FUNDAMENTALS OF FOOD TECHNOLOGY (1+1)

Syllabus

Theory

Food and its function, physico-chemical properties of foods, food preparation techniques, nutrition, relation of nutrition to good health.Characteristics of well and malnourished population.
Energy, definition, determination of energy requirements, food energy, total energy needs of the body. Carbohydrates: classification, properties, functions, source, requirements, digestion, absorption and utilization. Protein,classification, properties, functions, sources, requirements, digestion, absorption, essential and non-essential amino acids, quality of proteins, PER/NPR/NPU, supplementary value of proteins and deficiency. Lipids – classification, properties, functions, sources, requirements, digestion, absorption and utilization, saturated and unsaturated fatty acids, deficiency, rancidity, refining of fats. Mineral nutrition: macro and micro-minerals (Ca, Fe and P), function, utilization, requirements, sources, effects of deficiency. Vitamins: functions, sources, effects of deficiency, requirements of water soluble and fat-soluble vitamins. Balanced diet: recommended dietary allowances for various age groups,assessment of nutritional status of the population.

Practical

Methods of measuring food ingredients, effect of cooking on volume and weight, determination of percentage of edible portion. Browning reactions of fruits and vegetables. Microscopic examination of starches, estimation of energy, value proteins and fats of foods. Planning diet for various age groups.

Topic 1

- **FOOD - FOOD GROUPS, FUNCTIONS AND PHYSICO - CHEMICAL PROPERTIES**

Aim

To understand the food, its nutrients, physico chemical properties and functions.

- Food has been a basic part of our existence. Through centuries we have acquired a wealth of information about the use of food as a part of our community, social, national and religious life.
- It has been used as an expression of love, friendship and social acceptance.
- It has also been used as a symbol of happiness at certain events in life, for example, distribution of pedhas to announce success in examinations or the birth of a baby, association of laddus with marriages and festivals like Deepavali and cakes are associated with Christmas.

Definition

- Food is that which nourishes the body. Food may also be defined as anything eaten or drunk, which can be absorbed by the body to be used as an energy source, building, regulating or protective material.
- In short, food is the raw material from which our body is made. Intake of the right kinds and amounts of foods can ensure good health, which may be evident in our appearance, efficiency and emotional well being.

Classification of foods

- Based on the functions, foods are grouped into energy-yielding, body-building and protective foods.

- Nutrients which engage in these activities are known as energy-yielding nutrients, body-building nutrients and protective nutrients.
- Carbohydrates, fats and proteins release energy on metabolism in our body.

Foods may be broadly classified into 11 groups based on their nutritive value:

(1) Cereals and millets
(2) Pulses (Legumes)
(3) Nuts and oilseeds
(4) Vegetables
(5) Fruits
(6) Milk and milk products
(7) Eggs
(8) Meat, fish and other animal foods
(9) Fats and oils
(10) Sugar and other carbohydrate foods
(11) Spices and condiments

The nutritional importance of the different food groups in planning balanced diets is briefly discussed below.

Cereals and Millets

- Cereals and millets constitute by far the most important group of foodstuffs as they form the staple food of a large majority of the population throughout the world.
- They form about 70 to 80 per cent of the diets of the low income groups in India and other developing countries.
- They contain about 6 to 12 per cent proteins and are good sources of some vitamins e.g., thiamine, niacin, pantothenic acid and vitamin B6 and minerals e.g., Phosphorus and iron.
- Hence, they provide 70 to 80 % of the calories, 6-10% of proteinsand other nutrients mentioned above in the diets of the low income groups.
- All cereals except ragi are poor to moderate sources of Calcium. Ragi is one of the richest sources of Calcium containing about 344 mg/100g.

- Cereals are deficient in Vitamins A, D, B12 and C.
- Puffed cereals are consumed widely as a snack by the low income groups in India.

Pulses

- Dried pulses are rich in proteins containing about 19 to 24 per cent.
- They are good sources of many B vitamins and minerals, but are deficient in vitamins A, D, B12 and C. Supplement effectively with cereals.
- Puffed pulses e.g., puffed bengal gram and peas are consumed commonly as a snack by the low-income groups in India.
- Tender pulses e.g., green Bengal gram, green peas, green field beans etc., contain fair amounts of vitamin C.
- Further germination of pulses enhances the vitamin C content.

Nuts and Oil seeds

- They contain about **18-40 per cent proteins.**
- Soybean is the richest source of proteins containing about 40%, along with B-vitamins, vitamin E, phosphorus and Iron.
- They **do not contain Vitamin A, D, B12 and C.**
- Oilseeds can be used for the preparation of milk substitutes which can be fed to infants over 6 months of age and to young children in areas where milk is not available in adequate amounts and children having lactose intolerance.

Vegetables

- Vegetables may be broadly divided into three groups from the nutritional point of view
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- (i) Green leafy vegetables
  (ii) roots and tubers
  (iii) other vegetables

Green Leafy Vegetables

- Green leafy vegetables are rich in β carotene (provitamin A)
- They are good sources of **c**alcium, riboflavin, folic acid and vitamin C
- Daily consumption of 100g of leafy vegetables by adults and 50g by children will provide the daily requirements of β carotene, folic acid and vitamin C and a part of the calciumand riboflavin requirements
- They are the cheapest among the protective foods.

Roots and Tubers

- The important foods in this group are potato, sweet potato, tapioca, carrot elephant yam and colocasia.
- They are, in general, good sources of carbohydrate.
- They are, however, poor sources of proteins, except potato which is a fair source.
- Carrot and yellow flesh variety of sweet potato are good sources of carotene but potato, tapioca and white flesh variety of sweet potato do not have much of carotene.
- Since they are poor sources of proteins, they can be used only in small amounts as a partial substitute for cereals.

- Consumption of excessive amounts of tapioca by young children is the main cause for the protein malnutrition.

Other Vegetables

- This group includes a large number of vegetables.
- Some of them are good sources of Vitamin C.
- Yellow pumpkin is a fair source of β carotene.

Fruits

- Mango and papaya are in general good sources of β carotene, Amla and guava are very rich in vitamin C.
- They are the cheapest among the fruits.
- Tomato, citrus, papaya, cashew apple and pineapple are also the richest source of Vitamin C.
- Apple, banana and grapes are poor sources of vitamin C.

Milk and milk products

- Milk is a food for infants and supplement to the diets of children and adults.
- Milk is almost a complete food except for iron and vitamin C.
- Milk proteins are of high biological value - 100 ml of cow's milk provides about3.2g protein, 4.1g fat, 120 mg calcium, 0.19 mg riboflavin, 53µg of vitamin A and substantial amounts of B-vitamins and minerals.
- Fat content of buffalo milk is twice the amount present in cow's milk.

Full Fat Milk Powder

- It is eight times as rich as cow's milk containing about 26 per cent proteins and 26 per cent fat**.**
- It can be reconstituted with 7 times its weight of warm water and is used in place of fresh milk.

Skimmed Milk Powder

- Skim milk powder is prepared from fat–free milk.
- It is completely devoid of fat and vitamin A.
- It's about 10 times as rich as fresh skim milk and contains about 35 % proteins.
- It can be used as a supplement to the diets of children.
- It is not suitable for feeding infants.

Eggs

- Hen's egg contains about 13 per cent protein of very high biological value and 13 per cent fat.
- It is a rich source of vitamin A and some B –vitamins.
- It is a fair source of vitamin D but doesn't contain Vitamin C.
- Egg white contains about 12 per cent proteins and some B-vitamins and devoid of fat and vitamin A.
- Egg yolk contains about 15 per cent proteins and 3 per cent fat.
- It's a rich source of vitamin A and fair source of Iron, B-vitamins and vitamin –D.

Meat, Fish and other Animal foods

Meat

- Meat is rich in proteins (18-22 per cent) of high biological value.
- It is fair source of B-vitamins.
- It does not contain Vitamin A, C or D and fibre.

Fats and Oils

- They serve as source of energy and provide the essential fatty acids.
- Butter, ghee and vanaspathi are good source of vitamin A (2500 IU per 100g).
- The common vegetable oils and fats do not contain carotene and vitamin A.
- Many of them are good source of Vitamin E

Sugar and Other carbohydrate foods

- The carbohydrate foods commonly used are cane sugar, jaggery, glucose, honey, syrup, custard powder, arrowroot flour and sago.
- They serve mainly as a source of energy.
- Honey and jaggery contain limited quantities of minerals and vitamins.

Spices and Condiments

- Spices and Condiments are not important sources of nutrient in average diets, but are used mainly for enhancing the palatability of the diet.
- The flavour principles present in them help to improve the flavour and acceptability of food preparations.
- Spices are the treasure of antioxidants and health promoting components.

The 4-Food Group plan

- The 4-food group plan was developed by the U.S. Department of Agriculture in 1956. The 4 food groups together with their nutrient contribution are given in table.

S.No	FOOD GROUP	NUTRIENTS
1.	**Milk group** Milk, cheese, ice cream (cheese and ice cream can replace part milk)	Calcium, Phosphorus, Proteins and Vitamins.
2.	**Meat group** Beef, veal, pork, lamb, poultry, fish, eggs	Proteins, Phosphorus, Iron and B-Vitamins
3.	**Vegetable-fruit group**	Vitamins, Minerals and Fibre
4.	**Broad-Cereals group** (Whole grain, enriched, restored)	Thiamine (B_1), Niacin (B_5) Riboflavin, Iron, Carbohydrates and Fibre.

Five Food Group Plan

The nutrition expert group of Indian Council of Medical Research, India suggested a five food group plan and the nutrients supplied by each food group are given in Table.

Five Food Group Plan (Nutrition Expert Group, I.C.M.R.)

S.No	Food group	Nutrients
1.	Protein group This includes protein rich foods such as pulses, nuts, milk, meat, fish, eggs etc.	Rich sources of proteins, minerals and Vitamins.
2.	Fruits and green leafy vegetables Papaya, Orange, Mango, Indian gooseberry, Guava etc., and all green leafy vegetables.	Fair sources of certain vitamins, minerals
3.	Other vegetables Beans, Brinjal, Lady finger etc.	Fair sources of certain vitamins, minerals and fibre
4.	Cereals, roots and tubers, Rice, Wheat, maize, ragi, pearl millet etc. potato, tapioca, sweet potato, etc.	Rich sources of starch-fair to good sources of proteins and certain B-Vitamins.
5.	Fats and oils and pure carbohydrate foods Vegetable oils, animal fats, sugar, jaggery, honey, sago, custard powder, starch, etc.	Rich sources of energy, Vegetable oils are fair sources of essential fatty acids (EFA) and vitamin E. Butter is the good source of Vitamin A. Animal fats are rich in cholesterol but poor sources of EFA and Vitamin E. Pure carbohydrate foods – rich sources of energy.

The 7-Food Group Plan

- The 7- food group plan was developed by the U.S. Department of Agriculture in 1943.The 7 groups together with their nutrient contribution are given in table.

S.No	Food groups	Nutrients contributed
1.	Green and yellow vegetables	β Carotene (Provitamin A), Ascorbic acid (vitamin C) and iron
2.	Oranges, grape fruits, tomatoes or raw cabbage or salad greens	Ascorbic acid and lycopene
3.	Potatoes, other vegetables and fruits	Vitamins, minerals and fibre
4.	Milk and milk products	Calcium, Phosphorus, Proteins and Vitamins
5.	Meat, Poultry, fish and egg	Proteins, Phosphorus, Iron and B-Vitamins
6.	Bread, Flour and cereal (Whole grain, enriched or restored)	Thiamine, Niacin, Riboflavin, Iron, Carbohydrate and Fibre.
7.	Butter or fortified margarine	Vitamin A and Fat

The 11-Food Group Plan

- The 11-food group plan was suggested by the U.S. Department of Agriculture in 1964. The foods in each of the 11 groups are given in table.

S.No	Food group
1.	Cereals and millets
2.	Pulses
3.	Nuts and oil seeds
4.	Vegetables
5.	Fruits
6.	Milk and milk products
7.	Eggs
8.	Meat, fish and other animal foods
9.	Fats and oils
10.	Sugar and other carbohydrate foods
11.	Spices and condiments

Functions of the nutrients

Nutrients are components of food that are needed by the body in adequate amounts in order to grow, reproduce and lead a normal healthy life. Nutrients include water, proteins, fats, carbohydrates, minerals and vitamins.

Carbohydrates: The chief function is to provide energy. Those which are not used immediately for this purpose are stored as glycogen or converted to fat and stored, to be mobilized for energy supply when needed.

Proteins: The main function of protein is building of new tissues and maintenance and repair body tissues. Proteins are precursors of regulatory and protective substances such as enzymes, hormones and antibodies. About 10 per cent of the total energy is supplied by proteins, therefore it is the secondary function of proteins. Proteins in excess of requirement can be converted to carbohydrates or fats and stored.

Fats: Fats are concentrated sources of energy, carriers of fat-soluble vitamins and essential fatty acids. If excess fats are supplied in the diet, these may be stored as fat

reserves in the body. When excess energy is supplied to the body, the carbohydrates, fats or proteins are stored as fat in the body.

Minerals: Functions include body-building (bones, teeth and structural parts of soft tissues) and regulation (e.g., muscle contraction).

Vitamins: Needed for growth and for regulation of body processes.

Water:An essential part of the body structure. It is a carrier of nutrients and a regulator of a number of body functions.

All individuals need the same nutrients for the body functions. The only variation is in the amounts of each nutrient required according to age, size, activity etc., For example, though all persons need energy for work, a man, who carries load (heavy worker) need more energy than a man who does desk job (sedentary worker).

Physiological functions of food

- The first function of the food is to provide energy. The body needs energy to sustain the involuntary processes essential for continuance of life, to carry out professional, household and recreational activities, to convert food ingested into usable nutrients in the body, to grow and to keep warm. The energy needed is supplied by the oxidation of the foods consumed.
- The foods we eat become a part of us. Thus one of the most important functions of food is building the body. A newborn baby weighing 2.7-3.2 kg can grow to its potential adult size of 55-60 kg if the right kind and amounts of food are eaten from birth to adulthood. The food eaten each day helps to maintain the structure of the adult body and to replace worn out cells of the body.
- third function of food is to regulate activities of the body. It includes regulation of varied activities such as:
- Heart beat

- Maintenance of the body temperature.
- Control of water balance
- Clotting of blood
- Removal of waste products from the body

The fourth function of food is to improve our body's resistance to disease.

Social Functions of Food

- Food has always been a central part of our social existence. It has been a part of our community, social, cultural and religious life. Special foods are distributed as a benediction or Prasad in the religious function in homes, temples and churches. Feasts are given at specific stages of life such as birth, naming ceremony, birthdays, marriages, etc. Most of the religious festivals also call for feasts and feeding of specific segments of the population. Certain menus are associated with most of these feasts in each region.

- Food has been used as an expression of love, friendship and social acceptance. It is also used as a symbol of happiness at certain events in life, for example, pedhas are distributed to announce success in examinations, or the birth of a baby: laddus are associated with the celebration of Deepavali and marriage, cakes are associated with Christmas and birthday and tilgul with sankranti the festival of friendship.

- As food is an integral part of our social existence, this function is important in daily life. Refreshment served at get-together or meetings create a relaxed atmosphere. The menu for such get-together should bring the people together, rather than divide them. This basic aspect should be considered in planning menus for such occasions.

Psychological Function of Food

- Psychological Function of Food. In addition to satisfying physical and social needs, food must satisfy certain emotional needs. These include a sense of security, love and attention. Thus familiar foods make us feel secure. Anticipating needs and fulfilling these are expressions of love and attention. These sentiments are the basis of the normal attachment to the mother's cooking.

- Sharing of food is a token of friendship and acceptance. In a friendly gathering we try unfamiliar foods and thus enlarge our food experiences. It must be noted that even a nutritionally balanced meal may not be satisfying to the individual, if the foods included are unfamiliar or distasteful to him/her. With time and repeated experience, strange foods become familiar and new tastes are formed.

- These aspects are important in food acceptance and must be considered in planning meals, which are not only nutritionally adequate, but also enjoyable for the group for whom they are intended.

Physical properties of solution

- A solution is a homogeneous mixture of two or more substances dissolved in a medium in which the molecules of dissolved substances are uniformly distributed in the solvent.

  Solubility The amount of solute that can be dissolved in a given amount of solvent at a given temperature is expressed as solubility.

  Hydration

  The attachment of molecules of the solvent to solute molecules of ions, by electrical attraction or chemical bonding. The water molecule is highly polar and so water is an excellent solvent for ionic substances. The salvation that takes place in this case is known as hydration.

Vapour Pressure

The intermolecular forces in a liquid prevent escape of most molecules from the surface.

Boiling Point

A liquid boils when its vapour pressure is equal to the external atmospheric pressure.

Freezing Point

A freezing point is the temperature at which the material changes from a liquid to a solid.

Osmotic Pressure

The flow of solvent into a solution, or from a more dilute solution to a more concentrated one, when the two liquids are separated from each other by a semi permeable membrane.

Viscosity

The internal friction which tends to bring to rest portions of the fluids moving relative to one another.

Surface and interfacial tensions

The boundary between a liquid and a gas or vapour is termed surface, whereas that of a liquid-liquid or solid-liquid junction interface.

Specific gravity

The density of one substance in relation to the density of another material is known as specific gravity.

Colloids

Colloid is classified into two groups viz., crystalloids and colloids, depending upon their ability to diffuse through parchment membrane. According to Graham, colloidal solutions contain substances whose molecular aggregates possess a diameter greater than 1 mμ and less than 100 mμ . If the particle size is greater than 100 mμ, a suspension is obtained.

Solution

The difference between true and colloidal solutions

Solution	Solute particle size
True solutions	Molecules and ions less than 1 mμ diameter.
Colloidal solutions	Molecular aggregates, diameter greater than 1 mμ but less than100 mm.
Suspenoids	Molecular aggregates – diameter greater than 100mμ

Classification

Colloids are classified into two groups

(1) Lyophobic colloids

(2) Lyophilic colloids.

- The lyophobic colloids which have no affinity for water (e.g. inorganic colloids) while the lyophilic organic colloids such as proteins, starch, etc. which have greater affinity for water.

Food Sols and Gels

- Colloidal dispersions of proteins or polysaccharides may be broadly divided into two groups (1) sols and (2) gels.
- Sols are free flowing liquids at room temperature while gels are relatively firm and do not flow from a spoon.

Food Sols

- Food sols are dispersions of colloidal particles with diameters 1 mμ to 100 mμ.
- Typical examples are solution of egg albumen in water and dilute solution of gelatin in water.

Rheology

- The viscosities of hydrophilic sols are much greater than that of water.
- The increase in the concentration of the colloids increases the viscosity of the sols.

Food Gels

- A food gel consists of a continuous phase of inter-connected macromolecules intermingled with a continuous liquid phase such as water.
- Common food gels are fruit jelly, gelatin gels and starch gels.
- Gels possess varying degrees of rigidity and elasticity, depending on the type and concentration of gelling agent.

