200mg/100ml blood.If the diet is deficient in cholesterol, the body can synthesize the required cholesterol.The human gets cholesterol from two sources:

1. Synthesis in the liver
2. Food rich in cholesterol

Dietary Sources:

A. **Plant Sources:**All oils and oilseeds, such as groundnut, sesame, soya bean, rice bran, coconut, almond, cashew nut, corn, safflower, sunflower, and all hydrogenated fats and margarine are sources of lipids.
B. **Animal Sources:**Mutton, pork, fish, poultry, milk and milk products (butter, cream, yoghurt, cheese), eggs. And organ meat are rich sources of lipids.

C. **Invisible Sources:**Invisible sources of fats are nuts, salad dressings, flesh food, desserts, cookies, cakes, milk, eggs, milk based sweets etc., which are rich in fat, but fat is not visible.

Table 5a- Fatty acid and their food sources.

Fatty Acid	Number Of Carbon Atoms	Number Of Double Bonds	Food Sources
Oleic Acid	18	1	Groundnuts, Sesame, Olives, Butter, Cocoa Butter, Cashew Nuts, Avocado.

Linoleic Acid	18	2	Safflower, Sunflower, Cottonseed, Corn, Soyabean, Groundnut, Salmon, Tuna.
Linolenic Acid	18	3	Soya Bean, Rapeseed, Sesame, Butter.
Arachidonic Acid	20	4	Animal Fats, Groundnut.
Eicosapentaenoic Acid	20	5	Fish Oils.
Erucic Acid	22	1	Rapeseed Oil/ Mustard Oil.

Table 5b- Fatty acid and their food sources.

Fatty Acid	Number Of Carbon Atoms	Food Source
Acetic Acid	2	Vinegar
Butyric Acid	4	Butter
Caproic Acid	6	Butter
Caprylic Acid	8	Coconut, Palm Kernel
Lauric Acid	12	Palm Kernel, Coconut
Myristic Acid	14	Coconut, Butter
Palmitic Acid	16	Palm, Soya, Sesame, Butter, Lard, Cotton Seed
Stearic Acid	18	Beef Tallow. Cocoa Butter, Lard

Table 5c- Cholesterol content in different food sources.

Food	Cholesterol (Mg)	Food	Cholesterol (Mg)
Beef	109	Mutton	70
Lard	95	Beef	70
Butter	250	Pork	70
Processed Cheese	150	Chicken With Skin	80
Paneer	19	Liver	300
Ice Cream	40	Brain	2000
Whole Milk	14	Fish	60
Skimmed Milk	2	Shellfish	150
Mawa Based Sweets	65	Vanaspati	0
Egg White (1 Egg)	0	Margarine (Veg Fat)	0
Egg Yolk (1 Egg)	252	All Plant Foods	0

Cholesterol is present in animal body only.Whole milk, butter, ghee, cream, egg yolk, organ meat, and shellfish are rich sources.Cholesterol is also synthesized by the body independent of the dietary intake.It is a precursor of all steroid hormones, e.g., sex hormones.A precursor of vitamin D, 7-dehydrocholesterol is present in the skin which is irradiated by ultraviolet (UV) rays of sunlight to form vitamin D. It is required for formation of bile and is an essential constituent of cell membrane.

Functions:

1. **Energy:** Fats are a concentrated source of energy in our diet. One gram of fat/oil gives 9 kcal when it is oxidized in the body. All tissues, except those of the central nervous system and brain, can utilize fat as a source of energy.
2. **Protein Sparing Action:**The kilocalories from fat spare dietary proteins from being oxidized for energy. An adequate intake of fat in the diet allows protein to perform their main function of growth and maintenance.
3. **Thermal Insulation:**Subcutaneous fats act as an insulation and help in retaining body heat.
4. **Absorption of Fat-Soluble Vitamins:**Fat is necessary for the absorption of fat-soluble vitamins A, D, E, and K.
5. **Protection of Vital Organs:**Fat provides a protective padding to vital organs from mechanical shock and keeps them in place.
6. **Essential Fatty Acids:**An adequate intake of fats /oils is necessary to meet the body's requirement for linoleic and linolenic acids.
7. **Satiety Value:**Fats slow down the secretion of gastric juice and speed of digestion. Food is more flavorsome because of volatile essential oils naturally present in fats used for cooking. A well-cooked meal containing fats is more satisfying than a meal devoid of fats.
8. **Synthesis of Cell Membrane:**Fats are an important constituent of all cell membranes.
9. **Synthesis of Hormones:**The lipid cholesterol is necessary for the synthesis of some hormones, e.g., sex hormones.

Fat should contribute not more than 30 percent of the total kilocalories. Kilocalories from saturated fat should not exceed 10 percent of the total calories and at least 10 percent calories should be provided by PUFA to ensure an adequate intake of essential fatty acid. The correct ratio of omega-3 to omega-6 fatty acids should be maintained.

The cholesterol intake should not exceed 200 mg/day. A variety of cooking oils should be used everyday to ensure consumption of all essential fatty acids. Non vegetarians should eat groundnut, corn, soya, and olive oil throughout the year, while for fish eaters a mixture of safflower and sunflower oil is adequate. Rice bran oil and corn oil is recommended for vegetarians.

RDAs:

Table 6: EAR values for Indians Of Fats-(2020)

Age Group	Category Of Work	Body Weight (kg)	Fats/Oils (visible)(g/d) (#)
Men	Sedentary	65	25
	Moderate		30
	Heavy		40
Women	Sedentary	55	20
	Moderate		25
	Heavy		30
	Pregnant	55+10	30
	Lactation (0-6m)		30
	Lactation (7-12m)		30
Infant	0-6m	5.8	-
	6-12m	8.5	25
Children	1-3y	11.7	25
	4-6y	18.3	25
	7-9y	25.3	30
Boys	10-12y	34.9	35
Girls	10-12y	36.4	45
Boys	13-15y	50.5	50
Girls	13-15y	49.6	35
Boys	16-18y	64.4	40
Girls	16-18y	55.7	35

#: Visible fat requirement is in proportion to EER

Deficiency:

- A deficiency of fat causes a deficiency of essential fatty acids, linoleic and linolenic acids and subsequently a deficiency of arachidonic acid.
- These (PUFA) are required for healthy cell membranes and their permeability. A deficiency results in characteristic eczema and skin lesions. It is seen in infants as dry scaly lesions on the skin. Toad skin or dry papules are seen on upper limbs.
- A deficiency of fat may result in a deficiency of fat-soluble vitamins, and growth and weight may be affected in children.

- Fat is present in minute quantities in almost all foods including cereals and pulses, a deficiency in adults is unlikely because these foods are consumed in large quantities.

Excess:

- The percentage consumption of fat varies widely in different regions and in different income groups. The percentage consumption increases directly with incomes, and today it is a major problem faced in urban areas and changing lifestyles.

- Excess intake of fat causes obesity because more kilocalories are consumed than required by the body. Excess fat is stored in the adipose tissue.

- Excessive consumption of saturated fats can elevate blood cholesterol levels. A high intake of saturated fats and cholesterol are predisposing factors for cardiovascular diseases, whole foods rich in omega-3 fatty acids have a protective effect.

8.10 PROTEINS:

Definition: Proteins are large, complex, organic compounds made up of carbon hydrogen, oxygen and nitrogen. Apart from nitrogen, elements such as sulphur, phosphorus, copper, and iron are also found in some proteins.

The basic units from which proteins are built are the amino acids. Each amino acid contains a carboxyl group (COOH) or acid group and an amino group (NH_2) or basic group.Proteins consist of chain of amino acids that are linked to each other by a peptide linkage (-C0-NH-)

Amino Acids: Twenty-two different amino acids are widely distributed in nature.

Essential Amino Acids: Those amino acids which cannot be synthesized in sufficient amounts by the body and must be provided by the diet are called essential amino acids.The human adult requires eight essential amino acids, while growing children require ten essential amino acids. Essential amino acids are indispensable to life.

Non-Essential Amino Acids: All amino acids are required by the body for tissue synthesis and repair.Non-essential amino acids do not mean that these amino acids are not required by the body.They are termed non-essential because they are not dietary essentials.If they are lacking in the diet, they can be synthesized by the body from other amino acids.Innumerable proteins can be formed by using the 22 amino acids in varying sequences and quantities.

Classification:

Proteins may be classified on the basis of their structure or on the basis of their quality, i.e., the amino acids present in them.

1. Classification By Structure

- **Simple Proteins:**These proteins are made up of amino acids only, e.g., zein in corn, albumin in egg white, and gliadin in wheat consist of amino acids only
- **Conjugated Proteins:**These proteins have a non-protein molecule attached to the protein, e.g., blood protein hemoglobin, which contains a haem (iron) group attached to protein and milk protein casein, which has a phosphate group attached.
- **Derived Protein:**These result from a partial breakdown of a native protein. Proteoses, peptones, and polypeptides are formed when digestive enzymes begin their action on proteins.

2. Classification By Quality: Proteins are classified into three groups on the basis of their quality.

- **Complete Proteins:** These proteins contain all essential amino acids in sufficient proportions and amounts to meet the body's need for growth and repair of tissue cells.

  A complete protein food has a high biological value. Eggs, Milk, Meat, fish, and poultry are complete protein foods. They are found in animal foods
- **Partially Complete Proteins:**These are proteins in which one or more essential amino acids are present in inadequate amounts.They cannot synthesize tissues without the help of other proteins. The value of each is increased when it is consumed in combination with another complete protein at the same meal.Cereals, pulses, nut, and oilseeds are partially complete protein foods.Cereals contain inadequate amounts of essential amino acid lysine, and pulses are deficient in essential amino acid methionine.
- **Incomplete Proteins**: These proteins are incapable of growth and repair of body cells.One or more essential amino acids may be completely lacking in these proteins, e.g., gelatin and zein in corn.Gelatin lacks three essential amino acids and is the only animal protein which is incomplete.

Dietary Sources: Proteins are present in both plant and animal foods

Animal Food Sources: Animal food sources provide the highest quality or complete proteins such as eggs, milk and milk products (cheese, paneer, mawa, milk powder, curds, condensed milk), meat, fish, shellfish, poultry, and organ meat.

Plant Food Sources: Pulses especially, soya bean (43% protein) and its products such as soya milk, tofu, textured vegetable proteins; nuts, and oilseeds- groundnut and gingelly seeds are important sources of protein in the Indian diet.

Cereal contain 6-12 % partially complete proteins and as they form the bulk of the diet, they contribute significantly to the protein content.Vegetables, with the exception of peas and beans, are poor sources of proteins. Green leafy vegetables contain a small percentage of good quality protein (1-3%). Fruits do not contribute towards the protein content of the diet

Special Protein Supplements:

1. Special protein supplements in the form of premix powders or ready to consume health drinks are available in a variety of popular flavours and different nutrient composition.
2. They are used by sports persons for minimizing muscle catabolism, boosting energy and muscle growth and stimulating greater fat loss.
3. Protein supplements are available in the form of pure protein isolates, weight gainers or as meal replacements.
4. The protein, carbohydrate and fat content varies in these supplements depending on what they are being recommended for.
5. The following proteins are used:

- Whey protein concentrate
- Complete milk protein
- Micellar casein
- Soya protein isolate

Functions: Proteins perform three main functions: structural function, regulatory function, and energy.

1. **Structural Functions:**

A. **Growth:** The primary function of food protein is the synthesis of body cells. All body tissue and fluids, except urine and bile, are made up of protein.Protein are the major constituent of muscles, organs, endocrine glands, and collagen. Collagen is the main structural protein of bones, tendons, ligaments, skin, blood vessels, and connective tissue.All enzymes and some hormones, e.g., insulin are made up of proteins. Proteins are required for the formation and growth of all these substances.During periods of rapid growth, additional proteins are needed for synthesis of body components.

B. **Maintenance Or Wear and Tear:**Protein is required by all age groups for continuous maintenance of all the cells in the body.Cells have a varying lifespan and proteins are needed to replace the old or worn out cell.

2.Regulatory Functions:

- All amino acids from food protein are used for growth and maintenance. Certain amino acids and proteins have highly specialized functions in the regulation of body processes and protection against disease. Some of the regulatory functions are as follows:
- Haemoglobin, an iron containing protein in the red blood cells, performs an important role by transporting oxygen to the tissue cells.
- Plasma proteins maintain water balance and regulate the osmotic pressure in the body.
- Antibiotics that are protein in nature perform a protective function by increasing the body's resistance to disease.
- The hormone insulin regulates blood sugar levels. Enzymes act as specific catalysts to metabolic processes in the body.
- Some amino acids have specific functions, e.g., tryptophan serves as a precursor for niacin, a B complex vitamin. The amino acid tyrosine in combination with iodine forms the hormone thyroxine.

3. Providing Energy:

- Like carbohydrates, proteins to provide 4 kcal/g when broken down in the body. The basic need of the body is energy and takes priority over protein synthesis.
- If the diet does not supply adequate calories from carbohydrates and fats, the proteins from the diet will be oxidized to meet the energy needs of the body.
- If the diet is deficient in calories, the body uses up its protein and fat stores. Using protein as a source of energy is not advisable as it puts an extra burden on the body and the pocket.
- Protein is used by the body as a source of energy only when no other source of energy is available.

RDAs:

Table 7: Summary of recommended protein requirements for Indians 2020.

		Body weight (kg)	EAR (g/kg/d)	RDA (g/kg/d)	EAR (g/d)	RDA (g/d)	
Adult Men	Sedentary	65	**0.66**	**0.83**	**42.9**	**54.0**	
	Moderate						
	Heavy Work						
Adult Women	Sedentary	55	**0.66**	**0.83**	**36.3**	**45.7**	
	Moderate						
	Heavy Work						
Pregnant Women	2nd Trimester				**+7.6**	+9.5	
	3rd Trimester				**+17.6**	+22.0	
Lactating Women	0-6 months				+13.6	+16.9	
	6-12 months				+10.6	+13.2	
Infants	0-6 months	5.8	1.16	1.40	6.7	8.1	
	6-12 months	8.5	1.04	1.23	8.8	10.5	
Children	1-3y	12.9	0.79	0.97	10.2	12.5	
	4-6y	18.3	0.70	0.87	12.8	15.9	
	7-9y	25.3	0.75	0.92	19.0	23.3	
Boys	10-12y	34.9	0.75	0.91	26.2	31.8	
Girls	10-12y	36.4	0.73	0.90	26.6	32.8	
Boys	13-15y	50.5	0.72	0.89	36.4	44.9	
Girls	13-15y	49.6	0.70	0.87	34.7	43.2	
Boys	16-18y	64.4	0.70	0.86	45.1	55.4	
Girls	16-18y	55.7	0.67	0.83	37.3	46.2	

For people consuming cereal-based diet with low quality protein, the protein requirements are 1 g/kg per day
Note: The cereal-legume-milk composition of the diet should be 3:1:2.5 for good protein quality.

Deficiency:

- A reduced intake of protein over a prolonged period of time leads to loss of weight, fatigue, anemia, nutritional oedema, lowered resistance to infection, and poor healing of wounds.
- Protein deficiency is more marked during periods when protein needs are more, e.g., during infancy, childhood, pregnancy and lactation.
- The deficiency occurs when an individual does not eat enough proteins or obtains insufficient calories.
- Protein calorie malnutrition (PCM) is common in preschool children in developing countries and manifests itself in the form of kwashiorkor, a deficiency of protein or marasmus, a deficiency of calories as well as protein, which is equal to starvation in adults.
- Protein deficiency is also seen in people who follow a crash diet for weight loss. It can be prevented by including the correct mixture of inexpensive protein rich foods in the diet.

Excess:

- An excessive intake of protein is not beneficial for health. When the diet provides more protein than what is necessary for body building, repair, and regulatory functions, the excess protein is used as energy or converted to fat and stored in the adipose tissue in the body.
- A high protein intake has many disadvantages:

1. Once the body needs have been taken care of, the excess protein is determined by the liver and urea is synthesized. The kidneys have to work more to excrete the additional amount of urea. A high protein intake is an unnecessary burden on two vital organs, i.e. the liver and the kidneys. If these organs are diseased, toxic waste tend to accumulate in the body.
2. When animal proteins, such as meat, poultry, and whole milk products, forma substantial part of the high protein diet, there is risk of high blood levels of cholesterol.
3. A high intake of protein increases the loss of calcium through the urine.
4. Protein rich foods are much costlier, are in short supply and are not an economical source.

UNIT: IX VITAMINS

Structure

9.1 INTRODUCTION:

Students you all must be well aware with the fact that our body requires various kinds of macro as well as micro nutrients for sustaining our life. Vitamins are one such nutrient that is needed in minute quantities by our body.

VITAMINS: Vitamins are complex organic compounds, and are present in minute amounts in natural food stuffs.The term vitamin was coined from the words **"VITAL AMINE"** as early scientist felt these chemicals, which are vital for life, were amines.

Vitamins were discovered one at a time from 1900 to 1950, some as a cure for classic disease such as **beriberi, pellagra, and scurvy**, while others were discovered after research on various body functions.

DEFINITION: Vitamins is the term used for a group of potent organic compounds other than proteins, carbohydrates and fats which occur in minute quantities in food and which are essential for some specific body functions such as regulation, maintenance, growth, and protection. Many of them cannot be synthesized, at least in adequate amounts, by the body and must be obtained from the diet.

'An organic substance that occurs in foods in small amounts and is necessary for normal metabolic functioning of the body'.**"VITAMIN"** means **"vital for life"**.

Vitamins are organic substances present in small amounts in food. They do not contribute directly to the structure of the body, nor do they supply energy. They regulate metabolism by releasing energy from fats and carbohydrates. They are required for carrying out vital functions of the body. They are involved in amino acid metabolism and also assist in forming blood, bones and tissues. Though needed in small amounts, they are essential for health and well-being of the body. Vitamins were discovered based on their function and chemical nature and were designated as A, B, C, D.

They are generally susceptible to change in structure and stability when the environmental conditions are not favorable. Losses of vitamins may take place during processing, handling, packaging, exposure to heat, pH, presence or absence of oxygen and cooking. In our body system, they act as co-enzymes and pre-cursors of many vital reactions, antioxidants against free-radicals and are very essential for overall health. When the body is deficient in one or more vitamins they lead to diseases.

9.2 CLASSIFICATION:

Thirteen vitamins are recognized in human nutrition and these may be conveniently classified into two major categories on the basis of criteria of solubility, i.e.:

a) Fat Soluble Vitamins- A, D, E & K.
b) Water Soluble Vitamins- B-Complex &C (Fig.1)

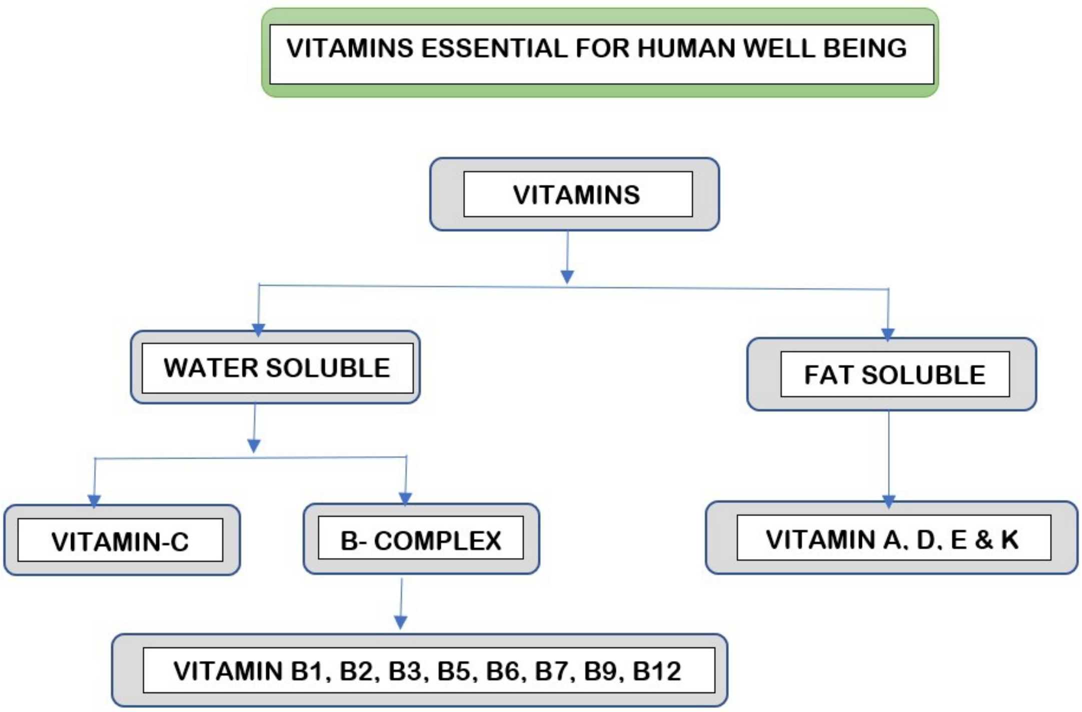


Fig. 1: Classification of Vitamins.

9.2.1 FAT SOLUBLE VITAMINS

They occur in nature in association with lipids and their absorption is known to take place in the presence of dietary fats. The conditions which are observed favorable to fat absorption are considered to be favorable for the absorption of fat soluble vitamins also. Fat-soluble vitamins can be stored in appreciable amounts in the body due to their lipid nature and are excreted in the feces via the bile.

(1) VITAMIN A- Vitamin A is a generic term used for a large number of related compounds such as **retinol** and **retinal** which are often referred to as preformed vitamin A. It was discovered in 1909 by Mccullum and Davis. Vitamin A is required for the maintenance of normal vision. Retinol as well as retinal can be inter-converted. Other most important compounds of vitamin A family are retinyl esters and β- carotene. Carotenoids are the major precursors of vitamin A and are structurally associated with β-carotene.

1.1 Functions of Vitamin A:

1. Vision – it facilitates vision in dim light. Adequate amount of retinol is essential otherwise it results in impaired dark adaptation, normally known as night blindness.

2. Immunity- it is also known as anti-infective vitamin. The skin and mucosal cells which line the digestive and urinary tract functions as a barrier to form body's first line of defense against infection. Retinol and its metabolites are much needed for maintaining the integrity and function of those cell lines.

3. Growth and development- both retinol and retinoic acid are very essential for embryonic development.

4. Cell differentiation & gene expression– the differentiation of immature bone cells into several types of mature cells is a very important process, highly dependent on vitamin A.

5. Reproduction– vitamin A is considered to be very essential during pregnancy as evidenced in recent years. Serum retinol concentration,20µg/dl was found to be associated with preterm delivery.

1.2 Sources of Vitamin A

Vitamin A has been estimated to possess different potencies which vary with dietary sources. For instance-carotene is less easily absorbed than retinol and needs to be converted to retinal. Free retinol is not generally found in food. Retinyl palmitate is a precursor and is the major storage form of retinol which is exclusively find in foods of animal origin. Yellow orange and green coloured vegetables and fruits contains significant quantities of Vitamin A. Cod liver oil, eggs, butter, milk, sweet potato, carrot, papaya, mango, spinach and broccoli are considered as the good sources.

1.3 Deficiency of Vitamin A

Maintenance of normal vision is the unique function of vitamin A. Night blindness is one of the specific manifestations of this deficiency. Untreated cases would progress towards the development of bitot's spots, corneal ulceration, keratomalacia and development of corneal scar and it is non-reversible. Deficiency of vitamin A affects growth and development as it impairs skeletal growth. Severe deficiency could have adverse effect on fetal growth and development. Sterility in males is a common problem seen as a consequence of degeneration of germinal epithelium. Both specific and non specific protective mechanisms are known to be adversely affected which tends to increase the individuals susceptibility to develop infections.

1.4 Toxicity of Vitamin A

The major symptoms include head ache, drowsiness, nausea, loss of hair, dry skin, reabsorption of bone are the major problems encountered among adults. Among infants it results in scaly dermatitis, loss of weight, anorexia, hyper irritability and skeletal pain. These symptoms are observed when the dose exceeds more than 8000 RE/day which when taken for more than 30 days.

1.5 RDA of Vitamin A

ICMR has recommended an intake of 4800 μg β-carotene for both adult man and woman. During pregnancy extra allowances are needed to support fetal growth and is estimated to be about 6400μg. During lactation it is 7600μg. For children between the age group of 1-6 years and 7-9 years it is suggested to consume about 3200μg and 4800μg/day of β-carotene.

(2) VITAMIN D: Vitamin D is commonly known as a sunshine vitamin since it is synthesized in the skin when exposed to sun light. It was discovered by Sir Edward Mellanby in 1918 who identified the antirachitic properties of vitamin D. This vitamin exists in two forms; vitamin D_3 also known as cholecalciferol which is found in foods of animal origin. The other form is vitamin D_2 referred to as ergocalciferol and is widely distributed among plant substances. Available scientific evidences have suggested that exposing hand and face for about 15 minutes a day for at least three times a week is considered to be sufficient to synthesize vitamin D in the body.

2.1 Functions of Vitamin D

The most important metabolite of vitamin D which has physiological significance is 1, 25-dihydroxy vitamin D. It has the ability to enhance the level of calcium binding protein in the small intestine thus helps in the absorption of dietary calcium and phosphorus. Mobilization of calcium and phosphorus in association with parathyroid hormone occurs in the bone due to vitamin D. In the kidney vitamin D promotes reabsorption of calcium. 1, 25-dihydroxy is not directly involved in bone mineralization process, but it exerts significant amount on osteoblasts and these in turn would help for proper mineralization. Vitamin D is also involved in the regulation of specific gene activity. This mainly occurs through the binding at specific regions in the DNA.

2.2 Sources of Vitamin D

Vitamin D is naturally synthesized by exposing the skin to sun light. Most foods have negligible amounts of vitamin D. marine fishes are the good source. Egg yolk and butter milk are the poor sources. Cod liver oil is one of the richest sources having the highest concentration of 100000 IU/100g.

