

UNIT – 1

Introduction to Food and Nutrients

Food

Food can be defined as any substance which nourishes the body and is fit to eat. It may be solid or liquid.

Nutrition

Nutrition is the combination of processes by which the human body receives and utilizes nutrients which are necessary for carrying out various functions and for the growth and renewal of its components.

Thus, nutrition refers to the various processes in the body for making use of food. It is eating right kind and amount of food, absorption of nutrients into the bloodstream, use of individual nutrients by the cells in the body, maintenance and growth of cells, tissues and organs and elimination of wastes.

Nutrients

Nutrients are the chemical substances present in food, which the body needs to carry out its functions. Food is the source of all nutrients except vitamin D. There are six major groups of nutrients namely carbohydrates, proteins, fats, vitamins, minerals and water.

Carbohydrates

Carbohydrates are either simple or complex, and are major sources of energy in all human diets. They provide energy of 4 Kcal/g. The simple carbohydrates, glucose and fructose, are found in fruits, vegetables and honey, sucrose in sugar and lactose in milk, while the complex polysaccharides are starches in cereals, millets, pulses and root vegetables and glycogen in animal foods. The other complex carbohydrates which are resistant to digestion in the human digestive tract are cellulose in vegetables and whole grains, and gums and pectins in vegetables, fruits and cereals, which constitute the dietary fibre component. In India, 70-80% of total dietary calories are derived from carbohydrates present in plant foods such as cereals, millets and pulses. Dietary fibre delays and retards absorption of carbohydrates and fats and increases the satiety value. Diets rich in fibre reduce glucose and lipids in blood and increase the bulk of the stools. Diets rich in complex carbohydrates are healthier than low-fibre diets based on refined and processed foods.

Proteins

Proteins are primary structural and functional components of every living cell. Almost half the protein in our body is in the form of muscle and the rest of it is in bone, cartilage and skin. Proteins are complex molecules composed of different amino acids. Certain amino acids which are termed “essential” have to be obtained from proteins in the diet since they are not synthesized in the human body. Other nonessential amino acids can be synthesized in the body to build proteins. Proteins perform a wide range of functions and also provide energy (4 Kcal/g).

Protein requirements vary with age, physiological status and stress. More proteins are required by growing infants and children, pregnant women and individuals during infections and illness or stress. Animal foods like milk, meat, fish and eggs and plant foods such as pulses and legumes are rich sources of proteins. Animal proteins are of high quality as they provide all the essential amino acids in right proportions, while plant or vegetable proteins are not of the same quality because of their low content of some of the essential amino acids. However, a combination of cereals, millets and pulses provides most of the amino acids, which complement each other to provide better quality proteins.

Fats

Oils and fats such as butter, ghee and vanaspathi constitute dietary visible fats. Fats are a concentrated source of energy providing 9 Kcal/g, and are made up of fatty acids in different proportions. Dietary fats are derived from two sources viz. the invisible fat present in plant and animal foods; and the visible or added fats and oils (cooking oil). Fats serve as a vehicle for fat-soluble vitamins like vitamins A, D, E and K and carotenes and promote their absorption. They are also sources of essential polyunsaturated fatty acids. It is necessary to have adequate and good quality fat in the diet with sufficient polyunsaturated fatty acids in proper proportions for meeting the requirements of essential fatty acids. The type and quantity of fat in the daily diet influence the level of cholesterol and triglycerides in the blood. Diets should include adequate amounts of fat particularly in the case of infants and children, to provide concentrated energy since their energy needs per kg body weight are nearly twice those of adults. Adults need to be cautioned to restrict intake of saturated fat (butter, ghee and hydrogenated fats) and cholesterol (red meat, eggs, organ meat). Excess of these substances could lead to obesity, diabetes, cardiovascular disease and cancer.

Vitamins and minerals

Vitamins are chemical compounds required by the body in small amounts. They must be present in the diet as they cannot be synthesized in the body. Vitamins are essential for numerous body processes and for maintenance of the structure of skin, bone, nerves, eye, brain, blood and mucous membrane. They are either water-soluble or fat-soluble. Vitamins A, D, E and K are fat-soluble, while vitamin C, and the B-complex vitamins such as thiamine, riboflavin, niacin, pyridoxine, folic acid and cyanocobalamin are water-soluble. Pro-vitamin like beta-carotene is converted to vitamin A in the body. Fat-soluble vitamins can be stored in the body while water-soluble vitamins are not and get easily excreted in urine. Vitamins B-complex and C are heat labile vitamins and are easily destroyed by heat, air or during drying, cooking and food processing. Minerals are inorganic elements found in body fluids and tissues. The important macro minerals are sodium, potassium, calcium, phosphorus, magnesium and sulphur, while zinc, copper, selenium, molybdenum, fluorine, cobalt, chromium and iodine are micro minerals. They are required for maintenance and integrity of skin, hair, nails, blood and soft tissues. They also govern nerve cell transmission, acid/base and fluid balance, enzyme and hormone activity as well as the blood-clotting processes.

Health

The World Health Organization (WHO) defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

Body Mass Index (BMI)

It is a value derived from the weight and height of a person. The formula is $BMI = \text{kg}/\text{m}^2$ where kg is a person's weight in kilograms and m^2 is their height in metres squared. The WHO regards a BMI of less than 18.5 as underweight and may indicate malnutrition or other health problems, while a BMI equal to or greater than 25 is considered overweight and above 30 is considered obese. The healthy range is 18.5 to 24.9.

BMI	Weight status
Below 18.5	Underweight
18.5-24.9	Normal weight
25.0-29.9	Overweight
30.0-34.9	Obesity class I
35.0-39.9	Obesity class II
Above 40	Obesity class III

Overweight and obese individuals are at an increased risk for the following diseases.

- Coronary artery disease
- Dyslipidemia
- Type 2 diabetes
- Gallbladder disease
- Hypertension
- Osteoarthritis
- Sleep apnea
- Stroke
- Infertility
- At least 10 cancers, including endometrial, breast, and colon cancer
- Epidural lipomatosis

Nutritional status

The nutritional status of an individual is defined as the condition of health as influenced by the utilization of nutrients in the body.

The nutritional status of an individual or a community can be assessed by surveying the kind and amount of food being consumed, signs of ill – health or deficiency symptoms if present, height, weight and other measurements as well as level of nutrients in the blood and excreted in the urine.

Relationship between Food, Nutrition and Health

Good nutrition and health are closely interlinked. Clean wholesome and nutritious food promotes health and keep away diseases. When the diet does not supply all nutrients in required amounts, it results in ill-health or malnutrition.

Malnutrition

Malnutrition is an impairment of health resulting from a deficiency, excess or imbalance of nutrients in the diet. It includes both undernutrition or deficiency and overnutrition or excessive consumption.

Undernutrition

It refers to a deficiency of one or more nutrients in the diet.

Overnutrition

It refers to an excess of one or more nutrients in the diet. An excessive intake of calories results in overweight which can lead to obesity. An excessive intake of fat-soluble vitamins can cause hypervitaminosis or vitamin toxicity.

Functions of food

Food is our basic necessity. It may include rice, chapatis, dal, curries, curd, milk, fruits etc. Food performs the following three major functions

1. Physiological functions.
2. Psychological functions.
3. Social functions.

Physiological function – Each nutrient in food has specific functions to perform in the body. The physiological functions performed by food are as follows.

Providing energy – The body needs energy to carry out voluntary and involuntary work. Involuntary work includes all processes which are not under the control of our will such as digestion, respiration and circulation and go on continuously irrespective of whether we are asleep or awake. Voluntary activities are activities which we wish to do such as walking, playing games and working require energy and the amount of energy required will depend on the nature of activity. The energy needed for these activities is supplied by oxidation of the foods we eat, mainly carbohydrates and fats.

Body building and growth – It is one of the most important functions of food. An infant grows into a healthy adult by consuming the right kinds and amounts of food year after year. Our body is made up of millions of cells and when growth takes place, new cells are added to the existing cells and cells increase in size.

Maintenance or repair – In the adult body, worn out cells are continuously being replaced by new ones. The daily wear and tear of cells needs to be maintained. Proteins, minerals, and water are the main nutrients required for growth as well as maintenance of all cells and tissues in the body.

Regulation of body processes – Food also regulates numerous activities in the body such as the beating of the heart, maintenance of body temperature, clotting of blood and excretion of wastes. Each of these processes is controlled and carried out by specific nutrients. E.g vitamin K and calcium are necessary for clotting of blood.

Protective function – Nutrients keep body cells in a health condition to ward off infection. They help in building up the body's resistance to disease and help the body recover rapidly from any infection. These functions are performed by vitamins and proteins

Psychological Function – We all have emotional needs such as need for love attention and security. Food can play an important role in fulfilling these needs. A mother can express her love for her child by preparing the child's favourite meal. Food can be given as a reward for good behaviour or deprived as a punishment for bad behaviour.

People feel comfortable and secure when they are served food they have been used to consuming. Many people eat to relieve anxiety and frustration while some may eat less or refuse food when they are depressed and lonely.

Certain foods may be associated with sickness eg. Sago kheer and khichidi while some others such as pedha are associated with good tidings. Food is therefore strongly associated with ones emotions and feelings.

Social Function – Food carries a lot of social significance. Warmth and friendship are expressed through sharing ones food or inviting people to dine. Preparing special food or ones favourite food is a way of showing respect or affection.

Food is a significant part of celebrations for occasions such as birthdays, weddings and other joyous occasions. Festivals such as Diwali, Dussehra, Christmas and Eid have special menus prescribed for the occasions.

Food also has religious significance. Some foods can be offered to God while others are avoided on certain days for religious reasons. The type of food prepared and served is a status symbol. Even today in some communities adult men are given more and better quality food than women because of their higher social status.

Balanced Diet

A balanced diet is one which provides all the nutrients in required amounts and proper proportions. It can easily be achieved through a blend of the five basic food groups. The quantities of foods needed to meet the nutrient requirements vary with age, gender, physiological status and physical activity.

In addition, a balanced diet should provide bioactive phyto chemicals such as dietary fibre, anti-oxidants and other nutraceuticals which have positive health benefits. Low glycaemic index foods are preferred.

A balanced diet should provide around 50-60% of total calories from carbohydrate, 10-15% from proteins and 20-30% of total calories from both visible and invisible fat.

Balanced diet

- Meets nutritional requirement
- Provides phyto chemicals
- Prevents degenerative diseases
- Improves longevity
- Prolongs productive life
- Improves immunity
- Increases endurance level
- Develops optimum cognitive ability
- Helps in coping up stress

Food Groups

All the foods we use in our daily meals are divided into five groups. The food groups are chosen because of the specific nutrients contributed by each to the total diet. Foods have been assigned to the groups based on their composition. The food groups are designed to direct selection of foods and quantities consumed to meet the RDA (Required Dietary Allowances), thus forming the foundation of an adequate diet.

Cereals, millets and products:

The first food group includes preparations of cereals and millets, which are the staple foods in India. The foods in the group include rice, wheat, jowar, bajra, ragi and products such as rawa, vermicelli etc. These foods provide more than half of our body's daily need for energy and protein. In addition, if the whole grains or its flour is used in the preparation, these foods will be a valuable source of thiamine and iron.

A sedentary person may need about ten servings. Those who need more servings of foods in this group are:

- Teenagers

- Expected and nursing mothers
- Persons involved in heavy physical work
- Players who practice for hours etc.

Food groups	Foods	Main Nutrients	Size of serving	No. of servings
1	Cereals, millets and products	Carbohydrates, Energy, protein, Invisible fat, Vitamin B1, Vitamin – B2, Folic Acid, Iron, Fibre.	25g	9-16
	Rice, wheat, maize, jowar, bajra, ragi and their preparations.			
2	Pulses, legumes, nuts and oil seeds	Protein, Invisible fat, energy, Vitamin –B1, Vitamin – B2, Folic Acid, Calcium, Iron, Fibre.	25g	3-5
3	Milk, meat and eggs	Protein, Fat, Vitamin B2, B12, Calcium.	150ml 1No. 30g	
	Milk and milk Products Eggs Fish, poultry and meat			
4	Fruits and Vegetables	Carotenoids, Vitamin – C, Fibre, Vitamin – B2, Folic Acid, Calcium, Iron, Fibre.	50 to 75 g	3-5
	a. Yellow, orange fruits and vegetables. Pumpkin, papaya, carrot		50 to 75 g	
	b. Green leafy vegetables c. Other Fruits and Vegetables Brinjal, ladies fingre		50 to 75 g	
5	Fats and Sugars	Energy, Fat, Essential Fatty Acids	5g	5 or more
	Oils and fats		5g	5 or more
	Sugars	Energy	5g	5 or more

Pulses and legumes:

This group includes important plant protein. Dhals are good sources of iron. These foods also supply part of our requirement of the B vitamins.

Milk, meat and eggs:

These are rich sources of protein, minerals such as iron and calcium and B vitamins and vitamin A.

The number of servings varies with the person's age and body size. For example an adult woman may need 3 servings where as a teenager may need 5 servings.

Fruits and Vegetables:

Foods in this group provide beta-carotene, vitamin C and folic acid and minerals. Dark green leafy vegetables supply iron, calcium and vitamin C.