Syneresis of gels

- The spontaneous exudation of liquid from a gel is called syneresis (weeping).
- This phenomenon occurs sometimes in fruit jellies due to defective formulation of the product

Emulsion

- ***Definition***
- When a liquid, e.g., oil is dispersed in another immiscible liquid, e.g., water (continuous phase) by mechanical agitation, an emulsion is obtained.

Emulsifying agent

An emulsifying agent is a surface active agent that lowers the interfacial tension and forms a physical barrier around each droplet of the dispersed phase.

Types of emulsion

Oil in water emulsion

Where the dispersed phase consists of droplets of oil dispersed in the continuous phase which is mainly water.

eg. Salad oil, Mayonnaise, milk, beverages, cream soups and ice-creams.

Water in oil emulsion

Where the dispersed phase consists of droplets of water dispersed in the continuous phase which is mainly oil. eg: Butter, margarine and egg yolk.

Multiple emulsions

The fat content of food emulsion like water in oil can be reduced by replacing some fat inside the oil droplets with small water droplets.

Water multiple emulsions

The substance within the droplets is referred to as the dispersed or internal phase, where as the substances that makes up the surrounding liquid is called continuous or external phase.

Foam

- "Foam is a dispersion of gas bubbles in a liquid or semi solid phase". Because of the foaming nature, the bubbles are separated from each other by liquid or semisolid wall also called film or lamellae that are elastic stable foams. The diameter of air bubbles varies widely.

Topic 2
Methods of Cooking

- Heat may be transferred to the food during cooking by conduction, convection, radiation or by the energy or microwaves – electronic heat transfer.
- Water or steam and air or fat or combination of these is used as cooking media.
- Moist heat involves water and steam.
- Air or fat are used in dry heat.
- Foods can also be cooked by microwaves.

Cooking

Cooking: The process of subjecting foods to the action of heat is termed as cooking.

Objectives of cooking

1. Improves the taste and food quality

For ex. roasting of groundnut and coffee seeds, frying of onions and papads, cooking meat with spices, frying cashew nuts in ghee, etc.

2. Destruction of microorganisms

Harmful microorganisms causes infections or produce toxins. Eg. *Clostridium botulism* and *Salmonella*. Some moulds produce toxin. Aspergillusflavus produces aflatoxin in groundnuts, cereals and spices. Cooking helps to destroy the harmful microorganisms eg in cooked meat.

3. Improves digestibility

Cooking softens the connective tissue of the meat and the coarse fibres of cereals, pulses and vegetables so that the digestive period is shortened and Gastro Intestinal tract is less subjected to irritation. Cooking improves the texture and hence it becomes more chewable. Cooking also bursts the starch digestion is easier, rapid and complete. When dry heat is applied to starches they are converted to easily digestible dextrins. Cooking increases the access to enzymes and improves digestibility.

4. Increases variety

By cooking, same food can be made into different dishes, for eg. rice can be made into plain,

bular, lemon rice, biriyani or combination withpulses into idli, wheat can be made into chapatis, bun, paratha or halwa.

5. Increase consumption of food

Cooking improves the texture and makes the food chewable. Improvement in texture and flavour by cooking increases the consumption of food to meet our nutritional requirement.

6. Increase availability of food

Raw egg contains avidin which binds biotin making biotin unavailable to the body. By cooking, avidin gets denatured and biotin is available to the body. Toxin substances from khesari dhal can also be removed by boiling in and throwing away the water. By reducing phytic acid, oxalic acid the availability of minerals can be enhanced.

7. Concentration of nutrients

This may be due to removal of moisture or using combination of foods or due to cooking procedures ex. Sweets, dehydrated foods, dry fruits.

Limitations of cooking

- Thiamine and vitamin C which is heat sensitive, may be lost during cooking. Water soluble vitamins are leached into the water during cooking. Vitamin A content may be reduced due to oxidation and heat.
- Quality of protein may be reduced due to destruction of certain amino acids during cooking eg. bread crust has less quality of proteincompared to the crumb.

Methods of Cooking

- Heat may be transferred to the food during cooking by conduction, convection, radiation or by the energy or microwaves – electronic heat transfer.
- Water or steam and air or fat or combination of these is used as cooking media.
- Moist heat involves water and steam.
- Air or fat are used in dry heat.
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Classification of cooking methods

I. Moist heat

- Boiling
- simmering
- poaching
- stewing
- blanching
- steaming
- pressure
- cooking

II. Dry heat

- Roasting
- grilling / broiling
- toasting
- baking
- sautering
- frying

III. Combination methods

Moist Heat Method

Boiling

- Boiling is cooking foods by just immersing them in water at 1000C and maintaining the water at that temperature till the food is tender.
- Foods that are cooked by boiling are rice, eggs, dhals, potatoes, meat, sago and beet root.
- Boiling can be done with excess of water (eggs, potatoes) or with sufficient water (dhal, upma).
- Boiling is generally used in combination with simmering or other methods, e.g. cooking rice, vegetables or dhal.

Advantages

- It is the simplest method. It does not require special skill and equipment.
- Soluble starches can be removed and rice grains are separated.
- Protein gets denatured, starch gets gelatinized and collagen gets hydrolysed.
- Uniform cooking can be done.

Disadvantages

- Loss of nutrients: If excess water is used in cooking and the water is discarded 30-70% water soluble nutrients may be lost. To prevent the loss, cooked water should be used in soups, rasam, sambar and dhal. Some protein may be lost if vegetablesare cooked in water containing salt and the cooking water is discarded. There is considerable loss of nutrients especiallysodium, potassium and calcium due to leaching.
- Loss of colour: Water soluble pigments, like betalains from beetroot may be lost.
- Time consuming: Boiling may take time and fuel may get wasted.
- Loss of flavour and texture: Boiled foods are not considered tasty because flavour compounds are leached into the water or volatile compounds gets evaporated. Over boiling of food may make the food mashy.

Simmering

- When foods are cooked in a pan with a well fitting lid at temperature just below the boiling point 82 – 92^{o}C of the liquid in which they are immersed the process is known as simmering.
- It is a useful method when foods have to be cooked for a long time to make it tender as in the case of cheaper cuts of meat, fish, cooking custard, kheer, vegetables and carrot halwa.This method is also employed in making soups.

Advantages

- Foods get cooked thoroughly
- Scorching or burning is prevented
- Losses due to leaching is minimum

Disadvantages

- There is loss of heat sensitive nutrients, due to long period of cooking.
- Takes more time and more fuel.

Poaching

- This involves cooking in the minimum amount of liquid at a temperature of 80-85°C, that is below the boiling point.
- Foods generally poached are eggs, fish and fruits.
- For poaching eggs, the addition of little salt or vinegar to the cooking liquid lowers the temperature of coagulation.
- Eggs cook quickly by poaching

Advantages

- Very quick method of cooking.
- Easily digestible since no fat is used.

Stewing

This is a gentle method of cooking in a pan with a tight fitting lid, using small quantities of liquid to cover only half the food.
The food above the liquid is cooked by the steam generated within the pan.
The liquid is brought to a boiling point and then the heat applied is reduced to maintain the cooking at simmering temperature ie. 980C.
Stewing is a slow method of cooking taking 2-4 hours depending upon the nature and volume of the foods being stewed.
This method is generally used for cooking cheaper cuts of meat along with some root vegetables and legumes all put in the same cooking pot and cooked in stock or water.
The larger cooking time and lower temperatures enable tougher meat fibres to become soft.
The cooking of meat and vegetables together make the dish attractive and nutritious since no liquid is discarded.
Apples can also be cooked by this method.

Advantages

- Retention of nutrients.
- Flavor is retained e.g. in making Oondhya.
- The vegetables are stewed by which flavour is retained.

Disadvantages

- Time consuming.

Disadvantages

- It is bland in taste.
- Water soluble nutrients may be leached into the water

Steaming

- This method requires the food to be cooked in steam.
- This is generated from vigorously boiling water or liquid in a pan so that the food is completely surrounded by steam and not in contact with the water or liquid.
- Hence the food gets cooked at 100°C.
- Steaming is generally done in idli cooker.

There are 2 types of steaming

a. Wet steaming

- Here the steam is in direct contact with the food e.g. idli.

b. Dry steaming

- Here double boiler is used for cooking the food.
- Double boiling is cooking in a container over hot or boiling water.
- This process is used for such preparations as sauces and custards where temperatures below boiling point are desirable.
- The food is placed in a utensil which is kept in another utensil containing water.
- When the water is heated or boiled the food gets cooked.
- Recipes made by steaming are idli, dhokla, rice (or) ragiputtu, idiappam, appam, kolukattai and custards.

Advantages

1. It does not require constant attention.
2. Nutritive value is maintained because there is no leaching and cooking time is less.
3. Easily digestible since not much fat is added. It is good for children and patients.
4. There is less chance for burning and scorching.
5. In double boilers sudden increase in temperature in making custards and overflow of milk can be avoided.
6. Texture of the food is better and becomes light and fluffy.
7. Steamed foods have good flavour.

Disadvantages

1. Special equipment is required.
2. Many foods cannot be prepared by this method eg. rice.

Pressure cooking

- A relatively small increase in temperature can drastically reduce cooking time and this fact is utilized in pressure cooker.
- In pressure cooking, escaping steam is trapped and kept under pressure so that the temperature of the boiling water and steam can be raised above 1000C and reduce cooking time.

Advantages

1. It takes less time to cook.
2. Different items may be cooked at the same time.
3. Fuel is saved.
4. Requires less attention.
5. Nutrient or flavour loss may be less.
6. Food is cooked thoroughly by this method.
7. There is an indication for the completion of cooking.
8. There is less chances for scorching or burning.

Disadvantages

1. Thorough knowledge of using the equipment is required.
2. There may be mixing of flavours.
3. Foods may be undesirably soft.
4. Foods cooked in pressure cooker are rice, dhal, vegetables and meat.

Dry heat methods

- In this method either **air or fat** is used as the medium of cooking.

Air as medium of cooking

Grilling (or) Broiling

- Grilling consists of placing the food below (or) above (or) in between a red hot surface.
- When under the heater, the food is heated by radiation only.
- This results in the browning of foods.
- Then the heat is more slowly conducted through the surfaces of the food downward.
- As heating is mostly superficial, grilled foods are usually reversed or rotated.
- If the food is above the heater, heat is transmitted to the food through convection currents as well as radiations.
- This will consequently increase efficiency.
- Foods cooked by grilling are cob of the corn, papad, brinjal, phulkas and sweet potato.

Toasting

- The term toasting is used to describe a process by which bread slices are kept under the grill or between the two heated elements to brown from both sides of the bread at the same time.
- This can be adjusted to give the required degree of brownness through temperature control.

Advantages

1. Quick method of cooking.
2. Less or no fat is required.
3. Flavour is improved.

Disadvantage

1. Constant attention is required to prevent charring.
2. Reduce protein quality due to browning and loss of lysine

Pan broiling (or) Roasting

When food is uncovered on heated metal or a frying pan the method is known as pan broiling. e.g. groundnuts and chapathi.

Advantages

1. Improves the colour, flavour and texture of the food.
2. Reduces the moisture content of the food and improves the keeping quality e.g. rava.
3. It is easy to powder e.g. cumin seeds and coriander seeds after roasting.
4. It is one of the quick methods of cooking foods.

Disadvantages

1. Constant attention is required
2. Losses of nutrients like amino acids occur when the food becomes brown

Baking

- Here the food gets cooked by hot air.
- Foods baked are generally brown and crisp on the top, soft and porous in the centres, e.g. cakes, pudding and breads.
- The principle involved in baking is the air inside the oven is heated by a source of heat either electricity (or) gas and wood in the case of tandoori.
- The temperatures that normally maintained in the oven are 120^{o}C – 260^{o}C.
- Foods prepared by baking are custards, pies, biscuits, pizzas, puffs, buns, bread, cakes, tandoori chicken, meat and fish.

Advantages

1. Flavour and texture are improved.
2. Variety of dishes can be made.
3. Uniform and bulk cooking can be achieved e.g. bun and bread.

Disadvantages

1. Special equipment and skill are required.
2. Source of trans fat if hydrogenated fats are used.

Fat as a medium of cooking

Sautering : This method involves cooking in just enough of oil to cover the base of the pan (greasing the pan) e.g. dosa. The food is tossed occasionally or turned over with a spatula to enable all the pieces to come in contact with the oil and get cooked evenly. Sometimes the pan is covered with lid, reducing the flame and allowing the food to be cooked till tender in its own steam. The product obtained in cooking by this method is slightly moist, tender but without any liquid or gravy. Foods cooked by sautéring are generally vegetables used as side dishes in a menu. The heat is transferred to the food mainly by conduction.

Frying : Two types : Shallow fat frying and deep fat frying.

a. Shallow fat frying: Here the food is cooked in larger amounts of fat but not enough to cover it. Heat is transferred to the food partially by conduction by contact with the heated pan and partially by the convection currents of the foods. This prevents local burning of the food by keeping away the intense heat of the frying pan. e.g. paratha, chapatti, cashewnuts, potatoes, fish, cutlets and tikkis.

b. Deep fat frying : Food is totally immersed in hot oil and cooked by vigorous convection currents and cooking is uniform on all sides of the foods. Cooking can be rapidly completed in deep fat frying because the temperature used is $180^{o} – 220^{o}C$. In most foods, this high temperature results in rapid drying out of the surface and the production of a hard crisp surface, brown in colour. The absorption of fat by the food increases the calorific value of the food. Fats when heated to smoking point decompose to fatty acids and glycerol followed by the decomposition of glycerol to acrolein, which causes irritation to the eyes and nose. Generally 10% of oil is absorbed but larger amount of fat is absorbed when oils are used repeatedly. Samosa, papad, chips, poori, muruku, pakoda, bajji and bonda are made by deep fat frying.

Advantages

1. Taste is improved, along with the texture.
2. Increases the calorific value.
3. Fastest method of cooking.
4. In shallow fat frying the amount of oil consumption can be controlled.
5. Fried foods have greater shelf life.

Disadvantages

6. Sometimes the food may become oily or soggy with too much absorption of oil.
7. More attention is required while cooking and care should be taken to avoid accidents.
8. The food becomes very expensive.
9. Fried foods take long time to digest.
10. Repeated use of heated oils may produce harmful substances and reduce the smoking point.

Combination of cooking methods

Braising: Braising is a combined method of roasting and stewing in a pan with a tight fitting lid. The meat should be sealed by browning on all sides and then placed on a lightly fried bed of root vegetables. Stock or gravy is added to 2/3 of the meat. Flavourings and seasonings are added and allowed to cook gently.
Many food preparations are made by not only single method but by a combination of cooking methods.

- Vermicelli payasam - Roasting and simmering
- Vegetable curry - Sautering and simmering
- Upma - Roasting and boiling
- Meat cutlet - Boiling and deep frying
- Vegetable pulav - Frying and simmering

Microwave cooking : In microwave cooking heat is generated within the food and the dramatic reduction in cooking time is the main advantage of this method of cooking.

Microwave cooking

The essential component of a microwave oven is a magnetron which converts electrical energy into microwave energy. The microwaves can be absorbed, transmitted or reflected.
They are reflected by metals and absorbed by food. When food is kept in the cavity of the microwave oven for cooking, the microwaves generated by the magnetron strike the food and the metal walls of the oven. Microwaves that strike the metal walls are reflected and bounced back so they disperse throughout the oven and accomplish uniform heating of the food.

Advantages ; They cook many foods in about ¼th of the time necessary on a gas burner. There is no wastage of energy.It saves time in heating frozen foods. Thawing can be done in minutes or seconds.Only the food is heated during cooking. The oven or the utensil does not get heated except under prolonged heating periods.
Flavour and texture do not change when reheated to a microwave oven.
Loss of nutrients is minimized.After cooking in a microwave oven washing dishes is much easier as food does not stick to the sides of the vessels.
Food gets cooked uniformly.Preserves the natural colour of vegetables and fruits.

Disadvantages

Due to short period of cooking, food does not become brown and crispness unless the microwave has a browning unit.
It is not possible to make chapathi or tandoori rotis in it. It cannot cook soft or hard boiled eggs.Deep frying cannot be done.
The short cooking time may not give a chance of blending of flavours as in conventional methods.The operator should be careful in operating the microwave oven since any exposure to microwave oven causes physiological abnormalities. If the food is greater than 80mm the control portion is out of range of the microwave radiation will only heat by the normal slow process of conduction. It will be relatively uncooked while the extension accessible to microwave is cooked in minutes or seconds.

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Topic 3

NUTRITION – RELATION TO GOOD HEALTH, CHARACTERISTICS OF WELL AND MALNOURISHED POPULATION

Functions of proteins

DEFENITION

Digestion & Absorption

- The digestion of proteins takes place in the stomach and intestines. As a result of digestion, the proteins are broken down to amino acids and absorbed.

Gastric digestion

- The proteolytic enzyme present in gastric juice is called as pepsin which acts on proteins in an acid medium and hydrolyse them to simpler compounds known as polypeptides.

Intestinal digestion

- The digestion of proteins is further carried out in the intestines by the action of proteolytic enzymes (trypsin, chymotrypsin and peptidase) present in pancreatic and intestinal juices.
- The polypeptides produced by gastric digestion are hydrolysed to free amino acids by the above enzymes.
- The amino acids are absorbed in the small intestine and enter the blood circulation through the portal vein.

NUTRITION

- It refers to the process in the body for making use of the food which includes the correct kinds and amount of food required for the body needs like digestion, absorption of nutrients into the blood stream, utilization of the nutrients and elimination of waste.

HEALTH

- World Health Organization defines health as “the state of complete physical, mental and social well being and not merely the absence of disease or infirmity”.

Nutritional status

- Nutritional status is the condition of the body as influenced by the food .Dietitians and physicians can observe physical signs that suggest good or poor nutrition as listed in the table.

- **Characteristics of well and malnourished population**

Criteria	Well nourished child	Poorly nourished child
Hair	Bright, black, shiny and glossy	Brown, sparse and thin
Ear	Clear, free from discharge	Infected running ear
Eyes	Bright with clear vision	Poor vision, Infected eye
Nose	Clear, free from any discharge	Running nose
Mouth	Bright, without any infection	Sores (Angular stomatitis at the corners of the mouth)
Teeth	Regular, without any decay	Irregular with decayed teeth
Gums	Bright, healthy looking	Bleeding or swollen gum
Position of the head	Straight looking	Mal functioning
Shoulders	Erect	Mal formation or irregular
Hands/ Nails	Bright, pink in colour	Spoon shaped nails, cracked nails
Abdomen	Regular	Protruding belly
Legs	Straight	Bow legs, knock knees

Relation of nutrition to health

- Food is essential for human existence just like the air we breathe or the water we drink.
- The food that we eat is utilized in the body and the assimilated substances are used for the growth and maintenance of tissues.
- A living organism is the product of nutrition.
- The human being requires more than 45 different nutrients for its well being.
- Food materials ingested by the body are digested, absorbed and metabolized.
- Useful chemical substances derived from food by the body are called nutrients.
- A number of foodstuffs have to be selected to get all the nutrients.
- The health of a person depends on the type and quality of foodstuff he chooses to make his diet.
- For sustaining healthy and vigorous life, diet should be planned according to the principles of nutrition.
- Extensive research work carried out on human beings and on experimental animals throughout the world has provided us with sufficient knowledge on nutrition and health.