2.3 Deficiency of Vitamin D

The common manifestations include rickets and osteomalacia. Rickets is usually seen among children between the ages of 1 and 3 years. The pronounced effect is seen during pubertal stage. Occurrence of osteomalacia is associated with multiple parity. Osteoporosis is an age-related problem and is often accompanied by osteomalacia. Deficiency is very common in Indian subcontinent. Practice of purdah, living in improperly ventilated crowded houses.

2.4 Toxicity of Vitamin D

An intake of 100µg of vitamin D causes hypercalcemia in children. Among adults, consistently higher amounts of intake in the range of 25,000 – 60000 IU/day for 1-4 months would cause hypercalcemia. Common symptoms observed are loss of appetite, nausea, weight loss and failure to thrive. Hyper vitaminosis occurs when the serum concentration of 25 (OH) D (25, hydroxyl vitamin D) exceeds 700-1600nmol/l. Over exposure to sunlight does not cause toxicity.

(3) VITAMIN E : Vitamin E was basically discovered and characterized as a fat-soluble nutritional factor essential for normal reproductive processes. This specific role of vitamin E was found out in the course of carrying out reproductive studies with rats. In the year 1922 it was demonstrated that to prevent fetal death and sterility in rats an important fat-soluble dietary constituent was identified to play a vital role in this regard. Initially this was termed as "factor X' and was also been referred to as "antisterility factor". Later the name vitamin E was assigned. During the year 1936 it was isolated from wheat germ oil which was termed as tocopherol which is derived from the Greek word tokos and pherein. The term vitamin E is often used to denote a mixture of biologically active tocopherols. There are totally 4 tocopherol compounds namely α, β, γ and δ tocopherol. About 4 types of tocotrienols have also been discovered. ά- tocopherol is most abundantly available in nature and has been shown to possess highest biological activity and also has a vital role in reversing vitamin E deficiency symptoms among humans. In the year 1950s it was rediscovered that, vitamin E has specific role in cellular antioxidant system along with sulphur amino acid and selenium. Subsequently it was also proven that it is very effective in preventing lipid peroxidation and various other events associated with radical driven oxidative stress.

3.1 Sources of Vitamin E

Vitamin E is synthesized only by plants and hence is primarily found only in plant based foods. Thus, fats and oils of vegetable origin are known to be the richest sources of vitamin E. vegetable oils and oils derived from food grains have been estimated to contain about 50-100mg per 100g of the product. Only 8mg is present in coconut oil. Wheat germ oil is exclusively the rich source of vitamin E containing about 260mg/100g. The chief sources in Indian diets are the vegetable oils, nuts, oil seeds and whole grains. Significant amount of tocotrienols are found in palm oil, rice bran oil and the bran and germ portions of certain cereals like oats, barley and rice. On an average, consuming 20g oil would contribute 10mg of vitamin E. hence; consuming 400g of food grains would have been found to contain 6-8g of fat, out of which 3-4g of vitamin E might be obtained.

Table 1: Total tocopherol content of various vegetable oils.

Type of Vegetable oil	**Total tocopherol (mg/100g)**
Sunflower	75.82
Corn	48.54
Sesame	29.84
Peanut	29.45
Walnut	23.83
Olive	20.44
Grape Seed	15.3
Rice	7.49

3.2 Functions Vitamin E

1. Antioxidant activity: Due to its antioxidant property vitamin E protects key cell components by neutralizing free radicals before they can cause lipid oxidation or DNA damage. By reducing free radical attack, antioxidants help to break the chain reaction of lipid peroxidation (chain-breaking antioxidant) and they protect the cell membranes by facilitating the processes of lipid repair and lipid replacement. Through this mechanism they may prevent cancer or heart disease or any other form of degenerative disorders. A high plasma concentration of vitamin E is associated with lower risk of cardiovascular disease.

2. Role in cardiovascular disease: Supplementary vitamin E was reported to be effective in reducing atherosclerosis progression in subjects with previous coronary artery bypass graft surgery who have not been treated with lipid-lowering drugs 3. Role in cancer Vitamin E is known to induce apoptotic phase mainly via a process mediated through mitochondrial pathway and cell cycle arrest which happens due to the suppression of cyclin D by tocotrienols. Other functions Apart from its antioxidative role, vitamin E takes part in other biological processes also which are as follows;

- Facilitates the maintenance of cell membrane integrity.

- Exerts anti-inflammatory effect mainly by direct and regulatory interaction with the prostaglandin synthetase and complex of enzymes which are mainly involved in the metabolism of arachidonic acid.
- Plays a major role in DNA synthesis.
- Stimulates immune response.
- Regulates intercellular signaling and cell proliferation mainly by modulating protein kinase C activity.

3.3 Deficiency of Vitamin E

Vitamin E deficiency is rarely encountered in humans. Overt deficiency symptoms in normal healthy individuals consuming diets low in vitamin E have never been described. Vitamin E deficiency may occur only as a result of certain genetic conditions such as abnormalities occurring in α- tocopherol transfer protein, fat malabsorption syndromes or in severe protein energy malnutrition.

3.4 Toxicity of Vitamin E

At present there are no reports regarding the adverse effects resulting due to the consumption of vitamin E from natural foods. It is one of the least toxic vitamin. Both humans as well as animals are capable of tolerating relatively high intake levels of more than 100 times the estimated requirement. At very higher doses, vitamin E is thought to impair the utilization of the fat soluble vitamins in the body. For instance, animals that were supplemented high doses of vitamin E were shown to have developed impaired bone mineralization, impaired storage of hepatic vitamin A and prolonged blood coagulation.

3.5 RDA of Vitamin E

There are very limited data on vitamin E (alpha tocopherol) requirements. Alpha tocopherol content of vegetable oils and invisible fat in cereals and other foods is generally adequate to meet the daily requirement. Requirement is limited to essential fatty acids. Alpha tocopherol requirement is related to its major role in protecting antioxidant property of essential fatty acid content in the diet and the suggested intake is 0.8 mg per g of EFA. This roughly contributes about 8-10 mg tocopherol/d, depending on the type of edible oil used. Vegetable oils and invisible fat from cereals and other foods like nuts and vegetables contributes adequate tocopherol in Indian diets.

(4) VITAMIN K: Vitamin K was the last fat soluble vitamin to be discovered. Vitamin K was appeared to have very limited functional role in humans i.e. its major role in initiating blood clotting mechanism. This vitamin was discovered in 1934 by a Danish scientist Dam. He explored the fact that bleeding in chickens could be prevented by feeding decayed fish meal.

Vitamin K is also referred to as coagulation vitamin, antihemorrhagic vitamin and prothrombin factor. Vitamin K is highly indispensable for maintaining normal blood coagulation system in both humans as well as other experimental animals.

In general, it exists in two forms in nature.

- Vitamin K_1 is widely distributed among plant kingdom and is termed as phylloquinone.
- The other form is K_2 which was isolated from putrid fish and is called as menaquinone.
- The last form is K_3 known as menadione and it is of purely synthetic form. This vitamin can be synthesized by intestinal flora. It is considered as one of the most important nutrients during infancy because intestinal synthesis is insufficient and it needs to be provided externally.

4.1 Functions of Vitamin K

The well-known function of vitamin K is its role in the synthesis of blood clotting factors. Vitamin K is considered as one of the most essential nutrients required for catalyzing the conversion of the precursor of prothrombin to thrombin. In-turn prothrombin in the blood catalyzes the conversion of fibrinogen to fibrin, a factor involved in blood coagulation. The level of prothrombin in the blood is a major determinant of the rate at which the blood will clot. There are mainly two pathways- extrinsic and intrinsic and are thought to have involved in the process of generating prothrombin and thrombin. The clotting process is proposed to be initiated by the absorption of factor XII into collagen which further leads to into activation into XIIa. This in turn cleaves IX and is known to be vitamin K dependent. Once it is carboxylated it binds with calcium and phospholipids and converts X to Xa which is also a vitamin K dependent factor. Further Xa hydrolyzes prothrombin to thrombin. This is the final step which results in the conversion of fibrinogen to fibrin and initiates the clot formation.

4.2 Sources of Vitamin K

Vitamin K is widely distributed in plant foods. Green vegetables are known to contain highest concentration. Dark green leafy vegetables such as kale, parsley and spinach would have been estimated to contain about 300-600µg/100g. Broccoli, Brussels sprouts and lettuce are the intermediary sources having about 100-200µg/100g. non leafy vegetables such as green beans, cauliflower and cucumber are also considered as significant sources which contains on an average 20-50µg/100g. certain vegetables oils such as soy bean, rapeseed and olive oils are known to contain relatively higher amount which ranges from 50-200µg/100g. Fermented foods such as cheese are also known to contain considerable amounts. Apart from this intestinal bacterial synthesis is also known to provide significant amount.

4.3 Deficiency of Vitamin K

Deficiency is rare among adults. Primary deficiency normally referred to as neonatal hemorrhage is occasionally seen among infants. This could be mainly due to the fact that infants when they are born their stomach is completely sterile and is free from bacterial contamination. This could become a causative factor for the infants to develop deficiency particularly when they are fed for long periods on cow's and human milk as they are known to contain relatively smaller amounts of vitamin K. Antibiotics, and salicylic acid-based medications are known to intestinal bacterial flora. Symptoms of deficiency is mainly manifested as prolonged blood coagulation time and increased susceptibility to hemorrhage.

4.4 RDA of Vitamin K

The incidence of deficiency is very rare among Indians and ICMR considered that no such recommendation is needed. A dose of 0.5-1.0mg of vitamin K can be administered intramuscularly to infants suffering from deficiency. The committee on medical aspects of food policy of the United Kingdom declared that an intake of 1µg/kg/day is thought to be safe and adequate for adult age group.

CONCLUSION Adequate intake of fat soluble vitamins is very essential for maintaining normal physiological functions. They could also be consumed as a means of correcting and preventing the disorders resulting due to the deficiency of these vitamins. Foods composed of fat soluble vitamins are widely distributed in nature and a regular intake of such food would help to meet the daily requirement. Since fat soluble vitamins can be stored in appreciable amounts in the body it is safer to consume them at a level designated by the nutrition expert committees in order to prevent the adverse effects.

9.2.2 WATER SOLUBLE VITAMINS

Water-soluble vitamins are not accumulated in the body, but are readily excreted. In the case of a deficiency, the clinician should be able to recognize the syndrome caused by a lack of the particular vitamin. In this country of abundant and varied food supply, the individual should instead think in terms of what a specific vitamin does rather than what disease it prevents.

The water-soluble vitamins are chemically different, so are heterogeneous in nature. Since, they are soluble in water, are subjected to subsequent cooking losses. They are readily excreted through urine because of the solubility in water. Their continuous supply is needed by the body as there no reserved forms in body. They are usually non-toxic. They function as a coenzyme and participates in various metabolic pathways, for eg. Energy metabolism. It is reported that 50-90% of B vitamins are absorbed and only marginal deficiencies are more common. Generally, deficiencies due to water soluble vitamins are multiple rather than individual with overlapping symptoms.

Water-soluble vitamins are members of the B-complex and vitamin C (ascorbic acid). Most of the B-complex group can be further divided according to general function: energy releasing or hematopoietic. Other vitamins cannot be classified this narrowly because of their wide range of functions.

(I) **ASCORBIC ACID** -Vitamin C, anti-scorbutic factor

(II) **B-COMPLEX VITAMIN-**

1. THIAMINE -Vitamin B_1(Thiamine), antineurotic factor, anti-beri-beri factor
2. RIBOFLAVIN-Vitamin B_2,Vitamin G, lactoflavin, hepatoflavin, ovoflavin
3. NIACIN-Vitamin B_3, pellagra-preventive factor, Nicotinic acid, Nicotinamide, Niacinamide.
4. PANTOTHENIC ACID -Vitamin B_5, “Anti-Stress vitamin” Its name derives from the Greek word *pantothen*meaning from “everywhere”.
5. PYRIDOXINE-Vitamin B_6, Pyridoxal, Pyridoxamine
6. BIOTIN-Vitamin B_7, Vitamin H, anti-eggwhite injury factor
7. FOLATE-Vitamin B_9, Folic Acid, vitamin M, vitamin Bc, Folacin, Pteroylglutamic acid (PGA)
8. CYANOCOBALAMIN-Vitamin B_{12} (Cobalamin, anti-pernicious anemia factor)

(I) VITAMIN C: The chemical name for Vitamin C is ascorbic acid. It was discovered in 1747 by demonstrating that citrus fruit juices prevented and cured scurvy. Vitamin C functions in oxidation-reduction reactions and is synthesized from glucose and galactose by plants and most animals. However, humans and other primates, lack the enzyme l-gulonolactone oxidase and thus cannot biosynthesize the factor, which for them consequently is a vitamin.

1.1. Effects of Deficiency: Prolonged deficiency of vitamin-C produces a disease condition called as ‘scurvy’ in both infants and adults. Scurvy is typically manifested when the total body vitamin-C pools

fall below about 300mg and plasma vitamin-C concentrations drop to <0.2mg/dL. Scurvy is fatal if untreated. The four Hs-
hemorrhagic signs, hyperkeratosis of hair follicles, hypochondriasis (psychological manifestation), and hematologic abnormalities (associated with impaired iron absorption)—are often used as a mnemonic device for remembering scurvy signs.

a. **Infantile scurvy:** There will loss of appetite, failure to gain weight, irritability, palor, defective growth of bones. Haemorrhage occurs under the skin. There will be defective formation of teeth and gums will be swollen (Figure 2a). The ends of the ribs become prominentresulting in beaded appearance called scorbutic rosary.

Scorbutic gums. Unlike other lesions of the mouth, scurvy presents a symmetrical appearance without infection.

Pinpoint hemorrhages. Small red spots appear in the skin, indicating spontaneous bleeding internally.

Scorbutic Rosary

Follicular Hemorrhages

b. Adult Scurvy:

i. General manifestations are fever, susceptibility to infection, lethargy, fatigue, rheumatic pains in the legs, muscular atrophy and delayed wound healing.

ii. Anaemia: Microcytic hypochromic anaemia develops due to failure of absorption of iron.

iii. Gums become spongy and bleed easily. Gums become swollen, ulcerated and eventual tooth loss.

iv. The blood vessels become fragile and porous due to defective formation of collagen. Joints become swollen and tender.

v. Clinical symptoms appear when total body pool of vitamin-C decreases. Skin becomes rough and dry. There will be small petechial hemorrhages around hair follicles.

(II) B COMPLEX VITAMINS

1.THIAMINE (B_1)

Thiamine is known as Vitamin B_1. Deficiency of thiamine leads to beriberi. This condition is widely prevalent among population whose diet contains more of polished cereals.

1.1. Effects of Deficiency: Deficiency of thiamine is associated with low calorie intake. Severe deficiency of thiamine produces a disease known as beriberi (beri means "weakness") One of the first symptoms of thiamin deficiency is a loss of appetite (anorexia) and thus weight loss. As the deficiency worsens, cardiovascular system involvement (such as hypertrophy and altered heart rate) and neurological symptoms (such as apathy, confusion, decreased short-term memory, and irritability) appears. There are three types of beriberi

a. Dry beriberi
b. Wet beriberi
c. Acute/Infantile beriberi

a.Dry beriberi: Found predominantly in older adults. Deficiency is of result from a chronic low thiamin intake, especially if coupled with a high carbohydrate intake. Dry beriberi is characterized by muscle weakness and wasting, loss of appetite, tingling numbness and burning sensation in hands and feet. Calf muscles will become tender. Knee and ankle jerks will be sluggish. In later stages complete loss of sensation in hands and legs will occur. It is characterized by foot and waist drop. Mental depression and confusion occurs.

b.Wet beriberi: In this case, there is enlargement of heart and the cardiac output is high. Oedema or accumulation of fluid in legs, face and trunk is observed. Palpitations are marked.

c.Acute/Infantile beriberi: It occurs in first few months of life if the diet of the mother is deficient in thiamine.

Symptoms are anorexia, vomiting, restlessness, sleeplessness, constipation, enlargement of the heart and breathlessness. Thiamin deficiency is often associated with alcoholism. Wernicke's encephalopathy or Wernicke Korsakoff syndrome, a neuropsychological complication, is also commonly found in those with alcoholism and AIDS, and in those receiving parenteral nutrition that is high in dextrose and low or absent in thiamin. People with alcohol dependency are particularly prone to thiamin deficiency because of:

- Decreased intake of the vitamin from decreased food consumption
- Increased requirement for the vitamin because of liver damage
- Decreased thiamin absorption

Wernicke's encephalopathy is characterized by ophthalmoplegia (paralysis of the ocular muscles), nystagmus (constant, involuntary eyeball movement), ataxia (impaired muscle coordination), loss of recent memory and confusion.

2. RIBOFLAVIN (B_2)

Riboflavin or Vitamin B_2 is the yellow enzyme which is heat stable unlike other B Vitamins. Riboflavin in the combined form with proteins form flavo proteins or yellow enzymes.

2.1. Effects of Deficiency:A deficiency of riboflavin, known as ariboflavinosis, rarely occurs in isolation but most often is accompanied by other nutrient deficits. Riboflavin deficiency is prevalent mainly among the low-income groups particularly the vulnerable group and the elderly adults. Riboflavin deficiency becomes manifest after several months of deprivation of the vitamin.

Riboflavin deficiency is characterized by

- Soreness and burning of the mouth and tongue.
- Lesions at the angles of the mouth called Angular Stomatitis (cracks in the skin at the corners of the mouth-Figure 4a).
- The inflammation of the tongue called glossitis
- Dry chapped appearance of the lip with ulcers termed cheilosis.
- The skin becomes dry and results in seborehoeic dermatitis.
- Photophobia, lacrimation, burning sensation of the eyes and visual fatigue.
- Decreased motor co-ordination
- Normocytic anaemia

3. NIACIN

The term niacin (vitamin B_3) is considered a generic term for nicotinic acid and nicotinamide. Niacin is required by all the cells of our body. Like thiamine and riboflavin it plays a vital role in the release of energy from carbohydrates, protein, fat and alcohol. Like thiamin, which was discovered through its deficiency disorder beriberi, niacin was discovered through the condition pellagra in humans and a similar condition, called black tongue, in dogs.

3.1. Effects of Deficiency: Deficiency of niacin causes a disease known as pellagra (Figure 5). It is characterized by three D's - Dermatitis, Diarrhoea and Dementia.

a. Dermatitis–Name pellagra comes from pelle-skin and agra-rough. Marked changes occur in the skin especially in the skin exposed to sun and friction areas like elbows, surfaces of arms, knees. Lesions are symmetrically distributed, in the affected parts. At first there is reddening, thickening and pigmentation of the skin. Later on, there is exfoliation leading to ultimately parchment of skin – butterfly like appearance.

b.Diarrhoea–Diarrhoea enhances the deficiency state. There are structural and absorptive defects in the small intestine. Tongue appears raw, and mucous membrane of the tongue is inflammed. Gastrointestinal manifestations include glossitis, cheilosis, stomatitis, nausea, vomiting, and diarrhea or constipation.

c.Dementia–There is irritability, depression, poor concentration and loss of memory. Delirium is a common mental disturbance.

4. PANTOTHENIC ACID (B_5)

Pantothenic acid consists of β-alanine and pantoic acid joined by a peptide bond/amide linkage. The vitamin was once called vitamin B_5.

4.1. Effects of Deficiency:“Burning feet syndrome” is characterized by numbness of the toes and a sensation of burning in the feet. The condition is exacerbated by warmth and diminished with cold and is thought to result from pantothenic acid deficiency.

Other symptoms of deficiency include vomiting, fatigue, weakness, restlessness, and irritability.

Deficiency of pantothenic acid is thought to occur more often in conjunction with multiple nutrient deficiencies, as for example in malnutrition. Some conditions that may increase the need for the vitamin include alcoholism, diabetes mellitus, and inflammatory bowel diseases. Increased excretion of the vitamin has been shown in people with diabetes mellitus.

5. PYRIDOXINE (B_6)

Pyridoxine is unique among B–complex Vitamins in that it functions primarily in protein metabolism. Pyridoxine denotes related substances such as Pyridoxine, Pyridoxal and Pyridoxamine are three forms in which it is present in our body. Pyridoxine represents the alcohol form, pyridoxal the aldehyde form, and pyridoxamine the amine form. Some of the initial research was aimed at correcting dermatitis in rats.

5.1 Effects of Deficiency: Vitamin B_6 deficiency leads to abnormalities in protein metabolism which is manifested as poor growth, convulsions, anaemia, and skin lesions. Severe deficiency leads to microcytic hypochromic anaemia.

Symptoms such as weakness, nervousness, irritability, insomnia and difficulty in walking is predominant.

Deficiency also alters calcium and magnesium metabolism, impairs niacin synthesis from tryptophan, and inhibits metabolism of homocysteine. The last results in hyperhomocysteine Mia, a risk factor for heart disease. Groups particularly at risk for vitamin B_6 deficiency are the elderly, who have a poor intake of the vitamin; people who consume excessive amounts of alcohol and people on a variety of drug therapies.

6. BIOTIN (B_7)

Biotin's discovery was based on the research investigating the cause of what was called "egg white injury." Eating raw eggs was known to result in hair loss, dermatitis, and various neuromuscular problems. In 1931 a substance was found (now called biotin) in liver that could cure and prevent the condition. Biotin was once called vitamin H (the H refers to haut in German and means "skin") as well as vitamin B_7.

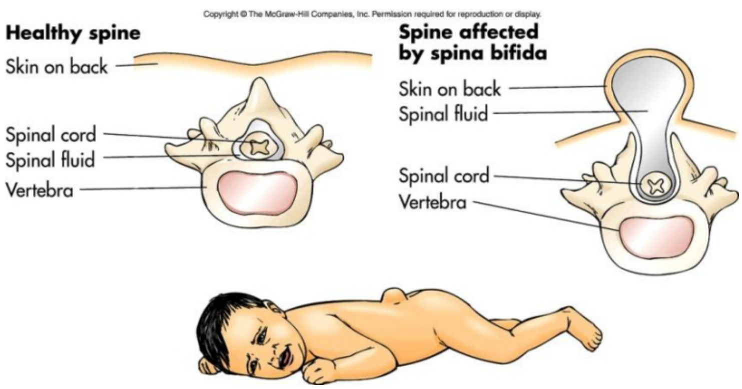
6.1 Effects of Deficiency: Biotin deficiency in humans is characterized by lethargy, depression, hallucinations, muscle pain, paresthesia in extremities, anorexia, nausea, alopecia (hair loss), and scaly, red dermatitis. A diet devoid of biotin can result in decreased plasma biotin and in reduced biotin excretion in about 2-4 weeks.

Biotin deficiency or poor biotin status, though fairly rare, occurs in various populations. People who ingest raw eggs in excess amounts are likely to develop biotin deficiency because of impaired biotin absorption. Impaired biotin absorption also may occur with gastrointestinal disorders such as inflammatory bowel disease and achlorhydria (lack of hydrochloric acid in gastric juices), in people on anticonvulsant drug therapy, or in chronic consumers of excessive amounts of alcohol. Biotin status has been shown to decline in some women during pregnancy.

7. FOLIC ACID (B_9)

Folic acid is the term used to refer to the oxidized form of the vitamin found in fortified foods and in supplements. Folate refers to the reduced form of the vitamin found naturally in foods. The Latin word folium means "leaf," and the word folate from Italian means "foliage". Folic acid was first extracted from dark green leafy vegetables. Folate's and vitamin B_{12}'s discovery resulted from the search to cure the disorder megablastic anemia, a problem in the late 1870s and early 1880s. As with many of the other vitamins, eating liver was shown to cure the condition.

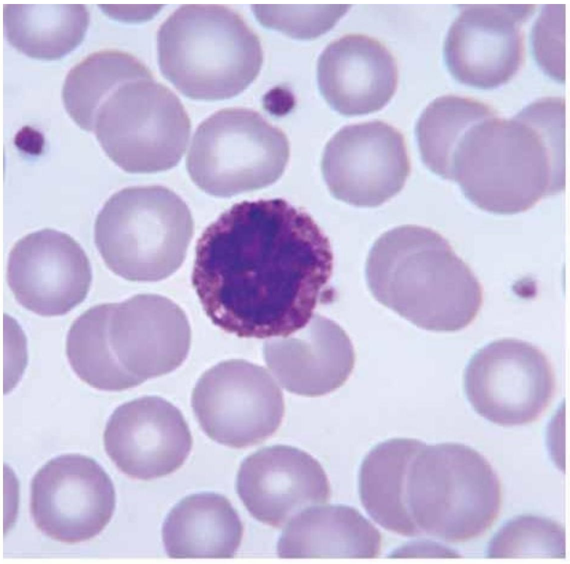
7.1. Effects of Deficiency: Simple folate deficiency results in the bone marrow producing immature cells (megaloblasts cells) and few matured red blood cells. This results in reduced oxygen–carrying capacity causing anaemia termed Megaloblastic anaemia. Folate deficiency during pregnancy causes neural tube disorders of the foetus. Folate deficiency impairs the ability of the immune system to fight infection.



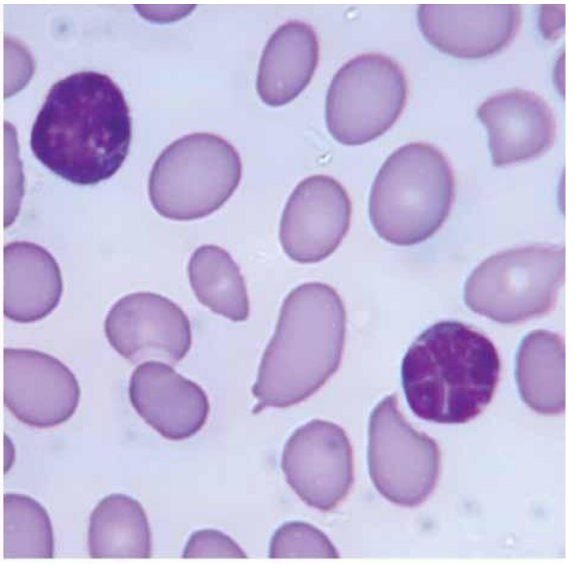
8. CYANOCOBALAMIN (B_{12})

Vitamin B_{12}, also called Cobalamin, is considered a generic term for a group of compounds called Corrinoids because of their Corrin nucleus. Vitamin B_{12} was the last vitamin to be discovered. It was isolated in 1940. Eating large amounts of liver could help correct pernicious anemia associated with deficiency of this vitamin. It took about two decades to identify the vitamin in liver.