Oils, fats and Sugars:

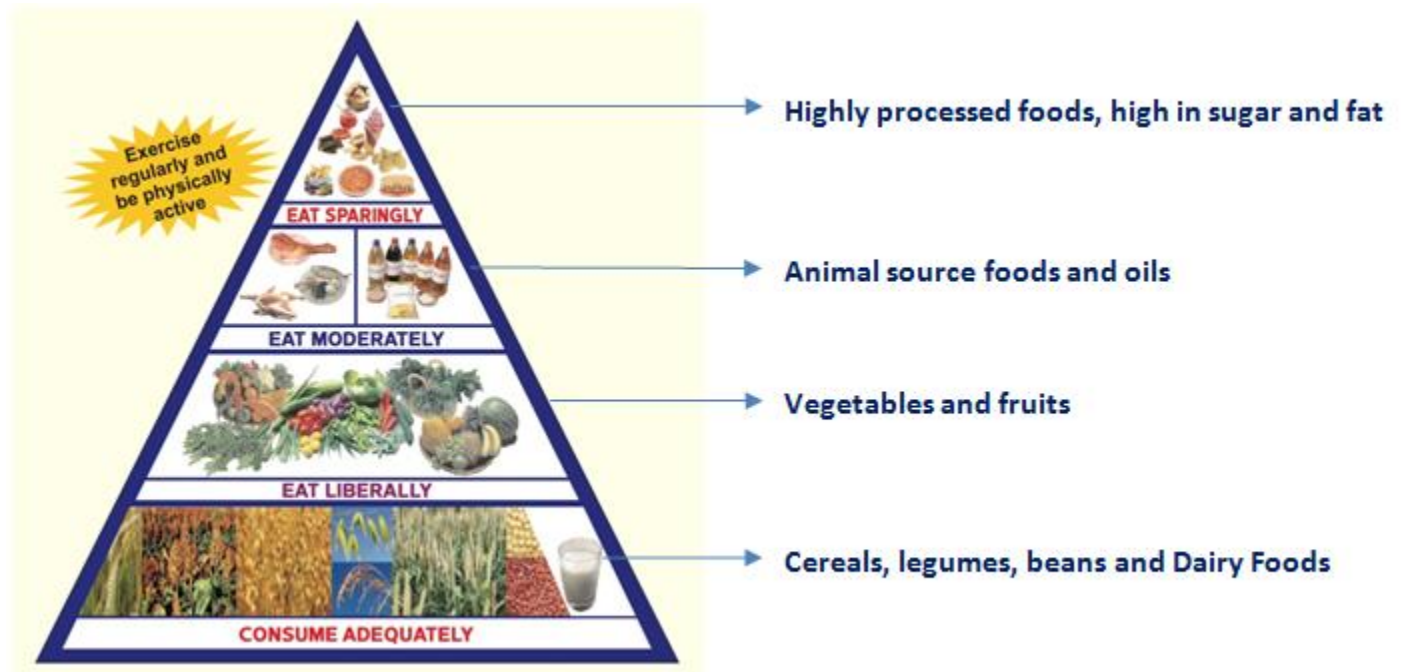
Foods in this group are mainly a source of energy. Apart from energy fats are important in assimilation of fat soluble vitamins. Ghee and butter are rich in Vitamin A.

Food Groups Based On Functions

Functions	Foods	Nutrients
Energy Giving Foods	Whole grain cereals, millets	Carbohydrates, Protein, fibre, minerals, calcium, iron & B-complex vitamins
	Vegetable oils, ghee, butter	Fat, Fat soluble vitamins, essential fatty acids
	Nuts and oilseeds	Proteins, fat, vitamins, minerals
	Sugars	Carbohydrates
Body Building Foods	Pulses, nuts and oilseeds	Proteins, B-complex vitamins, invisible fat, fibre
	Milk and milk Products	Proteins, Calcium, vitamin A, vitamin B12
	Meat, fish, poultry	Proteins, B-complex vitamins, iron, iodine, fat
Protective foods	Green leafy vegetables	Vitamins & minerals Antioxidants, fibre and other carotenoids
	Other vegetables and fruits	Vitamins & minerals, Fibre, sugar and antioxidants

FOOD PYRAMID

A food pyramid or diet pyramid is a triangular diagram representing the optimal number of **servings** to be eaten each day from each of the basic **food groups**. The first pyramid was published in Sweden in 1974. The 1992 pyramid introduced by the **United States Department of Agriculture** (USDA) was called the "Food Guide Pyramid". It was updated in 2005, and then it was replaced by **MyPlate** in 2011. The Indian adaptation of the Food Pyramid is divided into four levels of foods according to recommended consumption.



Food Pyramid

1. Cereals, legumes/beans, dairy products at the base should be eaten in sufficient quantity;
2. Vegetables and fruits on the second level should be eaten liberally;
3. Animal source foods and oils on the third level are to be eaten moderately; and
4. At the apex, highly processed foods that are high in sugar and fat are to be eaten sparingly.

One peculiarity of the Indian adaptation of the Food Pyramid is the recommendation to do regular physical activity. The Pyramid provides information on the food types and amounts necessary to meet daily dietary requirements. Each food group is represented by a band or level. Narrow bands at the apex indicate lower quantities, while wider bands at the base mean that more from that food group need to be consumed.

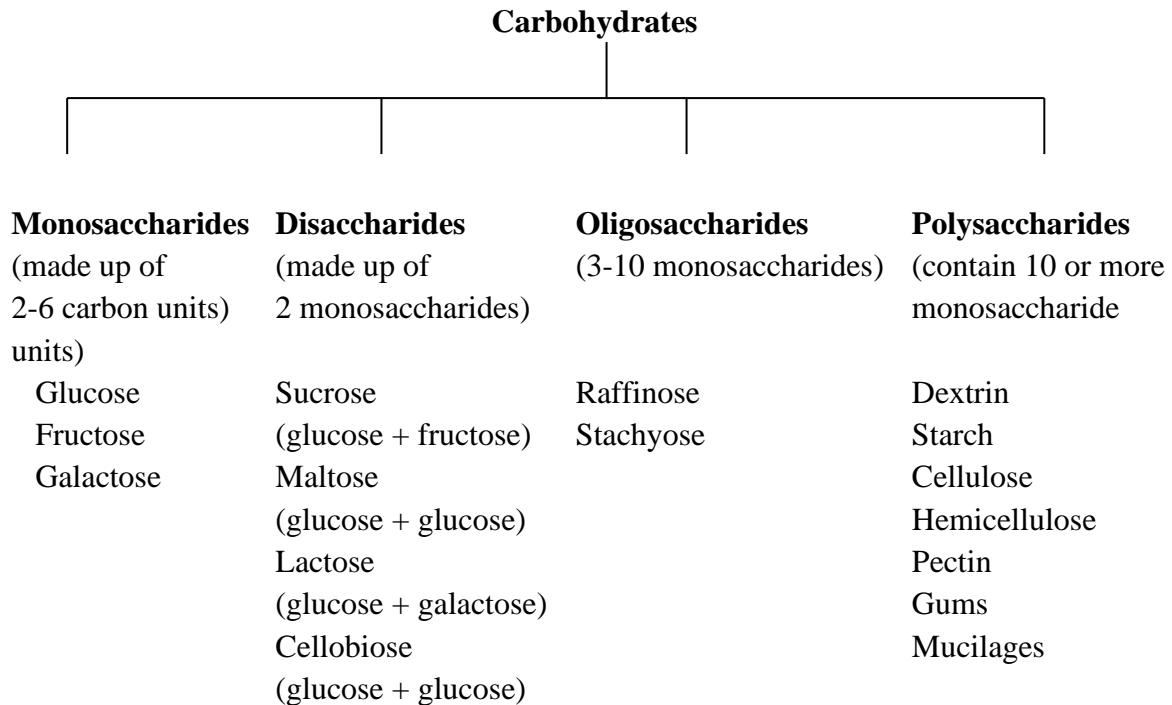
Most importantly, include plenty of water each day as it's the most important nutrient of all, accounting for 70% of our body weight and also helping in the upkeep of our health. It is very important that an individual ensures getting appropriate foods and incorporates the principle of good nutrition such as variety, a balanced intake of nutrients and moderation. The best way to meet the daily requirements is to eat a varied diet that combines cereals, fruits and vegetables, meat, fish, poultry, legumes and dairy products. Eating a variety of foods daily as guided by the Food Pyramid should provide all the nutrients needed by the body.

Unit – II

MACRONUTRIENTS

Carbohydrates are organic compounds made up of carbon, hydrogen and oxygen. They are called carbohydrates because hydrogen and oxygen are in the same proportion as found in water, i.e., 2:1

CLASSIFICATION OF CARBOHYDRATES



Carbohydrates are classified on the basis of the number of sugar units or saccharide units, which are present in their structures.

Monosaccharides

These are the simplest forms of carbohydrates found in nature. Three monosaccharides are of importance in human nutrition. They are glucose, fructose, and galactose. These simple sugars are made up of a six-carbon chain or ring to which hydrogen and hydroxyl (OH) groups are attached. All hexoses contain the same number and kinds of atoms and have the formula $C_6H_{12}O_6$. They differ from one another because of the arrangement of different atoms around the carbon chain. Because of the difference in structure, they have different properties and vary in their degree of sweetness. These are the chemical building blocks or units from which all other carbohydrates are built.

- **Glucose** It is the most important of all the monosaccharides as it is the primary carbohydrate used by the body. Glucose is the sugar which is absorbed into the

blood stream after carbohydrates are digested in the body. It is also known as dextrose. Glucose is available in powder and liquid form.

- **Fructose** It is the sweetest of all sugars and is also known as fruit sugar because it is found in fruits and honey. In the human body, it is converted to glucose and oxidized as a source of energy. It is also called levulose.
- **Galactose** It is found in combination with glucose in the disaccharide lactose in milk. This sugar is converted to glucose in the human body.

Disaccharides

These are double sugars composed of two monosaccharide's linked together with the removal of a molecule of water. The disaccharides which are of importance in the diet are sucrose, maltose, and lactose. Their general formula is $C_{12}H_{22}O_{11}$.

- **Sucrose:** Sucrose is the name given to the sugar which we use daily. It is prepared from sugar cane and sugar beet. It is the most common of all the disaccharides. It is present in some fruits and vegetables, and forms a substantial part of the diet of children and adults because of the increase in consumption of junk foods, processed foods, and fast foods. Sucrose is made up of one unit of glucose and one unit of fructose.
- **Lactose:** It is the sugar present in milk. It is made up of one unit of glucose and one unit of galactose. It is the least sweet of all the sugars and is easily fermented to lactic acid by lactic acid bacteria while preparing curd and cheese.
- **Maltose:** It is formed when whole grains are sprouted and in the commercial preparation of malt from starch. In the body, maltose is formed during digestion of starch. It is composed of two units of glucose.

Oligosaccharides

They are composed of three to ten monosaccharide units linked to each other by the removal of a molecule of water. They are not as common in food as the mono- di-, and polysaccharides, but are formed during breakdown of starch into simpler sugars, e.g., raffinose and stachyose. They are present in pulses.

Polysaccharides

These are complex carbohydrates made up of 100-2,000 glucose units linked to each other in a chain or branched form. The number of glucose units, their arrangement, and linkage to one another influence the properties of the polysaccharides.

- **Starches:** They form approximately half the dietary carbohydrates which are consumed. They are present in abundance in cereals, pulses, tapioca, *sago*, roots, and tubers.

- **Glycogen:** This is also called animal starch. It is the form in which the animal body stores carbohydrates as a reserve source of energy. One-third of the glycogen is stored in the liver and two-thirds is stored in the muscles. Approximately 340 g of glycogen is stored in the body. This store is sufficient to meet the energy needs for less than a day. However, animal liver or muscle is not a source of glycogen in the diet as it is immediately converted to lactic acid when the animal is slaughtered.
- **Dextrin:** This is formed in the first stage of starch breakdown either by enzymes during digestion, or by the action of dry heat on starch during toasting bread or browning flour. The very long chains of starch are split into shorter chains called dextrans. Dextrin is sweeter and more soluble than starch. This is the reason why bread or chapatti tastes sweeter when it is chewed for a longer time. Starch, glycogen and dextrin are available carbohydrates. These can be digested in the human body and yield energy when they are oxidised in the body.
- **Dietary fibres:** They are made up of many glucose units. The structure of cellulose differs from starch because the glucose unit in cellulose form a different linkage as compared to starch. Structural fibres in whole grain cereals, nuts, wheat bran, vegetables and non structural fibres in apples, citrus fruits, guava, oats, barley, pulses are the sources of dietary fibres. These cannot be digested because the human body does not contain the enzyme 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 regular elimination of faecal waste.

Digestion of Carbohydrates:

Complex carbohydrates and sugars are too large to be absorbed through the intestinal wall. They need to be broken down into their constituent monosaccharides so that they can be absorbed. Only monosaccharides can be absorbed into the blood stream. The mechanism and chemical digestion of starch begins in the mouth. Ptyalin or salivary amylase in saliva acts on cooked starch and partially breaks it down into dextrin. If ptyalin acts on starch long enough, i.e, if food is chewed well, some maltose may be formed. The stomach does not secrete any starch splitting enzyme, hence no digestion takes place in the stomach. In the small intestine pancreatic amylase acts on starch and dextrin, breaking it down into maltose.

The intestinal wall secretes maltase, lactase and sucrase which acts on maltose, lactose and sucrose reducing them to their respective monosaccharides.

Functions of carbohydrates:

1. The chief function of carbohydrates is to serve as the principal source of energy of the body. Each gram of carbohydrate yields 4 calories energy. This will be used in the form of glucose to meet immediate tissue energy needs. Small amount will be

stored as glycogen in the liver and muscles. Some will be stored as adipose tissue for later conversion. Glucose is the sole form of energy for the brain and nervous tissue.

2. Dietary carbohydrates have a protein sparing action. The body will use carbohydrates preferentially as a source of energy, sparing proteins for body building. Insufficient carbohydrates and fat will lead to conversion of proteins from dietary and tissue sources to meet the energy needs of the body, taking priority over other functions.
3. For the normal oxidation of fats certain amount of carbohydrate is necessary. When carbohydrates are severely restricted, fats will get oxidized faster. This leads to piling up of incompletely oxidized products leading to acidosis or ketosis. Occurrence of acidosis takes place when carbohydrates are entirely lacking in the diet. It is common in uncontrolled diabetes.
4. Carbohydrates can be converted into non-essential amino acids, provided a source of nitrogen is available.
5. Cellulose, hemicellulose and pectins yield no nutrients to the body. These indigestible carbohydrates serve a useful purpose by stimulating the peristaltic movement of the gastrointestinal tract and by absorbing water to give bulk to the intestinal contents.
6. Carbohydrates like sugar, honey and jaggery give flavour to the food, making it tasty and acceptable.
7. Fibre also helps in lowering blood cholesterol levels by binding bile acids and cholesterol.
8. The sugar lactose helps in the absorption of the minerals calcium and phosphorus.
9. Lactose helps certain bacteria to grow in the intestine. This bacterial flora is capable of synthesizing B-complex vitamins in the gut.
10. 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.