Topic 4

ENERGY – DEFINITION, DETERMINATION OF ENERGY REQUIREMENTS

Functions of proteins

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DEFINITION

- Energy is defined as the capacity for doing work.
- The energy contained within the chemical constituents of food can be either trapped in the body or used to produce heat or allow the body to move.
- So energy in nutrition is focused on chemical energy and the kinetic energy of motion.
- The energy value of food is expressed in kilocalories.
- Kilo calorie can be defined as 'heat required to raise the temperature of one kg of water through one degree celsius'

Inter conversion factors

The inter conversion factors are

- 1 K.cal = 4.184 J
- 1000 K.cal = 4.184 KJ
- 1000 K.cal = 4.184 MJ
- 1KJ = 0.239 K.cal
- 1MJ = 239 K.cal
- 100 MJ = 23900 K.cal

Thermic effect of food / Specific Dynamic Action (SDA)

Energy requirement is affected by the type of food ingested. The extra heat which is produced after taking food is known as the specific dynamic action.

- The stimulating effect of carbohydrates, fats and protein on energy metabolism is different.
- Protein foods produce the highest per cent increase in energy metabolism.
- The SDA of protein is about **30 per cent** while carbohydrates and fats exert 6 per cent and 4 per cent respectively.
- The average SDA of a mixed diet is about **8-10 per cent.**

Determination of Energy Requirements of the Body

The amount of energy released from foods and the amount of energy expended by an individual can be obtained by direct and indirect calorimetry methods. The amount of energy released from foods and the amount of energy expended by an individual can be obtained by direct and indirect calorimetry methods.

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Direct Calorimetry

- The chemical changes that occur when carbohydrate or fat oxidized during respiration in the body are identical overall to the chemical changes, when the chemicals are burnt in air.
- This is the principle of direct calorimetry. The amount of energy released or expanded is measured by the heat produced.
- In this method the amount of heat produced by the body is measured directly.
- At Water-Rosa, Benedict perfected the human respiration calorimeter. To measure the heat production in an individual, a specially constructed chamber, called a respiration calorimeter is used.
- It is determined through the relation between energy output and oxygen consumed in a person in the calorimeter.
- Respiration calorimeter consists of an airtight copper chamber insulated by wooden wall with air space in between.
- Enough provision for sitting or to lie down is made through a folding bed, chair and table.
- Food is provided through the opening at one end and the excreta is removed through another opening.
- The chamber is very well arranged for the individual to relax, read or write.
- It is insulated to prevent the entry and exit of heat through the walls.
- The chamber is ventilated by a current of air; the CO_2 and water given off are removed by soda lime and sulphuric acid respectively.
- For oxygen supply, a known amount of oxygen is introduced to the chamber through a gas metre with an air current.
- The oxygen consumption and CO_2 production are calculated using a formula.
- The heat produced is also measured by circulating a current of water through copper pipes and measured the quantity of water that has been circulated through the chamber and also the difference between the temperature of the water entering and leaving the chamber.

Respiratory Quotient

- Respiratory Quotient is the ratio between the volume of CO_2 given out and the volume of O_2 consumed by the human subjects.

$$\text{Respiratory Quotient (RQ)} = \frac{\text{Volume of } CO_2 \text{ produced}}{\text{Volume of } O_2 \text{ consumed}}$$

- The RQ varies with the type of food being oxidized.
- When glucose is oxidized RQ is 1, for a fatty acid it is 0.7 and for protein it is 0.8.
- Under resting condition with no food for 12-14 hours the RQ is 0.82.
- In this condition carbohydrate, fats and protein present in the body are utilized.

Indirect Calorimetry

- Indirect Calorimetry is based on the principle that when an organic substance is completely combusted either in calorimeter or in the human body, oxygen is consumed in amounts directly related to the energy liberated as heat.
- In this method oxygen consumed and carbon dioxide excreted in a given time under basal condition is measured.
- Many experiments on people of different ages have shown that 1 litre of oxygen is equal to 4.825 kcals when the person is in Basal Metabolic condition.
- The basal metabolic rate is measured by indirect calorimetry.
- The person has to observe certain conditions before measuring the basal metabolic rate.

They are:

1. In a post-absorptive state i.e., 12-16 hours after the last meal preferably in the morning.
1. In a reclining state but awake.
2. Before the test the person must take one hour rest if he is engaged in any work.
3. Relaxed and free from emotional upset, excitement or fear.
4. Body temperature must be normal
5. Room temperature must be comfortable.

- In these favourable conditions the BMR is measured.
- For an adult man the BMR rate is 34.2-36.7 kcals/sqm/hr.
- For an adult woman 30.9-35.1 / kcals/sqm/hr.
- For 7-8 years boys it is 49.1 / kcals / sqm/hr.

- For girls it is 45.2 / kcals/sqm/hr.
- For children it is more.

Determination of Basal Metabolism

- The amount of energy required to carry on the involuntary work of the body is known as basal metabolic rate.
- Basal metabolism is usually determined using the apparatus called **Benedict and Roth Apparatus.**
- The apparatus is a closed circuit system in which the subject breathes in oxygen from a metal cylinder of about 6-litre capacity and CO2 produced is absorbed by soda-lime present in the tower.
- The oxygen cylinder floats on water present in an outer tank.
- The subject wears a nose clip and breathes through a mouthpiece the oxygen present in the cylinder for a period of 6 minutes.
- The volume of O2 used is recorded on a graph paper attached to a revolving drum by a pen attached to it.
- Since the subject is in the post-absorptive state, R.Q. is assumed to be 0.82 and the calorific value of one litre of O2 consumed is taken as 4.8 Kcal.

Example

Subject: Adult male, 50 kg body weight.

Oxygen consumed in 6 minutes = 1,100 ml

Heat produced in 6 minutes = 4.8 x 1.1 = 5.28 Kcal

Heat produced in 24 hours = 5.2 x 10 x 24 = 1,267 Kcal

The basal metabolism of an individual for 24 hours = 1,264 Kcal.

Factors affecting the BMR

There are many factors that determine the basal metabolic rate of an individual

Size

Since the heat loss in body is proportional to the skin surface, a tall and thin person has greater surface and thus higher basal metabolic rate compared to the short person. The body composition shows variations in energy use. With little fat deposition in the body the basal metabolic rate increases and thus a tall, thin person has higher rates of basal

metabolism compared to a short fat man. Constant muscular activities of an athlete demand about 5 per cent more basal metabolic rate.

Sex

Sex also makes a variation in energy requirement. The metabolic rate of women is 6-10 per cent lower than that of men.Growth period During the growing period the basal metabolic rate and the energy requirement are increased. The highest BMR is during the first two years. After the growth period, especially after 25 years of age, there is a decline in energy requirement.

Endocrine glands: The thyroid gland exerts influence over energy requirements. Thyroid hyper activity will speed up basal metabolism. The pituitary gland also increase the metabolic rate. If there is disturbance in adrenalin the BMR increases.

Nutritional status: During undernourishment the basal metabolic rate also declines to an extent of thirty per cent.Pregnancy: During pregnancy the basal metabolic rate is increased by about 5 per cent during the first and second trimester and 12 per cent during the third trimester.

Sleep: During sleep the BMR is less than in the waking state. Sleep decreases BMR by 10 per cent.

Climate: Climatic conditions of the environment also affect the energy requirement. If the temperature falls below 140C the energy requirement increases.

Body temperature: Fever increases the BMR. Every one degree celsius increase in temperature increases BMR by 7 per cent.

Disease conditions: Disease like typhoid fever, medullary diseases and lymphatic leukaemia show an increases in the BMR

Physical activities: Physical activities half an hour before BMR measurement show high rates of BMR

Determination of Energy Value of Food

Determination of energy value of food

Bomb Calorimeter

The energy value of foods is usually determined using the instrument called **bomb calorimeter.**

- It consists of a heavy steel bomb, with a platinum or gold-plated copper lining and a cover held tightly in place by means of a strong screw collar.
- A weighed amount of sample, usually pressed into pellet form, is placed in a capsule within the bomb which is then closed except for the oxygen valve, charged with oxygen to a pressure of about 300 pounds to the square inch.
- The oxygen valve is then closed and the bomb immersed in a weighed amount of water.
- The water is constantly stirred and its temperature taken at intervals of one minute by means of a differential thermometer, capable of being read to one thousandth of a degree.
- After the temperature of the water has been determined, the sample is ignited by means of an electric fuse and on account of the large amount of oxygen present; it undergoes rapid and complete combustion.

The heat liberated is absorbed by the water in which the bomb is immersed and the resulting rise in temperature is accurately determined.

- The thermometer readings are also continued through an 'after period', in order that the 'radiation correction' may be calculated and the observed rise of temperature corrected accordingly.
- This corrected rise, multiplied by the total heat capacity of the apparatus and the water in which it is immersed, gives the total heat liberated in the bomb.
- From this, the heat arising from accessory combustions (the oxidation of the iron wire used as a fuse etc.) must be deducted to obtain the number of calories arising from the combustion of the sample.

Example

- Weight of sample taken = 2 g.
- Weight. of water in the outside vessel = 3,000 g
- Water equivalent of the calorimeter = 500 g
- Initial temperature of water = 24^{o} C.
- Final temperature of water = 26^{o}C

- Rise in temperature = 2°C\
- Heat gained by water and calorimeter = 3, 500 x 2 = 7,000 calories or 7 Kcal
- 2 g sample produces 3.5 Kcal.
- 1 g sample produces = 3.5 Kcal.

Gross fuel value of foods

- The amount of energy release from the nutrients in bomb calorimeter or oxy calorimeter is known as gross fuel value.
- 1 g carbohydrate 4.1 Kcal
- 1 g fat 9.45 Kcal
- 1 g protein 5.65 Kcal

Physiological fuel value of foods

- The amount of energy actually available in the body from a given amount nutrient is known as physiological fuel value.
- 1 g carbohydrates 4.0 Kcal
- 1 g fat 9.0 Kcal
- 1 g protein 4.0 Kcal

Topic 5

CARBOHYDRATES – CLASSIFICATION, PROPERTIES, FUNCTIONS

SOURCES AND REQUIREMENTS

- Carbohydrates are compounds which contain carbon, hydrogen and oxygen.
- Oxygen and hydrogen are present in carbohydrates in the same proportion as in water.
- They are the main sources of energy for our body and the only source of energy for our nervous tissues.

Classification of Carbohydrates

Carbohydrates are widely distributed in plants in which they are formed from carbon dioxide of the atmosphere by photosynthesis. They may be broadly classified as follows.

1. Monosaccharides

- Biose $C_2H_4O_2$ eg: Glycolic aldehyde
- Trioses $C_3H_6O_3$ eg: Glyceraldehyde &dihydroxy acetone
- Tetroses $C_4H_8O_4$ EgErythrose, threose
- Pentose $C_5H_{10}O_5$ Eg Arabinose, xylose, ribose &deoxyribose
- Hexoses $C_6H_{12}O_6$ Eg Glucose, fructose &galactose

2.Disaccharides

- $C_{12}H_{22}O_{11}$ eg: - Sucrose, lactose & maltose

3.Polysaccharides

- a) pentosans

eg: Arabon, xlyan

b) Hexosans

- Starch, dextrin, glycogen
- Cellulose, inulin, mannan&galactan

4. Complex polysaccharides

- Hemicellulose, gums, mucilages and pectins

Functions of carbohydrates and sources

Carbohydrates have a variety of functions in the animal and human body.

i. Supply energy for body functions and for doing work.
ii. Essential for the oxidation of fats
iii. Exert a sparing action on proteins.
iv. Provide the carbon skeletonfor the synthesis of some non-essential amino acids
v. Present in tissue constituents.
vi. Add flavour to the diet.

Sources

Best sources: Rice, wheat, ragi, maize, potato, tapioca, sweet potato, yam and colocasia, pulses, sugar and jaggery, honey, fruit andvegetables.
Good sources: Banana, apple, plantain, dried fruits
Requirements
Dietary reference intake
45% to 65% of an adult total caloric intake should come from carbohydrate foods.
Means 225 to 325g of CHO for a 2000kcal/day diet

Recommendedfiber: choosing carbohydrates contain whole grain cereals, legumes, vegetables, & fruits.
Sugars no more than 25% of total calories.

Dietary guidelines
As in food guide pyramid: grains, fruits, & vegetables are the foundation of a healthy diet.

Topic 6

CARBOHYDRATES –DIGESTION, ABSORPTION AND UTILIZATION

Digestion and absorption of carbohydrates

- The first stage in the digestion of carbohydrates takes place in the mouth when the food is chewed.
- The saliva contains an alpha amylase called ptyalin.
- This enzyme acts on starch splitting it into dextrin and maltose.
- Amylase acts best at neutral pH.
- As soon as the food reaches the stomach it mixes with the acidic gastric juice and amylase activity is inhibited.
- The digestion of carbohydrates is mainly accomplished in the small intestines where they are subjected to the action of pancreatic amylases and intestinal amylase, sucrase, lactase, maltase and isomaltase present in the intestinal juice.

Starch ---------->maltose + isomaltose

Amylase from saliva, pancreatic and intestinal juise

Maltose ----------> glucose

Maltase

Isomaltose ----------> glucose

Isomaltase

Sucrose ----------> glucose + fructose

Sucrase

Lactose ---------->glucose+galactose

Lactase

- The ultimate products of digestion of carbohydrate are glucose, fructose and galactose. These are absorbed in the intestines. The non-digestible carbohydrates present in the food like cellulose, hemicellulose, pentosans, galactans, fructosans etc., are not acted upon by the digestive juices. They add bulk to the contents of large intestine and are excreted in the faeces. Some of these are fermented by bacteria present in the large intestine.

Metabolism of carbohydrates

- Glucose, galactose and fructose absorbed in the intestines pass through the portal circulation to the liver. In the liver a part of the glucose and the entire galactose and fructose are converted into the general circulation and to the various tissues for being oxidized and used as energy. A small part of glucose is stored in liver and muscle as glycogen and some portion of the glucose is converted into fat stored in adipose tissue. The oxidation of glucose in the issues occurs into 2 stages as indicated below:-
  - The first stage is called glycolysis. The oxidation of pyruvic acid takes place through a series of reactions known as tricarboxylic acid cycle (Kreb's cycle)

Regulation of blood sugar

- If the blood glucose level reaches above 180 mg/100 ml (renal threshold level) glucose is excreted in urine. This condition is known as diabetes mellitus.

Diabetes mellitus

- It is a chronic disease in which blood glucose level is raised above 180 mg per 100 ml of blood and glucose is excreted in urine. This disease is primarily due to the insufficient production of the hormone insulin by the beta cells of the islets of langerhans of the pancreas.

Topic 7

PROTEIN –CLASSIFICATION, PROPERTIES, FUNCTIONS, SOURCES REQUIREMENTS

Proteins

- Proteins contain carbon, hydrogen, nitrogen, sulphur and sometimes phosphorous. Proteins are large molecules formed from the combination of number of simple substances known as amino acids, the building blocks.
  - **Structure of protein** (Primary structure, secondary structure, tertiary structure and quaternary structure)
  - Proteins are large molecules formed by the combination of a number of amino acids. About 21 amino acids have been found to occur in proteins they are listed below.
  - Mono amino – mono carboxylic acids. These include glycine, alanine, valine, leucine, isoleucine, moleucine, serine and threonine.
  - Mono amino – dicarboxylic acids. These include aspartic acid and glutamic acid.
  - Diamino – monocarboxylic acids. Arginine and lysine belong to this group.
  - Sulphur containing amino acids. These are cystine, cysteine and methionine
  - Aromatic and heterocylic amino acids. These include phenylalanine, tyrosine, histidine, tryptophan and hydroxyproline.

The main type of linkage between the amino acids in the protein molecule is the peptide bond.When proteins are heated, decrease in their solubility is observed. This is known as *denaturation*.

Classification of proteins

Proteins are biochemically classified into three groups based on their chemical composition. They are simple proteins, conjugated proteins and derived proteins.**1.Simpleproteins**

On hydrolysis simple proteins yield only amino acids.eg. Albumins, globulins, glutelins, prolamins, fibrous protein and histamines

2. Conjugated Proteins

On hydrolysis conjugated proteins give a protein fraction and a non-protein fractioneg. haemoglobin, nucleoprotein, glycoprotein and lecithoprotein

3. Derived Proteins

Derived proteins are derived from a mother protein either through hydrolysis or digestioneg. metaprotein, coagulated proteins, peptides and peptones

Nutritional classification of Proteins

Proteins are classified into complete proteins, partially incomplete proteins and

incomplete proteins based on the presence of essential amino acids in them.

Complete Protein

A complete protein food contains all essential amino acids in proper proportion. It helps the protein to promote growth, maintenance and repair,eg. Milk, egg and fish

Partially Incomplete Proteins

Partially incomplete proteins lack one or more essential amino acids and hence will help to maintain the body but cannot promote growth. eg: red gram, peas and green gram

Incomplete proteins

Incomplete proteins neither help maintenance nor growth. eg. Zein in maize

Nutritional classification of amino acids

Essential amino acids

Essential amino acids are ones that cannot be synthesized by the body at a rate sufficient to meet the needs for growth and maintenance.
eg. Histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine

Non essential amino acids

Non essential amino acids are ones that the body can make in adequate amounts if nitrogen is available in the diet.
eg. Alanine, aspartamine, aspartic acid, glutamic acid, glutamine and serine

Conditionally essential amino acids

Conditionally essential amino acids are needed in the diet unless precursors are available for the synthesis. The new born may not have enzymes in adequate amounts to synthesize nonessential amino acids or in intestinal metabolic dysfunction arginine may not be synthesized.
eg. Histidine, arginine, cysteine, glycine, proline and tyrosine

Functions of proteins

The important functions of dietary proteins are

i) To replace the daily loss of body proteins

ii) To provide amino acids for the formation of tissue proteins during growth

iii) To provide amino acids necessary for the formation of enzymes, blood proteins and certain hormones of protein nature and

iv) To provide amino acids for growth of fetus in pregnancy and for the production of milk proteins during lactation.

Properties

Amphoteric nature

Like amino acids, proteins are amphoteric, that is, they act as both acids and bases. Since proteins have electric charges, they migrate in an electric field, the direction of migration depending on the net charge on the molecule. For each protein, there is a pH at which the positive and negative charges will be equal and protein will not move in an electric field. This pH is known as the isoelectric point of the protein.

Solubility

Each protein has a definite and characteristic solubility in a solution of known salt concentration and pH. Albumins are soluble in water. Globulins are soluble in neutral sodium chloride solutions but are almost insoluble in water.