8.1. Effects of Deficiency: Pernicious anaemia is the major problem arising from an inadequate amount of vitamin B_{12}. Pernicious anaemia is a condition characterized by very large, immature red blood cells with normal amounts of hemoglobin. Most deficiency signs and symptoms are of neurologic and hematologic origin; some signs and symptoms include skin pallor, fatigue, shortness of breath, palpitations, insomnia, tingling and numbness (paresthesia) in extremities, abnormal gait, loss of concentration, memory loss, disorientation, swelling of myelinated fibers, and possibly dementia. Neurological problems occur in about 75% to 90% of deficient people.



Normal blood cells. The size, shape, and color of the red blood cells show that they are normal.



Blood cells in pernicious anemia (megaloblastic). Megaloblastic blood cells are slightly larger than normal red blood cells, and their shapes are irregular.

9.3 CONCLUSION : Vitamins are required for carrying out vital functions of the body. Though needed in small amounts, they are essential for health and well-being of the body. Vitamins are classified based on their solubility as fat-soluble and water-soluble vitamins. Water-soluble vitamins are members of the B complex and vitamin C.

Deficiency of vitamin-C produces a disease condition called as ‘scurvy’. The four Hs— hemorrhagic signs, hyperkeratosis of hair follicles, hypochondriasis, hematologic abnormalities are often used as a mnemonic device for remembering scurvy signs. Deficiency of thiamine leads to beriberi. There are three types of beriberi and they are dry beriberi, wet beriberi and acute/infantile beriberi. A deficiency of riboflavin is known as ariboflavinosis and of niacin is known as pellagra. Pellagra is characterized by three D's -Dermatitis, Diarrhoea and Dementia. Pantothenic acid deficiency leads to Burning feet syndrome and is characterized by numbness of the toes and a sensation of burning in the feet. Vitamin B_6 deficiency leads to abnormalities in protein metabolism and microcytic hypochromic anaemia. Biotin deficiency in humans is characterized by lethargy, depression, hallucinations, muscle pain, paresthesia in extremities, anorexia, nausea, alopecia, and scaly, red dermatitis. Folate deficiency causes Megaloblastic anaemia while, Pernicious anaemia is caused due to vitamin B_{12} deficiency.

9.4 : CHECK YOUR PROGRESS:

1. What are macronutrients, and why are they essential for the body?
2. How do micronutrients differ from macronutrients in terms of function and requirement?
3. Which nutrients are classified as energy-giving nutrients, and what role do they play in the body?
4. What is Basal Metabolic Rate (BMR), and how does it influence energy requirements?
5. How is Body Mass Index (BMI) calculated, and what does it indicate about a person's health?
6. What is Dietary Reference Intakes (DRI), and how do they guide nutrient consumption?
7. Why are proteins considered body-building nutrients, and what is their primary function?
8. How do carbohydrates contribute to energy metabolism in the body?

UNIT-X: MINERALS

Content:

10.1 INTRODUCTION:

Later in the nineteenth century, scientists were researching on the lacking nutrients which would be capable of promoting growth and sustaining health. The importance of minerals was not well understood, carbohydrate, fat, protein alone was not sufficient to boost the immunity and maintain good health. Hence, scientists and researchers strived to find out the "missing elements", namely minerals which were found to be essential for growth and maintenance.

DEFINITION: Minerals are the inorganic substances required for the normal functioning of body processes, including growth, development, water balance and neurological processes.

10.2 CLASSIFICATION:

Essential minerals are the nutrients which are classified as macro and micronutrients based on the amount needed by humans per day.

Microminerals are those which are vital to health and that are required in the diet by more than 100mg/day. The essential microminerals are Calcium, Phosphorous, Magnesium, Sodium, Sulphur, Potassium and Chloride.

Microminerals or trace minerals are those required in the diet less than 20mg per day. Important microminerals of relevance in human nutrition are Iron, Zinc, Copper, Fluoride, Manganese, Chromium, Iodine, Molybdenum and Selenium.

The ultratrace elements without established essentiality for humans, such as Cobalt, arsenic, boron, nickel, vanadium, and silicon, provide a negligible amount of weight.

10.3 DISTRIBUTION OF MINERALS IN THE BODY:

Minerals represent about 4-5% of body weight, or 2.8 to 3.5 kg in adult women and men, respectively. Approximately 50% of this weight is calcium, and another 25% is phosphorus, existing as phosphates. Almost 99% of the calcium and 70% of the phosphates are found in bones and teeth.

Now, we need to study these minerals thoroughly so as to understand their functions, sources, requirements and deficiency/excess of the minerals.

10.4 MACROMINERALS PART

1.1. Calcium

Calcium (Ca) is an essential element required for several life processes, representing about 1.5-2% of total body weight, or between ~1,000g in a 60kg human being. Bones and teeth contain about 99% of the body's calcium. The other 1% is distributed in intra- and extracellular fluids.

a. Functions

1. Bone formation: The major mineral ions of the bone is Calcium. For proper calcification of bones, (deposition of minerals on the bone matrix) which occurs during the growing years, adequate supply of Ca is essential.

2. Tooth formation: Calcium is essential for the formation of dentin and enamel.

3. Physiological Process:

i. Calcium is essential for the clotting of blood.

ii. Calcium regulates the permeability of the capillary walls and ion transport across the cell membranes.

iii. It is essential for the contraction of the heart and skeletal muscle.

iv. Ca regulates the excitability of the nerve fibers.

vi. Ca acts as an activator for enzymes such as rennin and pancreatic lipase.

b. Deficiency

Calcium related health problems occur due to inadequate intake, improper absorption or utilization of calcium.

i. Osteoporosis:

Osteoporosis is a condition found primarily among middle aged and elderly woman, where the bone mass of the skeleton is diminished. It results due to the following reasons:

a. Prolonged dietary inadequacy

b. Poor absorption and utilization of calcium

c. Immobility

d. Decreased levels of oestrogen in post menopausal women.

e. Hyper parathyroidism

f. Vitamin–D deficiency

ii. **Osteomalacia** – is a condition in which the quality but not the quantity of bone is reduced.

iii. **Tetany-** Tetany occurs when Calcium in the blood drops below the critical level.

There is a change in the stimulation of nerve cells resulting in increased excitability of the nerve and uncontrolled contraction of the muscle tissue.

c. Excess

Intake of calcium in amounts up to 2,500 mg daily appears to be safe for most people. The large intake of calcium resulted in hypercalcemia and deposition of calcium in soft tissues. Constipation also can occur when large amounts of calcium are ingested.

1.2. Phosphorus

Phosphorus is second only to calcium in abundance in the body. Approximately 560-850g are present in a 70kg human, representing about 0.8-1.2% of body weight. Of total body phosphorus, about 85% is in the skeleton, 1% is in the blood and body fluids, and the remaining 14% is associated with soft tissue such as muscle.

a. Functions

1. Bone formation: The major mineral ion of the bone is Phosphorous. For proper calcification of bones adequate supply of Phosphorous is essential.

2. Tooth formation: Phosphorous is essential for the formation of dentin and enamel.

3. ATP release & storage: Phosphorous is essential for the storage and release of adenosine triphosphate (ATP) molecules

4. Phosphates plays an important role as buffers to prevent changes in acidity of the body fluids.

5. Phoshpolipids are major components of cell membrane and intracellular organelles

6. In the DNA and RNA phosphate is an essential part of the nucleic acids

b. Deficiency

Phosphate deficiency is rare, but it could possibly develop in individuals who are taking drugs known as phosphate binders. Symptoms result primarily from decreased synthesis of ATP and other organic phosphate molecules. Neural, muscular, skeletal, hematologic, renal, and other abnormalities occur. Clinical phosphate depletion and hypophosphatemia can result from long-term administration of glucose or Total Parental Nutrition without sufficient phosphate, excessive use of phosphate binding antacids, hyperparathyroidism or treatment of diabetic acidosis and it may develop in those who have alcoholism with or without decompensated liver disease.

c. Excess

Toxicity from phosphorus is rare. Problems have been reported only in infants when calcium:phosphorus ratios are altered significantly in favor of phosphorus. Phosphorus toxicity is characterized predominantly by hypocalcemia and tetany.

1.3. Magnesium

Like calcium, magnesium is closely associated with skeletal system. About 20-25g magnesium is present in adult human body and about 60-70% of it occurs in the bone, 25-30% in the muscle, 6-8% in soft tissues and 1% in the extracellular fluid.

a. Functions

1. The major function of magnesium is to stabilize the structure of ATP in ATPdependent enzyme reactions.

2. Magnesium is a cofactor for more than 300enzymes involved in the metabolism of food components.

3. Magnesium plays a role in neuromuscular transmission and activity

4. In a normal muscle contraction, calcium acts as a stimulator, and magnesium acts as a relaxant. Magnesium acts as a physiologic calcium-channel blocker.

b. Deficiency

Poor magnesium status may be related to cardiovascular disease, renal disease, diabetes mellitus, toxemia of pregnancy, hypertension, or postsurgical complications. Symptoms of abnormal neuromuscular function occur in magnesium depletion associated with malabsorption syndromes like inflammatory bowel disease or sprue, primary idiopathic hypomagnesemia and severe protein energy malnutrition. In severe deficiency, the subjects suffer often from tetany and convulsions. Hypomagnesemia, hypocalcemia and hypokalemia are always associated with magnesium deficiency and are reversed by magnesium repletion. A syndrome of magnesium-dependent, vitamin D-resistant rickets is observed.

c. Excess

Although excess magnesium can inhibit bone calcification, magnesium excesses from dietary sources, including supplements, are very unlikely to result in toxicity. The only cases of toxicity that have been reported involve smelter workers who inhale.

1.4. Sodium

Approximately 30% of the ~105g of sodium in the body (70kg human) is located on the surface of bone crystals. The remainder of the body’s sodium is in the extracellular fluid, primarily plasma, and in nerve and muscle tissue. Sodium constitutes about 93% of the cations in the body, making it by far the most abundant member of this family.

a. Functions

Within the body, sodium plays important roles in the maintenance of fluid balance, nerve transmission/impulse conduction, and muscle contraction. Sodium, potassium and chloride display the most movement across cell membranes to maintain osmotic pressure and thus fluid balance. Sodium's roles in nerve transmission and muscle contraction involve sodium as part of the Na+/K+-ATPase pump found in the plasma membrane of cells.

b. Deficiency

Dietary deficiencies of sodium do not normally occur because of the abundance of the mineral across a broad spectrum of foods. Excess sodium in the diet is said to contribute to hypertension in genetically prone individuals. Symptoms include muscle cramps, nausea, vomiting, dizziness, shock and coma.

c. Excess

Apart from its relationship to hypertension, at intakes of 590-680mmol daily, healthy individuals can develop fluid retention.

1.5. Potassium

Potassium is the major intracellular cation. About 95-98% of the body's potassium is found within body cells. Potassium constitutes up to ~0.35% of total body weight, or upto ~245 g in a 70 kg human

a. Functions

Potassium contributes to intracellular osmolality. Enzymes involved in glycolysis and oxidative phosphorylation are potassium-dependent. It is involved in the maintenance of acid-base balance. Potassium is vaso-active, increasing blood flow and sustains metabolic needs of the tissue. Potassium supplements lower blood pressure. Potassium influences the contractility of smooth, skeletal and cardiac muscle and profoundly affects the excitability of nerve tissue.

b. Deficiency

Hyperkalemia is toxic, resulting in severe cardiac arrhythmias and even cardiac arrest. Similarly, hypokalemia does not occur by dietary deficiency because of the abundance of potassium in common foods. Hypokalemia is associated with cardiac arrhythmias, muscular weakness, nervous irritability, hypercalciuria, glucose intolerance, and mental disorientation and can result from profound fluid loss, such as the losses that occur with severe vomiting and diarrhea or with use of some diuretic medications. A moderate deficiency of potassium is associated with elevations in blood pressure, increased urinary calcium excretion, and abnormal bone turnover.

c. Excess

Hyperkalaemia can be fatal and result in cardiac arrest. Individuals with subclinical/clinical renal failure are at risk of hyperkalaemia.

1.6. Chloride

Chloride is the most abundant anion in the extracellular fluid, with approximately 88% of chloride found in extracellular fluid and just 12% intracellular. Its negative charge neutralizes the positive charge of the sodium ions with which it is usually associated. In this respect, it is of great importance in maintaining electrolyte balance. Total body chloride content is about 0.15% of body weight, or about 105g in a 70kg human.

a. Functions

Chloride has important functions in addition to its role as a major electrolyte. The formation of gastric hydrochloric acid requires chloride. Chloride is released by white blood cells during phagocytosis to assist in the destruction of foreign substances.

b. Deficiency

Dietary deficiency of chloride does not occur under normal conditions. As is the case for the other electrolytes, deficiency arises chiefly through gastrointestinal tract disturbance such as severe diarrhea and vomiting.

1.7. Sulphur

Although sulfur has long been studied as a mineral, it functions almost entirely as a component of organic molecules. Sulfur exists in the body as a constituent of three amino acids-cystine, cysteine, and methionine-and of many other organic molecules.

a. Functions

Sulfhydryl groups of proteins participate in diverse cellular reactions. The sulfur of cysteine is involved photosynthesis, nitrogen fixation and oxidative phosphorylation. In the broadest sense, sulfur can be considered an antioxidant. Sulfur exists as a component of heparin, an anticoagulant found in liver and some other tissues and as chondroitin sulfate in bone and cartilage. Sulfur is also an essential component of three vitamins-thiamin, biotin and pantothenic acid.

b. Deficiency and Excess

Excess inorganic sulfur generated as a result of hepatic or renal metabolism is excreted in the urine as sulfates. These sulfates are thought to combine with calcium ions in the glomerular ultrafiltrate, thereby reducing the renal tubular resorption of calcium. Sulfur deficiency or toxicity is highly unlikely.

10.5 Ultratrace elements

2.1. Cobalt

Most of the cobalt in the body exists with vitamin B12 stores in the liver. Blood plasma contains approximately 1mcg of cobalt per 100.

a. Functions

The well-known essential role of cobalt is as a component of vitamin B12 (cobalamin) which is essential for the maturation of red blood cells and the normal function of all cells. In addition, methionine aminopeptidase, an enzyme involved in the regulation of translation is the only enzyme in humans known to have an established requirement of this trace element.

b. Deficiency

A cobalt deficiency develops only in relation to a vitamin B12 deficiency. Insufficient vitamin B12 causes a macrocytic anemia and genetic defect limiting vitamin B12 absorption results in pernicious anemia.

c. Excess

A high intake of inorganic cobalt in animal diets produces polycythemia (an overproduction of red blood cells), hyperplasia of bone marrow reticulocytosis, and increased blood volume.

2.2. Arsenic

More than any other ultratrace mineral, arsenic, which is colorless and odorless, conjures an image of toxicity as a poison rather than of nutritional essentiality.

a. Functions

Arsenic appears to be needed to form and use methyl groups, generated in methionine metabolism to S-adenosylmethionine (SAM). SAM is a major methyl donor in the body and functions in synthesizing a variety of compounds and in methylating compounds needed for DNA synthesis.

b. Deficiency

Arsenic deficiency impairs metabolism of methionine, resulting in decreased SAM concentrations. Arsenic-deficient rats fed, experienced growth deficits compared with arsenic-supplemented rats. Effects of arsenic deprivation in animals include curtailed growth, reduced conception rate, and increased neonatal mortality.

2.3. Boron

Boron, as boric acid and sodium borate (called borax), was used to preserve foods such as fish, meat, cream, butter, and margarine for over 50 years—that is, until about the 1920s, when it was considered dangerous for humans but deemed essential for plants.

a. Functions

Boron is thought to have several functions in the body, including roles in embryogenesis, bone development, cell membrane function and stability, metabolic regulation, and the immune response. Because of its anti-inflammatory effects, boron is purported to reduce the severity of rheumatoid arthritis

b. Deficiency and Excess

Boron deficiency has not been reported in humans, and no toxicity level has been established.

2.4. Nickel

Nickel is used industrially in various capacities, such as production of stainless steel and nickel-cadmium batteries. Nickel's essentiality in human nutrition was first suggested in the 1930s.

a. Functions

A specific role of nickel in human and animal nutrition has not yet been defined, although roles for nickel in plants and microorganisms have been documented.

b. Deficiency

Signs of nickel deprivation continue to be described for some animal species. Among the more consistent signs are depressed growth, altered distribution of some minerals, changes in blood glucose, and impaired hematopoiesis.

c. Excess

Signs of toxicity in humans include nausea, vomiting, and shortness of breath; in animals, signs include lethargy, ataxia, irregular breathing, and hypothermia, among others, possibly including death.

2.5. Vanadium

Vanadium was first discovered in the early 1800s and named for a Swedish goddess, Vanadis. In solution, vanadium produces a range of colors, which accounts for its being named after the goddess. In its pentavalent state it is yellowish orange, whereas in its divalent state it is blue.

a. Functions

No specific biochemical function has been identified for vanadium. Vanadium mimics the action of insulin. Vanadium stimulates glucose uptake into cells, enhances glucose metabolism, and inhibits catecholamine induced lipolysis in adipose tissue. Vanadium also stimulates glycogen synthesis in the liver and inhibits gluconeogenesis. Vanadium also can substitute for other metals such as zinc, copper, and iron in metallo enzyme activity.

b. Deficiency

Vanadium deficiency has suggested that the element is associated with iodine metabolism, thyroid gland function, or both. Controlled depletion of vanadium has been reported to adversely affect growth rate, perinatal survival, physical appearance, hematocrit, and other manifestations in various animal species.

2.6. Silicon

Silicon occupies a unique position among the essential trace elements in that it is second only to oxygen in earthwide abundance.

a. Functions

The physiological role of silicon centers on normal formation, growth and development of bone, connective tissue, and cartilage. Silicon is thought to play both a metabolic and a structural role.

b. Deficiency

Silicon deficiency results in smaller, less flexible long bones and in skull deformation. Silicon deprivation in rats diminished bone collagen formation and increased collagen breakdown.

c. Excess

No tolerable upper intake level has been established for silicon. The major potential adverse effect reported is kidney stone. Toxicity of silicon also has been associated with diminished activities of several enzymes that prevent free radical damage. Silicosis occurs from inhaling dust high in silica; the condition is characterized by a progressive fibrosis of the lungs that leads to respiratory problems.

10.6 MICROMINERALS

A precise definition for the essential microminerals has not been established. The term micro when applied to microminerals can be defined as minerals that make up <0.01% of total body weight. An element is considered essential if a dietary deficiency of that element consistently results in a suboptimal biological function that is preventable or reversible by physiological amounts of the element. The abnormalities induced by deficiencies are always accompanied by specific biochemical changes.

Each essential micromineral is necessary for one or more functions in the body. Whenever the intake or body concentration is too low or too high, function is impaired and death can result. The body's content of the microminerals ranges from <1mg-~4g.

1. Iron

The human body contains ~2-4g iron, or ~38mg iron/kg body weight (BW) for women and ~50mg iron/kg BW for men. Iron exists in a complex form in our body. It is present as

i. Iron porphyrin compounds-hemoglobin (65%) in RBC, myoglobin (10%) in muscle.

ii. Enzymes (1-5%)–peroxidases, succinase dehydrogenase and cytochrome oxidase.

iii. Transport and storage forms (20%): transferrin and ferritin.

The total amount of iron found in a person not only is related to BW but also is influenced by other physiological conditions, including age, gender, pregnancy, and state of growth.

a. Functions

The chief functions of iron in the body are:

1. Iron forms a part of the protein–hemoglobin which carries oxygen to different parts of the body.

2. It forms a part of the myoglobin in muscles which makes oxygen available for muscle contraction.

3. Iron is necessary for the utilization of energy as part of the cell's metabolic machinery.

4. As part of enzymes, iron catalyzes many important reactions in the body.

Examples are

i. Conversion of β-carotene to active form of Vitamin-A

ii. Synthesis of carnitine, purines, collagen

iii. Detoxification of drugs in the liver

b. Deficiency

Iron deficiency occurs most often due to inadequate iron intake. Iron intake is frequently inadequate in four population groups:

- Infants and young children (6 months to about 4 years), because of the low iron content of milk and other preferred foods, rapid growth rate, and insufficient body reserves of iron to meet needs beyond about 6 months.
- adolescents in their early growth spurt, because of rapid growth and the needs of expanding red blood cell mass.
- females during childbearing years, because of menstrual iron losses.
- pregnant women, because of their expanding blood volume, the demands of fetus and placenta, and blood losses to be incurred in childbirth. In addition, many nonpregnant females during childbearing years fall short of the RDA for iron because of restricted energy intake and inadequate consumption of iron-rich foods.

Dietary iron deficiency leads to nutritional anemia. Nutritional anaemia is defined as the condition that results from the inability of the erythropoetic tissue to maintain a normal haemoglobin concentration. Anaemia occurs when the haemoglobin level falls below 12gm/dl in adult men and women. During pregnancy haemoglobin level below 11gm/dl is termed anaemia.

The major cause of anemia in India is because of Iron and folic acid deficiency.

Nutritional anemia is manifested as:

1. Reduced Haemoglobin level

2. Defects in the structure, function of the epithelial tissues

3. Paleness of skin and the inside of the lower eyelid is pale pink

4. Fingernails become thin and flat and eventually (spoon shaped nails) koilonychia develops.

5. Progressive untreated anaemia results in cardiovascular and respiratory changes leading to cardiac failure. The general symptoms include lassitude, fatigue, breathlessness on exertion, palpitations, dizziness, sleeplessness, dimmness of vision, and increased susceptibility to infection.

- Symptoms of iron deficiency, mostly demonstrated in children, include pallor, listlessness, behavioral disturbances, impaired performance in some cognitive tasks, some irreversible impairment of learning ability, and short attention span.

c. Excess

Accidental iron overload has been observed in young children following excessive ingestion of iron pills or vitamin/mineral pills. Other people susceptible to iron overload have a genetic disorder known as hemochromatosis. In most people with hemochromatosis iron absorption generally continues, despite high iron stores. The absorbed iron is progressively deposited within joints and tissues, especially the liver, heart, and pancreas, causing extensive organ damage and ultimately organ failure.

2. Zinc

The human body contains ~1.5-2.5g of zinc. Zinc is found in all organs and tissues and in body fluids. Largest stores of Zinc are present in the bones. Zinc forms a constituent of the blood. Zinc is an important element performing a range of functions in the body as it is a cofactor for a number of enzymes.

a. Functions

Zinc functions in association with more than 300 different enzymes. It participates in reactions involving either synthesis/degradation of major metabolites carbohydrates, lipids, proteins-and nucleic acids. It plays an important structural role in brain cells. Zinc is involved in the stabilization of protein and nucleic acid structure as well as in transport processes, immune function and expression of genetic information. It plays a major role in the synthesis of DNA and proteins, and a constituent of the hormone insulin. Zinc appears in the crystalline structure of bone, in bone enzymes. It is thought to be needed for adequate osteoblastic activity, formation of bone enzymes such as alkaline phosphatase and calcification.

b. Deficiency

Some population groups, especially the elderly and vegetarians, have been found to consume less than adequate amounts of zinc. Conditions associated with an increased need for intake include alcoholism, chronic illness, stress, trauma, surgery and malabsorption. Signs and symptoms of zinc deficiency are growth retardation, skeletal abnormalities, defective collagen synthesis or cross-linking, poor wound healing, dermatitis, delayed sexual maturation in children, hypogeusia (blunting of sense of taste), alopecia (hair loss), impaired immune function and impaired protein synthesis.

c. Excess

Excessive intake of zinc can cause toxicity. An acute toxicity with 1-2g zinc sulfate (225–450mg zinc) can produce a metallic taste, nausea, vomiting, epigastric pain, abdominal cramps and bloody diarrhea.

3. Copper

The adult body contains approximately about 80mg Copper. Concentrations of copper are highest in the liver, brain, heart and kidney. Muscle contains a low level of copper, but, because of its large mass, skeletal muscle contains almost 40% of all the copper in the body.

a. Functions

Copper is a component of many enzymes and symptoms of copper deficiency are attributable to enzyme failures. Copper in ceruloplasmin has a well-documented role in oxidizing iron before it is transported in the plasma. Lysyl oxidase, a copper containing enzyme, is essential in the lysine-derived cross-linking of collagen and elastin. Copper has roles in mitochondrial energy production. As part of copper containing enzyme such as superoxide dismutase, copper protects against oxidants and free radicals and promotes the synthesis of melanin and catecholamines

b. Deficiency

Clinical manifestations associated with copper deficiency. are hypochromic anemia, leukopenia, hypopigmentation or depigmentation of skin and hair, impaired immune function, bone abnormalities, cardiovascular and pulmonary dysfunction. The likelihood of copper deficiency increases in persons consuming excessive amounts of zinc (40mg/day) or antacids as well as in persons with conditions that promote increased loss of copper from the body, as occurs with nephrosis or gastrointestinal malabsorptive disorders such as celiac disease, tropical sprue, and inflammatory bowel diseases.

c. Excess

Copper toxicity is fairly rare. A tolerable upper level for copper is set at 10mg per day. Copper intake of 64mg (250mg copper sulfate) has resulted in epigastric pain, nausea, vomiting, and diarrhea. Other symptoms of toxicity include hematuria, liver damage resulting in jaundice, and kidney damage resulting in oliguria or anuria. Wilson"s disease, a genetic disorder characterized by copper toxicity, results from mutation(s) in the gene coding. In Wilson"s disease, copper accumulates in organs, resulting in disturbed function of organs, especially the liver, kidneys, and brain. Kayser-Fleischer (greenish gold) rings caused by copper deposition also are visible in the cornea.