Sources of Carbohydrates:

All foods of plant origin contain carbohydrates in varying amounts. With the exception of milk, animal foods do not contain carbohydrate. The important sources of carbohydrates in the diets of Indians are cereals and millets, roots, tubers, pulses, sugar and jaggery.

Some Rich Sources of Carbohydrates

Cereals	Pulses	Fruits and vegetables	Nuts and oilseeds	Miscellaneous
Wheat	All whole grain and dehusked pulses and their by-products, e.g., <i>rajma</i> , Bengal gram, whole green gram, lentils, and <i>besan</i>	Mango	Cashew nuts	Sugar
Rice		<i>Chikoo</i>	Coconut (dry)	Jaggery
<i>Jowar</i>		Jackfruit	Groundnuts	Honey
<i>Bajra</i>		Custard apple	Garden cress	<i>Sago</i>
<i>Ragi</i>		Banana	Seeds	Tapioca
Oats		Green peas	Niger seeds	Dates
Barley		Beans	Gingelly	Raisins
Corn		Potato	Seeds	Skimmed milk Powder
		Yam		
		Colocasia		

Recommended Dietary Allowances:

Carbohydrates usually supply the largest proportion of energy to the body. Any excess carbohydrate is converted by the body into fat and stored in tissues. Therefore, carbohydrates should be eaten only in sufficient quantity to satisfy hunger, after the need for other nutrients in the diet is satisfied.

The minimum requirement of carbohydrate is 100g. This is desirable to prevent ketosis. Normal balanced diet contains a much higher amount than this. ICMR has not given any specific recommendations for carbohydrates. However in a balanced diet sixty percent of total calories can be from carbohydrates. In a 2000kcal diet, 275-300g of carbohydrates is recommended.

Clinical Manifestation of excess and deficiency:

1. Excessive consumption of sugars could be one of the cause of dental caries or tooth decay.
2. Excessive sugar depress the appetite, provide hollow calories and could result in malnutrition
3. High intake of sugar and refined carbohydrates increase the blood triglyceride levels leading to heart diseases.
4. When excessive carbohydrates are consumed they are converted into fat and deposited in the adipose tissue which could lead to obesity
5. Excessive fibre could irritate the intestinal lining causing cramps or bloating.

The daily diet should not contain less than 100g of carbohydrate. Carbohydrate deficiency is uncommon in our country as diets are cereal based. 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 body.

Factors Affecting absorption of Carbohydrates:

The absorption of digested carbohydrates is influenced by the following

1. The rate at which the carbohydrates enters the small intestine
2. The type of food mixture present
3. Condition of the intestinal membrane
4. Normal endocrine activity of the anterior pituitary and the related functioning of the thyroid
5. Small intestinal absorption is slowed by increased meal frequency.

PROTEINS

Proteins are large, complex organic compounds made up of carbon, hydrogen, oxygen and nitrogen. The presence of nitrogen distinguishes proteins from carbohydrates and fats. The basic units from which proteins are built are the amino acids. Proteins are classified into 3 groups:

1. Simple proteins.
2. Conjugated proteins.
3. Derived proteins.

1. Simple proteins: These proteins are made up of only amino acids. E.g zein in corn, albumin in egg white and gliadin in wheat consists of amino acids only.

2. Conjugated proteins: These proteins have a non-protein molecule attached to the protein, e.g, blood protein haemoglobin, which contain a haeme (iron) group attached to protein and milk protein casein, which has a phosphate group attached.

3. Derived proteins: These result from partial breakdown of a native protein. Peptones, Peptones and polypeptides are formed when digestive system begins their action on proteins.

From the nutritional point of view, classification of proteins on the basis of their quality.

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 incomplete protein at the same meal. They can maintain life. They are found in

plant foods. Cereals, pulses, nuts, 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. They cannot maintain life. 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.

Essential and non essential amino acids

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 does 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.

Classification of amino acids

Essential amino acids		Non – essential amino acids
Adults	Additional for children	
		Alanine
Isoleucine	Histidine	Asparagine
Leucine	Arginine	Aspartic acid
Lysine		Cysteine (cystine)
Methionin		Glutamine
Phenylalanin		Glutamic acid
Threonine		Glycine
Tryptophan		Hydroxylysine
Valine		Hydroxyproline
		Prolin
		Serine
		Tyrosine

Digestion of Proteins:

To enable proteins to perform their various functions, dietary protein need to be broken down into its constituent amino acids.

The mechanical digestion of protein begins in the mouth, where the teeth grind the food into small pieces. The mouth does not produce any enzyme to digest proteins.

Chemical digestion begins in the stomach. The hydrochloric acid (HCl) in the gastric juice activates the enzyme pepsin, which acts on proteins and reduces them to polypeptides. After the partially digested proteins reach the small intestine, three pancreatic enzymes – trypsin, chymotrypsin and carboxypeptidase continue the process of chemical digestion. The peptidases secreted by the intestine finally reduce the smaller peptides and dipeptides into amino acids which are the end products of digestion.

Functions:

Growth: Proteins are required for growth and maintenance of the body tissues. More proteins are required by the body during periods of growth for they are needed to build up new tissues. Therefore, children need more proteins to grow normally. Pregnant mothers need more proteins for the growth of the foetus. Also lactating mothers need extra proteins to help them in the secretions of milk.

Maintenance: Proteins are present in muscles, organs, endocrine glands. These are the major components of the matrix of bones and teeth, skin, nails and hair. Blood cells and serum are also proteins. All body fluids except bile and urine contain proteins. Cell proteins are to be replaced continuously.

Regulation: Some proteins have highly specialized functions in the regulation of body processes. Haemoglobin and iron binding performs a vital role in carrying oxygen. Plasma proteins are important for the regulation of osmotic pressure and in the maintenance of water balance. Blood proteins have a role of maintaining the reaction of blood. The body's resistance is maintained by antibodies which are also protein in nature. Enzymes and hormones are protein substances.

Synthesis: Tryptophan serves as a precursor for niacin. Methionine can provide methyl group for the synthesis of choline.

As an energy source: Proteins yield 4 calories per gram when broken down into energy. Energy is derived from the metabolism of excess food protein or it results from the break down of body tissues. Protein foods are expensive items of the diet. The process of deamination and the excretion of the waste product - urea result in additional work for the liver and kidney.

Dietary Sources: Proteins are of two types:

1. Animal proteins
2. Vegetable proteins.

1. Animal proteins: These include milk, eggs, meat, fish, poultry and milk products like cheese, curd, khoa. These food stuffs have good quality proteins or complete proteins. They are high biological value proteins. These proteins contain all essential amino acids in required amounts.

2. Vegetable proteins: Pulses and dhal, soya beans, nuts and oil seeds like pea nuts, almonds and cashew nuts etc., are rich sources of vegetable proteins. Cereals like wheat and rice also provide some amount of protein. The proteins of these food stuffs are not of good quality.

Recommended Dietary Allowances for proteins:

Proteins are required, for growth and maintenance in infants and children, for foetal development in pregnancy and milk output during lactation. Infants and children require more proteins than adults. The actual amounts of protein to be consumed daily to meet the requirement will depend upon the quality of dietary protein. If the quality is higher, the requirement will be low.

The protein requirements	
Men	60 g or 1 g per kg body weight
Women	50 g or 1 g per kg body weight
Pregnancy	+ 15 g
Lactation	1-6 months + 25g
	” 6-12 months + 18g
Infants	0-6 months 2.05 g per kg body weight
	6-12 months 1.65 g per kg body weight
Children	1-3 years 22 g
	4-6 years 30 g
	7-9 years 41 g
.Boys	10 – 12 years 54 g
	13 – 15 years 70 g
	16-18 years 78 g
Girls	10-12 years 57 g
	13 to 15 years 65 g
	16-18 years 63 g

The adult requirement of egg protein is 0.7 g per kg body weight. In the case of mixed vegetable protein it is 1.0 g per kg. Young child of 1-2 years require 1.2 g of egg protein or 2.0 g of mixed vegetable protein per kg body weight per day. Protein needs of women are greater during pregnancy and lactation than during non-pregnant non-lactating states. These protein requirements are varied only when other nutrients, particularly calories in the diets are adequate.

Clinical Manifestations of Deficiency and Excess of Protein:

A reduced protein intake over a prolonged period of time leads to loss of weight, fatigue, anaemia, nutritional oedema, lowered resistance to infections 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 pre-school 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 proteins, which is equivalent 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 correct mixture of inexpensive protein rich foods in the diet. An excessive intake of protein is not beneficial to 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 deaminated by the liver and urea is synthesized. The kidneys have to work more to excrete the additional amount of urea which is a burden to kidneys.
2. When animal proteins are taken in more amounts there is a 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.

Factors Effecting Absorption of Proteins:

1. The structure of the protein
2. The digestibility of the protein
3. The amount of protein consumed in one meal
4. Other nutrients and food constituents present in the meal, e.g, fibre, carbohydrate.

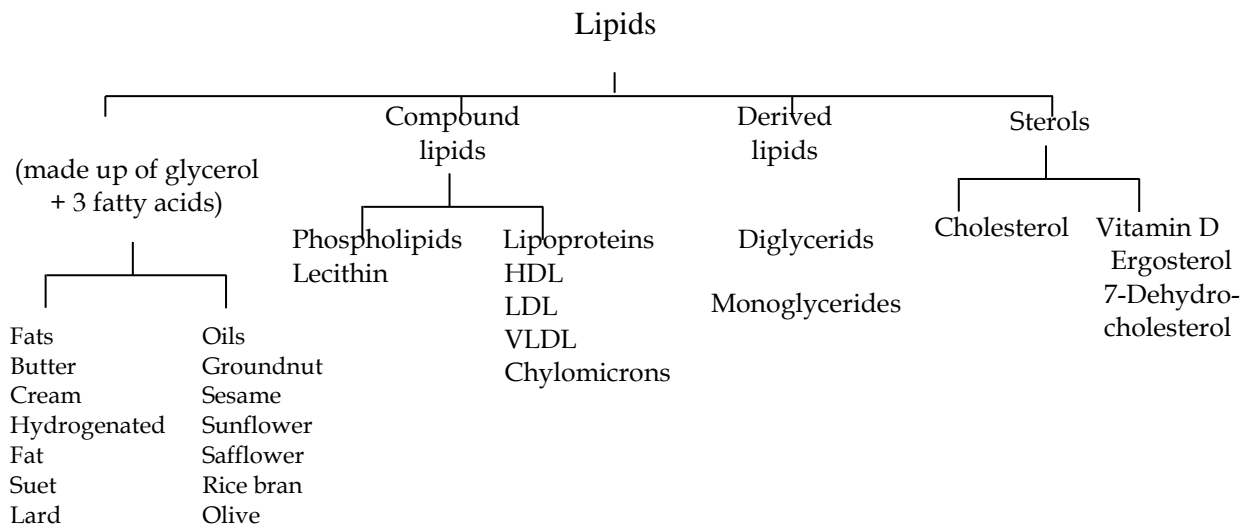
LIPIDS

Lipids are organic substances. Like 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. Hence they are a more concentrated source of energy, providing two and a quarter times more energy than carbohydrates and proteins.

Classification:

Based on their structure lipids are classified into simple lipids, compound lipids, derived lipids, and sterols.

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.



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

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

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 vitamins A, D, E, and K

Fatty Acids

Fatty acids consists of chains 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. They may be saturated or unsaturated. Saturated may 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.

Unsaturated fatty acids:

Unsaturated fatty acids are of two types: monounsaturated fatty acids(MUFA) and polyunsaturated fatty acids(PUFA).

Monounsaturated fatty acids:

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.

Polyunsaturated fatty acids:

The polyunsaturated fatty acids are those with two or more double bonds. They include linoleic acid, linolenic acid and arachidonic acid. 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-3 fatty acids: Omega-3 fatty acids are polyunsaturated fatty acids with the end most double bond on the third carbon from the methyl end. Omega-3 rich foods include olive oil, fish oils, mustard oil, soya bean, flax seed, fenugreek seeds, mackerel, black gram, rajma and green leafy vegetables.

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 and arachidonic acid are omega-6 fatty acids. Omega-6 rich oils include safflower, sunflower, cottonseed, corn, sesame and groundnut.

Saturated fatty acids:

These are found in animal foods such as meat, butter, cheese and egg yolk and in plant foods such as coconut oil, palm oil, and cocoa. Stearic acid, palmitic acid, myristic

acid and butyric acid are some of the saturated fatty acids. A minimum of 10 percent of our total calories should come from saturated fats.

These fatty acids can be synthesized in our body. Therefore no deficiency takes place in our body. If we do not take these fatty acids in the diet, no harm occurs, that is why these fatty acids are called as non essential fatty acids.

Fatty acids such as stearic acid, palmitic acid contain as many hydrogen atoms as the carbon chain can hold and comprise about 40 % of fatty acids contained in average diet. Most of these are concentrated in foods from animal sources. Chocolate and coconut (plant products) also contain appreciable quantities of fatty acids. In butter and cow milk the amount of stearic acid is about 12%. The palmitic acid in most animal fats is about 20-30 %.

Digestion of Lipids:

No chemical digestion of fat takes place in the mouth. Fat is broken into smaller particles by chewing and is mixed with saliva.

In the stomach, peristaltic movements churn the food along with the gastric juice. Two enzymes help in digesting fats, namely gastric lipase in the gastric juice and pancreatic lipase from the pancreas which acts in the small intestine. For fats to be digested they first need to be emulsified. Gastric lipase acts on emulsified butter fat and the main digestion of fats begins in the small intestine

The presence of fat in the duodenum stimulates the secretion of bile from the gall bladder. Bile acts as an emulsifier and breaks down large fat globules into smaller particles. This increase the total surface area of fat and increase the efficiency of enzyme action. The alkaline nature of bile helps pancreatic lipase to remove fatty acids from the triglycerides converting them to diglycerides and monoglycerides and finally to fatty acid and glycerol.

The final products of fat digestion to be absorbed are fatty acids, glycerol, monoglycerides and diglycerides. Some remaining fat which is undigested may be excreted through the faeces.