Colloidal nature of protein solutions

Proteins have large molecular weights. Protein solutions are colloids. They do not pass through semi permeable membranes. This property of proteins is of great physiological importance

Sources

Best sources: Meat, fish, poultry, eggs, milk and milk products

Good sources: cereals and legumes

Requirements - RDA

Children g/day

1-3 years - 16.7

4-6 years - 20.1

7-9 years - 29.5

Boys

10-12 years - 39.9

13-15 years - 54.3

16-18 years - 61.5

Girls

10-12 years - 40.4

13-15 years - 51.9

16-18 years - 55.5

Adult man - 60

Adult woman - 55.5

Pregnant woman - 82.2

Lactation - 77.9

Topic 8

PROTEIN – DIGESTION AND ABSORPTION, QUALITY OF PROTEINS AND DEFICIENCY DISEASES

Functions of proteins

DEFENITION

Digestion & Absorption

- The digestion of proteins takes place in the stomach and intestines. As a result of digestion, the proteins are broken down to amino acids and absorbed.

Gastric digestion

- The proteolytic enzyme present in gastric juice is called as pepsin which acts on proteins in an acid medium and hydrolyse them to simpler compounds known as polypeptides.

Intestinal digestion

- The digestion of proteins is further carried out in the intestines by the action of proteolytic enzymes (trypsin, chymotrypsin and peptidase) present in pancreatic and intestinal juices.
- The polypeptides produced by gastric digestion are hydrolysed to free amino acids by the above enzymes.
- The amino acids are absorbed in the small intestine and enter the blood circulation through the portal vein.

Protein metabolism

The metabolism of proteins can be conveniently discussed under the following heads.

Breakdown and synthesis of tissue proteins

- Nitrogen balance
- Oxidation of amino acids

1)Breakdown and synthesis of tissue proteins

Recent studies have shown that breakdown and synthesis of tissue proteins proceed simultaneously. A part of the tissue protein broken down continuously is replaced by the formation of new tissue proteins from the amino acids supplied by the diet. The breakdown of tissue protein is 'catabolism' and the formation of new tissue proteins is called 'anabolism'

2)Nitrogen balance

When a subject is on a protein free diet, the tissue proteins are broken down and the resulting amino acids are oxidized and the nitrogen is excreted in urine. The nitrogen lost in urine and feces on a protein free diet is called "endogenous nitrogen", it is derived from the body. Whenprotein is taken in the diet, new tissue proteins are formed. When the nitrogen intake equals the nitrogen lost from the body through urine and faces, the body is said to be in a state of nitrogen equilibrium. When the nitrogen lost from the body is less than that of the nitrogen intake, the body is in 'positive' nitrogen balance. In this case the nitrogen is retained to form new tissues, as for example during growth of the body. If the nitrogen lost from the body is higher than the nitrogen intake, the body is said to be in the 'negative nitrogen balance'. Under the above conditions the body proteins are slowly depleted. Negative nitrogen balances occur in under nutrition, fever, starvation etc.

3)Oxidation of amino acids

The amino acids not utilised for the formation of tissue proteins are oxidised by enzymes in the liver as indicated below

Amino acid ---------->keto acids + NH_3

oxidation

The ammonia thus formed is converted into urea in the liver and excreted in the urine. The keto acids are oxidized to yield energy.

Quality of Proteins

It is evident that the nutritive value of proteins will depend on the essential amino acids composition.

Quality of protein is affected by the amino acid content, amino acid imbalance, interference of non available carbohydrates and trypsin inhibitors and influence of heating and processing.

Biological Assays

In this method the Digestibility Coefficient (DC) and Biological Value (BV) of the protein can be determined using rats or humans. Proteindigested is expressed in terms of 'digestibility coefficient'.

$$DC = \frac{\text{Protein intake (g)} - \text{protein lost in digestion (g)} \times 100}{\text{Protein intake (g)}}$$

Protein intake

The term BV. refers to the percentage of digested protein utilized by the body.

$$BV = \frac{\text{Protein digested (g)} - \text{protein lost in metabolism (g)} \times 100}{\text{Protein digested (g)}}$$

Net Protein Utilization (NPU)

The net protein utilization takes into account the losses in digestion and metabolism. It is calculated by the following formula.

$$NPU = (\text{Digestibility coefficient} \times \text{Biological value}) / 100$$

Net Protein Ratio (NPR)

The net protein ratio is calculated by adding the loss in weight of the control group to the gain in weight of the test group and dividing the total weight (g) by the quantity of protein consumed by the test group

$$NPR = \frac{\text{Gain in weight (g) of the test group + loss in weight (g) of the non protein group}}{\text{Protein intake (g) of test group}}$$

Protein Efficiency Ratio (PER)

This method measure the ability of protein to promote the growth. PER is expressed as gain in weight of albino rats for every gram of proteinconsumed. Protein efficiency ratio (PER) as follows

$$\text{PER} = \frac{\text{gain in body weight (g)}}{\text{Protein intake (g)}}$$

Chemical score

The chemical scoring is one of the easiest methods if appropriate instruments for measuring amino acid content of a protein are available. The chemical score for a protein is arrived at by determining the most limiting amino acid for that protein by comparing it with standardprotein like hen's egg protein.

$$\text{Amino acid score} = \frac{\text{mg amino acid/ g test protein}}{\text{mg amino acid/ g reference protein}} \times 100$$

Information on the most limiting amino acid, is generally sufficient to arrive at the chemical score.

Supplementary / complementary value of proteins

If the protein of the diet is seriously deficient in one or more of the essential amino acids, nitrogen equilibrium cannot be sustained, no matter how complete and excellent the diet may be in other respects.

If, however, another protein containing the missing amino acids in adequate amounts is added to the diet, nitrogen equilibrium and normalnutrition can be established.

This capacity of proteins to complement and supplement each other is known as complementary or supplementary value.

Deficiency Diseases

Protein Energy Malnutrition (PEM)

The deficiency of proteins accompanied by that of energy is one of the most common nutritional deficiencies in India. PEM generally encompasses both Kwashiorkor and Marasmas.

Kwashiorkor

The term Kwashiorkor means, the disease the child gets when the next baby is born, i.e. sickness of the deposed milk and can be cured by milk. Kwashiorkor results principally due to the lack of protein in the diet. The clinical signs and symptoms are given below:

1. Growth failure
2. Mental changes – apathy, listlessness, disinterest in the surroundings.
3. Oedema – Due to low serum albumin, high sodium and low potassium levels are visible in the legs, hands and face.
4. Muscle wasting and reduction in the circumference of the upper arm.
5. Moon face – the face becomes full and well rounded.
6. Liver changes – liver is enlarged and there is fatty infiltration of the liver.
7. Gastrointestinal tract – loss of appetite, vomiting and diarrhoea.
8. Skin and hair changes – crazy pavement dermatosis of the skin and dark hyperpigmental brownish black areas of hair, flag sign, sparse hair, easy pluckability of hair.
9. Anaemia – due to iron and folic acid deficiency.
10. Vitamin Deficiency – Xerophthalmia and keratomalacia (vitamin A deficiency). Angular stomatitis and glossitis (Riboflavin deficiency).

Biochemical changes

The serum albumin level is lowered, the level of enzymes is lowered (choline esterase, and alkaline phosphatase), low level of digestive juice such as amylase and lipase, lipid metabolism is affected – leading to fatty infiltration of liver, blood glucose level is lowered, magnesium and potassium deficiency results due to diarrhoea.

Marasmus

- Nutritional Marasmus is principally due to the consumption of diets markedly deficient in both proteins and calories and is most common in weaned infants of about one year of age, in contrast to Kwashiorkor which occurs more often in children in the age groups of 2-4 years.
- Marasmus is usually precipitated as a result of diarrhoeal diseases.
- Causes Poverty, ignorance, superstitious belief, lack of food, inadequate hygiene, infectious diseases and family size leads to marasmus.
- Other factors include failure of breast feeding, late introduction or wrong choice of supplementary foods, unhygienic feeding practices, withholding foods in an attempt to cure diarrhoea, poverty, poor care of children, infectious diseases – diarrhoea, whooping cough, measles etc.

Clinical Features

- Growth retardation – the child is usually 60% below weight. There is severe muscle wasting, arms are thin, skin is loose – subcutaneous fat is absent.
- The skin is dry and atrophic, signs of dehydration and presence of vitamin A deficiency and anemia.
- Low serum albumin and low serum vitamin A levels.

Topic 10

LIPIDS – CLASSIFICATION, PROPERTIES, FUNCTIONS, SOURCES, AND REQUIREMENTS

LIPIDS

- The term 'lipid' is applied to a group of naturally occurring substances characterized by their insolubility in water, greasy feel and solubility in some organic solvents. They occur in the plant and animal kingdom.

Classification

Oils and fats:

These are esters of fatty acids and glycerol. Oils are liquid at 200C while fats are solid .

Compound lipids

They contain other organic compounds in addition to fatty acids and glycerol.

Phospholipids (phosphotides)

These contain phosphoric acid and nitrogeneous base in addition to fatty acids and glycerol e.g. (lecithin and cephalin)

Glycolipids

Compound lipids containing carbohydrates in combination with fatty acids and glycerol. e.g: cerebrosides

Waxes

These are esters of fatty acids and large chain aliphatic alcohols.

Derived Lipids

Substances derived from fat on hydrolysis or by enzyme activities are called derived lipids. Eg. fatty acids, alcohol

Fatty acids

Fatty acids in foods and in the body contain 4-24 carbon fatty acids

Short chain fatty acids- 4-6 carbon atoms
Medium chain fatty acids -8-12 carbon atoms
Long chain fatty acids- more than 12 carbon atoms

Fatty acids are divided into saturated fatty acid and unsaturated fatty acid

Saturated fatty acids

Saturated fatty acids have all the carbon atoms in the chain saturated with hydrogen atoms. eg. Palmitic, stearic, butyric acids

Unsaturated fatty acids

When a double bond is present between two carbon atoms the fatty acid is termed as unsaturated fatty acids. eg. Oleic acid

Poly unsaturated fatty acids

Three or more double bonds in a fat is called poly unsaturated fatty acids
eg. Linoleic, linolenic and arachidonic acid

Essential Fatty Acids

Nutritionally important fatty acids are known as essential fatty acids. Since the body cannot synthesize them the EFA must be supplied to the body.

Properties of fats

Solubility

- Fats are soluble in ethyl ether, petroleum ether, acetone, hot alcohol and enzyme. The quantity of fat present in food materials is usually determined by extraction with ethyl ether or petroleum ether.

Hydrogenation

- Unsaturated fats have a tendency to combine with hydrogen at the site of its double bonds. Vegetable fats are exposed to hydrogen at high temperature in the presence of an alkali. Nickel or cobalt is used as a catalyst e.g. Vanaspati

Emulsification

- Fat forms a homogeneous mixture with water it is called emulsification. This property is made use of in the preparation of ice cream, mayonnaise.

Saponification

- The ester linkage of fatty acids with glycerol brings this process of saponification. Neutral fats are rich in ester linkage. When neutral fats are heated with sodium or potassium hydroxide the fat molecules may readily rupture at the ester linkage. It is thus hydrolyzed into glycerol and sodium or potassium salts of fatty acids and this is known as soap. Thus, the formation of soap from the hydrolysis of fat with heat and alkali is termed as saponification

Iodine value / number

- This is the measure of the extent of unsaturated fatty acids present in fats and oils. It is defined as the number of grams of iodineabsorbed by 100 g of fat. 2 atoms of iodine are added to each unsaturation linkage.

Rancidity

- The development of off-flavours in fats is known as rancidity. There are three main types of rancidity.

7. Hydrolytic
8. Oxidative
9. Ketonic

Hydrolytic rancidity

- When fat is hydrolysed by lipase, free fatty acids are formed. The odours of low molecular weight fatty acids contribute to the rancidity.

Oxidative rancidity

- The oxidation takes place at the unsaturated linkage (double bond). The addition of oxygen to the unsaturated linkage results in the formation of peroxide which on decomposition yields aldehydes and ketones having pronounced off odour.

Ketonic rancidity

- It occurs in action of fungi aspergillus, blue green mould, pencillium on coconut and oil seeds. It produces tallowy odour.

Functions of fats

- It is a concentrated source of energy, yielding more than twice the energy supplied by carbohydrates per unit weight.
- Fats are essential for the absorption of vitamins A, D, E, K and especially carotenoids (Pro vit A) present in foods of vegetable origin.

Some animal fats

eg:- fish liver oil, butter and ghee contain vitamin A and many vegetable fats contain vitamin E and red palm oil is a good source of carotene (pro vit A)

- Fats contain essential fatty acids like linoleic, linolenic and arachidonic acids which are essential for maintaining tissues in normalhealth.
- Fats help to reduce the bulk of diet as starchy foods absorb lot of water during cooking.
- Fats improve the palatability of the diet and gives satiety value in a feeling of fullness in the starch
- Fats are essential for the utilization of galactose, present in lactose.
- Phosphatides and other complex lipids are essential constituents of nervous tissue.
- Fats are deposited in the adipose tissue and this deposit serves as the source of energy during starvation. Further, adipose tissue functions like an insulating material against cold and physical injury.

Sources

Visible fats - oils, butter, margarine and ghee

Invisible fats - meat, poultry, eggs, fish, whole milk cream, cheese and baked products

Requirements - RDA

Children g/day

1-3 years - 27

4-6 years - 25

7-9 years - 30

Boys

10-12 years - 35

13-15 years - 45

16-18 years - 50

Girls

10-12 years - 35

13-15 years - 40

16-18 years - 35

Adult man

Sedentary work - 25

Moderate work -30

Heavy work -40

Adult woman

Sedentary work - 20

Moderate work -25

Heavy work -30

Pregnant woman - 30

Lactation – 30

Topic 11

LIPIDS – DIGESTION, ABSORPTION, UTILIZATION AND DEFICIENCY DISEASES

Digestion,absorption, metabolism and deficiency of fats :

Digestion and absorption of fats

- Fat is not digested in the stomach.
- The presence of fat in the diet delays the emptying of the food from the stomach.
- Fats are hydrolyzed by the pancreatic and intestinal lipase in the intestines into a mixture of diglycerides, monoglycerides and fatty acids. Bile is essential for the digestion and absorption as it helps to emulsify fats before digestion.
- The products of digestion pass into the cells of the intestinal wall, where synthesis of new triglycerides characteristic of the animal species takes place.
- The resynthesised lipids pass through the lacteals of the small intestine to thoracic duct and then to the blood stream in the form of fine particles known as chylomicrons.
- A greater part of the cholesterol present in the diet is absorbed while phytosterols present in vegetable fats and oils are not absorbed.

Lipids in blood

- Normal human plasma in the post absorption state contains about 500 mg of total lipids (per100ml) of which about 120 mg are triglycerides, 160 mg phospholipids, 180 mg cholesterol and about 10-15 mg free fatty acids. Plasma contains two lipoproteins which are involved in the transport of fat.

Storage of fat

- Fat is stored in the adipose tissues in normal human subjects, adipose tissue constitutes about 10-15 per cent of the body weight. It increases upto 30 percent in obese person.

Fat metabolism

- The metabolism of fatty acids and glycerol are separate. Glycerol enters the glycolytic pathway through the formation of 2- glycerophosphate. Fatty acids are

oxidized to Acetyl -CoA and it is again oxidized to CO_2 and water through Kreb's cycle of carbohydrate metabolism.

- Energy is the end product in the metabolism of fat. In the stepwise reactions two carbon atoms are added or subtracted using co-enzyme A. For this reaction ATP or adenosine tri phosphate is required.
- The enzyme which catalyzes the reaction is thiokinase.
- In the next step dehydrogenation of fatty acids takes place.
- Fatty acids are dehydrogenated into alpha beta unsaturated fatty acids.
- Alpha beta unsaturated fatty acids are converted or hydrated to hydroxyacyl-CoA. Hydroxyl acid is oxidized to keto acid.
- The last step in the fatty acid oxidation is the thiolytic cleavage of ketoacyl-CoA ester to yield a fatty acid-CoA derivative.
- This is repeated and Acetyl-CoA molecules are released. Different fatty acids yield varying numbers of Acetyl-CoA. For example, one molecule of stearic acid gives 9 molecules of Acetyl-CoA and 1 molecule of palmitic acid gives 8 molecules of Acetyl-CoA and 1 molecule of lauric acid gives 6 molecules of Acetyl-CoA
- Acetyl Co-A thus formed is oxidized through Kreb's cycle and glycerol is converted into glyceraldehyde-3-phosphate and it enters into the glycolysis pathway

Deficiency of fats

- During infancy deficiency of essential fatty acids results in perianal irritation and skin changes like dry skin and itching. In adults phrynoderma is easily cured by essential fatty acids with vitamins B2 and A.

Topic 12

MACRO MINERALS –FUNCTIONS, SOURCES, REQUIREMENTS AND DEFICIENCY DISEASES

MACRO MINERALS

The minerals present in more than 0.05 per cent in the human body are defined as macro minerals. These are required in large amounts. Examples are-

- calcium
- phosphorus
- sodium
- chlorine
- potassium

CALCIUM

- The most abundant mineral element in the body is calcium. Nearly 99 per cent of the calcium in the body is present in the skeleton. The remaining part of calcium performs a variety of functions in the body. About 850-950 g of calcium is present in a healthy man.

Functions

1. The most important function of calcium is the ossification of bones. If calcium content in the blood is below normal, bone calcium is depleted and serum level is brought to normal
2. Calcium is essential for the formation of teeth
3. Calcium is necessary for the contraction of the heart and muscle
4. The regulation of muscle irritability is dependent upon the serum calcium level
5. Calcium is also required for normal nerve impulse transmission and excitability of nerve fibres and nerve centres
6. Calcium forms a part of acetylcholine which is necessary for the transmission of nerve impulses
7. Calcium helps in the coagulation of blood and is needed for permeability of capillary walls
8. Calcium exerts its influence in the absorption of vitamin B12 from the intestine
9. The mineral has been shown to activate certain enzymes especially lipase and certain proteolytic enzymes, adenosine triphosphate and rennin

Deficiency

- Calcium deficiency symptoms are usually accompanied by a lack of phosphorus and vitamin D.
- Any of the factors which affect calcium absorption can lead to its ineffective utilization.
- Vitamin D deficiency alone can produce calcium deficiency symptoms. Pure calcium deficiency is osteoporosis.
- In osteoporosis serum calcium level is normal but body store is reduced.
- During old age the capacity of the body to absorb and utilize calcium is diminished.
- In women hormonal imbalance during menopause or removal of ovaries at earlier stages results in osteoporosis.
- Corticosteroid injection for any purpose may result in osteoporosis.
- In osteoporosis pores are seen in the bones due to decalcification. Back pain, loss of weight, fracture of bones for no reason and loss of teeth are some of the clinical symptoms.
- Calcium and vitamin D deficiency results in rickets and osteomalacia among children and adults respectively.
- Tetany is another symptom of calcium deficiency. In tetany there is hyper-excitability of the nervous system.
- A series of spasmodic movements take place in the muscles. Depending upon the level of serum calcium symptoms of tetany vary.
- Irritation, confusion, pain, involuntary muscle spasm, bronchial spasm, spasm in the gastrointestinal tract, pain and convulsions are again symptoms of tetany.
- If parathyroid gland is in hypoactivety, calcium is not properly assimilated and results in chronic tetany.
- In this condition nervous changes occur and impairment of memory takes place. Depression, irritation, loss of hair and nails, roughness of the skin, pitting of teeth and epileptic fits are other symptoms of this condition occur. Cataract is common in such patients.