4. Fluoride

Fluoride is found in natural elements in nearly all drinking water and soil and in the human body in trace amounts. Fluoride is not considered an essential nutrient, but it is clearly recognized as important for the health of bones and teeth.

a. Functions

Fluoride is essential for tooth enamel. Fluoride incorporation into enamel produces more stable apatite crystals. Fluoride also acts as an antibacterial agent in the oral cavity, serving as an enzyme inhibitor.

b. Deficiency

Fluoride deficiency in test animals has been reported to result in curtailed growth, infertility and anemia. In humans, an optimal level of fluoride helps to reduce the incidence of dental caries and perhaps also to maintain the integrity of skeletal tissue.

c. Excess

Chronic toxicity of fluoride, called fluorosis, is characterized by changes in bone, kidney, nerve and muscle function. Dental fluorosis or mottling of teeth has been observed in children receiving 2-8mg fluoride/kg BW. Acute toxicity manifests as nausea, vomiting, diarrhea, acidosis, and cardiac arrhythmias.

3. Manganese

Although widely distributed in nature, manganese occurs in only trace amounts in animal tissues. The body of a healthy 70kg man is estimated to contain a total of 10-20mg of the metal.

a. Functions

Manganese is a component of many enzymes, including glutamine synthetase, pyruvate carboxylase and mitochondrial superoxide dismutase. Manganese is associated with the formation of connective and skeletal tissues, growth and reproduction, and carbohydrate and lipid metabolism

b. Deficiency

Manganese deficiency is associated with striking and diverse physiological malfunctions. Manganese deficiency generally does not develop in humans unless the mineral is deliberately eliminated from the diet. Symptoms and signs of deficiency included nausea, vomiting, dermatitis, decreased serum manganese, decreased fecal manganese excretion, increased serum calcium, phosphorus, and alkaline phosphatase, decreased growth of hair and nails; changes in hair and beard color; poor bone formation and skeletal defects; and altered carbohydrate and lipid metabolism.

c. Excess

Manganese toxicity has developed in miners as a result of absorption of manganese through the respiratory tract. The excess, which accumulates in the liver and central nervous system, produces Parkinson-like symptoms. Toxicity has also been reported in patients receiving TPN including manganese. Symptoms include headaches, dizziness.

6. Chromium

Chromium is found in air, water and soil. The chromium content of the human body is estimated at ~4-6 mg.

a. Functions

Chromium potentiates insulin action and as such influences carbohydrate, lipid and protein metabolism. Chromium may regulate the synthesis of a molecule that potentiates insulin action. Another possible role for chromium, similar to that of zinc, is in the regulation of gene expression.

b. Deficiency

Chromium deficiency is seen in people who received intravenous nutrition feeding (total parenteral nutrition) without chromium and without oral food intake. Signs and symptoms of deficiency included weight loss, peripheral neuropathy, elevated plasma glucose concentrations or impaired glucose use, and high plasma free fatty acid concentrations. Severe trauma and stress may increase the need for chromium. Chromium deficiency results in insulin resistance characterized by hyperinsulinemia, a risk factor for heart disease. Mild chromium deficiency also is a risk factor for metabolic syndrome. Metabolic syndrome increases the risk of heart disease.

c. Excess

Oral supplementation of upto about 1,000µg of chromium appears to be safe. Toxicity is associated with exposure to chromium absorbed through the skin, enter the body through inhalation, or be ingested. Inhalation of or direct contact with chromium may result in respiratory disease or in dermatitis and skin ulcerations. Liver damage may also occur. Ingesting chromium leads to severe acidosis, gastrointestinal hemorrhage, hepatic injury, renal failure and death.

4. 7. Iodine

Iodine is an essential micronutrient, which is required for the synthesis of thyroid hormone for optimal physical growth and development of humans. The healthy human body contains about 20mg of iodine, 70-80% of which is concentrated in the thyroid gland.

a. Functions

Iodine is stored in the thyroid gland, where it is used in the synthesis of triiodothyronine (Tr) and thyroxine (Tq). Uptake of iodide ions by the thyroid cells may be inhibited by goitrogens (substances that exist naturally in foods). Thyroid hormone is degraded in target cells and the liver, and the iodine is highly conserved under normal conditions.

b. Deficiency

Iodine deficiency in the diet causes enlargement of the thyroid gland called "goitre", as well as a wide spectrum of disorders, which are termed as iodine deficiency disorders (IDD). IDD includes abortion, stillbirths, low birth weight, cretinism, neonatal chemical hypothyroidism, psycho-motor defects, impaired coordination, mental retardation and hypothyroidism.

Goitre occurs in people staying in hilly regions where the iodine content of water and soil is comparatively less. Goitre can be treated by administration of iodine. If treatment is given in early stages goitre can be corrected. Severe iodine deficiency in children leads to hypothyroidism resulting in retarded physical and mental growth. This condition is known as cretinism.

Goitrogens are substances present in foods which cause goitre. These substances react with iodine present in the food making it unavailable for absorption.

Foods like cabbage, cauliflower, raddish contain goitrogens.

c. Excess

Excessive iodine intake is reportedly occurring because of poor monitoring and higher than necessary supplementation in several countries with supplementation programs. In addition, in some countries, excessive intake occurs from overconsumption of foods naturally high in iodine. Some signs of acute iodide toxicity include burning of the mouth, throat, and stomach; nausea; vomiting; diarrhea; and fever. A tolerable upper intake level for iodine has been set at 1,100µg/day.

5. 8. Molybdenum

The need for molybdenum was established in humans through the observation that a genetic deficiency of specific enzymes that require molybdenum as a cofactor resulted in severe pathology.

a. Functions

Xanthine oxidase, aldehyde oxidase, and sulfite oxidase, all enzymes that catalyze oxidation-reduction reactions, require a prosthetic group containing molybdenum.

b. Deficiency

Molybdenum deficiency has not been established in humans other than patients treated with TPN. Symptoms of molybdenum deficiency include mental changes and abnormalities of sulfur and purine metabolism

c. Excess

Molybdenum appears to be relatively nontoxic, with intake upto 1,500µg/day. However, symptoms such as gout have appeared in some people living in regions that contain high soil molybdenum levels and in those with occupational exposure to molybdenum.

9. Selenium

Selenium, a nonmetal, exists in several oxidation states. Selenium is important as it has antioxidant activity. The chemistry of selenium is similar to that of sulfur; consequently, selenium can often substitute for sulfur. The total body selenium content ranges from about 13-30mg.

a. Functions

Glutathione peroxidase is the only selenoprotein enzyme well studied for the biological role of selenium. Deiodinase isoenzymes that are involved in thyroid hormone metabolism are also selenium-containing proteins. Apart from its antioxidant protection against free radicals, selenium was found to be functional in detoxification.

b. Deficiency

Selenium deficiency has been associated with two childhood/adolescent endemic diseases, “Keshan” (cardiomyopathy) and “KashinBeck” (osteoarthritis). These diseases are found to be prevalent in certain areas where the intake of Selenium is very low, 7-11g/d. Poor intake of Selenium is associated with increased risk of cancer or heart disease.

c. Excess

Selenium toxicity, also called selenosis, has been observed both in miners and in people who consume excess selenium from supplements. Signs and symptoms of toxicity include nausea, vomiting, fatigue, diarrhea, hair and nail brittleness and loss, paresthesia, interference in sulfur metabolism and inhibition of protein synthesis.

Acute poisoning selenium is lethal, with damage occurring to most organ systems. Daily intakes above 700µg/d or acute consumption of 1-7mg Selenium/kg/d results in toxicity in humans.

CHECK YOUR PROGRESS:

1. What are minerals, and why are they essential for the human body?
2. How are minerals classified, and what distinguishes one class from another?
3. How are minerals distributed in the human body, and what factors influence their distribution?
4. Which minerals are considered macronutrients, and what roles do they play in bodily functions?
5. What are ultra trace elements, and how do they impact health, even in very small amounts?
6. What are the differences between macronutrients and micronutrients in terms of mineral content?
7. How does the body's requirement for macronutrient minerals differ from its need for micronutrient minerals?
8. Why are ultra trace elements important, and what are some examples of these elements?

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UGHN-101
FUNDAMENTALS OF FOOD & NUTRITION

BLOCK
4

METHODS OF COOKING AND CEREALS UTILITY

Block IV: Introduction - Methods Of Cooking And Cereals Utility

In this block, we'll explore the fascinating world of cooking methods and cereal grains, both of which play an important role in everyday nutrition.

In Unit XI: Methods of Cooking, we'll look at the different ways food can be prepared, like boiling, steaming, frying, baking, grilling, and more. Each method has its own effect on the texture, taste, and nutritional value of food. For example, steaming preserves more nutrients, while frying can add extra fats. Understanding these methods will help us choose the best ways to cook while keeping our meals healthy and flavourful.

Next, in Unit XII: Cereals and Their Utility, we'll talk about popular cereals like rice, wheat, maize, oats, and barley. Cereals are the foundation of most diets around the world because they are rich in carbohydrates, providing the energy we need throughout the day. We'll also discuss how cereals are processed, their nutritional benefits, and how they can be used in different recipes.

These units will help us understand how cooking methods and cereals impact both the taste and nutrition of our food!

UNIT – XI : **Methods of Cooking**

UNIT - XII : **Cereals and its Utility**

UNIT 11: METHOD OF COOKING

Content

11.1 INTRODUCTION

Cooking is an age-old art. A caveman who had lit a fire to warm himself up was the first person to prepare food. He had placed a piece of meat next to the fire. In addition to being delicious, he found that the meat prepared in this manner was also considerably simpler to chew. Cooking has developed since this point in the distant past to achieve its current level of expertise.

In the previous unit we have studied about nutritional importance of food, different methods of sensory evaluation & various laws for the regulation of food standards & acts. In this unit you will learn about different cooking methods as well as the impact of cooking methods of cooking on nutrients.

11.2 Introduction to Cooking & its Importance

The art, science, and craft of utilizing heat to enhance the flavour, ease of digestion, nutrition, or security of food is known as being cooked, cookery, or culinary arts. In order to reflect local conditions, cooking methods and ingredients vary greatly, from grilled food over an open flame to utilizing electric burners to baking in a variety of ovens.

Initially, the evolution of cuisine was only related to that of a single nation or region, but when each location came into touch with individuals from other places, ideas started to spread. As a result, a discernible pattern of civilizations from the Egyptians to the Assyrians to the Chaldeans to the Babylonians to the Hebrews to the Persians to the Greeks to the Romans to the Gallows Romans to the Franks emerged as the direct ancestors of the French cooking. For the majority of historians, the French kitchen served as the fulcrum of the early modern era in the developed world.

Beginning with the early Egyptian kings, a pattern of culinary preparation development and refinement persisted until the Persian era, when it was further developed by the Greeks. The first thorough cookbook was written in the Roman era by the wealthy businessman Apicius.

The changes in the French kitchen from the Tail event until the middle of the 1600s were brought into emphasis by François Pierre de la Verenne in his work "Le Cuisinier Francois." Due to the rich feasts and excessive use of spices, a concern for harmony and balance in meals started to emerge. Prior to the establishment of classical French cooking by the renowned chef and researcher Antonin Careme, there had been little advancement from the culinary profession towards anything scientific.He was the first to start writing recipes in a formal way. He started to organize the menus as well. 'Service a la Russe' was introduced by Urbain Dubois and Emile Bernard in the 1850s, which was a significant change. When Crème was in Russia, he was first exposed to this style of treatment, but he preferred the more showy "service a la Francoise." 'Service a la Françoise' was the presentation of many dishes at once, whereas 'Service a la Russe' was the offering of dishes one at a time.

The first culinary arts school, La Cuisine Classique, was founded in the 20th century by a Frenchman named MaitreAuguste Escoffier. The father of contemporary cooking is hailed as Chef MaitreAuguste Escoffier. Escoffier had a phenomenally successful career in the kitchen. He was revered as the ruler of kitchens everywhere. He made adjustments to the kitchen's layout, menu, and method of food preparation. Escoffier was responsible for creating the current menu. Dubois and Bernard offered the streamlined menus, which were created for the "service a la Russe." The menu was simplified and the service changed, which allowed the restaurants to thrive.

Escoffier committed himself to improving the kitchens in every way. He started the transformations that led to the contemporary kitchen. Escoffier introduced a wide range of characteristics, some of which include:

1. Checkered pants and a white jacket are essential for all cooks.

2. Regular bathing by cooks

3. Cooks should pursue education for their advancement

4. Kitchens will no longer be located in unventilated basements, as is customary.

5. Kitchen personnel will not be allowed to smoke or drink alcohol.

6. Escoffier invented the kitchen brigade to remove the confusion caused by the conventional kitchen layout.

7. Making recipes and menus uniform.

Escoffier's innovations made culinary preparations into a science and an art, placing a greater emphasis on quality. The 20th century saw enormous advancements in a variety of industries, including machinery, fuel, food preservation, refrigeration shipping and storage, hoover packaging, inert gas packaging, and others. All of these factors affected the commercial kitchen's organization and labor needs in addition to how food was prepared there. There are many different types of foods because of the nation's constant flow of immigrants from all over the world, which paired with the country's high standards for culinary excellence. The kitchen and menu have been simplified over the 20th century in terms of both taste and nutritional content. There is no doubt that the long tradition of food preparation is only just getting started, and there are still a lot of changes and improvisations to come in terms of cuisine, service style, and kitchen organization.

As a chemical process, the mixing of ingredients, the development of skills, methods, and procedures for cooking, the application of heat, and in phases where it incorporates the scope of creativity, new innovations, and ideas, cooking may be defined as these things. In other words, it combines art and science.

The goal of cookery is to get specific outcomes, like:

- To speed up digestion so that food is as quickly as possible absorbed by the gastrointestinal tract as we cook. The complicated meal transforms into a simpler form while cooking. The act of cooking softens the connective tissues, causing both physical and chemical changes in the texture, chemical alterations.

1. **Protein:** Heat coagulates the proteins in meat (myosin), eggs (albumen), wheat (gluten), and pulses (leguminous). The connective cells are transformed into water-soluble gelatine. Mutton has a lot of connective tissues, which become rubbery when cooked at a higher temperature.
2. **The carbohydrates** Starch in food is typically highly influenced by heat; wet heat first transforms it into its water-soluble form, and excessive heat transforms it into a new material with a swedish flavour. **Starch** expands in moist heat; it gelatinizes at temperatures below the boiling point, or below 100 °C. Moisture heat softens cellulose, while sugar dissolves while heated in water at first and turns to a caramel-like colour and consistency with more heating.
3. **Fats:** When cooked to extremely high temperatures for an extended period of time, fats partially break down into a combination of fatty acids and glycerine.

- Cooking is aesthetically pleasing to the sight, the palate, and it stimulates the digestive system, which increases appetite. Flavours are enhanced, and veggies that are cooler are made brighter.

- **Cooking sterilizes the food:** If food is heated above the boiling point, it extends its shelf life and allows for longer food storage. Additionally, it limits the growth of bacteria and food poisoning to some extent. Because of the greater temperature used during cooking, particularly in meat items, the germs are eliminated.
- Cooking improves the product's look by preserving the flavorful and nutritive elements to the greatest extent possible. The smallest amount of vitamin and nutrient loss is possible if cooking takes place in the liquid medium.
- **Cooking adds variety:** One component can be prepared in a variety of ways to provide diverse textures and flavours, and ultimately a new product. Examples include roasted mutton, mutton stew, kheema, and boti kebab. Here, the same sorts of meat are prepared using a variety of techniques, creating a wide range of flavours.
- Cooking aids in preservation since many substances have a natural preservative quality when cooked at higher temperatures to produce a variety of flavours. Saline, sweetener, etc.
- By producing a variety of intriguing items, cooking creates balance in the meal.

Food is partially sterilized by cooking. Bacterial growth slows down significantly above 40°C and generally stops at 45°C. For example, milk is pasteurized at 63°C for thirty minutes or at 72°C over 15 seconds to make it safe. Non-sporing microorganisms are killed at degrees above 60°C for varied lengths of time. Spores are the only live cells that are not killed by boiling in a matter of seconds. Boiling for between four and five hours will kill germs that carry spores.

Higher temperatures must be used in order to destroy them faster.

1. Food becomes easier to digest thanks to cooking. During cooking, complicated meals are frequently broken down into simpler ingredients. When compared to eating the meal raw, this makes it easier for the body to take in and utilize the food.

2. Cooking makes food more palatable.

3. Food that has been cooked looks better and is consequently more enticing.

4. Cooking offers diversity. The same component can be used to produce a wide variety of recipes.

5. Cooking contributes to a balanced supper. It is simpler to serve a balanced dinner when several elements are integrated in one dish.

11.3 Methods of Cooking

There are numerous different cooking techniques, the majority of which date back to ancient times. These include boiling, steaming, braising, grilling, barbecuing, roasting, and smoking. Microwaving is an innovation that is more recent. Different cooking techniques require varying amounts of heat, moisture, and time. Because some foods respond better to some techniques than others, the approach used has a significant impact on the outcome.

There are three fundamental types of cooking: dry heat, oil or fat medium, and medium with liquids or moist heat. All cooking methods fall under one of these three categories; for a fuller understanding, see the infographic below.

11.3.1 Dry Cooking Methods

When food is prepared with "dry heat," it is heated to a high temperature from below to above (often in an oven). Compared to "wet heat" cooking, this method of heat raises food temperatures significantly. Additionally, it imparts flavor by giving food a brown coating or top. When cooking using dry heat, you may utilize less fat (such as oil or butter) and yet produce a lot of delicious food. When cooked with dry heat, meats, poultry, fish, tofu, and vegetables are wonderful. Cooking with browning adds flavor as well as color. Adding richness, savory crusts, and alluring scents through browning. Just take care not to over brown (burn) your food since this will leave a bad taste and may be unhealthy.

Cooking using dry heat is accomplished without the use of liquids like broth or water. Instead, it depends on the movement of heated air or the interaction of fat to heat food. Browning, a process where the sugars and amino acids in food turn dark and produce a distinctive aroma and flavor, requires a temperature of 300 degrees Fahrenheit or higher. Both the distinct flavors of toasted bread and seared meat are effects of dry heat cooking.

GRILLING

When grilling, the food is cooked using heat from below. A typical grilling method is barbecuing. To prevent food from sticking, use a hot grill, and cover the pan to cook food rapidly. Grill beef steaks or hamburgers made with ground beef, salmon or seasoned chicken breasts. The grill is a great way to cook kabobs that include both meat and veggies or vegetables and tofu. Try some of these tasty and nutritious grilling dish ideas. If you don't have a barbecue, you may still grill food inside on a sandwich maker, skillet or grill pan on the hob.

Broiling and grilling are comparable because both methods employ radiant heat to quickly cook food. Grilling apparatus will often have an open grate with a source of heat beneath the food. Foods must be flipped over to cook on both sides, and grill scars from the hot rack or grate are preferred.

BROILING

While grilling uses heat from below, broiling uses heat from the top of the oven. Because it is only exposed to extremely high temperatures for a brief period of time when being broiled, food cooks fast and evenly. Put your meal on the top shelf of the oven and turn the oven on to broil. In a toaster oven, food can also be broiled. Simply keep an eye on your food because it will heat quite quickly. Similar to barbecuing, broiling is a great method for many types of meat, including loin or chunks of beef, lamb, or hog. Try seafood like this delicious Tandoori haddock or chicken pieces like thighs, breasts, or legs. Broiling can also be used to prepare vegetables, such as these thyme-braised mushrooms.

The process of broiling involves applying extremely high heat to food, typically from a radiant above the meal that cooks it one side at a time. With this technique, browning can happen extremely quickly, sealing in fluids and flavour and producing a crisp outside. Due to the speed of this cooking process, it can be useful to set a timer or monitor the doneness of the meal to prevent overcooking or burning. A salamander or grill oven can be used in industrial kitchens to broil food.

The best meals to broil are:

- Meats: Thinner cuts of meat, such as cuts of meat, pork chops, or hamburger patties, cook best when broiled. Although the heat that is dry will rapidly lose moisture while drying out the meat, tender pieces are ideal.
- Poultry: For tasty results, broil chicken halves, quarters, and legs.
- Fish: Salmon is a good option for fish because it can withstand extreme temperatures and won't dry up quickly.
- Fruits & Veggies: Broiling can be used to cook fruits and vegetables as well. Try broiling grapefruit or peaches for a special meal item.

BAKING

Similar to broiling in the oven, baking also involves surrounding the food with heat. The movement of air inside the oven bakes the food. The slowest way of cooking using dry heat is baking. You could observe that food bakes more quickly when you have a rapid oven. This occurs as a result of more fans being used to move the warm air within the oven. For meat recipes like these Green Meatballs, baking works well. Like this Mediterranean baked fish, fish bakes well when covered with fresh veggies and herbs.

Indirect heat is used in both baking and roasting to cook food from all sides. While preparing meats or vegetables, the phrase "roasting" is used, and while producing bread, rolls, and cakes, the term "baking" is used. Although technically equivalent, baking is often carried out at lower temperatures then roasting.

ROASTING

Typically, food is roasted in an oven where the dry heat can circulate and cook the meal evenly. In order to achieve a crisp, browned surface, roasting typically starts out at a higher temperature than baking does. Reduce the heat once a brown surface has developed until the meal has cooked to a safe internal temperature, which you can check with a food thermometer. For roast cattle, such as prime rib, whole or cut-up chicken parts, pig, such as this tenderloin of pork and caramelized carrots, and vegetables, such as these Parmesan Carrot Fries, are frequently roasted.

When roasting, indirect heat is used within the oven to cook the food evenly on all sides. Cooking in this manner brings out the flavors of the meats and veggies more gradually. For harder beef cuts, roasting can be done at a temperature range between 200 and 350 degrees Fahrenheit, or at temperatures that go up to four hundred fifty degrees Fahrenheit.

- **POT ROASTING**
  Only premium meat products, tiny bones, and birds are used, and it is prepared in a covered casserole or skillet. The meat goes in the pot with skewers in the bottom to keep it from adhering to the pan and is tied using foil to keep its form. Cooking should be done on a slow fire with fat covering the pan's bottom.

- **OVEN ROASTING**

With the help of fat, roasted is done in an oven in a roasting tray. We only utilize premium meat, poultry, and produce. To seal the juices, it is placed in hot fat and fried on all sides. Vegetables with a strong flavor should be added after 15 minutes.

- **Spit-roasting**
  In this method of cooking, food is prepared using dry heat and fat as a basting agent. Meat ought to be juicy and of the highest quality. Wood should be used as the fuel for this method of cooking.

- **Roasting in a tandoor**
  In a clay oven, this method of cooking is carried out. The fuel for the flames should be preferably coal, charcoal or gas since heat rises from below to above. With this method, we are able to cook seafood, vegetables, meat, poultry, and Indian bread.

SAUTEING

While sautéing and stir-frying are also forms of frying, they do so at higher temperatures and with less oil than pan- and deep-frying. On your hob, cook food directly over high heat while stirring constantly for a stir-fry or sauté. A crisp food item is produced as a result. A sweet chili tofu stir fry, teriyaki noodle dishes with veggies, / chicken or beef tenderloin are all excellent candidates for sautéing.

A tiny bit of fat or oil is used in sautéing, which is done over a hob in a hot, deep pan, to coat the food and provide equal browning. It is best to toss or flip the meal frequently because this technique cooks food quickly. The French term saute means "jump" in English. Prior to adding any food to an oiled skillet for sautéing, make sure the pan is hot, don't pack the pan too full of ingredients, and flip or toss the food often.

SEARING

Meat or fish can be quickly browned by searing. Put the dish in a hot pan, beneath a grill or in an extremely hot oven to sear it. While producing a lovely brown crust on the exterior, the intense heat maintains the food moist inside. To aid in the creation of this crust, add some oil. Reduce the heat after a few seconds or minutes of searing to allow the food to finish cooking. Salmon, pig, and chicken dishes like Blackened Chicken as well as Creole Lentils are all delicious when seared.

Even though it's sometimes said that searing "locks in the hydration" or "seals in the juices," searing actually causes more moisture to be lost than cooked to the same degree inside without searing. But for a number of reasons, it is still a crucial method for preparing meat:

- The Maillard process, which takes place during browning, produces tasty flavors.
- A well-browned crust usually enhances the food's appearance.
- The cuisine is made more fascinating by the contrast both taste and feel between the exterior layer and the contents.

11.3.2 Moist Cooking Methods

When food is prepared or cooked using moist heat, water or another liquid is used as the heat source. Other liquids outside water could be milk, broth, stocks, etc. The use of liquid in the cooking process affects not only the cooking process but also offers a chance to add flavor. For more difficult less succulent cuts of beef (like flank steak), moist heat is desirable because it break down and softens the fibrous proteins. Because moisture has the ability to dissolve within the cell walls of the veggies themselves, moist heat is further employed when cooking vegetables. As the name suggests, dishes are cooked using moist heat when there is liquid or steam present. Healthy dishes can be prepared using this technique without the use of additional oil or fat. Additionally, it's a fantastic technique to soften the rough fibres in some meats, such as pork chuck or brisket. When cooking beans and fibrous vegetables, moist heat cooking causes the food to soften until it reaches the ideal level of softness. Moist heat cooking does not result in a browned crust like dry-fire cooking does.

Moist heat, particularly when used on vegetables, can change the color, making the dish less appetizing, and it is known to lower the food's water-soluble nutrient content. Cooking veggies for the shortest time possible can help prevent nutritional loss. By blanching the vegetables, keeping them in smaller batches, and heating them only when necessary, the color of the vegetables can be preserved.

Cooking techniques using wet heat include:

- Scalding
- Poaching
- Simmering
- Stewing
- Braising
- Boiling
- Steaming
- Microwaving

SCALDING

Before pasteurization, the method of "scalding" milk has historically been used to eradicate microorganisms. In recent years, scalding milk is less frequently necessary, although the process still entails boiling the liquid to 150 F. There might be bubbles in the liquid, but only along the pan's sides.