Functions of fats:

1. **Energy:** Fats are concentrated source of energy. One gram of fat yields 9 calories of energy when it is oxidised in the body. All tissues, except those of the central nervous system and brain, can utilize fat as source of energy.
2. **Protein sparing action:** The calories from fat spare dietary proteins from being oxidized for energy. An adequate intake of fat in the diet allows proteins to perform their main function of growth and maintenance.
3. **Protection of vital organs:** Fats serve as padding around the organs to hold them in place and help in absorbing the shocks.
4. **It protects the nerves.**
5. **Thermal Insulation:** It acts as an insulator for the body thus avoiding rapid changes of body temperature by excessive heat loss from its surface.
6. **Synthesis of cell membranes:** Fats are an important constituent of all cell membranes.
7. **Absorption of fat soluble vitamins:** Fats in the diet serve as carriers for the fat soluble

vitamins (A, D, E and K)

8. **Lubricant:** It acts as a lubricant in the gastrointestinal tract.
9. **Satiety value:** It acts as depressor of gastric secretions, thus delaying the emptying of stomach and retarding the appearance of hunger.
10. **Taste:** Fats contribute to the palatability of the diet.
11. **Synthesis of hormones:** The lipid cholesterol is necessary for the synthesis of some hormones. Eg. Sex hormones
12. **Essential fatty acids:** An adequate intake of fats is necessary to meet the body's requirement for linoleic and linolenic acids.

Dietary Sources:

Some fats are visible such as fats and oils added to food or used for frying. Many sources are hidden or invisible such as the fats and oils naturally present in the food. Eg. Milk, egg yolk, oily fish and meat.

Plant sources:

All oils and oilseeds such as groundnuts, sesame, soyabean, rice bran, coconut, almond, cashewnut, corn, safflower, sunflower and all hydrogenated fats and margarine are sources of lipids.

Animal sources:

Mutton, pork, fish, poultry, milk and milk products, eggs and organ meat are rich sources of lipids.

Invisible sources:

Invisible sources of fats are nuts, flesh food, cakes, milk, eggs etc which are rich in fat, but the fat is not visible.

Recommended Dietary allowances:

The quantity of fat that should be included in a well balanced diet unlike proteins is not known with any degree of certainty. In deciding the desirable level of fat in the diet the following factors must be kept in mind.

- a) The minimum amount of fat to meet the essential fatty acid requirement.
- b) The amount needed to promote absorption of fat soluble vitamins.
- c) Providing palatability to food.
- d) The undesirable effect of excessive intake of fat. The essential fatty acid requirement has been placed at 3 – 6 % of total energy intake depending on age and physiological state. During growth, pregnancy and lactation E F A requirements are relatively higher. To obtain this level of E F A in the diet, the visible fat intake should be 15 – 25 g per day in terms of oils like groundnut oil. This amount of visible fat would not only provide the required amount of E F A, but help in absorption of fat soluble vitamins.

The invisible fat present in a diet is estimated to contribute to about 6 % of energy. Even a predominantly cereal based diet would provide 15 g of fat that is 50 % of which will be E F A. This with the 15 – 25 g of visible fat would meet E F A requirement of all age groups. However the upper limit of the diet should not exceed 30 % of calories less than 80 g per day. Because of the cost of providing additional fat in the diet, the diet of many poor people contains hardly any visible fat. However the invisible fat in these diets

is able to meet nearly 2 \ 3 of minimum requirement of E F A and hence prevalence of E F A deficiency among such population is low.

Clinical Manifestation of deficiency and excess fat in the diet:

Prolonged deficiencies of fat in the diet cause the following effects.

1. Dryness of the skin.
2. Secondary deficiency of the fat soluble vitamins (A, D, E and K).
3. Essential fatty acids are not being supplied; eczema like skin conditions may develop in some individuals, particularly in children.

Effects of excessive fat in the diet:

1. Excessive consumption of fats leads to obesity.
2. Digestive disturbances, particularly in children.
3. When large amounts of animal fat are consumed, cholesterol present in them may accumulate in the blood and may get deposited on the walls of the blood vessels, causing a disease known as atherosclerosis and finally heart disease.
4. Accumulation of excessive amounts of cholesterol in the gall bladder may cause stones in the gall bladder.
5. In diabetic patients consumption of excess fat may produce excessive amounts of ketone bodies that may lead to serious consequences like severe acidosis and coma resulting even in death.

Factors Effecting Absorption of Lipids:

Since fats are insoluble in water, they cannot be directly absorbed into the intestines and blood stream without making them absorbable. Bile helps in absorption of fat by forming a complex with fatty acids and glycerol which is absorbed by the intestinal wall. Once absorbed bile separates and returns to the intestine to recombine with fatty acids and glycerides and the process continues.

UNIT – 3

MICRONUTRIENTS

VITAMINS

Definition: Vitamin 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.

CLASSIFICATION

Vitamins are grouped according to their solubility in either fat or water.

Fat-soluble vitamins: The fat-soluble vitamins are vitamins A, D, E, and K. They require fat for their absorption and can be stored in the body. If their intake is poor, but body stores are ample, deficiency symptoms will not be seen immediately.

Water-soluble vitamins: The water-soluble vitamins are B-complex vitamins and vitamin C. Being water soluble, they are easily absorbed and the excess consumed is excreted in the urine. They are not stored in the body.

FAT-SOLUBLE VITAMINS

Vitamin A

Vitamin A is the generic name given to a group of compounds having vitamin A activity. These compounds are retinol, retinal, and retinoic acid. They are found only in the fatty phases of foods of animal origin. Plant foods contain yellow, orange, and/or red coloured pigments called carotene which gives colour to vegetables and fruits. Carotene pigments are converted to vitamin A in the body, i.e., carotene is a provitamin or precursor of vitamin A. Carotene is synthesized by plants and is the ultimate source of all vitamin A.

Pure vitamin A is a pale yellow crystalline compound occurring naturally in the animal kingdom. It is soluble in fat, insoluble in water, and relatively stable to heat, acids, and alkalis. It is easily oxidized and rapidly destroyed by ultraviolet (UV) rays.

Functions: Vitamin A performs the following functions.

1. Vitamin A maintains normal vision in dim light. Rhodopsin or visual purple is present in the retina of the eye. It is required for vision in dim light. It is formed when vitamin A combines with protein opsin. In bright light, rhodopsin absorbs light and breaks down into protein opsin and retinal. Every time rhodopsin breaks down, some retinal is lost.

In dim light or darkness, retinal and opsin re-combine rapidly to form rhodopsin provided there is an adequate supply of vitamin A. If there is a deficiency of vitamin A, the regeneration is slow and the person's eyes fail to adapt to changes in light quickly.

2. It helps in synthesis and maintenance of healthy epithelium—outermost lining of skin and innermost lining of mucous membranes of respiratory, gastrointestinal, and genitourinary tract. Epithelial glands secrete mucous that lubricates the lining of the eyes, respiratory and gastrointestinal tract, etc.

3. Vitamin A is required for normal bone and tooth development, and proper growth.
4. It helps the body to fight against infections by keeping mucous membranes in a healthy condition which act as a barrier to infection.

Dietary Sources:

Animal foods, such as whole milk and milk products, eggs yolk, oily fish, fish- liver oils, organ meat, butter, cream, and clarified butter or pure ghee, are rich sources.

Sources of carotene:

All yellow, orange, and red fruits and vegetables such as carrots, pumpkin, mango, papaya, peaches, and apricots, and all green leafy vegetables such as fenugreek leaves, spinach, colocasia leaves, amaranth, curry leaves, and turnip greens are rich sources of pro-vitamin A.

Recommended Dietary Allowances:

Dietary allowances of vitamin A		
Age	Recommended intakes (µg)	
	Vitamin-A	Carotene
0 to 1 years	350	2800
1 to 6 years	400	3200
7 to 18 years	600	4800
Adult men and women	600	4800
Pregnant women	800	6400
Lactating women	950	7600

Clinical Manifestation of Deficiency and Excess:

Deficiency: If the body has sufficient stores, deficiency does not develop at once.

1. Night blindness or nyctalopia- It is one of the earliest signs of vitamin A deficiency. In this condition, an individual is unable to see well in dim light, especially after coming from a brightly lit area. This happens because there is insufficient vitamin A to bring about quick formation of rhodopsin.

2. Epithelial changes- The epithelium becomes dry, scaly, and rough. Goose pimples are seen on upper forearms and thighs.

3. Changes in the eyes

- (a) Secretion of tears decreases
- (b) Eye ball becomes dry and lustreless
- (c) Bitot spots (pigmented spots) are seen on conjunctiva
- (d) Photophobia or sensitivity to bright light is observed
- (e) Xerophthalmia: Cornea becomes dry and inflammed. If not treated it leads to keratomalacia.

(f) Keratomalacia or softening of the cornea and permanent blindness results.

4. Bone development- Growth failure and stunted bones are seen in children.

Excess:

Hypervitaminosis A:

High doses of vitamin A is not recommended as excess is stored in the liver. This excessive accumulation of vitamin A in the body is toxic. Symptoms of toxicity are nausea, vomiting, abdominal pain, loss of hair, thickening of long bones, and joint pain.

Vitamin D

It is a fat-soluble vitamin. The two important forms are vitamin D₂ (activated ergosterol or calciferol) and vitamin D₃ (activated 7-dehydrocholesterol or cholecalciferol). Vitamin D₃ is produced when 7-dehydrocholesterol in the skin is exposed to the UV rays in the Sun. Vitamin D differs from other fat-soluble vitamins because it is synthesized in the body, and we do not depend on our diet for it. Being fat soluble, it requires fat for its absorption.

Functions:

1. Absorption of calcium and phosphorus from the small intestine requires the presence of vitamin D and the hormones of the parathyroid and thyroid gland.
2. Mineralization of bones and teeth- After calcium and phosphorus is absorbed; vitamin D is required to ensure that these minerals are deposited in bones and teeth to strengthen them.
3. Regulation of calcium and phosphorus levels in blood.

Dietary Sources:

Sunlight is the main source of vitamin D. The precursor in skin is converted to active vitamin D₃. Barriers such as clothing, fog, window glass, and melanin (pigment in the skin) interfere with synthesis of vitamin D. Sunscreen lotions with high SPF also prevent vitamin D formation.

It is found in fish liver oils, fortified milk, *vanaspati*, and margarine. Natural foods such as butter, milk, and fish have it in small amounts.

Recommended Dietary Allowances:

The daily requirements of vitamin D for infants and preschool children are estimated to be about 10 µg (400 I.U). For older children and adults lesser amounts i.e. 5 µg (200 I.U) are adequate. Pregnant and nursing mothers need about 10 µg (400 I.U). In tropical climate, half the above amounts are adequate if the subjects are exposed to direct sunlight for some hours in a day.

Clinical Manifestation of Deficiency and Excess:

Deficiency:

1. Vitamin D deficiency leads to lowered absorption of calcium, low serum levels of calcium, and reduced bone mineralization. Bones cannot withstand the weight and bend into deformities.

2. Rickets is seen in infants and children especially dark-skinned children. Bones are soft and yield to pressure. Joints are enlarged and there is delayed closing of the skull bones. Symptoms of rickets include enlarged skull, pigeon chest, poor muscle development, potbelly, and bowed legs or knocked knees.

3. Osteomalacia or adult rickets is more common in women who consume a diet deficient in calcium, phosphorus, and vitamin D, and have had several pregnancies. The softening of bones leads to a deformed spine, rheumatic pain in the legs and lower back, a waddling gait, and spontaneous fractures.

Excess:

Hypervitaminosis D: Large doses of vitamin D can be toxic. Excessive use of fortified foods leads to loss of appetite, vomiting, diarrhoea, growth failure, and calcification of soft tissues and kidney stones.

Vitamin E

Vitamin E or tocopherol is a fat-soluble vitamin. It is stable to heat and acids. It is rapidly oxidized in rancid fats.

Many claims are being made that supplements of this vitamin can prevent or cure a wide variety of diseases, from reproductive function to skin problems such as psoriasis and acne, but there is no proof.

Functions:

Vitamin E is the most potent natural antioxidant found in food. Polyunsaturated fatty acids (PUFA) form a structural part of all cell membranes. They are prone to oxidative breakdown by free radicals in the cell. The main function of vitamin E is to act as an antioxidant. Vitamin E itself gets oxidized and protects cell membranes from oxidative damage. It performs the following functions:

- 1.Prevents oxidation of vitamin A in the intestine
- 2.Protects normal cell membranes by preventing their breakdown
- 3.Prevents hemolysis of red blood cells
- 4.Prevents oxidation of PUFAs.

Dietary Sources:

Vitamin E is widely distributed in foods, particularly vegetable oils (corn, soya, sunflower, safflower), wheat germ, whole grains, legumes, nuts, and dark green leafy vegetables.

Recommended Dietary allowances:

The vitamin E requirements of the adult probably vary from 10 to 30 mg per day. The upper level represents the need when the diet contains a high level of polyunsaturated fatty acids. Trace amounts of selenium can replace part of the need for this vitamin, although the effective amount of selenium for human beings is not known. Ascorbic acid may reduce the tocopherol requirement.

Clinical Manifestation of Deficiency and Excess:

Deficiency:

In severe deficiency, although uncommon, increased haemolysis of red blood cells is seen in premature infants.

Vitamin K

Vitamin K is essential in the diet because it is needed for synthesis of prothrombin and other blood clotting factors. It exists as K₁ (found in plants), K₂ (synthesized by bacteria in the intestinal tract), and K₃ (synthetic form). Being fat soluble, it requires fat and bile salts for efficient absorption.

Functions:

Vitamin K is required for the formation of prothrombin and several other proteins involved in clotting of blood. The ability of blood to clot is dependent upon a high blood level of prothrombin.

Dietary Sources:

Bacterial synthesis in the intestinal tract supplies at least half of the daily needs. Green leafy vegetables, cabbage, cauliflower, and pork liver are excellent sources. Cheese, egg yolk, and tomato also supply vitamin K.

Recommended Dietary allowances:

The vitamin synthesised in intestine and in the diet has made it impossible to establish daily allowances. Dietary deficiency is not believed to be a problem.