Sources

- Best source : Milk and milk products
- Cheapest source : Ragi
- Good source : Sesame seeds and leafy vegetables

Requirements

- Adult man and women - 600mg/ day
- Pregnancy and lactation - 1200mg/day
- Infants - 500mg/day
- Children (1-9yrs) - 600mg/day
- Children (9-18yrs) - 800mg/day

PHOSPHORUS

No other mineral takes part in a number of functions as phosphorus in different parts of our body. An adult human body contains about 400-700 mg of phosphorus. About eighty per cent of the body's phosphorus is deposited in the bones and teeth as calcium phosphate. The remaining portion is located as sodium phosphate and potassium phosphate in the body fluids and in cells. Phosphorus is also present in many enzymes and co-enzymes. Thus it takes part in metabolism.

Functions

Phosphorus takes an important role in the calcification of bones

It also plays an essential part in carbohydrate metabolism in phosphorylation of glycogen

Phosphorus is an essential constituent of co-enzyme and co-carboxylase enzyme system in the oxidation of carbohydrate, proteins and fat metabolism.

Phosphorus compounds control the storage and release of energy through ATP, ADP system

Phosphorus is present in the nucleoproteins and phosphoproteins which are integral parts of the cells..

Inorganic phosphates in the body fluids act as a buffer system in the body

Deficiency

Retarded growth, poor teeth and bone formation, rickets and anorexia.

Sources

Good source : Milk and milk products and cereals and legumes

Excellent source : Meat, fish, poultry and eggs

Requirements

Phosphorus requirements depend on the availability of calcium present in the diets. It depends upon the calcium: phosphorus ratio. The optimal calcium phosphorus ratio for infants and children is 1:1 and or adults 2:1.

Group		Phosphorus
Adult	Men	600
Women		600

Pregnancy		1200
Lactation		
Post menopausal women		600-800
Infants		750
Children	1 – 3y	600
4- 6 y		600
7- 9 y		600
10-12 y	Boys	800
Girls		800
13-15 y	Boys	800
Girls		800
16–18 y	Boys	800
Girls		800

SODIUM

Extracellular fluid contains sodium for the maintenance of normal osmotic pressure and water balance. Approximately 50% of the body's sodium is present in the extracellular fluid, 40% in bones and 10% or less in intracellular fluid.

Functions

- Sodium along with chloride is major constituent in the extracelluar fluid. It is responsible to maintain osmotic pressure.
- Acid and base balance is regulated by sodium. Sodium along with calcium, magnesium and potassium are basic in reaction; but chloride with phosphate and sulphate are acidic in reaction. Thus, acid-base balance is maintained
- Sodium is concerned in the maintenance of water balance, muscle irritability contraction of muscles.

- It regulates permeability of cell membrane
- Maintenance of heart beat
- It contributes alkalinity to the gastro-intestinal secretions.

Deficiency

- Sodium deficiency occurs when the intake is poor or excessive amount is lost.
- Sodium loss through excessive sweating causes deficiency unless salt intake is not increased.
- Vomiting, severe diarrhoea, Addison's disease is also responsible for sodium deficiency.
- There is giddiness, cramps in muscles, collapsed veins, low blood pressure, dryness of mouth, inelastic skin and oliguria.

Excess of Sodium

- Any excess of sodium in the body accumulates in the extra cellular fluids.
- The increased concentration of sodium is partially offset by an increase in these fluids.
- Sodium excess may result in oedema.
- In some the kidneys are enlarged and glomerulo nephritis may occur.
- Persons consuming 10-25 gm of salt have been found to have a high incidence of raised blood pressure.

Sources

- Excellent source: Fresh meat, fish, poultry, egg, nuts, bakery products, milk and milk products, green leafy vegetables Salt used during cooking is the commonest source of sodium.

Requirements

- Adult - 500 mg
- Children - 58 mg/day
- Infants - 2.5 mmol/day

POTASSIUM

- Approximately 97% of the potassium in the body is available within the cells and remaining is distributed in the extracelluar fluid. Plasma contains very small amounts of potassium but large amount of it is present in red blood cells.

Functions

1. Within the cell, potassium is responsible for maintaining osmotic pressure and water balance.
2. Potassium ion increases the relaxation of heart muscles. Some amount of potassium together with other ions is required in extracelluar fluid for the transmission of nerve impulses and contraction of muscle fibres.
3. Potassium is an obligatory component of all cells hence greater the number of cells, higher the increase in potassium.
4. Potassium is required for enzymatic reactions which take place with in the cells.

Deficiency

- Less intake of food during starvation and surgery is responsible for the deficiency of potassium.
- Excessive losses might occur during vomiting and diarrhoea for long duration.
- In severe burns and prolonged fever potassium deficiency occurs.
- Patient might complain of nausea, vomiting, muscle weakness, low blood pressure and tachycardia.

Hyperpotassemia

- Excess of potassium is frequent complication in renal failure.
- The symptoms include muscular weakness, poor respiratory system which later on leads to cardiac failure.

Sources

Good sources - Meat, fish and poultry; fruits, vegetables and whole grain cereals are especially high in potassium. Banana, potatoes, tomato, carrots, grape fruit juice contains potassium.

Requirements

- Adult - 10-28 g
- Children - 4.5 g
- Infants - 1.8g

MAGNESIUM

- An adult human body has about 25 g of magnesium. Half of this quantity is present in the bones along with calcium and phosphorus and the rest in soft tissue.

Functions

- Magnesium plays an important role in normal calcium and phosphorus metabolism in man
- It is also present in certain enzymes like co-carboxylase which decarboxylates pyruvic acid.
- Magnesium also takes part in the phosphorylation as a cofactor, in metabolic pathways

Deficiency

- Prolonged starvation brings magnesium deficiency.

- Vomiting and intestinal fistula, neuromuscular irritability, tremors, cramps, twitching and convulsions occur in its deficiency.
- Confusion, disorientation and visual hallucinations are some other complaints of magnesium deficiency.
- Diabetic acidosis is associated with raised serum level of magnesium.

Sources

Dairy products (excluding butter), fresh green vegetables, meat, nuts, seafood and legumes.

Requirements

Requirements - RDA

Children mg/day

1-3 years - 50

4-6 years - 70

7-9 years - 100

Infants - 30 - 45

Boys

10-12 years - 120

13-15 years - 165

16-18 years - 195

Girls

10-12 years - 160

13-15 years - 210

16-18 years - 235

Adult man - 340

Adult woman - 310

Pregnant woman - 310

Lactation - 310

Topic 13

MICRO MINERALS – FUNCTIONS, SOURCES, REQUIREMENTS AND DEFICIENCY DISEASES

MICRO MINERALS

- The minerals present in less than 0.05 mg in the human body are called as micro minerals. These are required in small quantities less than a few mg a day example

- Iron
- Sulphur
- Zinc
- Copper
- Iodine

IRON

Those elements which are required in traces or minute quantities are known as trace elements. Iron is a trace element, as its presence in small amount is very significant. Most of the iron in the body is present as hemoglobin. Most of the body's iron is found in complex forms bound to proteins either as porphyrin or heme compounds or as ferritin. Free inorganic iron occurs in small amount. About 70% of iron is in circulating hemoglobin, 4% as myoglobin. 25% is stored in liver, spleen, kidney and 1% in plasma and various oxidative enzymes.

Functions

- For the formation of haemoglobin: Haemoglobin is the main component of red blood cells. It is composed of iron and protein(Heme+globin). Heme is a compound of iron and its synthesis depends upon the quantity of iron in the blood. Haemoglobin acts as a carrier of oxygen from the lungs to the tissues and indirectly helps in the return of carbon dioxide to the lungs.
- Essential constituent of muscles: Myoglobin is an iron-protein complex found in muscles which stores some oxygen for immediate use by the cells.

Transferrin of siderophilin is the circulating form of iron. Ferritin or haemosiderin is the storage form of iron.

- Enzymes like catalyses, xanthine oxidase contain iron as an integral part of the molecule
- Small amount of iron available in plasma, which is 1-2% of total iron in the blood. Iron in plasma is utilized in transportation, for example ferritin, transferritin etc.

Deficiency

- Deficiency of iron may be caused in a number of ways. The diet may not provide enough iron or it may be in un absorbable form.

Anemia

- In healthy individual blood contains approximately 14g of haemoglobin per 100 ml.
- Sometimes the level goes down and a low level of haemoglobin in blood is called anaemia.
- Anemia occurs when diet is deficient in one or other of the nutrients required for the synthesis of haemoglobin.
- Due to excessive intake of antibiotics bone marrow is unable to synthesize red blood cells.
- Iron is essential for the synthesis of the haemoglobin. It is also present in myoglobin and other proteins such as the cytochromes.Much of the iron in food is unabsorbable because it is irreversibly bound to phytates and phosphates.Also, iron is readily oxidized to ferric form in which it cannot be absorbed.
- Anaemia is a condition in which total circulating haemoglobin reduces.This can be due to deficiency of one or more essential nutrients (iron, calcium, copper, vitamin C, folic acid, vitamin B12, protein etc). Iron deficiency anaemia follows a specific sequence.The iron reserves getting depleted and transferrin (transport form of iron) level of blood goes on increasing and plasma iron is reduced.The blood cells are pale, less in number and small in size.This is usually by blood loss but occasionally iron may be excreted in urine and cause haemosidernuria.

Types of Anaemia

Hypochromic anaemia: Such a state is usually associated with chronic inflammatory disease in which there is an inhibition of mobilization of iron from body stores. The iron storage sites in the marrow show abundant iron but is not available for haemoglobinisation of developing red cells.

Sideroblastic Anaemia: These are rare conditions in which red cell production is impaired by disordered iron metabolism. Heredity can be one of the causes.

Megaloblastic anaemia: Red cells appear abnormally large. Normally in red cell production, cell division occurs rapidly. Between division the cells do not have time to re-grow to their full size and progressive reductions in cell size occurs. When DNA (deoxyribose nucleic acid) synthesis is reduced, the time between divisions is increased, more cell growth occurs and cells size decreases.

Pernicious anaemia: Absence of free hydrochloric acid in the stomach results in inability to absorb iron. This is due to degenerative changes in nervous system result in tingling sensation of finger and toes, loss of vibratory sense and impaired co-ordination. There is lack of appetite, weight loss, diarrhoea,constipation and shortness of breath.

Anemia Symptoms of Anemia Spoon shaped nail

Hemosiderosis

It is a disorder of iron metabolism.In this conditions large amounts of iron are deposited in the liver and in the recticulo endothelial system.Transferrin, the iron with carrier protein becomes saturated with iron.When transferrin is unable to bind all the absorbed iron this metabolic disorder takes place.If iron vessels are used for cooking, much more iron is ingested into the body, which may result in hemosiderosis.The Bantu population of Africa is an example of this condition.

In hemolyticanemia a large number of red blood cells are destroyed and this can lead to hemosiderosis. Prolonged prophylaxis with massive doses of iron can often produce hemosiderosis.

Sources of Iron

Best Sources : Liver, kidney, heart, lean meat, egg yolk and shellfish.

Good Sources : Dried beans, legumes, dried fruits, nuts, green leafy vegetables, whole cereals, enriched grains and molasses.

Poor Source : Milk

Requirement of iron

Recommended intake of iron is calculated, based on its loss and absorption.

Adult man -17mg/day

Adult woman -21mg/day

Pregnancy - 35 mg/day

Lactation -25 mg/day

Infants -0.5mg/kg body weight

Children g/day

1-3 years - 09

4-6 years - 13

7-9 years - 16

Boys

10-12 years - 21

13-15 years - 32

16-18 years - 28

Girls

10-12 years - 27

13-15 years - 27

16-18 years – 26

IODINE

Iodine is a constituent of thyroxine hormone secreted by thyroid gland. Thyroid glands weighing 25 g in an adult contains 10 mg of iodine.

Functions

- Iodine plays an important role as it is incorporated into thyroxine hormone. It is responsible for the rate of oxidation within the cells.
- Thyroxine is related with the tissues of nerves and muscles.
- It maintains heart rate.
- Iodine helps in converting glycogen to glucose. In this way it increases blood sugar level. Liver is affected because there is a possibility of emptying of glucose stores.

Deficiency

- Deficiency of iodine results in a disease known as goitre. Goitre is an enlargement of the thyroid gland.
- This occurs due to the deficiency of iodine, the secretion of thyroxine hormone is also reduced, so the gland cells try to produce iodine, in large quantity which leads to multplication of cells, resulting in the enlargement of the gland, that forms goitre.
- Goitre is more in the hilly regions where soil lacks iodine.
- So the vegetables, cereals and pulses grown here do not contribute iodine in an appreciable amount.
- The entire population in such areas suffer from goitre hence the name endemic goitre.

- **Goitre**

- **Cretinism:** Cretinism is caused in children when there is deficiency of thyroxine hormone. Infants suffer from this disease when the infant's mother is suffering from goitre and who is unable to meet the foetal demand for iodine. The symptoms of cretinism are:
-

Low basal metabolic rate.
Muscular flabbiness and weakness
Dry skin
Rough hair
Enlarge tongue
Thick lips
Retardation of skeletal development
Mental retardation

- **Myxedema**

- Iodine deficiency in adults results in Myxedema. Face becomes thick and looks puffy. Facial expression are poor and person becomes inactive.
-

Hyperthyroidism

- This condition may be due to a tumor of thyroid gland which produces an excess of thyroid hormone or it may be due to Grave's disease (toxic Goiter) an increased production of the hormone due to over active thyroid gland
-

- Hyperthyroidics shows hyper activity, tremors, a rapid heart rate, high blood pressure, bulging eyes, accelerated growth with loss of weight and emotional instability. If the symptoms do not subside with medicines surgery is required.

Goitrogenic Substances in Foods

Certain foods of brassica genus like cabbage, cauliflower, turnip, soya flour contain substances which react with iodine present in the food and make it unavailable. The substances are known as goitrogenic substances. Consumption of these foods in large quantities makes the iodine non available to the body.

-

Sources

Good source: Sea foods like fish, shellfish, fish liver oils, fortified salt.

Requirements

Recommended daily requirements of iodine according to age group and physiological status

Age/Physiological group	RDA of iodine(g/d)
Infants	90
Young children (1+ to 5+ y)	90
School age children (6+ to 11+ y)	120
Adolescents and adults (12 y)	150
Pregnant & Lactating women	200

FLUORINE

- Fluorine is present in the body as fluroide. It is present in teeth, bones, thyroid gland, skin and liver. Fluoride is necessary for the formation of caries-resistant teeth. Small amounts of fluroine prevents dental caries in children. It promotes calcification.

Fluoride and Tooth Structure

- For healthy tooth formation some amount of fluorine is essential. Though the exact mechanisms by which it prevents dental caries is not fully understood, it is assumed that fluorine is incorporated into the tooth enamel.
- This reduces the solubility of enamel in the acids produced by bacteria.
- In its absence the enamel is soluble in the acid and tooth decays.
- In experimental animals fluoride seems to help normal growth during the growing period, but in human beings its role is not yet proved.

Toxicity or Fluorosis

- If water contains more fluorine (1.2 to 3 ppm), dental fluorosis occurs. The enamel of the teeth loses its natural lustre and becomes rough .
- Opaque white patches with yellow or brown stains are found irregularly on the teeth.
- Ridges or diffused spots and pitting occur over the teeth.
- The surface of the teeth gives a corroded appearance.

- Loosening of teeth along with untimely loss of teeth is common.

Skeletal Fluorosis

- Skeletal fluorosis occurs when the water fluoride is more than 3 ppm. The bones of vertebral column, especially the cervical part of the spine, pelvis and bones of the lower extremities are affected in this condition. Hypercalcification of the bones and the collagen take place due to excessive fluorine deposition.
- Stiffness and pain are the earlier symptoms. Weakness and spasticity of lower limbs, wasting of the distal muscles of hands, deep jerks on lower extremities and numbness or girdle pain are the other symptoms of skeletal fluorosis.
- Gradually the person becomes crippled as he cannot bend or squat as the joints become stiff.

Sources:

water from affected areas, tea, tobacco, rock salt, tooth paste and other dentrifices

Requirements

Water containing 1 to 2 ppm prevents caries and so it is considered as the requirement.

ZINC

- In an adult 2 to 3 g of zinc is present. It is present in certain parts of the eye, certain glands and in their secretion. Liver, muscles, bone and hair contain some of the remaining zinc. Blood, especially the RBC, has some zinc. In small amounts it is present in tissues and bone cells.

Functions

1. The important function of zinc is its role in enzymatic action. In 25 enzymes of digestive and metabolic action zinc takes part.
2. It is also present in an enzyme carbonic anhydrase which is essential for the transport and elimination of carbon dioxide. Co-carboxypeptidase and alkaline phosphatase contain zinc in them.
3. Zinc plays an essential role in the formation of DNA and RNA. It is a constitution of insulin and it is necessary for the formation of connective tissues.
4. Zinc also aids in the healing of burns and wounds.

Deficiency

- Zinc deficiency in animals results in growth failure, loss of appetite, degeneration of the male sex glands, testes, skin lesions, alopecia or loss of hair, changes in the epithelial and cutaneous tissues, dermatitis and scaling and cracking of the paws.
- Abnormal bone formation, thickening and metabolism also occur during zinc deficiency.

- In human beings zinc deficiency produces anemia, growth retardation and delayed genital maturation.

Sources

- Sea foods, meat, poultry and eggs are good sources of zinc. Cereals, legumes and nuts contain considerable amounts, on milling, eighty per cent of zinc is lost. Fruits and vegetables are poor sources.

Requirement

RDA for zinc (mg/d) in different age and physiological groups

Group		FAO/ WHO**
Young children (1-3 years)		5.5 (3.3-11)
Pre-adolescents (11-14 years)	Male	9.3-12.1
	Female	8.4-10.3
Adults (25-50 years)	Male	9.4
	Female	6.5
Pregnancy		7.3-13.3
Lactation		12.7-9.6

COPPER

Functions

- Copper is found in all tissues of our body. It is an essential element in the formation of haemoglobin. About 100-150mg of copper is present in the human body.
- The brain, liver, heart and kidney contain the highest amounts.
- In the blood, copper is present in the plasma and RBC.
- Copper is absorbed rapidly into the blood.
- Copper is a component to certain enzymes in our body.

- It is part of the enzyme cytochrome oxidase (essential for glucose metabolism) and tyrosinase, (necessary for converting the amino acid tyrosine to melanin, the dark pigment of the skin).
- Copper stimulates the absorption of iron.
- Copper is a constituent of the elastic connective tissue protein elastin.