Scalding is a type of thermal burn brought on by heated fluids like steam or boiling water. The majority of scalds are first- or second-degree wounds, but persistent contact can sometimes cause third-degree burns. The name comes from the Latin calidus, which means hot.

Scalding is done in water that has been heated to about 185 °F (85 °C), typically in a pair of boilers that transfers the boiling point of the water's surface from a larger pan to a smaller pan that contains the food, preventing contact between the water and the food. Milk is frequently prepared using this method for custards and pastries. Foods, especially eggs and fish, can be poached when water starts to visibly circulate and shudder just above the boiling temperature. Simmering, whether in a covered or uncovered pan, is frequently used to create stews, soups, and pot roasts. The simmering point is differently described but generally nearing the boiling temperature.

POACHING

Have you ever prepared Eggs Benedict with a poached egg? For dessert, how about wine-poached pears? To keep the meat's moisture, delicately cook a fish in a covered pan with water, stock, or wine (poaching liquids). These are poaching instances that you're presumably already acquainted with. It is the technique that uses the least heat, making for a gradual, delicate cooking procedure. For really delicate goods like eggs, fish, white flesh poultry, and fruit, poaching is the best option. Because liquid—rather than fat—transports warmth into the meal, it is regarded as a healthy cooking technique.

Poaching is best carried out around 160°F to 190°F, or considerably below a simmer. An instant-read thermometer is the most accurate tool for determining whether a spawning liquid is at the proper temperature. Poaching requires endurance. Food proteins can progressively uncoil or denature when poached without losing moisture. The proteins could clump up so quickly if you dropped a tender chicken breast into the boiling water that every drop of liquid would get squeezed out, leaving you with a tiny piece of dry rubber.

A delicate cooking technique called poaching involves immersing food in a hot liquid that is between 140 and a full 180 degrees Fahrenheit. Low heat preserves moisture and flavor without the need of butter or oil, making it particularly effective for delicate foods.

SIMMERING

The term "simmering" is probably already familiar to you because it is regularly used in many dishes when the cooking environment is reduced to a "simmer" while food allows itself to cook for a longer period of time at a lower temperature. Mild bubbles that barely pierce the liquid's surface are a sign that something is simmering. Simmering is frequently favored to boiling due to the fact that it can lessen the amount of harm done to the food's look and the slower cooking procedure makes tougher meats softer.While simmering employs temperatures that are higher than poaching—typically between 180 and 205 degrees Fahrenheit—it is still a gentle method of preparing food. Tiny bubbles are created in this temperature range, which is below the boiling point. Water must first reach the boiling point before the temperature is lowered in order to achieve a simmer.

STEWING

In essence, stewing is a kind of simmer that uses a little to a little bit of water (or another cooking liquid). Meats and vegetables are often diced and cooked in a flavored broth or liquid for stews. Typically, the ingredients that have been chopped are placed in a sizable saucepan with sufficient water to cover them, simmered, and then covered. When stewing recipes, the broth is not drained out.The main distinction among stewing & braising is the fact that when stewing, meals are totally immersed in hot liquid as opposed to only partially. In a stew, smaller pieces of meat are utilized, but the cooking technique remains the same: slow cooking over low heat. The collagen and fat through the meats dissolve away as the stew simmer, breaking down the fibrous vegetables. The outcome is a rich, delicious sauce with soft veggies and tender beef chunks.

BRAISING

Traditionally, food is first browned or seared at an elevated temperature, followed by completion in a covered dish at a lower setting while seated in some (a variable) quantities of fluids (which in turn may also add flavor). Braising is a combination cooking technique which employs both dry and wet heats. Although some authors distinguish between the two cooking techniques depending on whether extra liquid is added, braise is a term that is frequently used to refer to pot roasting of meat. Braising is a great technique to prepare harder, more cheap cuts of meat because it uses warmth, time, and humidity to break apart the connective tissue made up of fibres (collagen) that holds the muscle fibres collectively known as "meat" together.

Foods are moved to a bigger pot to braise in hot liquid after being seared in a hot, oiled pan. The ingredients are simmering in stock, broth, or water that is only partially submerged. Low heat allows meals to soften over a prolonged cooking period and reduces liquid while enhancing flavor. Meats that slip off the bone when fork-tender are produced through braising.

Braising can be done under pressure as well as slowly, using a crockpot as an example. The majority of braises proceed in the same manner.

- To brown the food's surface and improve its flavor (by the Maillard process), the ingredients for the braised dish—meats, vegetables, mushrooms, etc.—are first pan-seared.
- If the food is unable to produce enough liquid on its own, stock is frequently added to the pot along with a specific amount of cooking liquid, which frequently contains an acidic ingredient (such as tomatoes, beer, vinegar with balsamic, or wine). The cooking liquid ought to cover between a third and a half of the meal in the pan when cooking a traditional braise, which uses a relatively entire cut of meat.
- The food is subsequently covered and simmered at an extremely low level until the meat is so tender that a fork, as opposed to a knife, can be used to "cut" it.
- Frequently, the liquid used while cooking is completed to make a sauce or syrup as well.

BOILING

Water has to reach a boiling point of 212°F, or 100°C, in order to boil. Only at sea level is this value accurate, and any elevational shift may have an impact on the degree at when water will boil. The amount of sugar or salt that is added to the water can also impact the degree at which it will boil, but most recipes do not call for enough of anything to make a significant difference. Larger bubbles will soon rise to the liquid's surface due to the increased temperature. Due to the visible movement of water's surface when it reaches boiling point, this phenomenon is occasionally referred to as a "rolling boil." Beans, difficult vegetables like potatoes, dry pasta, and other foods are frequently cooked by boiling.

In order to cook food using this method, water must be heated to 212 degrees Fahrenheit, the boiling point. Large bubbles created by the boiling water keep the food moving while it cooks. The term "slow boil" describes water that has just begun to form huge, slowly moving bubbles but has not yet reached the boiling point. At the boiling point, a full boil takes place, producing quick-moving, rolling bubbles. The water also releases steam as it begins to boil.

PARBOILING

Because it can significantly minimize the length of time a client must wait for their food to be cooked, simmering is a technique that is frequently utilized in restaurants and quick service facilities. In essence, parboiling means preparing food in advance and completing it at a later time. The item known as "Minute Rice" is an excellent illustration of this. The rice was parboiled previously, dried, and repackaged for the home cook to complete the process at home, which is why this product cooks in the household microwave in just under a minute.

BLANCHING

In addition to preparing foods for freezing or canning, blanching can be used to assist remove the peel from tomatoes and the shells from almonds.

In order to prepare food for subsequent cooking, it is sometimes but not always necessary to blanch it, which is the process of temporarily submerging it in a hot liquid, such as boiling water or oil. The most often blanched foods are fruits, vegetables, and nuts, each for a different purpose. Occasionally, it might be done to soften it, remove the skin in order to make ripping it simpler, or just to make it look more vibrant.

In the following description, take note of the phrase "briefly". The amount of time that must be spent blanching will vary depending on the recipe, however this duration is expressed in milliseconds rather than minutes. The typical blanching duration is between 30 and 60 seconds.

STEAMING

Comparing steaming to poaching, as well braising, and stewing, the temperature at which food is prepared is actually higher. When water is heated over 212°F, it ceases to be water and transforms into steam. As there is no movement involved, steaming is kinder to delicate foods like shellfish than procedures like boiling or even simmering. It doesn't necessitate submerging the food, therefore leaching of nutrients is prevented. Additionally, it cooks fairly rapidly.

A vessel and a basket for the steamer are the only two pieces of basic equipment needed to steam on a hob. The object to be prepared is put in a basket hanging over the simmering fluid, and the vessel is covered. The pot is then filled with a little amount of liquid. The food is cooked fast as the hot steam moves throughout the kettle. Compartment steaming is the term for this method. (A compartment steamer is somewhat like the bamboo steamers that are used in Asian cooking.)

Additionally, you can steam foodstuff in the microwave, considered a natural steaming appliance because it "excites the fluids in food." By putting the meal into a microwave-safe dish, adding water or another liquid, then covering it with a piece of plastic wrap that has a few holes pierced through it, you may make your own steaming system. Just a couple of minutes of cooking will result in flawlessly steaming food. If you frequently use this approach, you may also purchase a steamer basket designed specifically for the microwave.The two similar methods of steaming are both generally used to cook vegetables. In the initial stage, the food is cooked in a covered pan with the color, appearance, flavor, and nutrients preserved by placing it on a rack over a shallow pan of boiling water.When steaming, water is constantly boiled to generate a consistent volume of steam. Foods are surrounded by steam, which retains moisture while cooking food evenly. There are several methods for steaming. A commercial steaming or combo oven is particularly effective in kitchens with heavy food production. A saucepan and steamer basket, a microwave, or putting food in foil so it may steam in the oven are further steaming techniques.

A culinary technique that uses moist heat is steaming. Direct steaming and indirect steaming are the two types of steaming.

First, indirect steaming is accomplished by placing the meal in a steamer or a closed pan that is surrounded by a lot of steam from rapidly boiling water. Direct steaming, on an insulated plate placed over a pot of water, it is prepared.

MICROWAVING

Although it technically uses both moisture and dry heat techniques to cook food, for the sake of this lesson, we'll only talk about moist heat techniques. Steam is created as a result of the microwave's agitation of the water molecules in the food being cooked. The idea that food heated in a microwave merely cooks "from within out" is a widespread one. Instead, when thicker items are being prepared in the microwave first heats and cooks the outside layers, and then conduction cooks the Centre.

Compared to other ways, cooking in the microwave can be more energy-efficient and speed up the cooking process for a variety of meals.

11.3.3 Pressure Cooking

A new breed of cookers that offer a quick, set-it-and-forget-it route to dinner have given the ancient culinary technique of pressure cooking a recent rebirth. These appliances—whether electrical or stovetop—are much safer than those from decades past (which frequently exploded), and they all have systems in place to keep pressure from building up inside of them. However, if you carefully read the owner's manual, you'll still find one crucial safety measure to follow when boiling under pressure as follows: adding water. Pressure cooking and water go together. In actuality, water contributes to creating the high-pressure atmosphere that hastens the cooking of your meal.

Most directions for using a pressure cooker specify the minimal amount of water needed to pressurize even a little amount of food. The water gets heated and finally boils into steam inside the pressure cooker's tightly sealed interior. The steam builds up on top of the food since it can't leave. The pressure behind the cooker rises as a result of all those entrapped water molecules.

So what does speedier food preparation have to do with water and pressure? Generally speaking, cooking includes raising the internal temperature of a meal until certain chemical processes, such as those that break down the dense connective tissue in meat and soften the carbohydrates in vegetables, occur. Higher temperatures typically speed up those reactions.

Think of a typical pot that has water and meat. The temperature within the pot rises as it is heated until the water begins to boil. At that time, all of the heat energy is directed towards bringing the water to a boil. As a result, the temperature can never rise above the boiling point of water while it is still in liquid form.In the case of a pressure cooker, the same thing takes place, but the inside temperature is much higher. The pressure in the area affects what temperature a liquid boils. Freshwater boils with 100°C (212°F) when you boil in a typical saucepan at the pressure of the atmosphere (14.7 pounds every square inch [psi]). A pressure cooker's inside can experience a further 15 psi of pressure, or almost 30 psi. Water boils at 121°C (250°F) at that pressure. As a result, food may cook at considerably greater temperatures than it could under atmospheric pressure. Additionally, because cooking reactions quicken at higher temperatures, food cooks more quickly. Due to the water's continued liquid state, it also doesn't dry out. The identical phenomenon explains why high-altitude cooking can be difficult.

Food scientist and Institute of the Food Technologists spokeswoman KanthaShelke, Ph.D., resides in Chicago. She informed as follows:

- Heat-sensitive minerals (including vitamin C and iron) and bioactive phytonutrients, like beta carotene, glucosinolates (beneficial substances found in cruciferous vegetables), and omega-3 fatty acids, which are good for human health, can be reduced by pressure cooking. But other cooking techniques also do, usually to a similar degree.
- The heat-sensitive components found in vegetables and fruits, such as vitamin C, folate, and bioactive phytonutrients, are typically the ones most likely to degrade during pressure cooking. Some of the aforementioned losses can be recovered by eating the cooking liquid.
- In the case regarding grains and legumes, pressure cooking results in a net nutritional gain due to the increased the digestibility of the macro nutrients (protein, fiber, and starches) and the greater absorption of the essential minerals, despite the fact that the vitamins and sensitive to heat vitamins and phytonutrients that are susceptible to deterioration.
- Dishes made with beef that have been pressure-cooked have a large drop in unsaturated fat content, although it seems that iron is not lost.
- In addition to improving the digestibility of foods like cereals and legumes, cooking with pressure does not produce any of the harmful chemicals that are produced during baking or grilling.

11.3.4 Solar Cooking

One of the uses for solar thermal technology is sun cooking, which was developed by the German scientist Tschirnhausen between the years of 1651 and 1708. It operates on the tenet that solar thermal energy can be used for cooking. The solar radiation was focused and reflected onto the system using lenses and reflectors. To stop heat from escaping into the environment, the entire system is insulated.

The most fundamental energy requirements of over fifty percent of the world's population are met by dung, wood, crop waste, or coal1. However, the United Nations estimates that roughly a third of the world's population, or two billion people, are currently experiencing a fuel wood shortage, making it more difficult to procure and more expensive. To get fuel for the family, women and occasionally kids must travel farther. Some urban families may exchange food for gasoline to cook the remaining meals or spend 30 to 50 percent of their annual earnings on cooking fuel.

SOLAR COOKER

Food is prepared in solar cookers, which also pasteurize water to make it safe to drink. They do not harm the environment because they utilize a free, renewable energy source. Solar cooking has a variety of advantages, which are detailed further in the pack. They are especially helpful when other fuel sources are not accessible.

Solar cookers come in a variety of forms and configurations, but they all operate on the same fundamental principles.

- **Sunlight concentration**: Sunlight is focused and given off more energy when it is reflected by a mirror or other reflective material.
- **Creating heat from light:** The cooker's interior is decorated in parts with black paint. Black surfaces effectively absorb and store heat, which is crucial for maintaining the cooker's heat.
- **Heat trapping:** A significant difference is made by separating the air within the cooking vessel from the ambient air outside. To ensure that the heat is able to enter the oven but cannot escape out the other side, a plastic or transparent cover provides a greenhouse effect inside the oven**.**

One kind of solar energy collector is a solar cooker. The thermal (heat) energy of the Sun is "gathered" and captured. A low-frequency infrared radiation is created when high frequency visible and ultraviolet light is transformed into it. While both visible and ultraviolet light can easily flow through glass, they are transformed into heat when they come into contact with a darker surface. These long waves are trapped by the glass (referred to as lamination on a solar collector). For instance, a sunny day turns your car into a solar collector when the windows are pulled up. The glass allows solar energy to enter your car, stores thermal energy, and heats the air inside. The air inside the automobile gets hotter as more light comes in, to the point where we may say it appears like an oven!

Many people all around the world are living better thanks to solar cookers. A few locations in South America, East Africa, and India now have solar ovens. In these places, it is prevalent for a woman to spend almost half of her working day gathering firewood. Additionally, the gasses produced by burning of subpar wood have been implicated in respiratory issues in children from these locations. Utilizing solar cookers lessens the reliance on firewood. Additionally, some women have started businesses by constructing and selling cookers to generate additional revenue.

BOX COOKER

The same items that may be prepared in a conventional oven and a slow cooker can also be prepared in box cookers, also referred to as box ovens. They have an internal chamber (or "box"), as their name suggests, though it need not be square in shape. They employ windows to let sunlight into the container and then capture the heat, reflectors for directing more rays into the box, and insulation to keep as much temperature as possible. On a bright, sunny day, commercial box ovens may rise to 400 degrees. Box ovens are ideal for classroom building and cooking since they are simple to make from cheap or recycled materials.

PANEL COOKERS

Foods which you would typically prepare in a covered skillet on top of a burner can be prepared in panel cookers. They "gather" more sunlight using reflectors, which they then direct onto a black pot for cooking that is encased in a high-temperature oven bag. The insulation that keeps the heat in the bag that encloses the pot is the air in that bag. In a panel cooker, the pot's internal temperature can get to and stay at boiling. Panel cookers are simple to put to use for grilling on clear, sunny days and are simply constructed in classrooms from affordable materials.

PARABOLIC REFLECTOR COOKER

The highest temperatures are produced by parabolic cookers, which may also be used to grill or fry meals without the necessity of cooking bags or pot lids. Reflectors are used in parabolic cookers to focus a lot of sunlight onto a single center of gravity, where the ambient temperature can exceed 500 degrees. It's simple to construct parabolic-shaped cookers in the classroom out of old satellite dishes or big umbrellas. The focal point, however, might experience extremely high temperatures. While cooking, proper safety procedures should be followed.

11.3.5 Microwave Cooking

A lot of people use the microwave to cook, especially to thaw and reheat frozen meat. The transformation of electromagnetic radiation into heat energy within the meat is the fundamental idea behind microwave cooking. The rotation of molecules of water and the translation of ionic elements in meat absorb microwave energy during cooking; as a result, the amount of dissolved ions and water present are crucial considerations. In actual use, meat is cooked in a microwave oven after being placed in a vessel made for the purpose and sealed with a lid or a film wrap. The amount of time it takes to cook something relies on its pace, or power output (watts).

The overall duration of cooking can be reduced by a third to a half compared to traditional oven cooking. The length of time that meat will cook in the microwave depends on the meat's quantity, shape, structure, and temperature before heating. One issue with cooking in the microwave is that the meat's surface does not brown since there are no Maillard reactions because of the meat's comparatively low temperature on the exterior and the air's low temperature. Browning's work of the surface happens when a second heat source, like convection, is added to the microwave oven.

Food is cooked in an inductive oven when it is microwaved. Compared to similar techniques like boiling or baking, it is frequently speedier and more practical. For instance, many veggies can be microwaved rather than boiled or cooked.If food is microwaved for an extended amount of time, caution must be exercised, just as with other types of cooking appliances, and it should be checked frequently. Never put metal anything, even aluminum foil, in a microwave. To avoid food carcinogens, constantly employ a container marked "microwave safe." Similar to this, metallic embellishments on the foodstuffs can tarnish them and alter the flavor of the food.

There are several techniques used in microwave cooking that, on the surface, resemble those employed in traditional ovens. All of the approaches involve using a microwave oven, which may be either a basic microwave heating device or one that also features boiling, crisping, or grilling capabilities. Despite the widespread usage of microwave cooking, it is generally understood that its capabilities are more constrained than those of conventional ovens. Having said that, it is effective in terms of energy use and the amount of time required to perform activities for the purposes for which it can be especially valuable.

The fundamental microwave oven cooks food by circulating the water within it. The heat needed for cooking is produced by this motion. The combination ovens indicated above feature extra heating components (grilling) because this method cannot by itself create browning. Some foods dry out at the surface during cooking, much like in traditional ovens, hence both adding water and steaming are frequently employed. The surface of meals like pizza and mashed potatoes is crisped using additional crisping plates.

11.4 Effect of cooking

Food's nutritional content is influenced by how it gets prepared as well as when and how amount is consumed.Since it is doubtful that someone will consume something if it doesn't seem appealing, food preparation is crucial to ensuring a healthy diet. However, the act of preparing and heating food affects not only how it looks and feels, but also how readily available certain nutrients are. In this course, we'll evaluate how several food-related processes—including food development, harvest, processing, storage, preparation, and cooking—affect nutrients. The assessment and planning of diets as well as the nutrient demands of special needs subgroups will be covered after this.

Heat is applied while cooking using either moist or dry methods. Cooking may (during the process) improve the appearance and flavor of food by:

- Increasing and preserving natural tastes
- Combining flavors (for example, in cakes, casseroles, etc.) Creating the best color, form, and texture
- **Enhance digestibility –** After cooking, tough meat, for instance, should be more soft and easier to chew.
- Increase diet variety by including a range of flavors, colors, aromas, and textures to make food more appealing to consume.

Vitamin availability and content are frequently impacted by processing techniques. Regardless of the dish's kind, acidity, temperature, and other cooking techniques can all have an impact on water-soluble vitamins.

Vitamins that are water soluble can contaminate cooking water. This means that evaporation frequently results in the loss of some vitamin content. The degree of deterioration is contingent on the heat used. These vitamins can also become more bioavailable through cooking. On the other hand, it can also cause these vitamins to deteriorate, ultimately lowering the content. A water-soluble vitamin cannot be consumed in excess because the excess is expelled. The B-complex vitamins including vitamin C in particular are included in this category.

Cooking can also impact fat-soluble vitamins. They may seep into lipids like olive oil, but they won't leach into the water used for cooking.Cooking can cause these vitamins to lose some of their potency, although not as quickly as water-soluble vitamins.

Fat-soluble vitamins have the potential to be retained in the fat stores of the body when ingested in excess. This buildup over time could be harmful. Vitamins D, E, K, and A are among the vitamins in this category.

The vitamins that lose their potency the greatest when prepared, processed, and kept:

- Vitamin C, ascorbic acid
- Vitamin B9, or folic acid
- Vitamin B1 thiamine

Vitamins may be more enduring when prepared, handled, or kept:

- Pantothenic acid is a mineral (vitamin B5) and niacin (vitamin B3)
- B7 vitamin biotin
- (Vitamin D)
- Supplement K

Numerous procedures, such as growing techniques, harvesting techniques, food storage techniques, and food preparation techniques, have an impact on and alter the nutritional value of food. We'll focus on food preparation and cooking in this class.

Although they can leech in small amounts into cooking fluids, most cooking techniques do not significantly affect the amount of minerals in food. When fat becomes liquid during cooking and flows out of food, the amount of fat in the food can be lowered. To prevent frying, this calls for sufficient drainage away from the meal. At higher temperatures, carbohydrates may start to disintegrate or leak into cooking liquids. Heat and extended cooking times will cause complex proteins to denature (alter their structure and possibly start to break down into simpler pieces).

Vitamins of the B-group and C tend to leach into cooking liquid and are less heat-resistant compared to their solubility in fat equivalents (such as vitamins A, D, E, and K).When preparing food for cooking, air or light degradation should not be that something is amiss because it is typically a very slow process. However, storage is when this degradation becomes more of a problem.

The nutrients in food decay more quickly the longer they are cooked. Cooking does not change the quantity of calories of food unless you drain fats that are fluid or skim solid fats when cooking. Extremes in pH and temperature will cause proteins to break down, but the individual amino acid groups should still be present and easier to digest than an integrated protein.

11.4.1 Texture

Protein can be found in a variety of meals, including seafood, eggs, meat, vegetables, nuts, and legumes. Proteins are substantial molecules made up of strands of essential amino acids that are joined together in predetermined sequences by peptide bonds. By folding and then connecting the amino acid strands, proteins can take on a variety of three-dimensional shapes. In contrast to the strong peptide bonds that hold the foldable amino acid strands together, the bonds that hold them together are typically much weaker. The weak bonds of hydrogen binding those amino acid strand together are broken during cooking because the increased temperature causes protein molecules to shake abrasively. The protein eventually disassembles to retake its original shape of its amino acid strands.

Protein denaturation in food typically results in a significant alteration to the consistency of the final product. Ovotransferrin and ovalbumin, for instance, are two essential proteins that make up egg white. Ovotransferrin initially starts to denature as the egg white heats up, entwining and creating new bonds with ovalbumin. Ovalbumin begins to denature as the temperature rises, unwinding and creating new connections with the ovotransferrin until the protein strands are fully denatured and reorganize. Protein denaturation, on the other hand, can also result in the development of softer textures. For instance, the collagen protein, which makes up the majority of the tendons and ligaments in beef, is rough and chewy. But as a result of the weak bonds between hydrogen atoms being disrupted during cooking, the protein starts to break down and interact with the water molecules to create gelatin. This gives the meat a softer, more appetizing texture by tenderizing it. In this instance, the protein molecules are rearranged, changing the texture from runny and fluid to stiff and solid.

The polysaccharide starch found in foods like rice flour and maize flour is frequently used to make and/or thicken sauces. This is due to the phenomenon known as starch gelatinization, which occurs when certain meals are cooked.Amylose and amylopectin are two polysaccharide components that make up the starch granule. Amylopectin has a branching structure of glucose units, whereas amylose has a straight chain of glucose units. Granules of starch expand after absorbing water during cooking. The mixture thickens as a result of the amylose leaching out of the small particles and bonding to form structured lattice structures that trap the water molecules.

By including polysaccharides like lignin and gelatin in the plant walls, many plant meals, particularly vegetables, preserve their stiffness. During heating, cellulose and mascarpone can also degrade into their monosaccharide components, similar to how starch does. As a result, foods containing these types of polysaccharides are significantly softened.Veggies and other foods containing polysaccharides like cellulose and pectin. Boiling, frying, grilling, roasting, and baking are among the culinary techniques that could cause polysaccharide breakdown.

It has become clear in recent years that boiling food might cause the production of unfavorable chemicals. Due to the seriousness of their potential effects, the production of probable carcinogenic chemicals has drawn special attention.

The nitrosamines are perhaps the most well-known of these substances. Sodium nitrite is employed to cure meat, provide a smoky flavor, stop bacterial development, and produce a desired dark red color. Nitrosamines are created during cooking from nitrites and subsequent amines. They can be discovered in tobacco as well as some grilled, smoked, or fried meals like charred meat.

Other substances that are thought to be cancer-causing include furan, aromatic polycyclic hydrocarbons, chloropropanols/esters, acrylamide, and heterocyclic amines, all of which are all products of the maillard reaction. Furan is a chemical that can be produced in a variety of methods and has a tendency to evaporate quickly. However, it stays inside of the food for a while when it can't escape for whatever reason (such as in tightly sealed cans or jars). The incomplete combustion that results during grilling, roasting, and frying, as well as smoking and drying (depending on the fat content), produces polycyclic aromatic hydrocarbons (pahs). The majority of paths do not cause cancer, but some do (including pyrene and benzo(a)pyrene). Additionally connected to the thermal processing of processed food items is the use of chloropropanols/esters.