Clinical Manifestation of Deficiency and Excess:

Deficiency:

A deficiency of vitamin K is uncommon in adults. New born infants have a sterile intestinal tract, hence they are given a single dose of vitamin K to prevent haemorrhagic disease.

A deficiency interferes with formation of prothrombinogen and, thus, reduces clotting tendency of blood. It may occur during diseases of malabsorption, oral use of sulfa drugs and antibiotics, or certain drugs which are vitamin K antagonists and can cause haemorrhages.

WATER SOLUBLE VITAMINS

Vitamin C

Vitamin C, also known as the fresh fruit and vegetable vitamin, was discovered as an acid in lime juice which prevented scurvy among British sailors on long voyages at sea. It was named ascorbic acid because of its antisorbutic or antiscorvy properties.

It is highly soluble in water and most easily destroyed as compared to all other vitamins. It is readily oxidized and destroyed by heat and presence of alkali. It is lost when food is dehydrated.

Functions:

1. Synthesis of collagen which is the intercellular cementing substance that keeps cells in bone and muscle tissue together
2. Making haemoglobin by helping in absorption of iron from food
3. Healing of wounds and fractures
4. Increasing resistance to infections and fevers
5. Proper growth during periods of increased need or during rapid growth
6. As an antioxidant, like vitamin E, it prevents the oxidation of vitamin A and unsaturated fatty acids.

Sources: Fresh citrus fruits such as orange, sweet lime, grape fruit, lemon, other fruits and vegetables such as guava, *amla*, cabbage, capsicum, green chillies, green leafy vegetables, and tomatoes are excellent sources of vitamin C. Cereals and pulses are poor in vitamin C, but when dry pulses are sprouted ascorbic acid is formed in them. 85 per cent of the vitamin is formed in the grain and 15 per cent in the sprout. Green gram contains thrice as much vitamin C as compared to bengal gram. Sprouted pulses are a good alternative to fresh fruits and vegetables during periods of scarcity. Sprouts can be lightly steamed or consumed raw. Berries such as zizyphus, strawberries, gooseberries, and cashewfruit are seasonal rich sources. *Amla* is the richest source providing 600 mg/100 g as compared to oranges which provide 30 mg/100 g, i.e., *amla* contains 20 times as much vitamin C as compared to orange.

Recommended Dietary Allowances:

Man	40 mg/day
Women	40mg/day
Pregnancy	60 mg/day
Lactating	80 mg/day
Infants 0-6 6-12	25 mg/day
Children 1-3 4-6 7-9	40 mg/day
Boys 10-12 Girls 10-12	40 mg/day
Boys 13-15 Girls 13-15	40 mg/day
Boys 16-17 Girls 16-17	40 mg/day

Deficiency: Deprivation of vitamin C results in defective formation of the intercellular cementing substance.

Symptoms:

1. Poor wound healing because collagen is not synthesized
2. Increased susceptibility to infections
3. Painful joints and bleeding gums
4. Skin bruises by slightest injury
5. Severe deficiency causes scurvy. The symptoms are swelling, infection and bleeding of gums, and anaemia.

Excessive intake: The benefits of consuming megadoses of vitamin C to prevent common cold and cancer is still controversial. An increased intake beyond the RDA is advised in certain cases such as surgical cases, infections, and drug therapies, but benefits of megadoses of 1-5 g daily is still under study.

B-Complex Vitamins

Scientists discovered eleven water-soluble B essential for humans.

They differ from each other in their structure, distribution in foods, stability and symptoms that result from their deficiency. They are

- | | |
|---|---|
| 1. Thiamine (vitamin B ₁) | 5. Pantothenic acid (vitamin B ₅) |
| 2. Riboflavin (vitamin B ₂) | 6. Biotin (vitamin B ₇) |
| 3. Niacin (vitamin B ₃) | 7. Folic acid (vitamin B ₉) |
| 4. Pyridoxine (vitamin B ₆) | 8. Cyanocobalamin (vitamin B ₁₂) |

They are all water soluble.

These eight vitamins are grouped together because their functions are closely related. The remaining three B-complex vitamins, namely para-aminobenzoic acid (PABA), choline, and inositol play an active role in cell metabolism but the diet and intestinal synthesis can make good this requirement.

Thiamine (vitamin B₁)

Functions:

1. Thiamine functions mainly as a co-enzyme, thiamine pyrophosphate (TPP), which is required in the breakdown of glucose to yield energy.
2. It helps to maintain a healthy nervous system.
3. It is required for normal appetite and digestion.

Sources: Foods rich in protein such as pork, liver, pulses, groundnut, and eggs are good sources. Wholegrain and enriched cereals, parboiled rice, unpolished rice, and sprouted pulses contribute B₁. Soya bean is a rich source.

Recommended Dietary Allowances:

Daily requirement of thiamine is 0.5 mg/1,000 kcal. Thus, an adult who needs 3,000 calories would require 1.5 mg of vitamin B₁ per day.

Man Sedentary	1.2 mg/day
Moderate	1.4 mg/day
Heavy	1.7 mg/day
Women Sedentary	1.0 mg/day
Moderate	1.1 mg/day
Heavy	1.4 mg/day
Pregnancy	+ 0.2 mg/day
Lactating	+ 0.3mg/day
Infants 0-6	0.2mg/day
6-12	0.3mg/day
Children 1-3	0.5mg/day
4-6	0.7mg/day
7-9	0.8mg/day
Boys 10-12	1.1mg/day
Girls 10-12	1.0mg/day
Boys 13-15	1.4mg/day
Girls 13-15	1.2mg/day
Boys 16-17	1.5mg/day
Girls 16-17	1.0mg/day

Effect of cooking and processing: B₁ is easily destroyed by cooking food in neutral or alkaline medium. Losses are greater when food is cooked at high temperatures, overcooked, and when cooking water is discarded.

Deficiency: The symptoms of deficiency occur because the tissue cells are unable to receive sufficient energy from glucose. Therefore, they cannot carry out their normal functions. The gastrointestinal, nervous, and cardiovascular systems are specially affected.

Early symptoms of deficiency include fatigue, irritability, depression, poor appetite, tingling, and numbness of the legs. A severe deficiency causes beriberi. Beriberi is of two types.

1. *Dry beriberi*-Polyneuritis or inflammation of the nerves, numbness of extremities, muscle weakness, and cramps are the main symptoms.
2. *Wet beriberi*- Severe oedema, enlargement of the heart, palpitation, and increase in rate of heart beat are seen in wet beriberi.

A person may suffer from either type of beriberi. Beriberi is also known as rice-eaters' disease because it is seen in people whose chief diet consists of polished rice.

Prevention: Parboiling rice to retain B₁.

Excess: The kidneys clear excess thiamin therefore there is no evidence of toxicity from oral intake.

Riboflavin (vitamin B₂)

Functions:

1. As a co-enzyme, B₂ is vital for protein metabolism.
2. As a co-enzyme in carbohydrate metabolism, B₂ is a constituent of co-enzymes flavin mono nucleotide (FMN) and flavin adenine dinucleotide (FAD).

Sources: Milk, cheese, Organ meat, eggs and dark green leafy vegetables are good sources.

Recommended Dietary Allowances: 0.55 mg/1,000 kcal.

Man Sedentary	1.4 mg/day
Moderate	1.6 mg/day
Heavy	2.1 mg/day
Women Sedentary	1.1 mg/day
Moderate	1.3 mg/day
Heavy	1.7 mg/day
Pregnancy	+0.3 mg/day
Lactating	+0.4 mg/day
Infants 0-6	0.3 mg/day
6-12	0.4 mg/day
Children 1-3	0.6 mg/day
4-6	0.8 mg/day
7-9	1.0 mg/day
Boys 10-12	1.3 mg/day
Girls 10-12	1.2 mg/day
Boys 13-15	1.6 mg/day
Girls 13-15	1.4 mg/day
Boys 16-17	1.8 mg/day
Girls 16-17	1.2 mg/day

Effect of cooking and processing: B₂ is sensitive to light. If milk is kept in clear glass bottles, three-fourths of B₂ is lost in a short time. Cooking in open containers and in excess water is harmful.

Deficiency:

1. Swelling of lips with cheilosis
2. Cracks in the skin at the corners of the lip, i.e., angular stomatitis
3. Redness and swelling of the tongue or glossitis
4. Eyes look bloodshot, eye fatigue, itching, burning, watering, and sensitivity to bright light, i.e., photophobia.

Excess: No adverse effects of riboflavin intake from food or supplements have been reported.

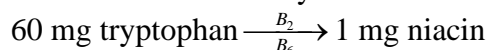
Niacin (Vitamin B3)

Niacin or nicotinic acid is a vitamin intimately connected with several metabolic reactions it takes part in as a component.

Functions: Like B₁ and B₂, niacin is also required for enzymes that bring about breakdown of glucose, amino acids, and fatty acids to yield energy, i.e., for release of energy from food

1. As a constituent of two co-enzymes, nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP), to release energy from carbohydrates, proteins, and fats.
2. For a healthy skin, normal gastrointestinal tract, and maintenance of the nervous system.

Because this vitamin takes part in many reactions of energy metabolism in the breakdown of proteins, carbohydrates, and fats, its requirement is related to calorie intake (6.6 mg/1,000 kcal). Although milk is not a good source of niacin, it contains essential amino acid tryptophan which is converted to niacin in the body.



Sources: Protein rich foods such as poultry, fish, meat, groundnut, beans, and peas are good sources. Grains are fair sources except maize and rice. Green leafy vegetables, potatoes, milk, eggs, and cheese are poor sources of preformed niacin but rich sources of tryptophan.

Effect of cooking and processing: It is most stable of all B-complex vitamins. Fairly stable to heat, acid, alkali, light, oxidation, and autoclaving.

Recommended Dietary Allowances:

This vitamin takes part in many reactions of energy metabolism. Its requirement has also been related to energy requirement. The safe level of this vitamin has been estimated to be 6.6 mg per 1000 calories. The daily requirement of this vitamin varies from 8 to 21 mg for various physiological activity groups.

Man Sedentary	16 mg/day
Moderate	18 mg/day
Heavy	21 mg/day
Women Sedentary	12 mg/day
Moderate	14 mg/day
Heavy	16 mg/day
Pregnancy	+ 2 mg/day
Lactating	+ 4 mg/day
Infants 0-6	710mg/kg
6-12	650 mg/kg
Children 1-3	8 mg/day
4-6	11 mg/day
7-9	13 mg/day
Boys 10-12	15 mg/day
Girls 10-12	13 mg/day
Boys 13-15	16 mg/day
Girls 13-15	14 mg/day
Boys 16-17	17 mg/day
Girls 16-17	14 mg/day

Deficiency: It is seen in low-protein or maize-based diets. Pellagra, which means rough skin, is characterized by four D's—diarrhoea, dermatitis, dementia, and death. Deficiency begins with weakness, headache, loss of appetite and weight, and a sore and swollen tongue. Dermatitis is symmetrical and on exposed parts of the body (forearms, legs, and hands) and is aggravated by sunlight.

Dementia or depression, confusion, poor memory, delirium, and hallucinations occur in severe deficiency. Without treatment, it results in death.

Excess: Excess niacin intake can cause skin flushing.

Pantothenic acid (Vitamin B5)

The name pantothenic acid refers to this substance's widespread functions in the body and its widespread availability in foods of all types. The name is based on the Greek word pantothen, meaning "from every side." Pantothenic acid is present in all living things, and it is essential to all forms of life.

Functions:

Pantothenic acid is part of coenzyme A (CoA) which is a carrier of acetyl moieties or larger acyl moieties. It is involved in cellular metabolism as well as both protein acetylation and protein acylation.

Sources: Pantothenic acid occurs as widely in foods as in body tissues. It is found in all animal and plant cells, and it is especially abundant in animal tissues, whole – grain cereals, fortified cereals, and sunflower seeds. Smaller amounts are found in milk, eggs, and some vegetables.

Recommended Dietary Allowances:

The recommended Dietary Allowance for men and women above 19 years is 5mg daily. For pregnancy and lactation the amount increases to 6mg and 7mg daily respectively.

Deficiency:

Given its widespread natural occurrence, pantothenic acid deficiencies are unlikely. The only cases of deficiency have been in individuals who are fed synthetic diets that contain virtually no pantothenic acid.

Excess: No adverse effects have been associated with pantothenic acid.

Pyridoxine (Vitamin B₆)

Functions:

1. Essential for synthesis and breakdown of amino acids
2. Helps in conversion of tryptophan to niacin
3. Conversion of linoleic acid to arachidonic acid
4. Needed for synthesis of haeme
5. Production of antibodies.

Sources: Liver, kidney, meat, wholegrain cereals, soya beans, and groundnuts are sources of pyridoxine. The requirement increases with an increase in protein content of diet.

Recommended Dietary Allowances:

Man Sedentary Moderate Heavy	2 mg/day
Women Sedentary Moderate Heavy	2 mg/day
Pregnancy	2.5 mg/day
Lactating	2.5 mg/day
Infants 0-6 6-12	0.1 mg/kg 0.4 mg/kg

Children 1-3	0.9 mg/day
4-6	0.9 mg/day
7-9	1.6 mg/day
Boys 10-12	1.6 mg/day
Girls 10-12	1.6 mg/day
Boys 13-15	2.0 mg/day
Girls 13-15	2.0 mg/day
Boys 16-17	2.0 mg/day
Girls 16-17	2.0 mg/day

Deficiency: Anaemia is hypochromic anaemia because Hb is not synthesized for the red colour of RBCs. Red blood cells are pale in colour. Soreness of tongue, depression, and sleepiness are other symptoms. Deficiency occurs along with other nutrient deficiencies, e.g., PCM and B-complex deficiency.

Excess: High vitamin B6 intake from food does not result in adverse effects, but large supplemental doses can cause uncoordinated movement and nerve damage.