Deficiency

- Copper deficiency is not common in human beings.
- In malnourished persons iron is not absorbed properly and anaemia occurs.
- Premature babies fed on cow's milk develop anaemia due to copper and iron deficiency.

Sources

Good sources: Sorghum, bajra, raw rice, whole grams, cow pea, dried peas, red gram, drumstick and organ meat like kidney.

Richest sources: liver

Requirements

- Adult -2mg per day
- Pregnancy and lactation -3mg per day
- Infants (0-12months) - 0.5-1.0mg per day
- Children -2gm per day
- Adolescents -3gm per day

Topic 14

WATER SOLUBLE VITAMINS – FUNCTIONS, SOURCES, REQUIREMENTS AND DEFICIENCY DISEASES

Functions of proteins

DEFENITION

Digestion & Absorption

- The digestion of proteins takes place in the stomach and intestines. As a result of digestion, the proteins are broken down to amino acids and absorbed.

Gastric digestion

- The proteolytic enzyme present in gastric juice is called as pepsin which acts on proteins in an acid medium and hydrolyse them to simpler compounds known as polypeptides.

Intestinal digestion

- The digestion of proteins is further carried out in the intestines by the action of proteolytic enzymes (trypsin, chymotrypsin and peptidase) present in pancreatic and intestinal juices.
- The polypeptides produced by gastric digestion are hydrolysed to free amino acids by the above enzymes.
- The amino acids are absorbed in the small intestine and enter the blood circulation through the portal vein.

Vitamins

Vitamins may be defined as organic compounds occurring in small quantities in the different natural foods and necessary for the growth and maintenance of good health in human beings and certain experimental animals. The compounds are vital for health and amine in nature, hence referred to as vitamins.

Classification of vitamins

- Water soluble vitamins
- Fat soluble vitamins

Classification of water soluble vitamins

Vitamin B complex

- Vitamin B1 (thiamine, anlurin)
- Riboflavin (B2)
- Nicotinic acid and nicotinamide (Niacin &niacinamide)
- Pyridoxin (vitamin B6)
- Pantothenic acid
- Folic acid
- Biotin
- Choline
- Para amino benzoic acid
- Inosital and

Vitamin B12

Vitamin C (Ascorbic acid)

Vitamin B1 (Thiamine)

- It is a white powder which is readily soluble in water. Alkali destroys thiamine. Thiamine is commercially produced as thiamine hydrochloride. It has yeast like odour and it is stable in its dry form.

Functions

1. Thiamine combines with pyrophosphate and forms thiamine pyrophosphate, which acts as intermediary metabolism of carbohydrates.
2. Transketolase, an enzyme has thiamine pyrophosphate, as a co-factor. It acts as a co-enzyme in the metabolic pathway of carbohydrates at different places.
3. Animal experiments showed that thiamine pyrophosphate is essential for protein metabolism
4. Thiamine is also required for the synthesis of glycine in the body

5. Thiamine pyrophosphate is present in the peripheral nerve cells. It has a specific effect on nerve tissues. In thiamine deficiency the peripheral nerves degenerate
6. Thiamine is also required for the maintenance of normal gastro-intestinal tone and motility
7. Thiamine seems to help the heart in its normal action
8. Thiamine is otherwise known as 'morale vitamin' because it helps the transmission of nervous impulses and maintains the stability of nerves

Deficiency

- It is difficult to identify the deficiency earlier. In mild deficiency loss of appetite, loss of weight and strength, fatigue, emotional upsets, irritability, depression, anger and fear are manifested.
- Constipation is common among such people.
- Headache, insomnia and tachycarida with slight exertion occurs during thiamine deficiency.
- Gastrointestinal and cardiovascular disorders with peripheral nervous problems initiate the deficiency state of thiamine.
- Severe deficiency of thiamine causes beriberi. Three forms of beriberi occur in human beings. They are dry beriberi, wet beriberi and infantile beriberi.

Dry beriberi

- The peripheral nerves of the legs and arms are affected first.
- Degeneration of the myelin sheath of the nerves is followed by the degeneration of the axis cylinder.
- Calf muscles become tender.
- Numbness in the toes and ankles takes place.
- The knee and ankle jerk and later on the sensation are lost.
- Tingling and numbness of the legs and hands are followed by wasting of muscles and difficulty in walking.

Wet beriberi

- All the symptoms of dry beriberi are seen in wet beriberi also.
- In addition to these, oedema in legs and in-between cardiac muscle fibre is observed.
- These changes in the heart muscles lead to enlargement of the heart.
- Later palpitation, oliguria and dyspnoea may develop.
- Oedema on the legs will be prominent.
- The patient may be bed-ridden and cardiac failure may take place.
- If untreated it leads to death within hours.

Infantile beriberi:

- It affects infants within six months.
- The early symptoms are restlessness, sleeplessness and loss of appetite.

- The affected child is pale, oedematous and ill tempered.
- Vomiting and green coloured diarrhea are common.
- If treatment is delayed it leads to death.

Sources

1. Rich sources – Rice polishing (Bran), dried yeast and wheat germ
2. Good sources - Wheat, oats, legumes, oil seeds and nuts
3. Fair sources - Milled cereals, vegetables, fruits, milk, meat and fish

Requirements

During deficiency state 5mg of thiamine orally three times a day is recommended. It is readily absorbed from the small and large intestines. It is not stored in the body.

RDA of Thiamine for Indians Age

Group	Category	Body weights kg	Thiamine mg/d
Man	Sedentary	60	1.2
Moderate		60	1.4
Heavy		60	1.7
Woman	Sedentary	55	1
Moderate		55	1.1
Heavy		55	1.4
Pregnant		55	+0.2
Lactation	0-6m 6-12m	55	+0.3 +0.2
Infants	0-6 m	5.4	0.2
	6-12m	8.4	0.3
Children Boys	1-3y 4-6y 7-9 y 10-12y	12.9 18.0 25.1 34.3	0.5 0.7 0.8 1.1

Girls	10-12y	35.0	1.0
Boys	13-15y	47.6	1.4
Girls	13-15y	46.6	1.2
Boys	16-17y	55.4	1.5
Girls	16-17y	52.1	1.0

RIBOFLAVIN (B2)

- Riboflavin is dimethyl- iso-alloxazine attached to ribose. It is slightly soluble in water and stable in acid medium. In alkaline medium it is easily destroyed. Bright light also destroys riboflavin.

Functions

- Riboflavin is part of food co-enzymes as riboflavin monophosphate or flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD)
- Riboflavin is closely related to biological oxidations in cells
- Flavoprotein enzyme system is present in different parts of our body. It takes part in cell respiration
- Cellular growth cannot evolve in the absence of riboflavin
- Riboflavin through the enzyme system possesses the ability of transferring hydrogen in chemical reactions. Thus, it takes part in carbohydrate and protein metabolism
- Riboflavin is essential for the health of skin, mucous membraneous structures of alimentary canal and eyes
- For normal vision riboflavin is essential. The retina has free riboflavin which is converted by light to a compound that stimulates optic nerves

Deficiency

- In mild deficiency of riboflavin weakness, anorexia, apathy, burning at the angles of mouth, in the eyes and over the skin occurs. Normal metabolism of carbohydrate and protein is affected.
- Riboflavin deficiency symptoms are generally known as ariboflavinosis.
- Ariboflavinosis consists of angular stomatitis with cheilosis, glossitis, skin changes, seborrheic dermatitis and vascularisation of the cornea.

- The angles of the mouth become pale and crust is formed in the corners.
- Fissures occur at the corners of the mouth and it is known as angular stomatitis .
- Crust is formed on the surface of lips and removal of it makes it red in colour, called cheilosis.
- Papillae of the tongue are peeled off and the tongue shows a 'magenta' or red tint on the surface. This is referred to as glossitis.

On the nasolabial folds, ears, vulva in the female reproductive organs and on the scrotum in the male, scaly desquamation of the skin takes place.
These are known as nasolabial seborrhoea or nasolabialdyssebacia and scrotal lesions.
The lesions are cured by the administration of riboflavin
Even in a mild deficiency state burning and watering of the eyes, sensitivity to light and dimness of vision take place.
Vascularisation of the cornea and abnormal pigmentation of the iris are the other symptoms manifested.
Vision is blurred and conjunctive and itching may occur in riboflavin deficiency.

Sources

Rich sources – Liver, egg, skimmed milk powder and other milk products Good sources - Milk, meat, fish, whole cereals, legumes, dals, oilseeds, nuts andleafy vegetablesFair sources - Milled cereals and flours, roots and tubers and other vegetables.

RDA of Riboflavin

Age group		mg/day		
		ICMR 1989	FAO/WHO 2004	NRC 1989
Infants	0-6 m	0.35 (0.6 mg/ 1000 kcal)	0.3	0.4
	7-12 m	0.52	0.4	0.5
Children	1-3 y	0.7	0.5	0.8
	4-6 y	1.0	0.6	1.1

Boys	7–9 y	1.2	0.9	1.2 (7-10 y)
	10-12 y	1.3	1.3	1.5 (11-14 y)
	13-15 y	1.5	1.3	
	16-18 y	1.6	1.3	1.8 (15-18 y)
Girls	10-12 y	1.2	1.0	1.3 (11-14 y)
	13-15 y	1.2	1.0	
	16-18 y	1.7	1.0	1.3 (15-18 y)
Male		1.4-1.9 Sedentary Heavy	1.3	1.7 (19-50 y) 1.4 (50+ y)
Female		1.1–1.5 Sedentary* Heavy*	1.1	1.3
Pregnancy		+ 0.2	1.4	1.6
actation	0-6 m	+0.3	1.6	1.8
	7-12 m	+0.2	1.5	1.8

*Minimum intake of 1.2 mg/1000 kcal is recommended.

NIACIN

- Niacin is a white crystalline compound soluble in water, stable to heat, light, acids and alkalies. In the body niacin is converted into niacinamide

Functions

1. Thiamine, riboflavin and niacin take part in the metabolism of carbohydrates, proteins and fats through the enzymatic action. It is a part of co-enzyme I and co-enzyme II which are essential for the conversion of pyruvic acid to lactic acid. They are otherwise known as NAD and NADH.
2. More than 40 biochemical reactions depend on these coenzymes. Dehydrogenation reaction in Kreb's cycle, oxidation of alcohol to aldehyde, glucose to gluconic acid, malic acid to oxaloacetic acid, pyruvic acid to lactic acid, glucose-1-6-diphosphate to

phosphohexouric acid and reactions in the synthesis of fatty acids, cholesterol and for the conversion of phenylalanine to tyrosine are some of them. It takes part in tissue oxidations.

3. Nicotinic acid is essential for the normal functioning of the skin, intestinal and nervous systems.

Deficiency

- In a mild deficiency state weakness, loss of weight, loss of appetite, lassitude, irritability, burning tongue and constipation occur.
- Pellagra is the characteristic disease resulting from niacin deficiency.
- It is otherwise known as three 'D's disease-dermatitis, diarrhea and dementia.
- The dermatitis of pellagra is different from other skin diseases.
- It occurs mainly on the exposed portions of the body. Lesions are seen on the face, neck, surfaces of the hands, elbows, feet and other parts of the body which are exposed to sunlight.
- Another peculiarity of dermatitis is that the skin lesions are symmetrical in shape and they always occur on both sides of the body simultaneously.
- The skin is cracked and scaly. Burning sensation and itching are common. The lesions leave a reddish, dark brown colour.
- The mucous membrane of the alimentary canal is affected and glossitis, abdominal pain and loss of appetite are some of the symptoms.
- Nausea, vomiting and diarrhea are the other symptoms of niacin deficiency.
- Delirium is the common mental disturbance in pellagra.
- Earlier symptoms of nervous disturbances are depression, dizziness and insomnia. It leads to death.
- Pellagra is common among sorghum eaters. sorghum has a very high leucine content and this excessive leucine interferes with the utilization of nicotinic acid.
- Leucine precipitates mental changes but isoleucine promptly reverses them to normal.

Sources

1. Good sources: Cereals, especially whole cereals, dried yeast, liver, groundnut,legumes, fleshy foods and fish
2. Fair source : Milk, eggs and vegetables.

Requirements

RDA of niacin

Age Group	Category	Body weights kg	Niacin equivalents mg/d
Man	Sedentary	60	16
Moderate		60	18
Heavy		60	21
Woman	Sedentary	55	12
Moderate		55	14
Heavy		55	16
Pregnant		55	+2
Lactation 0-6m 6-12m		55	+4 +3
Infants	0-6 m	5.4	710µg/kg
6-12m		8.4	650µg/kg
Children	1-3y 4-6y 7-9 y	12.9 18.0 25.1	8 11 13
Boys	10-12y	34.3	15
Girls	10-12y	35.0	13
Boys	13-15y	47.6	16
Girls	13-15y	46.6	14
Boys	16-17y	55.4	17
Girls	16-17y	52.1	14

PYRIDOXIN (VITAMIN B6)

- It is white crystalline substance soluble in water, quite stable to heat and acid. In an alkaline medium it is easily destroyable.

Functions

1. Vitamin B6 acts as a co-factor for several enzymatic reactions in all the three metabolisms. In protein metabolism, transamination takes place with the help of this enzyme system. In carbohydrate and fat metabolisms, there are intermediary reactions where vitamin B6 acts as a co-factor.
2. Tryptophan conversion to niacin has a series of biochemical reactions. In pyridoxine deficiency this conversion step will not materialize and niacin is not formed.
3. Removal and transfer of sulphur groups from sulphur containing amino acids like cysteine requires pyridoxine.
4. In carbohydrate metabolism pyridoxal phosphate is essential for the action of phosphorylase enzyme which converts glycogen to glucose
5. Vitamin B6 helps in energy transformation in brain and in nervous tissues. In its deficiency, convulsive seizures occur in animals and in human beings. Especially infants fed on evaporated milk develop nervous irritability and convulsion seizures.

Deficiency

- As a part of general deficiency of B complex, vitamin B6 deficiency also occurs otherwise Vitamin B6 deficiency is highly uncommon in humans.
- In experimental cases anorexia, nausea, restlessness, lethargy, seborrhea, hyperpigmentation, pellagra like dermatitis, cheilosis, glossitis and angular stomatitis were observed.
- Changes in the periphery of nerves with sensory impairment and motor abnormalities were also observed.
- In infants convulsion are seen. Immune response is impaired in B6 deficiency

Sources

1. Good sources: Dried yeast, liver and rice polishing
2. Rich to fair source : sorghum, bajra, pulses, beetroot, cabbage and fleshy foods

Table RDA of vitamin B6

Age Group	Category	Body weights kg	Vitamin B6 mg/d
Man	Sedentary	60	2.0

	Moderate Heavy		
Woman	Sedentary	55	2.0
Moderate			
Heavy			
Pregnant		55	2.5
Lactation 0-6m 6-12m		55	2.5 2.5
Infants	0-6 m	5.4	0.1
6-12m		8.4	0.4
Children	1-3y 4-6y 7-9 y	12.9 18.0 25.1	0.9 0.9 1.6
Boys	10-12y	34.3	1.6
Girls	10-12y	35.0	1.6
Boys	13-15y	47.6	2.0
Girls	13-15y	46.6	2.0
Boys	16-17y	55.4	2.0
Girls	16-17y	52.1	2.0

PANTOTHENIC ACID

It is soluble in water and it contains the amino acid alanine. It is stable to heat but prolonged exposure to dry heat destroys it. It is also destroyed by acid and alkali

Functions

- Pantothenic acid forms a complex compound co-enzyme A (CoA) and acyl carrier protein and thus it takes part in the metabolism of carbohydrates and fats

- It is also necessary for the formation of acetyl choline, which is a precursor of heme which in turn is essential for haemoglobin synthesis.
- CoA is also essential for the synthesis of cholesterol and sterols.
- In our body pantothenic acid is present in the liver, adrenal glands, kidneys, brain and heart.

Deficiency

- Deficiency of pantothenic acid is rare. Experimental production of its deficiency showed loss of appetite, fatigue, weakness, headache, insomnia, nausea, emotional instability, dizziness, impaired motor coordination, muscle cramps, burning sensations in the feet and changes in the heart beat rate and in blood pressure.
- Burning feet syndrome is associated with neurological and mental disturbances and it is cured only by pantothenic acid.

Sources

- Rich sources: Dried yeast, liver, rice polishing and wheat germs
- Fair sources: Whole cereals, legumes, nuts, fleshy foods, eggs and fish

Requirements

- Recommended by the FAO / WHO expert committee
- Adult - 10 mg per day
- Adolescents - 8-10 mg per day
- Children - 5-8 mg per day
- Infants - 1.5-2.5 mg per day

FOLIC ACID (Folacin)

- Folic acid is a yellow crystalline compound widely distributed in nature. Both folic acid and folinic acids occur in foods as conjugates of glutamic aicd. It is slightly soluble in water, relatively unstable to heat and easily destroyed by exposure to light. Folacin occurs in different forms. Most of it occurs as pterolypolyglutamates. It is sensitive to light and cooking loss is reduced by anti-oxidant agents like vitamin C.

Functions

1. Folic acid is converted to active folinic acid. Folic acid acts as a co-enzyme. Co-enzyme takes part in metabolic process when it transfers single carbon units from one compound to another. Folacin co-enzymes are involved in many methylation reactions.
2. Folic acid is essential for nucleoprotein synthesis and it is required for cell division and for maturation of erythrocytes.
3. The role of folacin in protein synthesis is made use of in cancer therapy
4. Folacin inhibitor like methortrexale is used in chemotherapy to inhibit tumor growth.
5. It is essential for reproduction in animals
6. Folic acid also helps the hair growth and health of skin

Deficiency

- Lack of folacin results in megaloblasticaneamia. It is otherwise known as macrocytic anaemia.
- This mainly affects pregnant women. Foilc acid deficiency in pregnant women leads to neural tube defect in infants.
- Poor vegetarian diet supplies very little folacin.
- This type of anaemia is due to inadequate formation of nucleoproteins. This prevents the megaloblasts in the bone marrow from maturing into erythrocytes.
- In megaloblastic anaemia the number of red blood cells produced in the bone marrow is reduced.
- The haemoglobin level is also reduced to 6-9 per cent and RBC count to two to three million per mm. Along with inadequate diet it also results from malabsorption syndromes like tropical sprue, B12 deficiency, after a surgical removal of a part of the stomach.

Sources

1. Rich sources: Kidney, liver and dark green leafy vegetables, soyabean and groundnut
2. Fair sources: Legumes, eggs, wholegrain cereals, other vegetables and fruits

Requirements

Age Group	Category	Body weights kg	Niacinequivalents mg/d

Man	Sedentary	60	16
Moderate		60	18
Heavy		60	21
Woman	Sedentary	55	12
Moderate		55	14
Heavy		55	16
Pregnant		55	+2
Lactation 0-6m 6-12m		55	+4 +3
Infants	0-6 m	5.4	710µg/kg
6-12m		8.4	650µg/kg
Children	1-3y 4-6y 7-9 y	12.9 18.0 25.1	8 11 13
Boys	10-12y	34.3	15
Girls	10-12y	35.0	13
Boys	13-15y	47.6	16
Girls	13-15y	46.6	14
Boys	16-17y	55.4	17
Girls	16-17y	52.1	14

BIOTIN

Biotin is an anti-egg white injury factor. Biotin is present in human tissues and is necessary for bacterial growth.