11.4.2 Flavor

The acceptability and ingestion of food by customers is significantly influenced by taste quality. Long regarded as one of those most crucial ways to raise food quality, flavor enhancement has gained popularity among food technologists in recent years. As a result of the heat processing that occurs in many food products today, cooking techniques have been extensively studied and may have a considerable impact on the finished product's quality.

As a result, it's important to use tools to objectively combine taste property analysis with an evaluation of the effects of cooking circumstances on the edible quality. Traditional heat treatments for crab include boiling and steaming; some people believe that boiling crab preserves the flavor compounds better, while others assert that steaming crab tastes better. The starting point of the heating medium was also taken into consideration as a factor that affected the different heating processes; cooking with heated water means heating the crab quickly, whereas cooking with cold water indicates heating and cooling the crab gradually. Both of these heating processes resulted in different heat stress reactions in the crab.

11.4.3 Pigment

Products may be subjected to a range of heat temperatures during the manufacturing and production operations. In manufacturing, employing heat or high temperatures is a frequent practice. Ceramics, for instance, undergo a heat-treatment process called sintering or firing to generate the completed product. Elevated temperatures can change a product's physical characteristics, particularly color, in both long-term and short-term ways. Thermochromism, or the color change caused by temperature, is a significant color issue that many companies deal with.

The chemical makeup and composition of a pigment or dye determine how it will react to high temperatures. An object's color may completely fade if it is exposed to high temperatures for an extended period of time. Other times, a sample or item turns to a different color until it stabilizes. The manufacture of ceramics, which was mentioned before in this essay, also offers a good illustration of thermochromism. A glazed ceramic sample is taken out of the oven after heat treatment and left to cure or cool to room temperature. Manufacturers might observe a color change during this "drying-time". Due to this momentary color drift, comparing the sample to the standard throughout this "cool down" stage will produce false findings.

Both quality assurance and process management should demand that a product fulfills a predetermined color standard through an effective procedural method due to the deceiving results seen during the "cool down" period. The procedure outlines the actions to be done, when the product should be examined, and how it should be appraised.

A sample's color may temporarily shift to a different shade or color even after processing. It is advised to evaluate the sample at certain intervals and note the period it takes for it to cool rapidly and take on the proper color. It is easier to determine if the sample's color complies with the standard using visual and quantitative evaluations after the sample has stabilized to room temperature.

In the ceramics sector, the spectrophotometer CM-700d is well-known. The vertical shape of the portable instrument makes measurement simple for a variety of surfaces frequently utilized in ceramic products. A sample needs to be at a constant temperature for proper color measurement in order to prevent thermochromics-related color variations. Additionally, color measurements need to be done in a temperature-controlled environment. It is best to keep the sample and spectrophotometer in the controlled environment for a while so that they can adjust to the temperature before taking more precise readings.

11.5 Prevention of Nutrient loss During Cooking

One of three ways can result in the loss of nutrients from food.

• Intentional losses, such as the ones that occur when milling grains, peeling vegetables, or removing certain nutrients from raw materials;

• Processing losses that are unavoidable and occur as a result of food blanching, sterilization, cooking, and drying;

• Accidental loss or losses that may have been prevented due to ineffective processing or storage methods.

NUTRIENT LOSS:

A vitamin

Foods including spinach, methi, carrots, etc. contain vitamin A. In fats and oils, vitamin A dissolves effortlessly. Vitamin A thus leaves the food and enters the oil when food gets cooked in it.

B vitamin

Due to its water solubility, vitamin B leaves the rice and is removed by the water. Rice is immersed in water after being washed. During this process, more vitamin B leaves the grains and enters the water. Rice is then cooked in water. There is some absorbed vitamin B in both the water used to boil the rice and the surplus water that is discarded. Vitamin B is also destroyed by cooking soda.

C vitamin

An essential component, vitamin C, is quickly damaged by cooking. Much of the vitamin C disappears when chopping fruits and vegetables. Additionally, washing produce after slicing and letting cut veggies sit out in the air for a long time before cooking cause vitamin C loss. Vitamin C is sometimes present in dishes that have been cooked for an extended period of time or in discarded water. Vitamin C is also destroyed by cooking soda. Therefore, using cooking techniques that reduce vitamin C loss results in the preservation of all other nutrients.

Proteins

Heat causes all of the proteins in the foods to coagulate. Proteins in foods like eggs, fish, and meat grow softer during cooking as a result of water being bound during the coagulation process. The coagulated protein loses moisture and turns dry and rubbery if it is heated any further. They become challenging to digest as well.

Fats and oils

The tendency of heated fat-containing meals is for the fat to be separated from the food. Cooking is done with fats and oils. During frying, some fat is absorbed. Ghee and oil lose quality when heated for an extended length of time.

Minerals

In water, minerals such as sodium, potassium, and others dissolve. When foodstuff is first sliced, then washed, and the additional water that was used to boil them is discarded, minerals are lost. When food is boiled or soaked by water and the resultant liquid is discarded, micronutrients like vitamins B and C are lost. When frying food in lipids, nutrients including vitamin A are lost.

Vegetables lose nutrients as soon as they are prepared, and this loss is greatest during cooking.

1. Vitamins found under the skin of fruits and vegetables may be lost when they are peeled.

2. When the usable leaves of carrot, beetroot, and the outermost portion of cabbage are eliminated, nutrients are also lost.

3. Water-soluble vitamins B complex and C are lost whenever the water used to boil vegetables is wasted. Additionally lost when the water used for cooking is dumped are sodium, potassium, and chlorine.

4. Oxidation from exposure to air causes the loss of vitamin C.

5. Ascorbic acid and beta-carotene are lost during dehydration.

6. When soda is added, cooking causes a significant loss of B vitamins.

BROWNING:

Due to the action of enzymes, cut fruits and vegetables like the apple, banana, potato, and brinjal develop a brown hue on the surface. Enzymatic browning is what's happening here. Phenol oxidase enzyme explodes at the surface of wounded or cut tissue when the exposed cut surface gets exposed to air. These interact with the polyphenols in the fruit and oxidize them to orthoquinones, thereby providing cut tissues their characteristic brown color.

The following techniques can be used to stop browning:

1. Heat treatment inactivates polyphenol oxidase.

2. Vacuum packing to remove oxygen.

3. A pH change to stop enzyme activity.

4. Submerging produce in brine & sugar solutions.

5. Antioxidants like ascorbic acid are used to delay oxidation.

11.6 Ways to Increase the Nutritive Value of Food

Did you know that foods can have their nutritional worth increased beyond what it is already? As follows:

Each bite you take results in a number of physical and chemical modifications. These modifications have an impact on the food's nutritional value and its bioavailability of each component ingested. The term "bioavailability" describes how quickly food enters the body after being digested. A strong digestive system is essential to stave off a number of illnesses.

This suggests that eating food in its raw state is the best way to get some nutrients. Here are some suggestions to increase the nutrient content of the meals you eat because some foods' nutrients are only accessible when they are cooked, crushed, sliced, or eaten with anything on the side.

How to Maximize Nutrition in Food

Here are some suggestions for maximizing the nutritional value of your meals. Look at that!

- **Insist Using locally produced food**
  Buying farm products from nearby farms has many advantages. It is first of all nutritious and fresh. The discussion between organic and conventional is a completely different topic, but buying fresh vegetables from your neighborhood farmer's market will improve the nutritious content of your regular meals.
- **Blend, Chop, Crush, and Soak**
  To extract additional minerals, vitamins, and other substances from foods, it is important to follow some fundamental food preparation procedures. Fruits and vegetables should be chopped to release the nutrients trapped within the tough plant cell walls. Chopping and crushing garlic and onion: This promotes alienage release. An enzyme called alienage aids in the formation of the nutrient Alicia. When ingested, Alicia promotes the synthesis of other substances that strengthen immunity. Grain and bean soaking grain and legumes before cooking helps reduce phytic acid, allowing for higher iron, calcium, zinc, and magnesium absorption.
  How to Properly Store Fruits and Vegetables
  Maintain easy access to the fruits and veggies. The nutritious value of fruits and vegetables is reduced by heat, oxygen (to prevent oxidation), and sunlight. The following foods can be stored as described below:
- All vegetables, with the exception of roots and tubers, should be kept in the fridge.
- All fruits, with the exception of berries, tomatoes, and the flesh of avocados should be kept at room temperature and out of direct sunlight.
- Before placing sliced fruits and vegetables in an airtight container, sprinkle them with lemon juice. Fruits and vegetables won't turn brown since it decreases nutritional oxidation.
- All herbs should be cut up, frozen in ice cube trays with water to preserve their phytonutrients.

11.7 Let Us Sum Up

After studying this you will have a basic understanding for all three kinds of cooking techniques, you may select the ideal approach to utilize when preparing any food. You'll learn how to utilize dry cooking to give meats a crispy, browned surface and how to use moist boiling to maintain meat fork-tender as you develop your own distinctive recipes. You'll be able to utilize a combination of moist and dry heat when necessary to turn tough portions of meat into tender, juicy morsels. If you have a basic understanding of each of the three kinds of cooking techniques, you may select the ideal approach to utilize when preparing any food.

You learned how to utilize dry cooking to give meats a crispy, browned surface and how to use moist heating to maintain meat fork-tender as you develop your own distinctive recipes. Now you will be able to utilize a combination of moist and dry heat when necessary to turn tough portions of meat into tender, juicy morsels.

11.8 Glossary

Al Dente -Pasta which is firm and just barely done.

Baste-To cover cooked meat with liquid fat or juices.

Blanching - Technique of briefly scalding food into boiling water then cooling it

off to stop the cooking.

Brunoise-Foods are diced to a size of 1/8" using brunoised.

Caramelize-To heat sugar until lightly browned is to caramelize them.

Chiffonade-Cut greens with leaves or herbs into lengthy thin slices by

chiffonading them.

Clarify-To melt buttery and divide it into butterfat and solids.

Cure- The process of salting and dehydrating food to preserve it

Deglaze - To use liquid to dissolve brown food particles in a hot pan.

Dredge-To cover moist items in a dry substance, such as flour, dredge them

Answers to Check Your Progress Exercises

1. Find out if there are any regulations governing the business preparation and cooking of food in your area by visiting the local government or council, browsing the internet, or using the library. If you can, make notes and get brochures and other materials.

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   Obtain an item by own choice (if you don't eat chicken, use fish instead, or a different vegetable altogether; you can even use an egg). Five bite-sized amounts are required. Cooking is done in several ways. Use techniques that are very different from one another. If you can, make notes or take pictures of the food both before and right after cooking. Don't forget to capture any fluids or cooking water that were present in the original cuisine. Record any changes you notice in the food, fluids, cooking water, etc. As a result of your various cooking techniques, taste the items and make comments on their texture, flavour, and palatability.

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One of the two kinds of heat is used when cooking. Name them before you categorise all the culinary techniques. (Baking, Blanching, etc.) are categorised in your course based on the type of temperature they employ.

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2. How can cooking increase food safety? Discuss no more than one paragraph.
   - Each of the following effects of cooking in a paragraph or two:
   - Meats include B group vitamins
   - Joints and tissues
   - Fats
   - Mineral composition of braised foods Mercury in fish

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3. Which cooking technique retains B group vitamins the best? Describe in roughly 100 words.

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Tell us how to make a serving of potatoes more nutrient-dense. If you have more effective preparation and cooking techniques than those used to make mashed potatoes, explain how they are superior at keeping nutrients in 2-3 words after listing the preparation processes.

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UNIT XII: CEREALS AND ITS UTILITY

Content:

12.1 INTRODUCTION

The structural and functional characteristics of cells and organelles are governed by food components, primarily proteins. People should be aware of the categorization, function, and processing modifications of proteins due to their significance in daily nutritional needs. In the current context, food processing is crucial for achieving food security and providing people with safe food. There are benefits associated with food processing, some of which are major. These consist of:

- Extended shelf life
- Reduced dangers from microbiological pathogen
- Reduced spoilage (microbial, enzymatic)
- Deactivation of anti-nutritional elements

- Guaranteed year-round availability of seasonal foods.
- Perishable goods were delivered to distant locations from their producing site.
- Increased accessibility to comfort (e.g., Ready-to-serve beverages, instant mixes)
- Increased range of meals, including those with enhanced sensory and nutritional characteristics.

These ideas emphasize the significance of protein and food processing. As a result of the processing of protein and its constituents,positive changes occur, such as the production of pleasant colors and tastes, the improvement of texture, and the enhancement of the usefulness of foods or components. Nevertheless, a variety of unwanted changes can occur during food processing, which are often product- and process-specific, such as harm to color and flavor, damage to nutritional characteristics, and/or the creation of hazardous ingredients, etc.To obtain a healthy food product, it is required to optimize the process parameters based on the obtained knowledge of the numerous physical, chemical, and nutritional changes that may occur during food processing. This course provides a detailed study of the functioning of proteins and the changes that occur in various meals during processing.

Objectives: After studying this unit, you will be able to:

- Discuss the structure and categorization of proteins.
- List the characteristics of amino acids and proteins,
- Understand the uses for protein concentrates, isolates, and hydrolysates.
- Determine the changes in food undergoes. different methods of processing.
- Distinguish between favorable and unfavorable processing and storage processes in distinct food class.
- Consider the optimization of process parameters to govern chemical, physical, and nutritional changes in accordance with the requirements.
- Functional involvement in cell and organelle maintenance.

12.2 PROTEINS

Proteins, as you may already know, consist of carbon, hydrogen, nitrogen, oxygen, and typically Sulphur. Many amino acid molecules are linked via peptide bonds to form proteins. Every amino acid has a trivial or common name, which frequently relates to the source from which it was initially isolated (Table 1).

Table 12.1 Common name and source of some protein

Name of Protein	Source
Asparagine	Asparagus
Glutamine	Tyrosine
Wheat gluten	Cheese (*Tyros* is the *Greek word for cheese)*
Glycine*)*	sweet taste (*Glykos* is the *Greek word for sweet)*

Amino acids are twenty in number and classified according to the nature of the side chain (R group). We shall not go into the classification and composition of amino acids here.

12.2.1 Classification

Classification of proteins are discussed in table 12.2:

Table 12.2 Classification of protein

Shape and size	Functional properties	Solubility and physical properties
• Examples of fibrous proteins include keratin in hair, actin and myosin in muscle, and collagen. • Globular proteins, such as enzymes and antibodies, are spherical.	• Immunoproteins include C-reactive protein, opsonin immunoglobulins, contractile respiratory, structural, enzymatic, and hormonal carrier proteins.	• Simpleproteins • Derivedproteins • Conjugatedproteins

As shown in table 12.2, proteins can be categorized according to:

a) *Size and structure:* fibrous and globular proteins. In organisms, fibrous proteins have structural roles. Globular proteins are composed of lengthy amino acid chains folded into intricate structures.

b) *Functional properties:* Immune, contractile, respiratory, structural, enzymatic, hormonal, and transporter proteins

c) *Solubility and material characteristics:* Proteins that are simple, conjugated, and derived. This categorization is provided in Table 12.3.

Table 12.3: Classification of proteins according to their solubility and physical character

Simple Proteins	Derived Proteins	Conjugated Proteins
Simple proteins mainly consist of amino acid units connected by a peptide link. They release a combination of amino acids and nothing else upon hydrolysis. *For examples*: *Albumins are egg albumin, serum albumin, Lactalbumin.* *Globulins are tissue globulin, serum globulin.* *Gliadins are gliadin from wheat, hordein (barley), etc.* *Albuminoids are keratin of hairs, skin, eggshell, and bones, elastin, and collagen of tendons, ligaments, and bones.* *Histones are globin of the hemoglobin,* *Protamine salmine is the spermatozoa of the salmon fish.*	These proteins are not found in nature and are generated from simple proteins by the action of enzymes and chemical agents, heat, mechanical shaking, ultraviolet light, or x-rays. *For examples:* Primary: Myosin, Fibrin, and Secondary: Peptones, peptides, proteoses etc.	Simple proteins are joined with a non-protein material to form conjugated proteins. The chemical is referred to as a prosthetic group or cofactor. *For examples:* *Chromoproteins:* Hemoglobin, in which the prosthetic group is iron. *Phosphoproteins*: casein in milk, in which the prosthetic group is phosphoric acid, vitellin in eggyolk. *Lipoproteins:* HDL (high density lipoprotein), LDL (low density lipoprotein) and VLDL (very low-density lipoproteins), the prosthetic group islipid *Glycoprotein*: Ovomucoid of egg white. *Nucleoproteins:* ribosomes andviruses. *Metalloproteins:* alcohol dehydrogenase, a Zn containingenzyme. *Mucoproteins:* Follicle stimulating hormone,β-ovomucoid.

12.2.2 Composition

Amino acids are the fundamental components of proteins. A peptide bond is created between amino acids by the removal of a water molecule. Considering the length of peptide chains and the structural diversity of twenty amino acids, the protein structure is separated into four distinct levels, as shown in Table 12.4.

Table 12.4 Different levels of protein structure

Primary structure	The fundamental structure of a protein consists of the order in which amino acids are peptide-bonded to one another.
Secondary structure	The secondary structure of a protein consists of the manner in which the chain of amino acids twists or folds back over itself to produce alpha helical, beta sheet, or a number of other potential configurations.
Tertiary structure	The secondary structure, in turn, folds back and forms three dimensional linkages with itself.
Quaternary structure	When a protein is composed of several chains, or the structure in which these chains bind together.

12.2.3 Functions

The structural and functional characteristics of cells and organelles include proteins. Proteins can be categorized using the following scheme:

A. Structural elements: Proteins that make up structural molecules are fibrous. Keratins, the most well-known fibrous proteins, constitute the protective covering of all terrestrial vertebrates: skin, fur, hair, wool, claws, nails, hooves, horns, scales, beaks, and feathers. The actin and myosin proteins of muscle tissue are equally pervasive, but less apparent. Support is highly dependent on structural proteins. Collagen and elastin provide a fibrous framework for animal connective tissues, such as tendons and ligaments, which are composed of collagen and elastin.

B. Defensive Proteins: These proteins provide disease protection. Antibodies are a type of protective protein. These battle viruses and germs. Furthermore, immunoglobulins, as you already know, protect the body against invading organisms and illnesses.

C. Contractile Proteins: These proteins are involved in contractile activities, such as those seen in muscle proteins and other cells and tissues. In the latter, these proteins are involved in cytoplasmic localized contractile events, motile activity, and cell aggregation processes. Contractile proteins include actin, myosin, myoglobin, and troponin, among others. Actin and myosin are responsible for muscular contractions. Numerous cells are propelled by the undulations of cilia and flagella, which are caused by contractile proteins.

D. Essential and Storage Proteins: These proteins are capable of storing amino acids. Ovalbumin is the egg white protein used by the developing embryo as a source of amino acids. Casein, the milk protein, is the most important supply of amino acids for infant mammals. Plants store proteins in seeds.

E. Transport of plasma proteins: Embedded in lipid membranes, transport proteins assist the import of nutrients into cells or the discharge of hazardous byproducts into the surrounding medium. Transport proteins are required for the passage of molecules that cannot move across a membrane by diffusion. These attach to tiny molecules and ions and carry them throughout the body as plasma carriers. Several popular instances include:

- Transferrin, an iron-binding protein, transports ferrous ions to hemoglobin producing loci.
- The ratio of free to bound species regulates the activity of ions, such as calcium.
- When hydrogen ions are bound, proteins serve as buffers to reduce the pH shift.
- Since cells are impermeable to proteins, they also contribute to the determination of ion distribution and, consequently, electrical potential difference across the cell membrane.
- Albumins mediate the distribution of bodily fluids between plasma and extracellular compartments by virtue of their osmotic action.

F. Enzymatic Proteins: The proteins with catalytic activity - the enzymes - are the most diverse and most specialized. Almost all chemical processes of organic biomolecules in cells are catalyzed by enzymes, as you may be aware. There are more than 2,000 recognized enzymes. Mechanochemical enzymes, such as actin, myosin, and associated proteins of the muscle structure, are responsible for the transformation of chemical energy into mechanical work.

G. Hormonal proteins: Hormonal proteins regulate biological functions. Diverse peptide and protein hormones (including insulin and growth hormone) contain information that affects the permeability and metabolism of cells. Built inside the membrane of a nerve cell, receptor proteins detect chemical signals emitted by other nerve cells. The response of a cell to chemical stimuli is mediated by receptor proteins.

H. Miscellaneous Functions: In addition to the functions listed above, this section also includes a number of significant miscellaneous functions of proteins. These consist of:

- Source of vitality: Amino acids are capable of being deaminated and converted to carbon dioxide and water.
- Toxic proteins (for humans - botulinum toxin, staphylococcal toxin, venom toxin; for microorganisms - antibiotics)
- Anti-nutritional factors (trypsin inhibitors).
- Numerous allergic responses to food are also mediated by proteins, resulting in a change of the

consumer's defense mechanism due to the presence of proteinaceous antigens in meals that stimulate antibody formation.

- Intense sweeteners (Monellin).

12.2.4 Sources

There are three primary types of protein-containing foods:

I. Origin of Animal Protein
II. Protein from Plant Source
III. Single cell protein

Detail all food sources are as follows:

1. Origin of animal proteins

The animal-based foods are categorized as protein-rich sources. Although you may already be aware of these sources, we have included them here for your consideration. For feeding purposes, skeletal or striated muscles are utilized.

Meat: The majority of the meat composition consists of beef, lamb, and swine. These are referred to as "Red Flesh," a word describing the hues of beef, lamb, and pork as contrasted to the pale and dark colors of poultry meat. Myoglobin is mostly responsible for the red hue. On a wet weight basis, a normal adult mammalian muscle devoid of all external fat comprises between 18 and 22 % protein. On the basis of their origin and solubility, muscle proteins can be classified as sarcoplasmic, contractile (myofibrillar), or stroma (connective tissue) proteins.

Milk: Typically, a protein content of 3.5 % is regarded to be ordinary for milk. Casein and whey proteins have typically been used to classify milk protein. Casein is a heterogeneous set of phosphoproteins that may be precipitated from raw skim milk at pH 4.6 and 20^0C by acidification. Whey proteins are the proteins left in solution following casein precipitation (or milk serum proteins). Casein fraction accounts for approximately 80% of the overall protein composition; whey protein makes up the remainder. Whey fraction consists mostly of -lactalbumin, -lactalbumin, immunoglobulins, bovine serum albumin, and so on.

Eggs: The composition of a chicken egg is around 11% shell, 31% yolk, and 58% white. 65 % of a liquid whole egg is white and 35 % is yolk. The major purpose of egg protein is to nourish and sustain the developing chick. Yolk appears to be the primary source of nutrition, whereas egg white appears to serve as a barrier before being used as a source of protein. White and yolk vary fundamentally in their makeup. Yolk: The yolk includes around 50% solids, of which two-thirds are lipids and proteins. On a dry-weight basis, the egg yolk comprises 31% fat, of which 1.3% is cholesterol. Essentially, white is an aqueous solution containing around 12 % protein. The edible element of a fish is its skeletal muscles. Despite the fact that the skeletal muscles of various animals are fundamentally identical, the variety of edible fish species is far greater than that of mammalian species.

Fish: It comprises between 40 and 60 % edible meat. 13 to 25 % of freshwater fish are composed of protein. In the midline or lateral line of many fishes, there is a layer of strongly pigmented, reddish-brown muscle that may account for 10 % of the total body muscle. This includes a high concentration of hemoprotein, which, after harvest, may accelerate lipid oxidation and induce significant rancidity. The proteins can be categorized as either sarcoplasmic, myofibrillar, or connective tissue proteins.Information about shellfish is sparse and insufficient. In shellfish, the shell constitutes a significant amount of the fish's live weight, resulting in a low edible content. Shellfish examples include crabs, lobsters, shrimp, and muscle oysters, etc.

II. Proteins derived from plants.

The origin of vegetable proteins, cereal proteins, nut and seed proteins is the plant kingdom. Let us investigate these sources further.

1) **Vegetable Proteins:** Fresh veggies are not a very reliable source of protein. Carrots and lettuce have an average protein value of 1 %, whereas white potatoes, asparagus, and green beans have an average protein content of 2 %, and fresh peas have an average protein content of 6 %.Even though potatoes contain only 2 % protein, their quality is rated as acceptable to outstanding due to their comparatively high lysine and tryptophan levels. The majority of tuber proteins are located in the outer layers, or "cortex." These layers contain significantly more necessary amino acids than the inner layers. Selective plant breeding can enhance the outer layer proteins.
2) **Cereal Protein:** Cereal grains that have been adequately ripened and dried for optimal storage stability contain between 6 and 20 % protein. Proteins are present in a variety of grain morphological tissues. In the milling of grain (such as wheat), the endosperm is effectively separated from the bran and germ before being ground into flour, which is subsequently consumed as food. Endosperm proteins appear to serve as both structural components and feeding stores for seedlings. The sub-cellular granules or organelles known as 'protein bodies' house a significant portion of the endosperm storage proteins in the kernel of numerous cereals (except in wheat kernel).The protein of the bran or seed coat supplies the kernel with shape and protection. Since bran is poorly digested by humans and its proteins are difficult to isolate, the majority of it is utilized as animal feed.

3) **Seed Proteins:** Although a vast variety of plants generate seeds with protein concentrations greater than 15 %, only a few are used as food, such as soybeans, cotton seeds, peas, peanuts, and beans. Proteins in seeds are concentrated mostly in protein bodies. These bodies, which contain more than 90 % protein, contribute for 70 % of soybeans' overall protein content.Proteins make up a substantial amount of food reserves, which are crucial during germination. The proteins of the majority of seeds (excluding grains) are globulins, which are water- or salt-soluble.

4) **Nuts protein:** Nuts are an exceptional source of protein. Nuts include cashews, almonds, hazelnuts, coconuts, walnuts, Brazil nuts, cashews, and pistachios, among others. Almonds and other nuts have full proteins. Those nuts that do not contain complete proteins can be incredibly valuable sources of protein when consumed with other protein-containing meals, milk, cheese, or vegetables.After studying proteins derived from plants, we will go on to studying proteins derived from microorganisms.