Biotin (Vitamin B7)

Functions:

Biotin is a coenzyme for five carboxylase enzymes. Carboxylase enzymes transfer carbon dioxide moieties from one molecule to another in the following biotin enzymes:

1. α -Acetyl-CoA carboxylase, which is involved in fatty acid synthesis
2. β -Acetyl-CoA carboxylase, which is involved in inhibiting fatty acid breakdown during the hours after starch, sucrose, or fructose is consumed
3. Pyruvate carboxylase, which is involved in synthesizing glucose during fasting (gluconeogenesis) or during short bursts of energy (from lactic acid)
4. Methycrotonyl-CoA carboxylase, which is involved in the degradation of the amino acid leucine.
5. Propionyl-CoA carboxylase, which is involved in the breakdown of the three-carbon fatty acid propionic acid

Sources: Biotin is widely distributed in natural foods, but it is not equally absorbed from all of them. For example, the biotin in corn and soy meal is completely bio available (i.e., able to be digested and absorbed by the body). However, almost none of the biotin in wheat is bioavailable. The best food sources of biotin are liver, meats, tomatoes, and yeast. The bacteria that normally inhabit the gut also synthesize biotin, which is available for intestinal absorption.

Recommended Dietary Allowance:

There is no recommended dietary allowance established for biotin. The adequate intakes for biotin are 30mcg for adults over 18years and pregnant women and 35mcg for breast feeding women.

Deficiency:

There are no known natural biotin dietary deficiencies. A rare inborn error of metabolism called biotinidase deficiency can result in neurologic disturbances if it is left untreatable with lifelong oral biotin supplementation.

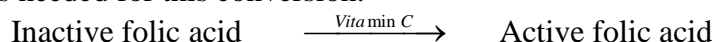
Biotin is bound by avidin, a protein that is found in uncooked egg whites; consequently, consuming raw eggs inhibits biotin absorption.

Excess: No toxicity or adverse effects from the consumption of biotin.

Folic acid or folacin (Vitamin B9)

It derives its name from the Latin word *folium*, which means leaf.

Functions: In order to perform its functions, folic acid needs to be converted into its active form. Vitamin C is needed for this conversion.



It is a component of specific enzymes required for formation of DNA and haeme in the RBCs. B₁₂ is required along with folic acid for maturation of RBCs.

Sources: Liver, kidney, green leafy vegetables, whole pulses, and yeast, and in fermented food such as idli, *dhokla*, and dosa. Some bacteria present in the intestinal tract are capable of synthesizing the vitamin.

Recommended Dietary Allowances:

Man Sedentary Moderate Heavy	200 µg/day
Women Sedentary Moderate Heavy	200µg/day
Pregnancy	500µg/day
Lactating	300 µg/day
Infants 0-6 6-12	25µg/day 25 µg/day
Children 1-3 4-6 7-9	80 µg/day 100 µg/day 120µg/day
Boys 10-12 Girls 10-12	140 µg/day
Boys 13-15 Girls 13-15	150 µg/day
Boys 16-17 Girls 16-17	200 µg/day

Deficiency: Deficiency results in megaloblastic anaemia which is common in underdeveloped countries, among the vulnerable age group. In folic acid deficiency, the bone marrow releases large nucleated cells into the circulation. The anaemia is a macrocytic, megaloblastic anaemia. Megaloblasts are large nucleated cells or immature RBCs. Other symptoms are weakness, loss of weight, pallor, and glossitis. Haemoglobin level may fall as low as 2-4 g/100 ml and blood transfusion may be needed. Normal Hb level is 11.5-14.5g for women and 12.5-16.5 g/100 ml blood for adult men.

Excess: No negative effects have been observed.

Cyanocobalamin (Vitamin B₁₂)

Functions:

1. It helps folic acid in the synthesis and maturation of RBCs.
2. It is essential for formation of myelin sheath around nerve fibers.

Absorption: Vitamin B₁₂ is absorbed only if a glycoprotein known as 'intrinsic factor' is present in gastric juice.

Sources: It is found only in foods of animal origin. Liver, kidney, milk, eggs, and cheese are good sources. Small amounts of animal protein in the diet take care of B₁₂ requirement.

Recommended Dietary Allowances:

Man Sedentary Moderate Heavy	1 µg/day
Women Sedentary Moderate Heavy	1 µg/day
Pregnancy	1.2 µg/day
Lactating	1.5 µg/day
Infants 0-6 6-12	0.2 µg/day
Children 1-3 4-6 7-9	0.2 µg/day 1.0 µg/day
Boys 10-12 Girls 10-12	
Boys 13-15 Girls 13-15	
Boys 16-17 Girls 16-17	

Deficiency: Vitamin B₁₂ deficiency results either in megaloblastic anaemia or in pernicious anaemia. The latter is more common and is serious. Megaloblastic anaemia is seen in strict vegetarians who do not consume milk. It is because of a dietary deficiency of B₁₂.

Pernicious anaemia occurs due to absence of intrinsic factor in the person's gastric juice. So, even if diet provides enough B₁₂, it will not be absorbed and deficiency will result.

Symptoms: The person appears well nourished with respect to body weight. Skin and eyes are pale, tongue is raw and red, and mouth ulcers are present. There is numbness, tingling sensation, and a feeling of pins and needles in the fingers, as nervous system is affected. Haemoglobin level is low and megaloblasts appear in blood. Treatment of pernicious anaemia involves injections of B₁₂ throughout life, as oral doses cannot be absorbed due to lack of intrinsic factor.

EXCESS: VITAMIN B12 HAS NOT BEEN SHOWN TO PRODUCE ADVERSE EFFECTS.

Minerals

The body contains about 25 minerals, all of which must be provided by the diet. These include calcium, phosphorus, potassium, sodium, chloride, magnesium, sulphur, iron, fluorine, nickel, chromium, cadmium, selenium, silicon, vanadium, molybdenum, iodine, zinc, copper, manganese, cobalt, boron, arsenic, aluminum and tin

Classification of Minerals

Minerals are classified into two main groups.

Major Minerals: Major minerals are required in more amounts by the body. They have a recommended intake of more than 100mg/day. The seven major minerals are calcium, phosphorus, sodium, potassium, magnesium, chloride and sulfur.

Trace Minerals: Trace minerals have a recommended intake of less than 100mg/day.

CALCIUM

Calcium is the most abundant mineral element in the body. Approximately 1.5% of adult body weight is calcium. About 90 % of it occurs in bones and teeth. Bone contains an organic matrix of insoluble protein in which various mineral compounds are also embedded. Bones are also storehouses of calcium. The ends of bones in the well nourished individual are exceptionally rich in needle like crystals of calcium salts. Only 1 % of the body calcium is in the blood, other body fluids and soft tissues.

Function of calcium:

The important physiological functions of calcium are:

1. It is essential for the formation of bone and teeth.
2. It is essential for the clotting of blood.
3. It regulates the excitability of nerve fibers and nerve centers.
4. It is essential for the muscle contraction.
5. It regulates permeability of cell membranes.
6. Necessary for intestinal absorption of vitamin B12
7. Necessary for activation of the fat splitting enzyme pancreatic lipase.
8. Helps in secretion of insulin by the β cells of the pancreas.

Sources:

Calcium is present in both animal and plant food. The richest source of calcium among animal foods is milk and among the vegetable sources are green leafy vegetables. Among the leafy vegetables, amaranth, fenugreek, spinach and drumstick leaves are particularly rich in calcium. Among root vegetables tapioca is a good source. Cereals and millets contain some amount of this elements and the millet ragi is particularly a rich source of calcium. Rice is a poor source of calcium.

Recommended Dietary Allowances:

Man Sedentary Moderate Heavy	600 mg/day
Women Sedentary Moderate Heavy	600 mg/day
Pregnancy	1200 mg/day
Lactating	1200 mg/day
Infants 0-6 6-12	500 mg/day
Children 1-3 4-6 7-9	600 mg/day
Boys 10-12 Girls 10-12	800 mg/day 800 mg/day
Boys 13-15 Girls 13-15	800 mg/day 800 mg/day
Boys 16-17 Girls 16-17	800 mg/day 800 mg/day

Deficiency:

1. Rickets - If sufficient dietary calcium is unavailable during growth years various bone deformities occur. When vitamin D is inadequate to absorb intestinal calcium rickets disease is seen.
2. Tetany - Hypocalcemia relative to blood phosphorus results in tetany.
3. Osteoporosis – Inadequate calcium intake or poor intestinal calcium absorption related to deviations in the amounts of hormones that control calcium absorption and metabolism causes osteoporosis.

Excess:

The toxicity of calcium from food sources is unlikely. Excess calcium supplementation overtime causes hypercalcemia. Hypercalcemia is associated with the calcification of soft tissue and the decreased intestinal absorption of several other minerals.

IRON

The amount of iron in the adult body is about 3 to 5 g. About 70 % is in the circulating haemoglobin, 4% in the myoglobin of the muscle and 25 % in the stores held in the liver, bone marrow, spleen and kidneys. The remaining 1 % is accounted for the plasma iron and by various oxidative enzymes. The haemoglobin levels commonly range between 11 to 15 g \ 100 ml of blood and the R B C count 3 to 4.5 million per mm³.

Functions:

1. Iron serves as functional part of haemoglobin and it plays a role in the body's general metabolism. Approximately 70% of the body's iron is in hemoglobin with in RBCs. Iron is a component of heme, which is the nonprotein part of haemoglobin. Hemoglobin carries oxygen to the cells, where it is used for oxidation and metabolism. Iron is also part of myoglobin a protein found in muscle.
2. Iron is necessary for glucose metabolism.
3. Iron is necessary for antibody production
4. Iron is necessary for collagen and purine synthesis
5. Iron is necessary for conversion of β -carotene to active vitamin A.

Sources:

1. Liver, organ meats, shellfish, lean meat, egg yolk are all good sources
2. Green leafy vegetables, wholegrain and enriched cereals, legumes and jaggery, garden cress seeds and niger seeds are excellent sources
3. Peaches, apricots, black raisins and figs are also excellent sources.
4. Use of iron cooking utensils contributes significantly to the iron content of the diet.

Recommended Dietary Allowances:

Man Sedentary Moderate Heavy	17 mg/day
Women Sedentary Moderate Heavy	21 mg/day
Pregnancy	35 mg/day
Lactating	21 mg/day
Infants 0-6 6-12	46 μ g/kg/day 5 mg/day
Children 1-3 4-6 7-9	9 mg/day 13mg/day 16 mg/day
Boys 10-12 Girls 10-12	21 mg/day 27 mg/day
Boys 13-15 Girls 13-15	32 mg/day 27 mg/day
Boys 16-17 Girls 16-17	28 mg/day 26 mg/day

Deficiency:

Inadequate intake of iron leads eventually to iron deficiency anaemia. In this condition haemoglobin content of the red blood cells is reduced and the cells appear pale when seen

through a microscope. Reduced haemoglobin level means that less oxygen can be carried per unit of time to the tissues.

Infants, adolescent girls and pregnant women are especially prone to anaemia if the dietary intake is inadequate over prolonged periods of time. Anaemia may also occur even when the diet is normally adequate and if excessive blood is lost or in faulty absorption of iron due to gastric acidity, intestinal disease or diarrhea.

The clinical features are general fatigue and lassitude, breathlessness on exertion, giddiness and pale skin. In severe cases there may be oedema of the ankles.

Excess:

Iron toxicity from a single dose (20 to 60 mg per kilogram of body weight) results in clinical manifestations that can be lethal. Symptoms include nausea, vomiting and diarrhea.

Hemochromatosis is a genetic disease resulting in iron overload.

IODINE

The average adult body contains only 15 to 20mg of iodine.

Functions:

Iodine's basic function is as a component of thyroxine (T4), a hormone that is synthesized by the thyroid gland and that helps to control the basic metabolic rate. T4 synthesis is ultimately controlled by the hypothalamus and the pituitary gland. The hypothalamus secretes thyrotropin releasing hormone (TRH). TRH in turn stimulates the release of TSH from the anterior pituitary gland.

Sources:

Seafood contains maximum iodine and fruits contain the least. Wide variations are seen because food content of iodine depends upon the soil where they are grown. To provide sufficient iodine, salt is being iodized.

Recommended Dietary Allowances:

Physiological need of iodine is influenced by many dietary and environmental factors such as intake of cabbage, the hardness of drinking water, the climate, age and activity of the people and exposure to infections or other stresses. N I N suggested 100 to 150 mcg \ day.

Deficiency:

Iodine deficiency disorders are generally found in geographic locations with mountains or frequent flooding that results in poor soil iodine levels. Iodine is the only nutrient deficient in

soil and has an adverse effect on human nutrition. Lack of iodine in the food supply leads to Goitre, enlargement of the thyroid gland and cretinism in children. Cretinism is characterized by a low basal metabolic rate (BMR), flabby and weak muscle, dry skin. Skeletal development stops and mental retardation is seen.

Excess:

Excess iodine supplementation may lead to thyrotoxicosis or iodine induced hyperthyroidism.

FLUORINE

Functions:

Traces of fluorine is present in human tissues, notably in the bone, teeth, thyroid gland and skin. Traces of fluorine in the teeth help to protect them against decay and is also needed for normal growth.

Sources:

Milk, eggs and fish are important sources. Fluoridation of water to ensure a concentration of 1ppm is a safe and economical way to reduce the incidence of dental caries.

Recommended Dietary Allowance:

An average intake of 4mg for men and 3mg for women is recommended.

Deficiency:

A deficiency results in dental caries and is seen in areas where drinking water contains less than 0.5ppm of fluorine. Adding fluorine at a level of 1ppm reduces the incidence of dental caries by 50%.

Excess:

Fluorosis or mottling of teeth occurs in parts of the world where drinking water contains excessive amounts of fluorine, i.e., 3-5ppm. Teeth lose their lustrous appearance. Enamel becomes dull and unglazed and chalky white patches are seen. Sometimes enamel is pitted giving the tooth surface a corroded appearance. Skeletal fluorosis may also be seen. There is hypercalcification of the bones.

COPPER

Functions:

Copper is involved in energy production and hemoglobin synthesis.

Sources:

Liver, seafood, whole grains, legumes, nuts

Recommended Dietary Allowances:

In adults average daily intakes of copper from food is 900mcg.

Deficiency:

Primary copper deficiency is rare. Prolonged deficiency leads to anaemia and bone abnormalities.

Excess:

High storage of copper in the body results in Wilson's disease. This can result in liver and nerve damage that leads to death.