Functions

- It is also necessary for normal gestation and lactation in experimental animals.
- It plays an important role in maintaining the skin structure and for the health of nervous system.
- It also acts as co-enzyme for carboxylation of acetyl-CoA to form malonyl-CoA in fatty acid metabolism.

Deficiency

- Deficiency of biotin among human beings is not common.
- Dermatitis of varying types on the necks, hands, arms and legs are seen.
- It was followed by lassitude, muscle pain, anorexia, nausea and anaemia. Injection of biotin results in rapid cure

Sources

- Good sources: Dried yeast, rice polishing, liver, groundnut, soyabean, whole cereals, legumes and fleshy foods

Requirements

- A normal balanced diet supplies the requirement of biotin. Its deficiency is not common.

CHOLINE

Function

1. Choline is a component of phospholipid lecithin and it forms acetyl choline with alcohol and takes part in biochemical reactions
2. It promotes growth in animals
3. In its absence neutral fats and cholesterol esters accumulate in the liver producing fatty liver.
4. Choline is otherwise known as a lipotropic factor as it prevents fatty liver.
5. Choline enhances the oxidation of fatty acids and promotes the formation of lipoproteins in the liver.
6. Phospholipids take part in the transport of fatty acids and cholesterol in the blood and from the liver; their deposition and removal in adipose tissues.
7. It is essential for the transfer of nerve impulse.
8. It takes part in the formation of methionine from homocystine

Sources

Good sources: Egg yolk, wheat germ, organ meats like kidney, brain, heart, meat, yeast,soyabean and peanut and skimmed milk.

Requirements

Choline requirements of human beings are not known and its deficiency is also uncommon.

PARA AMINO BENZOIC ACID - INOSITAL

Functions

1. Inosital is essential for the growth of fibroblasts.
2. It is present in phospholipids and it exerts a lipotropic effect.
3. It is present in different tissues, especially in heart and skeletal muscles.
4. It helps in the intestinal activity

Deficiency

In experimental animals deficiency of inositol produced retarded growth and loss of hair. It also produces spectacled eye or loss of hair around the eye.

Sources

Good sources: Fruits, milk, vegetables, nuts, meat, wholegrain, yeast and bacteria

VITAMIN B12

Vitamin B12 contains the mineral cobalt which gives its characteristic dark red colour. Cyanocobalamin and hydroxyl cobalt are the two forms of B12.

Functions

1. B12 is essential for the maturation of red blood corpuscles and it combines with globulin
2. B12takes part in the enzymatic reaction. Especially co-enzyme B12 is very prominent in the body. Niacin, riboflavin and magnesium are essential for this conversion of B12 to co-enzyme B12.
3. Co-enzyme is required for the action of dehydrase enzyme

4. Vitamin B12 acts as a necessary substance for the lipoprotein action in the nervous tissues. It is also necessary for the synthesis of myelin. Within the bone marrow B12 co-enzyme participates in the synthesis of DNA
5. Co-enzyme B12 is essential for carbohydrate, protein and fat metabolism. In experimental animals vitamin B12 has been found to stimulate growth.
6. B12 co-enzyme is also essential for the synthesis and transfer of single carbon units such as the methyl group. eg. Methionine andcholine synthesis

Deficiency

- Due to the deficiency of vitamin B12, pernicious anaemia occurs.
- To prevent anaemia two factors are required.
- An intrinsic factor produced by the gastric parietal cells and the extrinsic factor of vitamin B12.
- If due to any cause enough intrinsic factor is not secreted, B12 is not absorbed and utilized properly.
- B12 is otherwise known as extrinsic factor.
- Congenital intrinsic factor deficiency and low absorption of B12 or its deficiency leads to pernicious anaemia.
- In pernicious anaemia the life span of red blood cells is reduced to 60 days instead of the normal 120 days and their size and shape also is changed. Skin changes show a yellowish pallor.
- Soreness and shine on the tongue are other manifestations of skin lesions. Gastric secretion is reduced.
- Stomach mucosa shows atrophic changes.
- Nervous tissues are degenerated, especially the posterior column of the spinal cord is affected. Peripheral neuropathy and later on mental changes are common.
- Tingling, numbness, loss of sensation in the limbs, exaggerated knee jerks and ankle jerks are the other symptoms.
- Depression and other psychosis symptoms are common in later stages.

Sources

- Good sources: Organ meats like kidney, liver, brain, meat, poultry, egg, fish and milk

Requirements

RDA of Vitamin B12 for Indians

Group	Recommended intake µg/d
Adult male	1.0
Adult female	1.0
Pregnancy	1.2
Lactation	1.5
Infant	0.2
1-9 y	0.2-1.0
10-12 y	0.2-1.0
13-17y	0.2-1.0

VITAMIN C (ASCORBIC ACID)

Ascorbic acid is white crystalline substance readily soluble in water. It is easily destroyed by oxidation, heat and alkalies. It is readily absorbed from the intestine. Hence it is named as fresh food vitamin.

Functions

1. Due to its great affinity for oxidation it takes part in oxidation and reduction reactions in the tissues.
2. Ascorbic acid is essential for the formation of collagen present between cells. It is otherwise known as the cementing material or intercellular cement of the body
3. If collagen is defective, tissues in the capillaries teeth and bone matrix are not formed properly
4. Ascorbic acid is also necessary for the formation of osteoblasts
5. Vitamin C is essential for cholesterol metabolism
6. It is also necessary for the conversion of phenylalanine to tyrosine and for the oxidation of tyrosine
7. It takes part in the conversion of tryptophan to 5-hyrdroxy- tryptophan

8. Ascorbic acid reduces the ferric iron to ferrous iron and iron is absorbed only in this form

9. It is also essential for rapid healing of wounds as it helps in the formation of connective tissues.

10. Vitamin C is also essential for the utilization of folacin and for the absorption of iron.

Deficiency

Prolonged deficiency of vitamin C produces scurvy. In mild deficiency fatigue, weakness, irritability and frequent infections occur. Pain in bones is common.

Scurvy among infants is known as infantile scurvy. The infant cries on moving its legs and arms. Early symptoms include listlessness, fatigue, fleeting pains in the joints and muscles, bleeding gums, internal haemorrhages and shortness of breath. In severe deficiency of vitamin C scurvy occurs. Swollen gums, loose teeth, soft or malformed weak bones, anaemia, degeneration of muscle fibres including heart muscles are some of the symptoms of vitamin C deficiency. Separation of ribs through beading is also observed. This can be distinguished from rickets from its shape. The skin becomes rough and dry. Pyrexia, rapid pulse and susceptibility to infection are common in scurvy.

In adults, weakness, spongy bleeding gums, loose teeth, swollen joints and haemorrhages in various tissues are the symptoms.

Prophylaxis for infantile scurvy includes 50mg of vitamin C with orange juice three or four times a day. In the case of adults 100 mg of ascorbic acid twice daily is recommended. Citrus fruits, sprouted pulses and soaked cereals must be liberally used for vitamin C.

Sources

Richest sources :Amla or Indian gooseberry, guava, west Indian cherry

Good sources : Lime, orange, pineapple, ripe mango, papaya, cashew fruit and

tomato, leafy vegetables

Requirements

RDA of Ascorbic Acid (Vitamin C) for Indians Group			RDA (mg/d)
Adult		Man	40
Woman			40
Pregnant Woman			60
Lactating woman			80
Children		0 – 6 months	25
7 – 12 months			
1 – 3 years			40
4 – 6 years			
7 – 9 years			
Adolescents	Boys	10-12 years	40
Girls		10-12 years	
Boys		13-15 years	40
Girls			13-15 years
Boys		16-17 years	40
Girls			16-17 years

Topic 15

FAT SOLUBLE VITAMINS – FUNCTIONS, SOURCES, REQUIREMENTS AND DEFICIENCY DISEASES

VITAMIN A

Fat soluble vitamins are soluble in fats and fat solvents. They are insoluble in water. So these vitamins are used only if there is presence of fat in the body.

Functions

1. Vitamin A is essential for the building and growth of all cells, especially skeletal cells. Vitamin A is also needed for proper tooth structure. It helps in the integrity of the epithelium, especially the mucous membranes, which line the eyes, mouth, alimentary canal, salivary glands, respiratory and genito-urinary tracts. In the deficiency of vitamin A the epithelial tissues of these parts are keratonised.
2. Vitamin A maintains normal reproductive function in males
3. Vitamin A is again essential for the maintenance of normal vision in dim light. This vitamin combines with protein to form rhodopsin or visual purple which is present in the retina. Visual purple absorbs light and is decomposed to retinene and protein. The protein and retinine are partially recombined to form rhodopsin in the dark
4. Vitamin A plays an important role in maintaining the structure of myelin sheath
5. Vitamin A also helps the synthesis of mucopolysaccharides
6. High serum retinol levels reduce the risk of cancer. Vitamin A is also known as anti infective vitamin as it provides resistance power to the body by maintaining normal structure of the organs

Deficiency

Vitamin A deficiency in man may be due to low intake of vitamin A source or due to interference with absorption or storage of vitamin A in the body. In certain diseases proper assimilation of vitamin A is affected. Loss of vitamin A occurs in the blood during some infectious diseases.

Bitot's spots: Grey coloured triangular spots are located in the conjunctiva in severe cases.

Night blindness: In advanced deficiency the subjects cannot see objects in dim light. Difficulty to read in dim light is experienced.

Xerosis conjunctiva: The conjunctiva is dry thickened wrinkled and pigments. This is due to the keratinisation of the epithelial cells. The pigmentation gives the conjunctiva a smoky appearance

Xerosis of cornea: When dryness spreads to cornea, it takes on a dull, hazy and lustreless appearance.

Keratomalacia: When xerosis of the conjunctiva and cornea is not treated, it may develop into the condition known as 'keratomalacia'. The corneal epithelium becomes opaque and ulceration and bacterial invasion of the cornea bring about its destruction resulting in blindness.

Phrynoderma: In vitamin A deficiency, the skin becomes rough because the epithelial tissues are affected. This condition is known as follicular keratosis or toad skin or phrynoderma.
Hypervitaminosis: If excess amount of vitamin A is consumed it shows ill effect in the body. The symptoms are drowsiness, headache, vomiting, itching, skin lesions and loss of appetite.

Best sources of retinol – shark, halibut liver oil, sheep, goat and cow
Good source - butter, ghee, egg, all milk powders
Good sources of carotenoids - green leafy vegetables, carrot, pumpkin, papaya, jackfruit, mangoes and enriched
vanaspathi.
Requirements
Recommended Intake of Vitamin A
(Retinol Equivalents, RE, µg/ d)

Group	Sub group	FAO/WHO 2004	Present Committee	
Retinol			Retinol	β-carotene*
Adult man Adult Woman		600 500	600	4800
Pregnant women		800	800	6400
Lactating woman		850	950	7600
Infants	0-6 m 6-12 m	375 400	350	--- 2100
Children	1-6 y 7-9 y	400/450 500	400 600	3200 4800
Adolescents	10-17 y	600	600	4800

VITAMIN D

Vitamin D is otherwise known as 'sunshine vitamin' as it can be synthesized from sunlight by our body.

Functions

1. Vitamin D promotes the absorption of calcium and phosphorus from the small intestine
2. In the DNA vitamin D helps to form active calcium binding protein
3. It also maintains the concentration of calcium and phosphorus in the blood
4. Vitamin D helps the deposition of calcium phosphate in the bone. In rachitic children there may be delay in dentition and malformation of the teeth occurs

Deficiency

- Deficiency of vitamin D results in poor absorption of calcium and phosphorus from the intestine and excessive loss of them in the urine and faeces.
- Concentration of calcium in the plasma is diminished and it produces tetany which is characterized by hyperexcitability of the nervous system.
- This stimulates the parathyroid glands to decalcify bone calcium to raise the plasma calcium level.
- Deficiency of vitamin D leads to rickets in children and osteomalacia in adults

Rickets

- The name of Rickets is given to vitamin D deficiency after a famous English bone setter by EII. In mild deficiency of vitamin D, the symptoms shown are restlessness and irritability.
- Rickets is a disease of infancy and childhood. Calcium and phosphorus are not deposited enough to form strong bones and as a result the leg bones become bent and deformed.

Symptoms

- Small round unossified areas are developed near skull bones
- Projections are formed on the osteochondal junction of the ribs.
- It resembles a rosary and it is known as 'rickets rosary'.

- The abdomen is distended and chest deformities like depression of ribs attached to diaphragm take place. This is known as Harrison's sulcus and gives an appearance of 'pigeon breast'.
- In a later stage, pelvic deformities, bow legs and/or knock knees develop.
- Nutritional rickets occur in infants and children of poor families. Premature infants are more susceptible to rickets

Osteomalacia

- Osteomalacia occurs among adults.
- It is often known as 'adult rickets'. Osteomalacia is most common among women who live on a poor diet lacking incalcium and vitamin D. Pregnant women are more prone to this.
- It is mainly because of the increase in weight during pregnancy accompanied by the deficiency of vitamin D.
- It is again common among women who observe 'purdah'.
- Repeated pregnancies and prolonged lactation further deplete calcium stores which results in osteomalacia.
- Pain, softening and tenderness in the bones and fractures are the common complaints of the patients of osteomalacia.

Sources

- Best sources: Fish liver oils, egg yolk, milk, butter, ghee and fortified foods
- Best natural source: Sun light

Requirements

- The daily requirements of vitamin D for infants, children, pregnant and nursing women have been estimates to be 400 IU (10µg) and for older children and adults about 200 IU (5µg).

VITAMIN E

Vitamin E is otherwise known as Tocopherol or antisterility vitamin. Female rats with vitamin E deficiency are unable to carry the young ones throughout the gestation period.

Functions

Vitamin E has a prominent role in maintaining the stability and integrity of cell membranes.

It has a role in erythrocyte survival among premature infants

It reduces the oxidation of vitamins A and C and sulphur containing amino acids.

Through this activity it stabilizes the lipid parts of cell membrane

The presence of vitamin E as a natural component of vegetable fats protects against rancidity.

Polyunsaturated fatty acids have a role in brain development during infancy.

The antioxidant property of vitamin E helps fatty acids from oxidation and thus it indirectly helps the brain development.

Deficiency

Vitamin E deficiency is not common among human beings as it is widely distributed in foods.

Experimental deficiency in female rats results in fetal death and in males testicular changes in sterility.

Muscular dystrophy and paralysis are the other symptoms of vitamin E deficiency.

If vitamin E deficiency is present in the pregnant mother transfer of placental blood to foetus is poor and so haemolytic anaemia may occur in the baby after delivery.

Vitamin E deficiency in adults results in poor absorption of fat and increased haemolysis and increased excretion of urinary creatinine.

Brown muscle pigment deposition called ceriod occurs with tocopherol deficiency.

Liver necrosis, erythrocyte haemolysis and anaemia are the other symptoms.

Sources

Richest sources: Cereal germ oils

Fair sources: Vegetable oils and nuts

Requirements

For males 30 I.U. and for females 25 I.U. are recommended. Human milk supplies enough tocopherol for the infants. Daily balanced diet will supply sufficient Vitamin E, hence no deficiency is evident.

VITAMIN K

Functions

- Vitamin K is essential for the formation of prothrombin which helps normal clotting of blood.
- Vitamin K is not directly involved in the coagulation but it is essential for the coagulation on blood.
- It takes part in the carboxylation of glutamic residue

Deficiency

- Dietary deficiency is not common. Deficiency of vitamin K is indicated by a tendency to bleed from skin and mucous membranes.
- Deficiency occurs due to deficient production of it by the gut with prolonged antibiotic therapy, due to poor absorption of vitamin K, in malabsorption of fats and due to low prothrombin synthesis in liver disease.
- Pyloric obstruction and diarrhea or dysentery can result in poor absorption, surgical removal of gut.
- Deficiency of vitamin K among newborns, especially among premature babies, delays clotting of blood.
- If the mother's intake during pregnancy is poor it can lead to this condition.
- Excess of vitamin K due to excessive administration produces hypoprothrobinaemia and disorders in liver.
- Vitamin K is not stored in large quantities in the body. Only in the liver vitamin K is stored.

Sources

- Good sources - Plant oils
- Best source - Rice bran oil, wheat germ oil, soybean and cottonseed oils
- Poor sources – Vegetables and fruits

Topic 16

BALANCED DIET, RECOMMENDED DIETARY ALLOWANCES FOR VARIOUS AGE GROUPS

Balanced diet

- A balanced diet is one which contains different types of food in such quantities and proportions so that the need for calories, proteins, minerals, vitamins and other nutrients is adequately met and a small provision is made for extra nutrients to withstand short duration lean periods. (Srilakshmi, 2000)
- A balance diet may be defined as one which contains various groups of food stuffs such as energy yielding foods, body building foods and protective foods in the correct proportion so that individual is assured of obtaining the minimum requirements of all the nutrients.
- The components of balanced diet will differ according to age, sex, physical activity, economic status and the physiological state viz. pregnancy, lactation etc.

Recommended Dietary Allowance

- The nutrition Advisory Committee of the Indian Council of Medical Research (ICMR) has recommended the dietary allowances. The RDA implies addition of safety amount to the estimated requirement to cover both the variations among the individual and lack of precision inherent in the estimate requirement. To calculate the balanced diet RDA are prescribed for various individuals.

PLANNING OF BALANCED DIETS

Balanced Diets at High Cost

- It will include liberal amounts of costly foods such as milk, eggs, meat, fish and fruits and moderate quantities of cereals, pulses, nuts and fats.

Balanced Diets at Moderate Cost

These diets will include moderate amount of milk, eggs, meat, fish, fruits and fats and liberal amounts of cereals, pulses, nuts and green leafy vegetables.

Balanced Diet at Low Cost

These diets will includes small amounts of milk, eggs, meat, fish and fats and liberal amounts of cereals, pulses, nuts and green leafy vegetables. The ICMR Nutrition Expert Group (1968) recommended balanced diets at low costs.

Diets for Pregnant and Nursing Mothers

Balanced diets at low cost are suggested by the ICMR Nutrition Expert Group for pregnant and lactating women. The diets include fair amounts of legumes and green leafy vegetables.