III. **Single Cell Proteins (SCP)**

You may be familiar with SCP. What is a cellular protein? Let's find out. Prof. Caroll Wilson (MIT) invented the term SCP in 1966. It refers to the proteins derived from microorganisms, such as algae, fungus, bacteria, and yeast. From bacteria, proteins are extracted. Following are some of the benefits of selecting microbes as a protein source:

1 High protein yield on a dry weight basis.
2 Nutritional needs are cost effective.
3 The installation of plants for the synthesis of proteins requires less space than traditional sources.
4 The facility may be constructed so that continuous processing is possible, as opposed to batch-by-batch processing.

For single cell proteins, bacteria, yeast, fungi and algae may be used. Each of them has their own advantages and disadvantages. These have been highlighted in Table 12.5. Another interesting aspect which you would surely like to know about is how these single cell proteins are manufactured. This is some additional information for your knowledge.

Table 12. 5: Advantages and disadvantages of using microorganisms as a source of protein.

➢ **Organisms**	➢ **Advantages**	➢ **Disadvantages**
➢ Bacteria	➢ High protein content (60- 80 %) ➢ Grown on paraffin, waste cellulose, and molasses. ➢ The growth rate is rapid.	➢ If the bacterial strain is very tiny and has a low density, it is difficult to separate it from the culture medium. ➢ Bacteria have a high nucleic acid content (more than 15 %) and may arrive with proteins, which is unacceptable and unnecessary since it can induce hypertension, arthritis, and other conditions. ➢ Uric acid, the end result of purine metabolism, may contribute to the development of gout.
➢ Yeast	➢ Large size, hence simple separation from the culture media. ➢ As the growth pH moves towards the acidic side, a high amount of lysine is created in the proteins, making them more palatable and of greater biological significance.	➢ Reduced protein yield (45-60 %) ➢ Low pace of growth (1-3 h) ➢ High nucleic acid concentration leading to uric acid production.
➢ Fungi	➢ Easy to collect from the medium of cultivation. ➢ The cellular structure of fungus enhances the functional characteristics of proteins.	➢ Reduced protein yield (5-27 %). ➢ Low rate of growth. ➢ Proteins have low acceptance.
➢ Algae	➢ Produces proteins containing almost all Essential Amino Acids. ➢ Rich in tyrosine and serine but lacking in amino acids containing Sulphur.	➢ Due to the indigestible cellulose cell wall in humans, consuming more than 100 g of proteins might produce nausea, vomiting, and stomach discomfort, among other symptoms.

12.2.5 Functional properties

It may now be clear that functionality (as indicated to food items) refers to "any feature other than nutritional qualities that influences the usability of food components." The majority of functional features influence the sensory aspects (particularly textural attributes) of foods, but they can also have a significant impact on the physical behavior of food and food ingredients during preparation. Thus, the functional properties of proteins are the physicochemical features that allow the proteins to contribute to the desired qualities of the diet. Proteins may be added to diets for functional, nutritional, and economic reasons, as we have learned. Possible functional advantages include emulsification and stability, higher viscosity, enhanced appearance, flavor, or texture, formation of foams and gels, and binding of fat or water. These functional features enable the technician to adjust flow characteristics, emulsify, produce gels and foams, and bind water and fat. Dietary advantages include reducing the calorie number of meals, boosting the protein content, and balancing the amino acid balance. Obviously, economic or cost factors are also significant when employing protein as a component. Increased product yield due to the use of a protein addition is an illustration of an economic gain. It is also essential to understand that the origin of the protein (animal or plant) and its structure impact its functional qualities. Three categories of protein functional characteristics have been identified are as follows:

a. Hydration properties: It is dependent on protein-water interactions and includes swelling, adhesion, dispersibility, solubility, and viscosity.
b. Protein-protein interactions: They are associated with the processes of precipitation, gelation, and creation of various structures (like protein doughs and fibers).
c. The surface properties: It pertain largely to their surface tension, emulsification, and foaming qualities.

12.2.5.1 *Hydration Properties*

Individual proteins' structure in solution is mostly determined by their interaction with water. Hydration of protein preparations is connected to several functional characteristics. Water absorption (water uptake, affinity, or binding), swelling, wettability, water holding capacity (water retention), as well as cohesion and adhesion, are associated with the first four steps (figure 4.2), whereas dispersibility and viscosity (or thickening power) are also associated with the fifth step. Important functional qualities, such as solubility or immediate solubility, are connected to the soluble or insoluble (partially or completely) final state of proteins (in which all five steps take place rapidly). Gelation refers to "the production of a well-hydrated, insoluble mass with specialized protein-protein interactions" In addition to its qualities, surface properties such as emulsification and foaming require a high level of protein hydration and dispersion. The hydration qualities, such as solubility, viscosity, are discussed below:

Protein Precipitation/Solubility

- The degree of protein solubility dictates the majority of their functional characteristics. The solubility behavior is an excellent indicator of the possible applications of proteins. This is because the degree of insolubility is likely the most applicable measure of protein denaturation and aggregation, and because proteins that initially exist in a denatured, partially aggregated state typically have a diminished capacity to effectively participate in gelation, emulsification, and foaming.
- Note that, in general, highly soluble proteins can be utilized in applications where emulsification, whipping, and film formation are crucial, whereas low solubility may be desirable in applications with high protein levels and where minimal emulsification, or protein-protein interactions are required.
- Heating significantly and permanently reduces the solubility of proteins. However, heat treatments may be required to accomplish other goals (microbial inactivation, removal of off-flavor, removal of water and others).
- It is not necessarily accurate to assume that proteins must have a high initial solubility as a precondition for other functional qualities. It has already been established that preliminary denaturation and partial solubilization can occasionally boost the water absorption of a protein component. The creation of emulsions, foams, and gels can include varying degrees of protein unfolding, aggregation, and in solubilization.
- To be effective in emulsification, foams, and gels, whey proteins and some other proteins must have a relatively high initial solubility. Soluble caseinates are more effective in thickening and emulsifying than isoelectric casein (less soluble). Perhaps the greatest benefit of insolubility is that it allows for the quick and broad dispersion of protein molecules and particles, resulting in a colloidal system with a homogenous macroscopic structure and a smooth texture. Additionally, initial solubility enhances diffusion of proteins to the air/water and oil/water interfaces, therefore enhancing their surface activity.

- *Texture, viscosity, and gelation*

- The apparent diameter of the distributed molecule has the greatest influence on the viscosity performance of protein fluids, which is based on the following parameters:
- The intrinsic properties of a protein molecule (molar mass, size, volume, structure and asymmetry, electric charges, and ease of deformation) can be modified by environmental factors such as pH,

ionic strength, and temperature through unfolding; Protein solvent interaction, which affects swelling, solubility, and the hydrodynamic sphere surrounding the molecule; and Protein-protein interactions, which determine aggregates. Typically, a high quantity of protein components is employed, with protein-protein interactions predominating.

- Fluid meals, such as drinks, soups, sauces, and creams, rely heavily on the viscosity and consistency of protein systems for their functionality. There is no straightforward correlation between viscosity and solubility. When put in an aqueous solution, heat-denatured protein powders that are insoluble do not have a viscosity that is too thick. Whey proteins are highly soluble protein powders with minimal water absorption and swelling capabilities, as well as low viscosity at neutral or pH. The viscosity of soluble protein powders with a high initial water absorption capacity (sodium caseinates and soy protein preparations) is high. Thus, there is a positive link between water absorption and viscosity for proteins.
- Gelation is the process through which denatured molecules assemble into an organized protein network. In food items, proteins can produce a well-ordered gel matrix by balancing protein-protein and protein-solvent interactions. These gel matrices can retain additional food components, such as gelatin, yoghurt, minced meat products, tofu, and bread doughs, for manufacturing food items.
- Gelation is an important functional property of proteins that plays a crucial role in the preparation of numerous foods, such as various dairy products, coagulated egg whites, gelatin gels, various heated, ground meat or fish products, soybean protein gels, vegetable proteins texturized by extrusion or spinning, and bread doughs. Protein gelation is used not only for the creation of viscoelastic gels, but also for enhanced water and fat absorption, thickening, particle binding (adhesion), and emulsion or foam stabilization effect.
- It is essential, while investigating gelation, to distinguish it from other events in which the degree of dispersion of a protein solution decreases.

  Important keyword description is also discussed here:

I. Association: relates to subunit or molecular level alterations.

II. Polymerization or aggregation is characterized by the creation of massive complexes.

III. Precipitation: covers all aggregation events that result in complete solubility loss.

IV. Flocculation is a random aggregation process that happens in the absence of denaturation and is frequently caused by the suppression of electrostatic repulsion between chains.

V. Coagulation is characterized by random aggregation accompanied by denaturation and aggregation processes in which protein-protein interactions prevail over protein-solvent interactions and result in the formation of a coarse coagulum.

- *Texturization*

➢ Proteins, whether derived from live tissue (myofibrils in meat or fish) or manufactured molecules, serve as the structural and textural foundation for several meals (bread dough and crumb, soy or gelatin gels, cheese, curds, sausage, meat emulsion etc.).

➢ In addition, there are a variety of texturization techniques that begin with soluble vegetable or milk proteins and result in film or fiber-like products with chewiness and strong water-holding capacity and the ability to preserve these features following hydration and heat treatment. These texturized proteins are frequently employed as alternatives for meat and/or as meat extenders. In addition, certain texturization procedures were used to retexturize or reform animal proteins, such as beef or chicken flesh. Presented below are the known physicochemical bases for several of these texturization processes:

- *Thermal Coagulation and Film Formation*

➢ Soy proteins may be thermally coagulated over a flat metallic surface, such as that of a drum dryer, to form a film. Thin, hydrated sheets that result can be folded, pushed together, and sliced.

➢ The production of vegetable (particularly soy) and milk proteins into fibers resembles the development of synthetic textile fibers in many ways. Typically, it is required to begin with isolates having at least 90 % protein. Four to five surgeries can be performed constantly in succession.

➢ Thermoplastic extrusion is now the most used method for producing vegetable proteins. Instead of fibers, thermoplastic extrusion produces dry fibrous and porous granules or chunks with a chewy feel upon rehydration. Therefore, less expensive protein concentrates or flours (containing 45-70 % protein) can be utilized in place of protein isolates. Casein or gluten can be introduced in their natural state. The addition of a modest quantity of starch or amylose improves the texture of the finished product, however a lipid content greater than 5-10 % is negative. Adding 3 % sodium chloride or calcium chloride also strengthens the consistency. Proteins with the suitable initial solubility, high molecular weight, and the formation of the proper plasticizing and viscous characteristics of the protein-polysaccharide combination within the dye are required for good texturization using this method.

12.2.5.2 Properties related to protein-protein interactions.

- As one of the most significant functional characteristics of proteins, dough forming is one of the qualities associated with protein-protein interactions. Let us investigate dough creation.
- Dough Structure: You are well aware that gluten is the wheat protein. When combined and kneaded in the presence of water at room temperature, gluten proteins of wheat grain endosperm (and to a lesser degree rye and barley grains) are able to produce a highly cohesive and viscoelastic mass or dough. Wheat flour includes, in addition to glutens (gliadin and glutenin), starch granules, pentosans, polar and nonpolar lipids, and soluble proteins, all of which contribute to the creation of dough network and/or the final texture of bread.
- The composition and size of gliadins and glutenin explain the majority of gluten's behavior. Gluten proteins have limited solubility in neutral aqueous solutions due to their low concentration of ionizable amino acids. Rich in glutamine (>33 % by weight) and hydroxy amino acids, they are susceptible to hydrogen bonding, which is primarily responsible for gluten's water-absorbing ability and cohesion and adhesion capabilities. In addition, the presence of many polar amino acids and the resultant hydrophobic interactions lead to protein aggregation and the binding of lipids and glycoproteins. The capacity to create multiple -S-S cross-links explains the ease with which these proteins interlink tenaciously in dough.
- We have been kneading dough for a long time without comprehending the inside mechanics. Modifications are made to gluten proteins during dough formation are discussed below:

Changes In Gluten Proteins During Dough Formation

Initial gluten formation occurs when flour and water are combined. Using water as a medium, the flour proteins glutenin and gliadin cross-link to generate gluten. Improving this gluten structure is essential for generating a bread/chapati structure that retains gas. When bread flour that has been moistened is combined and kneaded, the gluten proteins align and partially unfurl. This increases hydrophobic contact and disulphide bridge production via -S-S- exchange events. As the first gluten particles change into this membrane (film), they serve to entrap starch granules and other flour components inside a three-dimensional protein network. Cleavage of disulfide bridges by reducing agents such as cysteine degrades the cohesion of hydrated gluten and bread dough; the addition of agents such as bromates increases toughness and elasticity. Certain types of "strong" wheat flour demand a lengthy mixing time and produce dough with a high degree of cohesion. When the energy or length of mixing surpasses a specific threshold, "weak flours" are less effective and the gluten network breaks down, most likely due to the rupture of -S-S- links (especially in absence of air). The relationship between dough strength and a high concentration of glutenin with high molecular weight, including completely insoluble "residue proteins," appears to exist. Experiments with "reconstituted" wheat flours of varying gliadin and glutenin ratios suggest that glutenin are responsible for the elasticity, cohesiveness, and mixing tolerance of dough, whereas gliadins contribute to dough's fluidity, extensibility, and expansion, resulting in a larger bread loaf volume. A precise ratio of proteins is required for breadmaking. Excessive cohesiveness (glutenin) inhibits the growth of trapped CO_2 bubbles during fermentation, dough rise, and consequent presence of open-air cells in the bread crumb. Excessive extensibility (gliadins) results in weak and permeable gluten films; hence, CO_2 retention is poor and dough collapse may ensue.

12.2.5.3 S*urface properties of proteins*

The surface properties of proteins are essentially related to their surface tension, emulsification, and foaming capabilities, which are detailed below:

- Proteins are the surface-active proteins that are widely utilized as emulsifiers in the food business to produce desserts, spreads, and whipped cream.
- Emulsions Stabilized with Protein: Numerous food items (e.g., milk cream, ice creams, cream, butter, etc.) are emulsions, and protein contents frequently play a significant role in stabilizing these colloidal systems. Immunoglobulins are the soluble proteins present in fresh milk. Homogenization of milk improves emulsion stability because it lowers fat globule size and because newly produced casein submicelles displace immunoglobulins and adsorb to fat globules.
- Proteins maintain emulsions and provide physical and rheological qualities, such as thickness, viscosity, elasticity, and stiffness, which influence droplet coalescence resistance. Depending on the pH, ionization of amino acid side chains may also occur, providing electrostatic repulsive force that promotes emulsion stability. This functional feature is essential to the creation of several common food items, including salad dressings and sausages.
- Proteins are often poor water/oil (w/o) emulsion stabilizers. In unit 7 of this course, you will read extensively about emulsions. This may be due to the hydrophobic nature of most proteins, which causes the majority of an adsorbed protein molecule to dwell on the water side of the contact.
- Proteins have the ability to attach to water, lipids, volatile flavors, and other molecules, and they exhibit vital functional qualities.

Foaming Properties

- To comprehend the foaming capabilities of proteins, a fundamental understanding of foam foods is required. Typically, foam meals consist of a colloidal dispersion of gas bubbles in a continuous liquid or semisolid phase including a soluble surfactant. (Surfactant is a chemical substance that works as a surface modifier which decreases the surface tension of the liquid). Cakes, whipped creams and toppings, ice creams, etc., are examples of foods containing a wide range of protein-based food foams with varying textures. In many instances, the gas is air (sometimes CO_2), and the continuous phase is a protein-containing aqueous or suspension. In unit 7, you will learn more about foams.

- What are the fundamental features of proteins that make them effective foaming agents? A protein must be capable of quick absorption at the air-water interface during whipping, rapid organization and rearrangement at the interface, and the formation of a cohesive viscoelastic film.

Flavor Binding

- Some protein preparations, although being functionally and nutritionally acceptable, require a deodorizing procedure to eliminate binding off-flavors. Aldehydes, ketones, alcohols, and oxidized fatty acids can generate beany or rancid odors as well as bitter or astringent taste. When attached to proteins or other components, these chemicals are liberated and become noticeable when cooking and/or chewing. Some are so tightly bonded that neither steam nor solvent extraction can extract them.
- Unlike the challenge of removing undesirable flavors, it may be beneficial to employ proteins as transporters for good flavors. It is desirable to provide a meat-like taste to texturized vegetable proteins. Ideally, all volatile flavor ingredients must stay bonded throughout storage, maybe also owing to processing, and then be rapidly and completely released in the mouth without distortion. The aforementioned problems can be resolved by studying the process by which volatile chemicals bind to proteins.

Protein Interactions with Volatile Substances

- Flavor binding may entail adsorption at the food's surface or diffusion into the food's core (absorption). We refer to adsorption as a surface phenomenon involving the adhesion of molecules of gases, dissolved chemicals, or liquids in more or less concentrated form to the surface of solids/liquids with which they come into contact.
- Adsorption-based flavor binding involves a physical or chemical adsorption process and hydrophobic contact. Hydrogen bonds bind polar molecules, such as alcohols, whereas hydrophobic interactions with nonpolar amino acids dominate the binding of low molecular weight volatile chemicals.
- In some instances, volatile chemicals form covalent bonds with proteins, a process that is often irreversible. High-molecular-weight volatiles are more susceptible to irreversible fixation.

Binding to Other Substances

- Depending on their chemical structure, dietary proteins can bind a variety of different molecules via weak interactions or covalent connections in addition to water, lipids, and volatile flavors. Examples include pigments, synthetic dyes (which may be utilized for protein analysis), and chemicals having mutagenic and sensitizing biological action. Such binding may result in an increase in toxicity or detoxification, and in certain instances, the nutritional value may be diminished.

12.3 Effect of cooking and processing on plant food

12.3.1 Fruits andvegetables

- You may already be aware that fruits and vegetables vary greatly in their chemical composition. However, some generalizations are possible. Fruits and vegetables have high water content, with a range from approximately 70 per cent for pears and bananas to 91 per cent for cabbage. The amount of protein and lipids in fruits and vegetables is usually very low, though both are good sources of vitamins particularly vitamins A and 4 C. Part of the carbohydrate in fresh fruits and vegetables is present as cellulose and pectic substances in the cell wall. Starch is present in almost all fruits and vegetables, although it may decrease on ripening. Glucose, fructose and sucrose are widely distributed whose content varies considerably in various fruits and vegetables. Further, we have also seen that carotenoid, chlorophylls, anthoxanthins and anthocyanins are the chief pigments present in fruits and vegetables.
- The detailed chemical changes that occur when fruits and vegetables are boiled in water or steamed, canned, dried or frozen, are still for the most part unknown. However, certain fruits and vegetables like apples, peaches, potatoes etc. turn brown when cut and exposed to air. This is a result of numerous enzymatic reactions that occur in fruit and vegetables on processing. These reactions may result in changes in the appearance, texture, flavor and color of the fruits and vegetables.
- Further, as a result of changes in the cell wall and intracellular structure, all fruits and vegetables undergo softening when cooked, no matter by what method. The changes occur in pectic substances, cellulose, starch and intercellular air. Cellulose, pectin and hemicellulose, as you have learnt earlier, are the major polysaccharide components in the cell wall of all plant foods. There has been a rapid progress in understanding the physical and chemical properties of polysaccharides in recent years. Studies on the role of cell wall components in food texture have been done, particularly on pectic substances. Alterations in pigments, formation of acids and release of low

molecular weight sulfur compounds have been reported as the major changes during processing of fruits and vegetables. In a study, reactivation of a pectin esterase has been found in cucumber slices. When fresh cucumber slices were blanched for 3 minutes at 81o C, enzyme activity could not be detected. However, when the blanched slices were stored in a pH 3.7, brine containing 0.6% acetic acid, 2.5% sodium chloride (NaCl), and 200 ppm Sulphur dioxide (SO2), about 20% of the activity present in the fresh tissue was regained during the first month of storage.

- In processing fruits and vegetables, loss of carotenoids into cooking or canning water is very slight. However, carotenoids undergo oxidation when exposed to air, so that drying of fruits or vegetables which contain these pigments, a problem is sometimes encountered. For example, carrots and apricots show loss of pigment on drying. Antioxidants partially protect the pigment from deterioration, as it is reasoned that the degradation of the pigment might be associated with the oxidative changes in the fat.
- Chlorophyll, the pigment responsible for giving bright green color to the vegetables, is very unstable and undergoes changes in color which are often considered to be undesirable. Have you ever noticed the color change in spinach when boiled in water? Yes, the green color of the spinach turns to olive green and then to brown when the leaves are cooked for long. Basically, chlorophyll changes to olive green color and then to brown when the food is heated, and the reaction is faster in acid solutions. When a vegetable becomes olive green on cooking, the chlorophyll gets converted to pheophytin (a derivative of chlorophyll) (Fig 1). The reaction can be written schematically as indicated below. Hence, special care must be taken to produce food products from plant sources to retain a bright, attractive green color.

$$\underset{\text{(Chlorophyll)}}{C_{32}H_{30}ON_4Mg\begin{smallmatrix}COOCH_3\\ COOC_{20}H_{37}\end{smallmatrix}} + 2H^+ \longrightarrow \underset{\text{(Pheophytin)}}{C_{32}H_{30}ON_4H_2\begin{smallmatrix}COOCH_3\\ COOC_{20}H_{37}\end{smallmatrix}} + Mg^{++}$$

Fig 12. 1 Effect of heating on chlorophyll

- Dehydration is one of the oldest food preparation methods. Dehydration is the process of removing all water from a food item under controlled conditions such that little changes occur. We shall study the approach in Unit 11 later. Here, we will examine the changes that occur in fruits and vegetables during dehydration. Vegetable dehydration decreases the natural water content below the crucial threshold for the development of germs (12 to 15 %) without compromising essential nutrients. Additionally, it aims to preserve flavor, scent, and appearance, as well as the capacity to recover original form or appearance upon reconstitution with water. However, the process of dehydration is also accompanied by considerable changes. These consist of:

- First, there is a concentration of important components, including proteins, carbs, and minerals. This is accompanied by chemical changes. Although fats are found in small quantities in vegetables, oxidation frequently reduces their aroma and flavor. In a Maillard reaction (you may recall reading about it in Unit 2), amino compounds and carbohydrates interact, resulting in a darker color and the formation of new scent molecules. Vitamin levels may also rapidly decline. Depending on the intensity of the processing conditions, the original volatile fragrance and flavor components are lost in large quantities during processing.
- Dried fruits are extraordinarily calorically dense and a considerable source of nutrients. Among the vitamins contained in fruits, only Carotene and the B-group vitamins remain unaffected. Vitamin C is lost in considerable quantities. Vitamin B1 is destroyed by sulfite treatment, however fruit color and vitamin C can be preserved and maintained.
- Freezing is another old food processing method that enables the long-distance transit of perishable food products from production to consumption centers. Freezing is the process of maintaining the available water in a food or food product at or below -18°C. Vegetables are often frozen using traditional freezing procedures including indirect cold transfer in plate or air freezers. We will study more about freezing in Unit 11, but for now we will examine the changes that occur in fruits and vegetables as a result of the freezing processing method.
- Vegetables and nutrients are preserved by freezing to a large extent. Spinach, peas, and beans retain vitamin A and -carotene well, but asparagus loses vitamin A and -carotene considerably after blanching, freezing, and deep freeze storage, and even after thawing at ambient temperature. Vitamin B-group losses rely mostly on the circumstances of the basic processing stages (washing, blanching). The remaining processes have no effect on B-vitamins. Vitamin C leaching by water or steam is harmful. Generally, preservation occurs during freezing and thawing. The preservation of vitamin C requires careful blanching and cold storage temperatures.
- Uncontrolled freezing can cause texture degradation, protein denaturation, and several other physical and chemical changes. There might be irreversible textural alterations indeep frozen veggies. Typical signs include softening, ductile stickiness, looseness, or flaccidity (a flabby softness, as in beans, cucumbers, and carrots); accumulation of a sticky, ductile, gum-like structure (asparagus) or a pasty, soggy structure (celery, kohlrabi); and hardening of the hull (peas).
- Producing pickled vegetables using spontaneous lactic acid fermentation. Fermentation enhances the product's digestibility and wholesomeness. The medium's acidic pH stabilizes vitamin C. Additionally, pickled veggies have a distinctive scent that is attractive.

- Canning, which requires heat sterilization, is one of the most essential methods for preserving vegetables. In comparison to other foods, vegetable sterilizing treatments are conducted at a greater temperature and for a shorter period of time (HTST sterilization). Thus, the products preserve a higher level of texture, fragrance, and color quality.

12.3.2 Nuts, oilseeds and spices.

Some oilseeds have gained enormous importance in the industrial production of edible oils on a big scale. You have already learned that the majority of fats and oils consist of triacylglycerols with varying fatty acid contents. The unsaponifiable fraction, which comprises less than 3 % of fats and oils, and a variety of acyl lipids, such as traces of free fatty acids, mono- and di- acylglycerols, are also present.

- Soybean and peanut (or groundnut) oils are extremely important to the economy. Low quantities of branched furan fatty acids in refined soybean oil are quickly oxidized upon exposure to light. This can lead to the creation of the intense fragrance component 3-methyl–2,4-nonandione, which, together with diacetyl, is implicated in the emergence of the olfactory defect known as reversion taste (bean-like, buttery, hay-like scent). Soybean oil is relatively stable in the full absence of light. By giving the oil a melting point between 22 and 28° or 36 and 43°, partial hydrogenation greatly extends its shelf life. These oils are used as raw ingredients for margarine and shortening production.
- The processing of fats and oils is essential for removing impurities contained in the raw material. To eliminate impurities, the refining procedure includes lecithin removal, degumming, free fatty acid removal, bleaching, and deodorization.
- Now, we will discuss spices. You are aware that dried or fresh plants with intense and distinctive flavors and fragrances are utilized as seasonings and spices. The scent components of the vast majority of spices exist as essential or volatile oils, which may be extracted using steam distillation. Mono- and sesquiterpenes or phenols and phenol ethers are the primary oil components. The most major pungent component of black pepper is piperine, which accounts for 3 to 8 % of the peppercorn's weight. Pepper is light-sensitive. During the processing and storage of ginger, gingerol readily dehydrates to shogaol, hence intensifying its pungent flavour.
- Spices are offered either whole or as coarse or fine powders. The flavor is enhanced by grinding the spices with a cryogenic mill. After grinding, spices have a short shelf life. Crushed spices quickly lose their scent and absorb other smells. Leaves and herb spices are dried prior to being pulverized. The loss of fragrance compounds is contingent upon the spice and drying conditions.