ZINC

Zinc is a constituent of the enzyme carbonic anhydrase of RBC. It has been found in several other enzymes and also in the hormone insulin. The body of an adult man weighing 70 kg may contain about 1.4 to 2.3 g of zinc. It is present in small amounts in different tissues. It is present in large amounts in the skin, bone and prostate gland, greater concentrations are found in RBC.

Functions:

1. Zinc is essential for a number of metalloenzymes like carbonic anhydrase, carboxy peptidase, phosphatases, dehydrogenases and transaminases.
2. Zinc is required for the optimal function of more than 300 enzymes.
3. Zinc is required for DNA, RNA and protein synthesis as well as energy metabolism.
4. All aspects of the immune system are dependent on adequate zinc availability.
5. Reproduction, optimal activity of growth hormone depend on zinc.
6. Zinc functions as a stabilizer of erythrocyte membranes, thus decreasing peroxidation and oxidative damage (prevention of free radical formation)

Sources:

Oysters are very good sources of zinc. Cereals, pulses, nuts and oil seeds, vegetables and fruits are fair sources. The zinc present in animal foods are well absorbed while zinc present in cereals, pulses, nuts and oil seeds are poorly absorbed due to the presence of phytates which interfere in its absorption.

Recommended Dietary Allowances:

Infants	3 to 5 mg \ day
Children	10 mg \ day
Adolescents	11 mg for boys & 8mg for girls/day
Adults	11 mg for men & 8 mg for women/day
Pregnancy	11 mg \ day
Lactation	12 mg \ day

Deficiency:

Zinc deficiency has been found to retard growth and genital development and cause loss of taste sense termed as Hypogeusia. Zinc deficiency commonly causes poor wound healing, hair loss, diarrhea, skin irritation and overall compromised immune function.

Excess:

Zinc toxicity from food sources alone is uncommon. However prolonged supplementation that exceeds the recommended zinc intake can alter lymphocyte function and cause adverse symptoms such as nausea, vomiting and epigastric pain.

UNIT – IV

ENERGY

Energy is the invisible component needed for the functioning of our body.

It is used to build our body, to keep it functioning, to enable it to perform various activities (sitting, walking, playing etc), to keep it warm and to breakdown the food into usable components.

Most of the energy supplied to the body is in the form of chemical energy. It is supplied by the food. The nutrients which supply the major part of the energy to the body are carbohydrates and fats (about 85 to 90 %). A small part of the energy need is met by the proteins (about 10 %).

Energy value of Foods:

One kilocalorie is the amount of heat required to raise the temperature of one kilogram (1kg) of water by 1°C. The unit which has been used in human energy measurements (nutrition) and food composition tables is the kilocalorie (*kcal or cal*).

	In calories
Fats	9Kcal
Carbohydrates	4Kcal
Proteins	4Kcal
Alcohol	7Kcal
Short chain fatty acids	6.7Kcal

Bomb Calorimeter:

The gross energy value of foods is measured using Bomb calorimeter. The bomb calorimeter is based on the principle of calorimetry. It measures the heat produced when the food sample is ignited by an electric spark in the presence of oxygen and platinum which acts as a catalyst. The bomb calorimeter is made up of two main parts – an inner part in which a measured quantity of food sample to be tested is placed and an outer portion which contains a known volume of water. When the food sample is electrically ignited, the surrounding water absorbs the heat produced. The energy value of the food is calculated by measuring the rise in temperature of water, based on the definition of the term calorie.

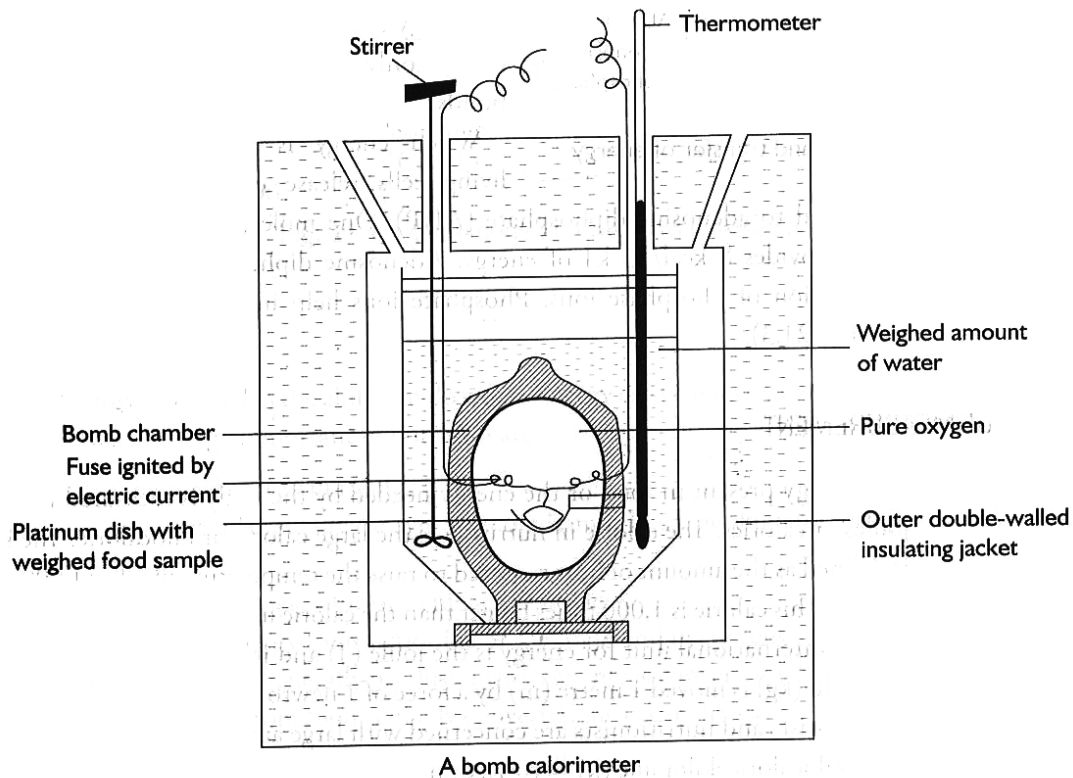


Fig. 21.4 Measuring the potential energy of food

Physiological Energy Value of Foods:

The energy value of food obtained by igniting it in the bomb calorimeter is the potential energy value of food.

The potential energy present in food when measured in a bomb calorimeter is higher than the energy released in the body. This is because some losses occur during digestion, absorption, and metabolism. The potential energy value must be corrected to allow for the losses that occur during digestion, absorption, and metabolism of nutrients.

The physiological fuel factors are based upon the corrections for losses of unabsorbed nutrients in the faeces and nitrogenous products excreted in the urine. On a mixed diet containing high quality protein, 85 – 90 per cent carbohydrate, 95 per cent fat, and 92 per cent proteins are digested and absorbed. The carbohydrates and proteins which are absorbed are fully oxidized.

However, when proteins are oxidized as a source of energy, they first need to be deaminated (removal of amino group). The amino group is converted to urea and is excreted in the urine. Hence, the body loses a part of the protein that is digested and absorbed. This loss of protein is about, 25 per cent.

The net energy value obtained from food by the body is lesser than that measured in a bomb calorimeter.

	Potential energy in food (kcal/g)	Physiological energy value (kcal/g)
Carbohydrates	4.15	4.0
Proteins	5.65	4.4
Fats	9.4	9.0

Total energy requirement of the body

The total energy required by a person is based on basal energy needs, the energy effect of food intake or the specific dynamic action and energy cost of physical activity. Energy is needed for growth, for maintenance, for the innumerable processes continuously taking place, for regulating body temperature, and for physical and mental activity. Activities that need energy are broadly classified into the following:

1. Voluntary activities, e.g., activities under the control of our will such as walking, sitting, cycling, and dish washing.
2. Involuntary activities that go on irrespective of whether we want them to. They are not under the control of our will and are vital activities on which our survival depends such as beating of the heart, respiration, and maintaining body temperature. Energy is first provided for these activities and is referred to as basal metabolism.

$$\text{Total energy Needed by the body} = \text{Basal metabolic rate} + \text{Physical Activity} + \text{Specific Dynamic Action}$$

Total Energy

Basal Metabolic Rate:

The amount of energy required by the body for carrying out involuntary work and maintaining the body temperature is known as the basal metabolic rate (BMR). The involuntary work includes the functioning of various organs and systems which work continuously to keep the body processes going such as the heart and blood circulation, the kidneys and excretion. Approximately one-third of this energy is needed for these processes, while the remaining two-thirds is utilized for maintenance of muscle tone. The Basal Metabolic Rate is measured using Indirect and Direct Calorimetry.

Test for Basal Metabolic Rate using Indirect Calorimetry:

To measure the BMR, the following conditions need to be observed.

1. The test is conducted before breakfast 12-16 hours after the last meal, i.e., in a post-absorptive state, to eliminate the influence of food.
2. The subject should be relaxed and lying down but awake because sleep reduces BMR and activity or exercise increases the rate of oxidation in the cells.
3. The subject should have a normal pulse rate and be free from tension or fear of the test.
4. The ambient temperature should be comfortable as perspiration or shivering may affect the rate of oxidation.
5. The subject should be afebrile as fever increases the BMR by 7 per cent for every degree Fahrenheit rise in temperature.

The test is conducted by measuring the amount of oxygen consumed and carbon dioxide exhaled in a predetermined time, usually 6-8 minutes.

A deviation of 10-15 per cent from the accepted standards may be considered normal. The adult BMR is 1 kcal/kg body weight/hour for men and 0.9 kcal/kg body weight/hour for women, or approximately 1,440 kcal for men and 1,080 kcal for women, respectively.

BMR (kcal) = 0.9 kcal/kg/hour for women

1.0 kcal/kg/hour for men

Test for BMR using Direct Calorimetry:

Direct calorimetry obtains a direct measurement of the amount of heat generated by the body within a structure large enough to permit moderate amount of activity. These structures are called whole room calorimeters. Direct calorimeter provides a measure of energy expended in the form of heat. The technique of direct calorimetry has several disadvantages. The structure is costly and subject must remain in a physically confined environment for long periods.

Factors Affecting the BMR:

Body size: Heat is continuously lost through the skin. A tall well-built person has a greater skin surface area than a shorter or smaller person and loses more heat through the skin and hence has a higher BMR.

Body composition: The amount of muscle tissue and adipose or fatty tissue in the body affects the BMR. An athlete with well-built muscles and little body fat has a higher BMR than a non-athlete with more body fat of the same weight. The metabolic activity in muscle tissue or lean tissue is much more as compared to adipose or fatty tissue.

Age: During periods of rapid growth, the BMR increases by 15-20 per cent because the growth hormone stimulates cell metabolism and new cells are formed. It is high during infancy, pre-school years, and puberty. During pregnancy and lactation it rapidly increases once again. The BMR

gradually declines with age at the rate of 2 per cent for each decade after the age of 21 years.

Sex: The BMR is 10 per cent higher in men as compared to women. The difference in BMR is attributed to a higher proportion of adipose tissue in females and hormonal variations between the sexes.

Fever: Fever increases the BMR by 7 per cent for each degree Fahrenheit rise in body temperature. This is one of the reasons for loss of weight during fever.

State of health: The BMR is low during starvation and malnutrition because of reduction in muscle tissue. In diseases and conditions where catabolic processes are high, such as cancers, tuberculosis, and burns, BMR is high.

Hormones: Disorders of the thyroid gland markedly influence the BMR. Hyperthyroidism, a condition of excessive production of thyroid hormone, increases BMR and hypothyroidism or decreased production of thyroid hormone decreases BMR.

Climate: The BMR rises when the climate is cold in order to maintain normal body temperature. In very warm climates leading to profuse sweating, BMR may increase by trying to reduce body temperature.

Psychological tension: Worry and anxiety increase BMR.

Physical activity:

Physical activity increases the energy requirement above the basal metabolism. There is a wide variation in the energy required for physical activity among individuals. Physical activity includes energy needed for work, recreation, and mental activity, i.e., all voluntary activities. Some people use up more energy for physical activity than for basal metabolism.

On the basis of occupation, activities are grouped under three heads.

Sedentary/light work

Moderate work

Heavy work

Sedentary work Teaching, office work, executive, housewife, tailoring

Moderate work Farming, industrial labour, driver, maidservant

Heavy work Stone cutter, miner, wood cutter

The energy requirement varies with the type of activity and the speed and efficiency with which it is performed. For example, swimming uses up twice the energy of bicycling, and walking briskly uses up thrice the energy of walking at a moderate pace. The body size of the person also affects energy expended for a task. The larger the body size, the more energy would be needed just as more energy is needed to move a heavy sack of potatoes compared to a lighter one.

The energy expended for physical activities is measured indirectly by strapping a light- weight respirometer, collecting the expired air and analyzing the carbon dioxide and oxygen content to calculate the energy expended.

<u>Activity</u>	<u>Physical Activity Level(PAL)factor</u>
Sedentary	1.4 – 1.5
Very light	1.6 – 1.7
Moderate	1.8 – 1.9
Heavy	2.0 – 2.4

Physical activity energy cost (kcal) = BMR X Your PAL

For example, if you are sedentary: BMR X 1.4

Specific dynamic action or thermic effect of food:

Specific dynamic action (SDA) or the Thermic Effect of Food (TEF) is the energy the body uses in the processes of digestion and absorption. It averages 10% of the energy in the food.

Record your food intake for one day (24 hours) and calculate estimated energy value (kcal), using table of food values.

TEF (kcal) = 10% of total kcal in food consumed

Recommended Dietary Allowances of Energy:

Group	Particulars	Body Weight	Net Energy Kcals/day
Man	Sedentary	60	2320
	Moderate		2730
	Heavy		3490
Women	Sedentary	55	1900
	Moderate		2230
	Heavy		2850
	Pregnancy		+ 350
	Lactating 0-6 months 6-12 months		+ 600 + 520

Infants	0-6 months	5.4	92 kcal/kg/d
	6-12 months	8.4	80 kcal/kg/d
Children	1-3 years	12.9	1060
	4-6 years	18	1350
	7-9 years	25.1	1690
Boys	10-12 years	34.3	2190
Girls	10-12 years	35.0	2010
Boys	13-15 years	47.6	2750
Girls	13-15 years	46.6	2330
Boys	16-17 years	55.4	3020
Girls	16-17 years	52.1	2440

Sources of Energy:

All foods provide energy. The nutrients carbohydrates and fats are consumed mainly as a source of energy. All refined carbohydrates i.e., sugar and starch and all foods rich in fats are rich sources of energy. The cereal group is another excellent source of energy and supplies the highest percentage of calories.

UNIT – V

WATER AND NON NUTRIENT CONSTITUENTS OF FOOD

Water is the largest constituent of the body, about 60 to 70% of the total body weight constitutes water. The body's need for water is second only to that for oxygen. It is possible to live for days even weeks without food but death is likely to follow when deprived of water in few days. Infants and young children have more water in their bodies than adults. The percentage of water in lean individuals is higher than in obese persons. The water content of soft tissues ranges from 70 to 80% while that of bone is 20%. Body fluid is distributed as follows.

- Fluids within the cells- intracellular water (50%) 2. Outside the tissue cells- extracellular water (20%). The extracellular water is further subdivided into water in blood plasma, interstitial water – water in tissue spaces and lymph in lymphatic vessels.

Functions:

- Water quenches thirst and is the most refreshing and cooling of all liquids
- It is a structural component of all cells
- Water is the medium in which all chemical reactions take place
- It is an essential component of all body fluids such as blood, lymph, cerebrospinal fluid, bile, digestive juice and urine.
- It acts as a lubricant and helps food to be swallowed and digested food to pass through the gastro-intestinal tract
- It acts as a solvent for the products of digestion and helps in transporting these products to different tissues
- Water regulates body temperature by taking up and distributing heat produced in cells when metabolic reactions takes place.
- It helps in excreting waste products of metabolic reactions.

Requirement:

About 1ml of water is needed per 1kcal energy intake, thus about 2000ml water is necessary when energy intake is 2000kcal. Individuals who have large body surface area, in proportion to body weight, need 1.5ml water per kcal energy intake. The amount of water needed by an individual will depend on many factors such as the environmental temperature, humidity, occupation and the diet. In general, apart from water obtained in the food, an individual may need to drink about 1.5-2 litres of water per day. It should be consumed at regular intervals so that the body is always well hydrated.

Regulation of Water Balance:

Sources of water in the body:

There are three sources of water to the body

1. Water as such.
2. Water contained in foods and
3. Water formed by oxidation of foodstuffs in the body.

Hot and cold beverages such as tea, coffee, milkshakes, fruit juices and soups are largely made up of water. Another important source of water is fruits, vegetables and the water used for cooking food. Solid foods contain varying percentage of water. The water consumed from beverages and solid food amounts to 2100ml/day.

Metabolic water is synthesized in the body as a result of oxidation of fat, protein and carbohydrate adding to about 200ml/day.

Oxidation of 100 g of fat → 107ml of water.

100 g of carbohydrates → 56ml of water

100 g of protein → 41ml of water.

Water loss from the body:

Water is lost from the body through the kidney and skin and to a lesser extent through lungs and gastrointestinal tract. The rate of filtration in the normal kidney is about 125 ml per min or approximately 180 litres daily for an adult. About 99 % of water filtered is reabsorbed into the blood while 1500 to 2000 ml are excreted as urine. The volume of the urine reflects to some extent the fluid intake of the individual. The urine volume decreases when perspiration is more, unless the fluid intake is proportionately increased.

A relatively constant amount of water is lost daily from the skin as insensible perspiration that is the water loss is not noticeable because evaporation takes place immediately. This evaporation is an important means of which the body temperature is maintained. The loss of water is proportionate to the surface area of the body. During warm weather and with increase in activity, much water is lost as visible perspiration. Many athletes lose several quarts of water during strenuous games / exercises.

Air expired from the lungs also contains water which may amount to 300 ml or so per a day. As the activity increases, the rate of respiration also increases and more water will be lost from lungs.

Normally the water lost from the gastrointestinal tract is small. The volume of water contained in the daily secretion of saliva and gastric juice is roughly 7000 to 8000 ml.

These fluids are poured into the alimentary tract from the respective glands and at the end of digestion the water from these juices is reabsorbed into the blood stream. About 100 ml of water is normally lost each day in the saliva and in the faeces.

Water balance:

The importance of keeping the body in fluid balance is universally recognized. The body is said to be in water balance when the available water equals that of the water excreted or lost from the body.

NORMAL WATER BALANCE			
Available water		Excreted water	
Water intake as such	1100 ml	in urine	1000 ml
Water in diet	900 ml	in stool	200 ml
Water of oxidation	200 ml	in vapour	1000 ml
Total	2200 ml	Total	2200 ml

The body maintains water balance precisely even though the fluid intake varies widely from day to day. The regulatory mechanisms are not fully understood, but certain regions of the hypothalamus are believed to regulate thirst just as other regions regulate the appetite. Several hormones are known to control the rate of water excretion. One of these is an anti-diuretic hormone produced by the posterior portion of the pituitary gland. This hormone decreases excretion of water by the kidney by increasing the rate of re-absorption from the kidney tubules. The hormones produced by the adrenal cortex regulate the excretion of sodium and hence the excretion of water, since the body fluids are maintained with constant levels of sodium. To some extent the female sex hormones also influence water excretion. It is a common finding that women show slight increase in weight just before the commencement of menstruation and that weight is subsequently lost.

Effect of Deficiency and Excess:

Dehydration: Dehydration takes place when our body loses more fluid than we drink. Common causes include:

- excessive sweating
- vomiting
- diarrhea

When too much water is lost from the body, the organs, cells, and tissues fail to function properly which can lead to dangerous complications. If dehydration isn't corrected immediately, it could cause shock. Dehydration can be mild or severe. Mild dehydration can be treated at home. Severe dehydration needs to be treated in a hospital or emergency care setting.

Body regularly loses water through sweating and urination. If the water is not replaced, the body becomes dehydrated. Any situation or condition that causes the body to lose more water than usual leads to dehydration.

Sweating:

Sweating is part of body's natural cooling process. When the body become hot, the sweat glands activate to release moisture from the body in an attempt to cool it off. The sweat comprises mainly salt and water. Excessive sweating can cause dehydration since a large amount of water is lost from body.

Illness:

Illnesses that cause continuous vomiting or diarrhea can result in dehydration. This is because vomiting and diarrhea can cause too much water to be expelled from the body. Important electrolytes are also lost through these processes. Electrolytes are minerals used by the body to control the muscles, blood chemistry, and organ processes. These electrolytes are found in blood, urine, and other fluids in the body. Vomiting or diarrhea can impair these functions and cause severe complications, such as stroke and coma.

Fever:

When there is fever, body loses fluid through skin's surface in an attempt to lower the temperature. Often, fever can cause too much sweat. If the body is not hydrated properly it could end up dehydrated.

Urination:

Urination is the body's normal way to release toxins from the body. Some conditions can cause chemical imbalances, which can increase urine output. If the lost fluid is not replaced the fluid lost through excessive urination, can develop dehydration.

Signs of dehydration:

The symptoms of dehydration differ depending on whether the condition is mild or severe. Symptoms of dehydration may begin to appear before total dehydration takes place.

Symptoms of mild to moderate dehydration include:

- fatigue
- dry mouth
- increased thirst
- decreased urination
- less tear production
- dry skin
- constipation
- dizziness
- lightheadedness

- headache

In addition to the symptoms of mild dehydration, severe dehydration is likely to cause the following:

- excessive thirst
- lack of sweat production
- low blood pressure
- rapid heart rate
- rapid breathing
- sunken eyes
- shriveled skin
- dark urine

Treatment for dehydration:

Treatments for dehydration include rehydrating methods and electrolyte replacement

Rehydration:

Rehydration by drinking may not be possible for all people, like those who have severe diarrhea or vomiting. In this case, fluids can be given intravenously. For those able to drink, drinking water along with an electrolyte-containing rehydration drink is recommended.

Homemade rehydration solution:

If an electrolyte drink is not available it can be prepared at home with

- 1/2 teaspoon salt
- 6 teaspoons sugar
- 1 liter water

Things to avoid: Avoid soda, alcohol, overly sweet drinks, or caffeine. These drinks can worsen dehydration.

Excess: Overhydration is an imbalance of fluids. It happens when our body takes in or holds on to more fluid than our kidneys can remove. Drinking too much water or not having no way to remove it can cause water levels to build up. This dilutes important substances in our blood. Overhydration can lead to water intoxication. This occurs when the amount of salt and other electrolytes in the body become too diluted. Hyponatremia is

a condition in which sodium (salt) levels become dangerously low. This is the main concern of overhydration. If electrolytes drop too low too quickly, it can be fatal. Death by overhydration is rare, but it can happen.

Different types of overhydration: There are two main types of overhydration.

Increased water intake:

This occurs when we drink more water than our kidneys can remove in our urine. This can cause too much water to collect in our bloodstream.

Retaining water:

This occurs when our body can't get rid of water properly. Several medical conditions can cause our body to retain water.

Electrolyte Balance:

Electrolytes are minerals in the body that have an electric charge. They are in our blood, urine, tissues, and other body fluids. Electrolytes are important because they help

- Balance the amount of water in our body
- Balance our body's acid/base (pH) level
- Move nutrients into our cells
- Move wastes out of our cells
- Make sure that our nerves, muscles, the heart, and the brain work the way they should

Sodium, calcium, potassium, chloride, phosphate, and magnesium are all electrolytes. We get them from the foods we eat and the fluids we drink. The levels of electrolytes in our body can become too low or too high. This can happen when the amount of water in our body changes. The amount of water that we take in should be equal the amount of water that we lose. If something upsets this balance, we may have too little water (dehydration) or too much water (overhydration). Some medicines, vomiting, diarrhea, sweating, and liver or kidney problems can all upset the water balance. Treatment helps to manage the imbalance.

Non nutrient constituents of foods and their importance:

Phytochemicals:

Phytochemicals (from Greek *phyto*, meaning "plant") are chemicals produced by plants through primary or secondary metabolism. They generally have biological activity in the plant host and play a role in plant growth or defense against competitors, pathogens, or

predators. Phytochemicals are non-nutritive plant chemicals that have protective or disease preventive properties. They are non-essential nutrients, meaning that they are not required by the human body for sustaining life. There are more than thousand known phytochemicals. **Phytochemicals** are defined as bioactive nutrient plant chemicals in fruits, vegetables, grains, and other plant foods that may provide desirable health benefits.

Curcumin: Curcumin is a yellow pigment found primarily in turmeric, a flowering plant of the ginger family best known as a spice used in curry. It's a polyphenol with anti-inflammatory properties and the ability to increase the amount of antioxidants that the body produces. It helps in protection from heart diseases and helps in prevention of cancers

Lycopene: Lycopene is a natural compound that is found in bright red fruits and vegetables like tomatoes, watermelon, and grapefruit. Lycopene is a carotenoid, which are yellow, orange, or red pigments that give this color to its plants. Lycopene has been linked to many health benefits, including disease prevention and protection. One of the biggest benefits of lycopene is that it is an antioxidant and protects the body of damage from free radical stress, which can hurt DNA and other cell structures.

The antioxidant properties help balance free radical activity in the body and in doing so, may offer protection against certain diseases, keep bones strong and healthy, and help eyesight by helping delay or prevent cataracts, macular degeneration, and other age-related eye disorders. Lycopene may have the ability to reduce LDL (bad) cholesterol while increasing HDL (good) cholesterol levels.

There may also be a connection to those who have higher amounts of lycopene in their tissues and a lower risk of heart attack, blocked or clogged arteries, lower blood pressure, and other cardiovascular diseases.

Flavonoids: Flavonoids, a group of natural substances with variable phenolic structures, are found in fruits, vegetables, grains, bark, roots, stems, flowers, tea and wine. Flavonoids have anti-oxidative, anti-inflammatory, anti-mutagenic and anti-carcinogenic properties coupled with their capacity to modulate key cellular enzyme function. Research on flavonoids received an added impulse with the discovery of the low cardiovascular mortality rate and also prevention of Coronary Heart Disease.

Antioxidants:

Antioxidants are substances that can prevent or slow damage to cells caused by free radicals. Free radicals are waste substances produced by the cells as the body processes food and reacts to the environment. If the body cannot process and remove free radicals efficiently, oxidative stress can result. This can harm cells and body function. Free radicals are also known as reactive oxygen species (ROS). They are sometimes called "free-radical scavengers." Certain plant-based foods are thought to be rich in antioxidants. The

body also produces some antioxidants, known as endogenous antioxidants. Antioxidants that come from outside the body are called exogenous.

Factors that increase the production of free radicals in the body can be internal, such as inflammation, or external, for example, pollution, UV exposure, and cigarette smoke.

Oxidative stress has been linked to heart disease, cancer, arthritis, stroke, respiratory diseases, immune deficiency, emphysema, Parkinson's disease, and other inflammatory or ischemic conditions.

Antioxidants are said to help neutralize free radicals in our bodies, and this is thought to boost overall health. Tocopherols (**vitamin E**), ascorbic acid (**vitamin C**), and the **carotenoids** react with free radicals, notably peroxy radicals, and with singlet molecular oxygen ($1O_2$), which is the basis for their function as **antioxidants**.

Detoxifying Agents:

Detoxification means helping the body get rid of harmful substances and protecting against their damage. Usually, it involves consuming certain foods or drinks or following a particular diet. The body's organs are already very adept at removing toxins. Fruits, vegetables, and pulses all support this process, and adding antioxidant-rich foods to the diet may help protect against toxin-induced damage.

Anthocyanins: Anthocyanins are red, blue, or purple pigments in some plants. These pigments have antioxidant properties that help protect against free radical damage. Anthocyanins may support health for many reasons, including their antimicrobial properties, anti-inflammatory properties and anticancer properties. Some fruits that are rich in anthocyanins include berries, currants, grapes etc.

Chlorophyll: Chlorophyll plays an important role in making plants green and healthy. It also has vitamins, antioxidants, and therapeutic properties that have the potential to benefit the body. Chlorophyll helps to stimulating the immune system, eliminating fungus in the body, detoxify the blood, cleaning intestines, getting rid of bad odours, energizing the body, preventing cancer.