Regarding scent preservation, freeze drying yields the greatest results when the water content is lowered to 16 %.

12.3.3 Cereal & cereal products, legumes

The grains may be kept without quality loss for two to three years if the kernel moisture content (which is 20 to 24 %) is lowered to at least 14 % after threshing. The kernel is composed of three components: the seed coat (bran), the endosperm, and the embryo or germ. Figure 12.2 illustrates these four elements.

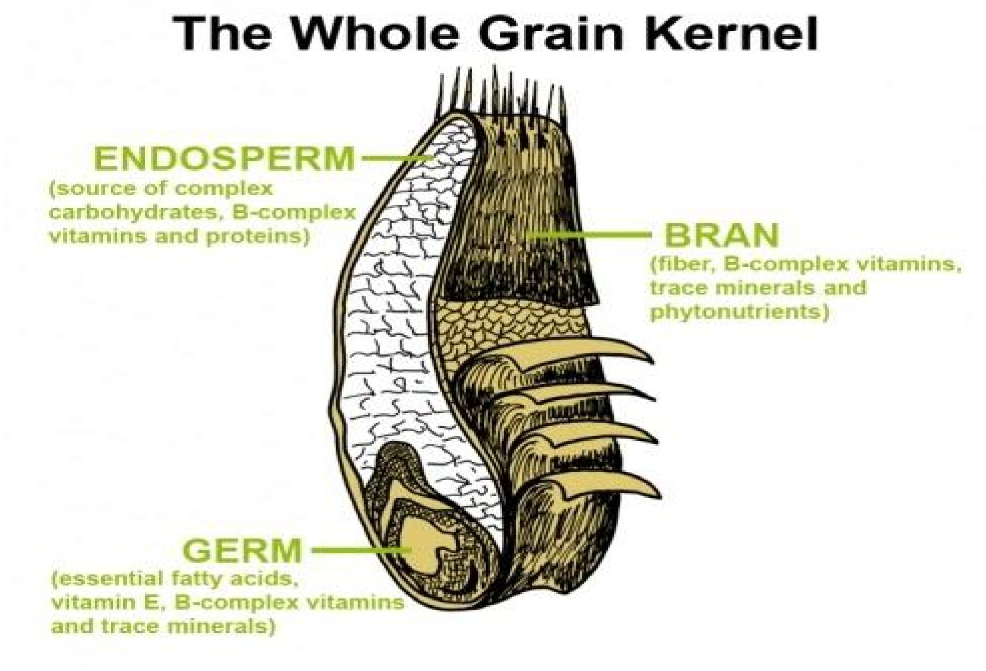

Figure 12.2: Cereal grain

- The purpose of milling (the process involving crushing and grinding) is to create flour in which the endosperm cell contents predominate. The exterior portion of the kernel is removed, including the germ and aleurone layer. 5 to 8 % of the wheat kernel's starch granules are mechanically destroyed during milling. The extent is contingent upon the type and intensity of milling as well as the hardness of the kernel, the tougher the structure, the greater the damage. Due to the fact that the rate of water absorption during dough preparation and the enzymatic destruction of starch rises with increasing damage, these factors are essential for the baking process and, to a certain degree, beneficial.
- The milling extraction rate affects the chemical makeup of the flour. Increasing the rate of flour extraction reduces the quantity of starch while increasing the number of kernel-coating components such as minerals, vitamins, and crude fiber. Compared to wheat flour, rye flour has larger quantities of minerals and vitamins at the same extraction rate. In the case of some B-vitamins,

including niacin, this disparity is well-balanced by the greater amounts of wheat kernels relative to rye kernels.

- Semolina is a commercial product manufactured from the endosperm cells of hard durum wheat. Semolina maintains its integrity throughout cooking and is mostly used to make pasta. As a milled flour with a poor extraction rate, semolina contains few minerals and vitamins.
- Vitamins of the B-group are lost to varying degrees during baking. White bread loses 20 to 50 % of its thiamine, 6 to 14 % of its riboflavin, and 0 to 15 % of its pyridoxine. By baking, the frothy texture of dough is transformed into the spongy texture of crumbs. At the comparatively high temperatures to which the dough's exterior is subjected, starch degrades into dextrin, mono- and disaccharides. Caramelization and non-enzymatic browning processes also occur, contributing to the crust's taste and color. The crust's thickness is determined by the temperature, baking time, and kind of baked goods.
- In the crust and crumb of white bread, aroma-rich substances play a significant role. Two heterocyclic chemicals, furanol and 2- and 3- methyl butanol, are responsible for the roasty, malty, and caramel notes in the crust, while linoleic acid- methional and diacetyl contribute to the scent of the crumb. If the dough is fermented for a longer period of time, 3-methylbutanol and 2-phenylethanol, two byproducts of yeast, rapidly accumulate in the crumb and are responsible for the "yeasty" taste perception.

Baking's effect on dough:

- Active enzyme stage (from $30^{o}C$ to $70^{o}C$).
- Phase of gelatinization of starch. (From 55 to 70 degrees)
- Phase of water vapor loss
- Phase of browning and aroma development.
- These modifications vary between the exterior of the dough and the interior of the crumb. Because heat transfer in dough is sluggish, there is a sharp temperature gradient inward from the dough's outside in the oven. The following are the sequences of changes that occur during the transformation of the frothy texture of dough into the spongy texture of bread and other products during baking at temperatures between $220^{o}C$ and $250^{o}C$.

Chemical and physical modifications

- As heat permeates the dough when the dough is placed in the oven, the rate of fermentation initially rises. Up to $50^{o}C$, yeast produces increasing amounts of CO2 and ethanol.

Simultaneously, the dough's viscosity decreases rapidly and reaches its lowest point at around 60°C. Simultaneously, the heat expansion of gas within each cell causes a fast increase in loaf volume, known as "oven spring."

- As the interior temperature of the dough rises over 37 °, the yeast's activity diminishes and becomes inactive around 54 °. In addition, the viscosity of dough rapidly increases over 60°C. This rise is generated by the expansion of starch, the release of amylose, and the denaturation of protein. As the crumb starch gelatinizes at 65 °, the existing - and -amylase will attack the starch. The amylolytic activity continues until the enzymes are inactivated at a temperature of around 74°C. Optimal amylolytic activity is required to restrict the breakdown of gelatinized starch in order to prevent bread from staleness. At around 74 °, denatured protein, swelled and partially gelatinized starch create a stable crumb network. This process continues until the interior temperature reaches 93 to 100 ° at the conclusion of baking. During this period, gluten loses its toughness and elasticity, becoming rigid and brittle.
- This stiffens the starch structure, resulting in the formation of a solid, elastic crumb. Nearly all of the starch granules on the surface of the crust gelatinize. This is especially true when the "oven humidity" is high; the resulting starch film creates a delicious glaze. This also delays the crust's drying and settling and allows the dough to fully expand.
- This procedure results in a significant increase in the dough's tensile strength and the presence of air bubbles. Therefore, the membrane breaks down and becomes porous, enabling water, carbon dioxide, and ethanol to evaporate. This leads to weight reduction from baking. The inside temperature never exceeds 100°C, while the outside temperature approaches that of an oven (200°C). Thus, more water evaporates from the surface, and the crust forms. This results in weight losses of 8 to 14 % of the new dough during crust development.
- The high temperature to which the dough's outside is exposed. At 110°C to 140°C, starch degrades into dextrin, mono, and disaccharides. At 140-150°C, caramelization and non-enzymatic browning also occur, imparting flavor and color to the crust. The roasted flavors evolved between 150 and 200°C.
- In the crust, the heterocyclic chemicals pyrroline and pyridine, as well as furanone and 2- and 3-methyl butanal, which are responsible for the roasty, malty, and caramel flavors of the goods, respectively, are created. Methional and diacetyl, two autoxidation derivatives of linoleic acid, also contribute to the scent of the crumb.

Changes during rice milling.

The milling of rice comprises the following steps:

- Paddy rice
- Dirt removal, we obtain brown rice.
- Rice polishing is the process of removing the bran coats (fruits and seeds) of the cuticle, the germ, and the aleurone layer to get white rice.

In contrast to brown rice, white rice has less vitamins and minerals, as seen in Table 12.6.

Table 12.6:Vitamin content of unprocessed, white, and cooked rice

B-Vitamins (mg/kg)			
	Thiamin	**Riboflavin**	**Niacin**
Raw Rice	3.4	0.55	54.1
White rice	0.5	0.19	16.4
Parboiled rice	2.5	0.38	32.2

A parboiling procedure, which was first devised to aid seed coat removal, can provide a nutritionally enhanced product. Approximately 25 % of the global rice harvest undergoes the following treatment:

- Raw rice
- steeping in hot water
- followed by drying and polishing following autoclaving.
- Parboiled rice

➢ This parboiling procedure results in the following changes: the starch gelatinizes, but then partially degrades after drying. The heat inhibits enzymes by inactivating them.

➢ during rice storage, the enzymatic breakdown of lipids. The oil droplets are shattered, and lipids travel partially from the endosperm to the rice kernels' outer layers. Rice that has been parboiled is more sensitive to lipid peroxidation due to the destruction of its antioxidants. In contrast, nutrients and vitamins seep from the outer layers into the inner endosperm, where they stay after the aleurone layer has separated. The cooking quality of parboiled rice is superior, and cooked parboiled rice lacks pastiness.

- Now, let's examine the processing-induced modifications that occur in legumes. Toxic compounds (e.g., cyanogenic glycosides and anti-nutritional factors, such as proteinase inhibitors, lectins, etc.) found in some legumes can be eliminated using processing techniques such as boiling.
- Individual cotyledonous cells disintegrate during the cooking process, resulting in the softening of beans. This is due to the conversion of protopectin to pectin, which depolymerizes rapidly upon heating. This process results in the disintegration of the central lamella of the cell wall, which is composed of pectin and supports the tissue.
- In contrast, the toughening of legumes after cooking is caused by the cross-linking of their cell walls. The following reactions which can commence even during storage at higher temperatures are under discussion as the source of cross linking. The current phytase hydrolyzes the calcium and magnesium phytates found in the middle lamella. In addition to meso-inositol and phosphoric acid, Ca^{2+} and Mg^{2+} ions are also produced, which cross-link the pectic acids and fortify the middle lamella. Pectin esterase, enzymes that convert pectin to acid via demethylation, induce tissue calcification. In the case of legumes that are particularly abundant in phenolic compounds and polyphenol oxidases, the creation of complexes between proteins and polyphenols should contribute to the tissue's fortification.
- Sprouting legumes promotes a partial breakdown of carbohydrates and proteins, which adds to their enhanced digestibility. The unique flavor associated with sprouted legumes is a benefit. Sprouting has been demonstrated to trigger the hydrolysis of oligosaccharides, which are responsible for the flatulence of legumes.

12.4 Effect of cooking and processing on animal food

12.4.1 Dairy products and milk

In the dairy business, milk is frequently subjected to heat treatment for a number of reasons. Due to the production of insoluble complexes, protein denaturation, and interactions between milk components, this technique may produce many changes in the milk, including salt precipitation, depending on the heating temperature. A film or skin forms on the surface of milk when it is heated to approach the boiling point. This skin is mostly composed of calcium caseinate;however, it also contains the other milk components.

- Have you ever observed what happens to milk when it is heated over its boiling point? When milk is autoclaved at an approximate temperature of 121 °C, it becomes brown. The brown color is caused by a reaction between the casein (or amino acids) and the sugar, which is triggered by the heat. Changes in milk's physical and chemical characteristics are also influenced by the method used to heat the substance. The effects of indirect heating (steam injection) on the physical and chemical characteristics of ultra-heated milk (95°C to 145°C) were much greater than those of direct heating (steam injection), according to research. In milk that was ultra heated, browning intensified and whey protein denaturation increased.

- Depending on the temperature and length of heating, milk additionally undergoes taste variations in addition to the aforementioned modifications. A cooked flavor develops when milk is heated to high temperatures. In the holding technique of pasteurization (62°C for 30 minutes) or the high-temperature short-time (HTST) method (71°C for 15 minutes), very little cooked taste is detected. However, at higher temperatures or longer heating times, cooked flavor becomes more pronounced. Upon temporary heating to 70°C, the taste emerges. This cooked flavor is attributed to the formation of sulfhydryl (compounds with a -SH group, present in many plant and animal enzymes) at high temperatures. Sulfhydryl compounds are quickly oxidized and retard the oxidation of milk or cream fat at elevated temperatures. Until the sulfhydryl is oxidized and the cooked flavor has vanished, oxidized flavors in milk often do not manifest.
- Milk's composition and characteristics are also significantly altered by freezing. As milk freezes, the composition of the frozen and other solids becomes extremely inhomogeneous, while the liquid component becomes highly concentrated with milk solids, to the point that milk never completely freezes solid. Milk's physical state is irreversibly changed by freezing. It causes the fat globules to lose their whole emulsion structure, cluster together, and become deformed and uneven in shape and size. Freezing has an effect on casein as well. It is precipitated as flakes as calcium caseinate is partially separated from its presence in milk. This state, together with the presence of certain free fat particles, imparts an odd look to the thawed milk. Affected as well is the flavor, which is fairly watery.
- Freezing has the potential to disrupt the heat-stable caseinate micelles of milk. When milk is frozen, the caseinate's stability degrades with time and may result in total coagulation.
- Casein is a notable example of a protein that can be cooked without much alteration in stability. Milk may be boiled, sterilized, and concentrated without coagulation due to the extraordinary stability of casein.
- Now, we'll examine the variables that impact viscosity. Low temperatures and ageing enhance the viscosity of milk by causing the fat globules to clump together. Mechanical agitation lowers the viscosity of whole milk because the fat globule clumps are partially broken up, however in the case of skim milk, mechanical agitation has no impact due to the absence of lipids.

- As the fat globules in homogenized milk have already been broken down, the milk will not be harmed. The viscosity of whole milk is increased by homogenization, whereas that of skim milk is somewhat decreased. This procedure reduces the size of the fat globule, hence increasing its surface area. A protein film is adsorbed on the surface of the globules, and because this surface is considerably bigger than in non-homogenized milk, a significantly greater adsorption occurs, resulting in a greater viscosity. Some of the protein particles in skim milk may be disrupted, resulting in a decrease in viscosity.
- Pasteurization temperatures somewhat reduce viscosity by dispersing fat globule clusters, but high temperatures or pressure increase viscosity by denaturing proteins.

12.4.2 Meat and poultry

- Meat, as you probably well know, is protein-rich and includes the majority of important amino acids. In addition, it is rich in minerals such as copper and iron, as well as vitamins A, B1, B2, and B3. Depending on the kind, breed, diet, and age of the animal, its fat content ranges from 5 to 40%. Meats are abundant in saturated fatty acids (SFA). A brief description of the impact of thermal processing on meat products might be provided. It is becoming increasingly apparent that the kind and amount of the alterations that occur within the muscle as it transforms into meat may significantly influence its behavior.
- It is vital to note that too successful cooling of heated carcasses might lead to hardness. If the temperature of the meat (muscles) may be lowered to -10 to -15°C while they are still in the early pre-rigor state (pH between 6.0 and 6.4), there is a propensity for shortening and, consequently, harshness during later cooking. The term for this phenomenon is "cold shortening." When the temperature reached by the pre-rigor muscle is closer to the freezing point, the propensity of cold shortening increases.
- Researchers have paid close attention to the impact of irradiation on the nutritional content of meats and poultry since it has been cited as a justification against the process's approval and commercial implementation. The most unreasonable aspect of this controversy is the consistent emphasis on the negative effects of irradiation on food nutrients, including those in meat and poultry, which has been largely reported by extrapolating data from studies in which isolated, selected nutrients were irradiated in model systems.
- In terms of amino acid composition, strong radiation doses such as those required for sterilizing (e.g., 25-27Kgy) had little effect on the level of cystine, methionine, and tryptophan in beef, despite the fact that these amino acids are extremely sensitive to destruction by other mechanisms.
- Numerous studies demonstrate the impact of processing on vitamins, particularly thiamine. In

research comparing the effects of ionizing radiation and normal thermal processing on the thiamine content of enzyme-inactivated ground pork, it was determined that conventional thermal processing led to a decrease in thiamine content.

- thiamine losses in pork were equivalent to or larger than those produced by radiation sterilization.
- Another research investigated the influence of irradiation, storage, and cooking on the thiamine level of ground pork. The pork was irradiated at 1Kgy while wrapped in polyethylene bags at room temperature, then stored at 0°C for 8 months with or without heating for 10 minutes at 100°C or 30 minutes at 200°C prior to irradiation. The results obtained are as follows. Losses of thiamine in unheated pork samples immediately following irradiation were 5%, but losses during refrigerated storage at 0°C were identical to those in non-irradiated samples. Heating pork at 100°C for 10 minutes before irradiation had no influence on the thiamine loss observed in unheated, irradiated samples.

12.4.3 Fish

Fish skeletal muscle has small fibers placed between sheets of connective tissue. Fish muscle contains less connective tissue than mammalian muscle, and its fibers are shorter than those of mammalian muscle. Fish has a more delicate feel than beef due to the distinct physical qualities of its tissues. The myofibrils of fish muscles resemble those of mammalian muscles in that they are striated and contain the same four key proteins, myosin, actin, actomyosin, and tropomyosin.

- During processing and storage, actomyosin from fish is shown to be very unstable and susceptible to alteration. During freezing, actomyosin becomes gradually less soluble and the flesh gets progressively harder. Proteins derived from fish are more prone to instability during freezing and storage. The fish may become brittle and lose moisture after being frozen.
- The nutritional value of protein does not appear to be considerably changed by exposure to time/temperature procedures during canning, according to studies on the effects of heat processing on fish. Salmon and sardine bones, for example, are softened to the point that they may be consumed. Protein denaturation by heat results in water losses ranging from 9 to 28%, depending on the intensity of the process/pre-process, the species, the pH, and other physiological parameters.
- Changes in texture caused by heat processing are also unavoidable and might be helpful to a limited degree. Excessive protein denaturation and the resulting loss in the water-holding capacity of the structural components result in a product with a dry and chewy texture. However, oily-flesh fish display fewer of these effects due to the restricting effects of lipids on water migration. In this regard, the choice of raw material is crucial, since less fresh fish loses more water and, thus,

exhibits higher textural degradation following processing.

- In the section on fruits and vegetables, we have previously examined browning. Are you able to recollect which components caused the reaction? Sugars and amino acids, indeed. Similarly, the number of sugars and amino acids in fish may be responsible for Maillard-type reactions that occur during heat processing.
- Proline is a common amino acid in fish and may add to sweetness. The sugars ribose, glucose, and glucose-6-phosphate contribute to flavor, as does 5-inosinic acid, which imparts a meaty taste. Volatile Sulphur molecules add to fish flavor; hydrogen sulphide, methyl mercaptan, and dimethyl sulfide may contribute to fish fragrance.
- Usually, ribose is responsible for the browning of canned fish. During canning, undesirable color changes in shellfish frequently result from the presence of metal ions; for instance, the blue discoloration of crab flesh is due to the presence of iron, whereas the black discoloration of prawns is due to the presence of copper. Due to the high iron concentration of the raw material, the processing of eels, abalone, and albacore tuna results in discoloration. Due to the accumulation of free Sulphur in the tissue, the discoloration of this sort of material is exacerbated by freezing storage prior to canning. Iron and free Sulphur react during heat processing, precipitating black iron sulphone on the edges of the container, in the fish itself, and most notably in any free liquid.
- Comparing fresh and canned fish has indicated slight losses of B-group vitamins, thiamine, riboflavin, nicotinic acid, folic acid, and cyanocobalamin.
- Do you know what causes fish flesh to go rancid? Fish rotting is caused by a number of variables, including differences in the composition of tissues between species, environment, procurement, and storage procedures.
- Fish flesh that has been subjected to significant autolysins during spoilage may result in a heat-processed product with a pitted or honeycombed texture, whereas a limited amount of proteolysis before processing may result in a desired softening of the texture of the final product.

12.4.4 Egg

The pace and circumstances of handling, uncoated shells, storage durations and temperatures have a higher and more immediate negative impact on the quality, flavor, composition, and functional qualities of eggs.

- Eggs that have been frozen or dehydrated are nutritionally equivalent to fresh eggs. There is no considerable loss of nutrients throughout the drying or freezing operations. Properly
- Eggs that have been dried and frozen exhibit no nutritional loss over time. The following facts

provide support for this assertion.

- A study of the thiamine content of hard-cooked eggs versus scrambled eggs revealed that neither preparation method was superior. However, scrambled eggs had 20% less riboflavin than hard-cooked eggs. Both cooking procedures resulted in the same loss of threonine (an amino acid), 0.22 %.
- Under typical conditions, the drying of eggs results in minimal loss of nutritional value. It has been discovered that the levels of vitamin A, vitamin B, thiamine, riboflavin, pantothenic acid, and nicotinic acid in dried whole eggs are comparable to those in fresh egg products. The protein content of dried eggs has not changed significantly. Unfavorable drying conditions or poor storage conditions may compromise nutritional qualities. Nevertheless, any egg product that lacks an off flavor will likely retain all of its nutritious qualities.
- In general, egg products retain their heat-coagulating capabilities during the drying process. If drying conditions are excessively harsh or storage circumstances are unfavorable, whole egg and yolk products can lose their solubility, which is accompanied by a loss of heat-coagulating capabilities. Increased viscosity upon reconstitution is one symptom of high heat during the drying of plain whole egg and plain yolk. The viscosity of dried plain yolk changes substantially more than that of dried plain egg whites or entire eggs. During storage, it is possible to see a rise in the viscosity of whole egg and yolk products. At temperatures exceeding 100° F, the viscosity of reconstituted liquids increases relatively fast.
- Dehydration has no bearing on the density of egg products. When a dried egg product is reconstituted to its original solids, it has about the same density as the liquid from which it was extracted. Depending on the techniques and conditions of drying, the bulk density of dried egg products might vary substantially. Egg products that are pan-dried have a significantly greater bulk density than their spray-dried equivalents. The lowest bulk density is found in freeze-dried egg products.
- Changes in the chemical characteristics of the egg's numerous constituents are responsible for the modifications in functional qualities. Proteins comprise most of the egg white, as you know. Consequently, any changes that occur in egg white after drying appear to be a result of alterations in these proteins. Denaturation and coagulation of proteins are considered chemical alterations because they entail the unfolding of proteins, which exposes specific chemical groups, such as the sulfhydryl group, thereby modifying the proteins' chemical reactivity. Since water is an essential component of the protein molecule, removing it from egg white may alter its characteristics.
- The presence of glucose in eggs can cause chemical alterations during drying and storage. The

process in egg white includes the reducing or aldehyde groups of glucose and the amino groups of proteins (Maillard reaction). This reaction leads to the formation of a brown hue and a decrease in solubility. Drying to a low moisture content and lowering the pH reduces the reaction. Since glucose comprises around 4% of the solids in egg white, the glucose has been eliminated from all dried egg white.

- The transformations that occur in egg-yolk and yolk-containing egg products are significantly more complicated than those in egg white. The interaction with glucose might also result in modifications to the egg yolk and egg product. In this instance, glucose might react with the amino groups in both protein and cephalin. During storage, off-flavors and odors are produced due to the interaction with cephalin. The process may be stopped by removing glucose and is also hindered by adding carbs such as sucrose.
- As noted earlier, the differences in viscosity of plain egg yolk and entire egg are attributable to the changes in lipoproteins. The lipids account for roughly 45 % of the solids in a whole egg and 60 % of the solids in the yolk, and hence play a predominant role in the changes that occur after drying. 62 % of egg yolk lipids are glycerides, 33 % are phospholipids, and 5 % are cholesterol. Lecithin accounts for 73% of phospholipids, while cephalin accounts for 15%. This oxidization
- Approximately 100 times faster than lecithin, the rate of cephalin synthesis is incredibly quick. This connection between these phospholipids and protein requires the presence of water. The equilibrium changes when water is removed. In general, removing water from lipoproteins without altering their characteristics is challenging.
- Gelation, which happens when yolk is frozen and thawed, appears to be caused by the aggregation of yolk lipoproteins due to the water imbalance and shift. Carbohydrates inhibit a rise in the viscosity of egg yolk during drying and storage.

12.5 Let us Sum up:

In this unit, we studied chemical, physical and nutritional changes that occur in foods during processing and storage. These alterations were already among a variety of food groups such as fruits and vegetables, milk and milk products, meat and poultry, fish, egg, cereal, cereal products and legumes, and nuts and oilseeds. A number of processes that occur because of such alterations were also dealt with, such as browning, caramelization, gelation etc.You have also learnt about the perspective of food processing in the current scenario, that is, you came to know of the various desirable and undesirable changes that occur during processing of foods.

CHECK YOUR PROGRESS:

Short-Answer Questions:

1. What are the main sources of dietary protein?

2. Define protein gelation and its significance in food production.

3. How does cooking affect the nutritional value of fruits and vegetables?

4. What are the key changes that occur in milk products during processing?

5. What role does emulsifying play in the functional properties of proteins?

Long-Answer Questions:

1. Explain the classification, composition, and functions of proteins in the human diet.

2. Describe the various functional properties of proteins and their applications in food science.

3. What are the effects of cooking and processing on plant foods, particularly fruits, vegetables, nuts, oil seeds, spices, cereals, and legumes?

4. Analyze the impact of cooking and processing on animal-based foods like milk, meat, poultry, fish, and eggs.

5. Compare and contrast the effects of different cooking and processing methods on both plant and animal foods.

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