BALANCED DIETS AT MODERATE AND HIGH COSTS

Table 16.1 Balanced Diets for Pre-school Children (High Cost)

Foodstuffs	1 to 3 Years		4 to 5 Years	
	V	NV	V	NV
Cereals (g)	100	100	140	140
Pulses (g)	30	20	40	30
Green leafy vegetables (g)	50	50	75	75
Other vegetables, roots and tubers (g)	30	30	30	30
Fruits (tomato or papaya or guava) (g)	100	100	100	100
Milk (ml)	1000	700	1000	700
Fat and oils (g)	-	30	-	30
Meat, fish and eggs (g)	-	20	-	30
Sugar and jaggery (g)	20	20	25	25
Cereals (g)	30	30	40	40

V-Vegetarian NV-Non-vegetarian

Table 16.2. Balanced Diets for Pre-school Children (Moderate Cost)

Foodstuffs	1 to 3 Years		4 to 6 Years	
	V	NV	V	NV
Cereals (g)	120	120	170	170
Pulses (g)	50	40	60	50
Green leafy vegetables (g)	50	50	75	75
Other egetables, roots and tubers (g)	30	30	50	50
Fruits (tomato or papaya or guava) (g)	100	100	100	100
Milk (ml)	600	400	600	400
Fat and oils (g)	20	20	25	25
Meat, fish and eggs (g)	-	40	-	50
Sugar and jaggery (g)	30	30	40	40

Table 16.3. Balanced Diets for Pre-school Children (Low Cost)

Food stuffs	1 to 3 Years		4 to 6 Years	
	V	NV	V	NV
Cereals (g)	150	150	200	200
Pulses (g)	50	40	60	50
Green leafy vegetables (g)	50	50	75	75
Other Vegetables, roots and tubers (g)	30	30	50	50
Fruits (tomato or papaya or guava)(g)	50	50	50	50
Milk (ml)	300	200	250	200
Fat and oils (g)	20	20	25	25
Meat, fish and eggs (g)	-	30	-	30

Sugar and jaggery (g)	30	30	40	40

Table 16.4. Balanced Diets at Low Cost for Children and Adolescents

Foodstuffs	School children						Adolescents			
	7-9 yrs		10-12 yrs		13-15 yrs		Boys 16-18 yrs		Girls 13-18 yrs	
	V	NV	V	NV	V	NV	V	NV	V	NV
Cereals (g)	250	250	320	320	430	430	450	450	350	350
Pulses (g)	70	60	70	60	70	50	70	50	70	50
Green leafy vegetables (g)	75	75	100	100	100	100	100	100	150	150
Other vegetables, roots and tubers (g)	50	50	75	75	150	150	175	175	150	150
Fruits (g)	50	50	50	50	30	30	30	30	30	30
Milk (ml)	250	200	250	200	250	150	250	150	250	150
Fat and oils (g)	30	30	35	35	35	40	45	50	35	40
Meat, fish and eggs (g)	1.	30	-	30	-	30	-	30	-	30
Sugar and jaggery (g)	50	50	50	50	30	30	40	40	30	30
Peanut (roasted) (g)	1.	-	-	-	-	-	50	50	-	-

Table 16.5.Balanced Diets at High Cost for School Children and Adolescents

Foodstuffs	School children						Adolescents			
	7-9 yrs		10-12 yrs		13-15 yrs		Boys 16-18 yrs		Girls 13-18 yrs	
	V	NV	V	NV	V	NV	V	NV	V	NV
Cereals (g)	200	200	260	260	370	370	390	390	290	290
Pulses (g)	40	50	40	30	50	30	50	30	50	30
Green leafy vegetables (g)	75	75	100	100	100	100	100	100	150	150

Other vegetables,roots and tubers(g)	50	50	75	75	75	75	100	100	75	75
Fruits (g)	100	100	100	100	100	100	100	100	100	100
Milk (ml)	1000	700	1000	700	1000	700	1000	700	1000	700
Fat and oils (g)	30	30	35	35	35	40	45	50	35	40
Meat, fish andeggs (g)	1.	90	1.	90	1.	120	1.	120		120
Sugar and jaggery (g)	50	50	50	50	30	30	40	40	30	30
Peanut (roasted) (g)	30	20	40	30	40	30	50	30	50	30

Table 16.6 Balanced Diets at Moderate Cost for Children and Adolescents

Foodstuffs	**School children**						**Adolescents**			
	7-9 yrs		**10-12 yrs**		**13-15 yrs**		**Boys 16-18 yrs**		**Girls 13-18 yrs**	
	V	**NV**	**V**	**NV**	**V**	**NV**	**V**	**NV**	**V**	**NV**
Cereals (g)	200	200	260	260	370	370	390	390	290	290
Pulses (g)	40	50	40	30	50	30	50	30	50	30
Green leafy vegetables (g)	75	75	100	100	100	100	100	100	150	150
Other vegetables,roots and tubers(g)	50	50	75	75	75	75	100	100	75	75
Fruits (g)	100	100	100	100	100	100	100	100	100	100
Milk (ml)	1000	700	1000	700	1000	700	1000	700	1000	700
Fat and oils (g)	30	30	35	35	35	40	45	50	35	40
Meat, fish andeggs (g)	1.	90	1.	90	1.	120	1.	120		120
Sugar and jaggery (g)	50	50	50	50	30	30	40	40	30	30

Peanut (roasted) (g)	30	20	40	30	40	30	50	30	50	30

Table 16.7 Balanced Diets for Adult male (Low-cost)

Foodstuffs	Sedentary work		Moderate work		Heavy work	
	V	NV	V	NV	V	NV
Cereals (g)	400	400	475	475	650	650
Pulses (g)	70	55	80	65	80	65
Green leafy vegetables (g)	100	100	125	125	125	125
Other vegetables, roots and tubers (g)	75	75	75	75	100	100
Fruits (g)	30	30	30	30	30	30
Milk (ml)	200	100	200	100	200	100
Fat and oils (g)	35	40	40	40	50	50
Meat, fish and eggs (g)	30	30	40	40	55	55
Sugar and jaggery (g)	-	30	-	30	-	30
Peanut (roasted) (g)	-	-	-	-	50*	50*

*An additional 25g of fats and oils can be included in the diet in the place of groundnut

Table 16.8.Balanced Diets for Adult Male

(Moderate cost)

Food stuffs	Sedentary work		Moderate work		Heavy work	
	V	NV	V	NV	V	NV

Cereals(g)	350	350	425	425	600	600
Pulses(g)	70	55	80	65	80	65
Green leafy vegetables(g)	100	100	125	125	125	125
Other vegetables (g)	75	75	100	100	100	100
Roots and tubers(g)	75	75	100	100	100	100
Fruits(g)	60	60	60	60	60	60
Milk (ml)	600	400	600	400	600	400
Fat and oils (g)	35	40	40	40	50	50
Sugar and jiggery(g)	30	30	40	40	55	55
Meat, fish andeggs(g)	-	60	1.	60	-	60
Eggs(g)	1.	30	1.	30	-	30
Peanut (roasted) (g)	50	50	50	50	50	50

PLANNING OF BALANCED DIETS

Balanced Diets at High Cost

- It will include liberal amounts of costly foods such as milk, eggs, meat, fish and fruits and moderate quantities of cereals, pulses, nuts and fats.

Balanced Diets at Moderate Cost

These diets will include moderate amount of milk, eggs, meat, fish, fruits and fats and liberal amounts of cereals, pulses, nuts and green leafy vegetables.

Balanced Diet at Low Cost

These diets will includes small amounts of milk, eggs, meat, fish and fats and liberal amounts of cereals, pulses, nuts and green leafy vegetables. The ICMR Nutrition Expert Group (1968) recommended balanced diets at low costs.

Diets for Pregnant and Nursing Mothers

Balanced diets at low cost are suggested by the ICMR Nutrition Expert Group for pregnant and lactating women. The diets include fair amounts of legumes and green leafy vegetables.

BALANCED DIETS AT MODERATE AND HIGH COSTS

Table 16.1 Balanced Diets for Pre-school Children (High Cost)

Foodstuffs	1 to 3 Years		4 to 5 Years	
	V	NV	V	NV
Cereals (g)	100	100	140	140
Pulses (g)	30	20	40	30
Green leafy vegetables (g)	50	50	75	75
Other vegetables, roots and tubers (g)	30	30	30	30
Fruits (tomato or papaya or guava) (g)	100	100	100	100
Milk (ml)	1000	700	1000	700
Fat and oils (g)	-	30	-	30
Meat, fish and eggs (g)	-	20	-	30
Sugar and jaggery (g)	20	20	25	25
Cereals (g)	30	30	40	40

V-Vegetarian NV-Non-vegetarian

Table 16.2. Balanced Diets for Pre-school Children (Moderate Cost)

Foodstuffs	1 to 3 Years		4 to 6 Years	
	V	NV	V	NV
Cereals (g)	120	120	170	170

Pulses (g)	50	40	60	50
Green leafy vegetables (g)	50	50	75	75
Other egetables, roots and tubers (g)	30	30	50	50
Fruits (tomato or papaya or guava) (g)	100	100	100	100
Milk (ml)	600	400	600	400
Fat and oils (g)	20	20	25	25
Meat, fish and eggs (g)	-	40	-	50
Sugar and jaggery (g)	30	30	40	40

Table 16.3. Balanced Diets for Pre-school Children (Low Cost)

Food stuffs	1 to 3 Years		4 to 6 Years	
	V	NV	V	NV
Cereals (g)	150	150	200	200
Pulses (g)	50	40	60	50
Green leafy vegetables (g)	50	50	75	75
Other Vegetables, roots and tubers (g)	30	30	50	50
Fruits (tomato or papaya or guava)(g)	50	50	50	50
Milk (ml)	300	200	250	200
Fat and oils (g)	20	20	25	25
Meat, fish and eggs (g)	-	30	-	30
Sugar and jaggery (g)	30	30	40	40

Table 16.4. Balanced Diets at Low Cost for Children and Adolescents

Foodstuffs	School children			Adolescents	
	7-9 yrs	10-12 yrs	13-15 yrs	Boys 16-18	Girls 13-18 yrs

							yrs			
	V	**NV**	**V**	**NV**	**V**	**NV**	**V**	**NV**	**V**	**NV**
Cereals (g)	250	250	320	320	430	430	450	450	350	350
Pulses (g)	70	60	70	60	70	50	70	50	70	50
Green leafy vegetables (g)	75	75	100	100	100	100	100	100	150	150
Other vegetables, roots and tubers (g)	50	50	75	75	150	150	175	175	150	150
Fruits (g)	50	50	50	50	30	30	30	30	30	30
Milk (ml)	250	200	250	200	250	150	250	150	250	150
Fat and oils (g)	30	30	35	35	35	40	45	50	35	40
Meat, fish and eggs (g)	1.	30	-	30	-	30	-	30	-	30
Sugar and jaggery (g)	50	50	50	50	30	30	40	40	30	30
Peanut (roasted) (g)	1.	-	-	-	-	-	50	50	-	-

Table 16.5.Balanced Diets at High Cost for School Children and Adolescents

Foodstuffs	**School children**						**Adolescents**			
	7-9 yrs		**10-12 yrs**		**13-15 yrs**		**Boys 16-18 yrs**		**Girls 13-18 yrs**	
	V	**NV**	**V**	**NV**	**V**	**NV**	**V**	**NV**	**V**	**NV**
Cereals (g)	200	200	260	260	370	370	390	390	290	290
Pulses (g)	40	50	40	30	50	30	50	30	50	30
Green leafy vegetables (g)	75	75	100	100	100	100	100	100	150	150
Other vegetables,roots and tubers(g)	50	50	75	75	75	75	100	100	75	75
Fruits (g)	100	100	100	100	100	100	100	100	100	100
Milk (ml)	1000	700	1000	700	1000	700	1000	700	1000	700
Fat and oils (g)	30	30	35	35	35	40	45	50	35	40

Meat, fish andeggs (g)	1.	90	1.	90	1.	120	1.	120		120
Sugar and jaggery (g)	50	50	50	50	30	30	40	40	30	30
Peanut (roasted) (g)	30	20	40	30	40	30	50	30	50	30

Table 16.6 Balanced Diets at Moderate Cost for Children and Adolescents

Foodstuffs	**School children**						**Adolescents**			
	7-9 yrs		**10-12 yrs**		**13-15 yrs**		**Boys 16-18 yrs**		**Girls 13-18 yrs**	
	V	**NV**	**V**	**NV**	**V**	**NV**	**V**	**NV**	**V**	**NV**
Cereals (g)	200	200	260	260	370	370	390	390	290	290
Pulses (g)	40	50	40	30	50	30	50	30	50	30
Green leafy vegetables (g)	75	75	100	100	100	100	100	100	150	150
Other vegetables,roots and tubers(g)	50	50	75	75	75	75	100	100	75	75
Fruits (g)	100	100	100	100	100	100	100	100	100	100
Milk (ml)	1000	700	1000	700	1000	700	1000	700	1000	700
Fat and oils (g)	30	30	35	35	35	40	45	50	35	40
Meat, fish andeggs (g)	1.	90	1.	90	1.	120	1.	120		120
Sugar and jaggery (g)	50	50	50	50	30	30	40	40	30	30
Peanut (roasted) (g)	30	20	40	30	40	30	50	30	50	30

Table 16.7 Balanced Diets for Adult male (Low-cost)

Foodstuffs	**Sedentary work**		**Moderate work**		**Heavy work**	
	V	**NV**	**V**	**NV**	**V**	**NV**

Cereals (g)	400	400	475	475	650	650
Pulses (g)	70	55	80	65	80	65
Green leafy vegetables (g)	100	100	125	125	125	125
Other vegetables, roots and tubers (g)	75	75	75	75	100	100
Fruits (g)	30	30	30	30	30	30
Milk (ml)	200	100	200	100	200	100
Fat and oils (g)	35	40	40	40	50	50
Meat, fish and eggs (g)	30	30	40	40	55	55
Sugar and jaggery (g)	-	30	-	30	-	30
Peanut (roasted) (g)	-	-	-	-	50*	50*

*An additional 25g of fats and oils can be included in the diet in the place of groundnut

Table 16.8.Balanced Diets for Adult Male

(Moderate cost)

Food stuffs	**Sedentary work**		**Moderate work**		**Heavy work**	
	V	**NV**	**V**	**NV**	**V**	**NV**
Cereals(g)	350	350	425	425	600	600
Pulses(g)	70	55	80	65	80	65
Green leafy vegetables(g)	100	100	125	125	125	125
Other vegetables (g)	75	75	100	100	100	100
Roots and tubers(g)	75	75	100	100	100	100

Fruits(g)	60	60	60	60	60	60
Milk (ml)	600	400	600	400	600	400
Fat and oils (g)	35	40	40	40	50	50
Sugar and jiggery(g)	30	30	40	40	55	55
Meat, fish andeggs(g)	-	60	1.	60	-	60
Eggs(g)	1.	30	1.	30	-	30
Peanut (roasted) (g)	50	50	50	50	50	50

Topic 17

ASSESSMENT OF NUTRITIONAL STATUS OF THE POPULATION

Assessment of Nutritional Status

- Assessment of nutritional status of community is one of the steps in the formulation of any public health strategy to combat malnutrition. The principle aim of such an assessment is to determine the type, magnitude and distribution of malnutrition in different geographic areas, to identify 'at risk' groups and to determine the contributory factors. In addition, factual evidence of the exact magnitude of malnutrition is essential to sensitize administrators and politicians to obtain allocation of material and human resources and to plan appropriately.

Nutritional status can be assessed by the following methods

Direct methods	Indirect methods
Anthropometry	Dietary assessment
Clinical examination	Vital health statistics
Biophysical or radiological examination	
Functional assessment	
Laboratory and Biochemical estimation	

ANTHROPOMETRIC ASSESSMENT

- Anthropometric measurements of human body reflect changes in morphological variation due to inappropriate food intake or malnutrition.
- A variety of anthropometric measurements can be made either covering the whole body or parts of the body.
- Anthropometric measurements can be taken for cross sectional and longitudinal studies.
- The measurements to be taken for nutritional assessment includes; height, weight, fat fold thickness, circumferences like mid upper arm, waist, hip, head and chest.

- Recorded measurements need to be compared with suitable standards. However, there is no permanent standard as there is no uniformity of growth in subsequent generation.
- Local standards need to be developed of various ethnic groups. It is wise to compare with international standards.
- Most commonly used and recommended is the NCHS (National center for Health Statistics) standard.

Body Weight

- Body weight is the most widely used and the sensitive and simplest reproducible measurement for the evaluation of nutritional status of population.
- It indicates the body mass and is a composite of all body constituents like water, mineral, fat, protein and bone. It reflects more recentnutrition than do height.
- Serial measurements of weight, as in growth monitoring are more sensitive indicators of changes in nutritional status than a single measurement at a point of time.
- Rapid loss of body weight in children should be considered as an indicator of potential malnutrition.
- For measuring body weight, beam or lever actuated scales, with an accuracy of 50-100g are preferred. Bathroom scales may give errors upto 1.5 kg.
- Beam balances are extensively used in Integrated Child Development Services projects (ICDS).
- Periodically scales need to be calibrated for accuracy using known weights.
- Weights should be taken with the individual under basal conditions with minimum clothing and without shoes.
- The zero error of the weighing scale should be checked before taking the weight and corrected as and when required.

Height

- The height of an individual is influenced both by genetics and environmental factors.
- The maximum growth potential of an individual is decided by hereditary factors, while the environmental factors, the most important being nutrition and morbidity, determine the extent of exploitation of that genetic potential.
- Height is affected only by long-term nutritional deprivation; it is considered an index of chronic or long duration malnutrition.

- In children below the age of two years cannot stand properly, recumbent length (crown-heel length) should be measured with infantometer.
- The legs need to be held straight and firm with the feet touching the sliding board.
- In the older children and adults, heights are measured with a vertical measuring rod using anthropometer or stadiometer.
- The subject should stand erect looking straight on a leveled surface with heels together and toes apart, without shoes.
- The moving head piece of the anthropometer should be lowered to rest flat on the top of the head and reading should be taken.
- Height should be read to the nearest ¼" or 0.5 cm. An average of three measurements is taken as the final measurement.

Mid-Upper Arm Circumference (MUAC)

- Mid-upper Arm Circumference is recognized to indicate the status of muscle development.
- It is useful not only in identifying malnutrition but also in determining the mortality risk in children.
- It correlates well with weight, weight for height and clinical signs.
- On the left hand, the mid-point between the tip of the acromion of scapula and tip of the olecranon of the fore-arm bone, ulna is located with the arm flexed at the elbow and marked with a marker pen.
- Fibre glass tape is used and the reading is taken to the nearest millimeter.

Fat fold at triceps

- By using skin-fold calipers thickness of the fat layers is measured. This is measured by picking the skin fold between the thumb and forefinger on the dorsal side at the same mid point where mid upper arm circumference is measured on the right arm.

Fat Fold at Sub-scapula

- The fat fold is measured just below and lateral to the angle of the left scapula by picking it up with the thumb and forefinger in a line running approximately 45^0 to the spine, in the natural line of skin cleavage.
- The calipers used should have a standard contact surface (pinch area) of 20-40 mm and an accuracy of 0.1mm.
- Some of the standard calipers used are Harpenden, Lange and Best. Unacaliper is used in India.

Head and Chest circumferences

- Head size relates mainly to the size of brain which increases quite rapidly during infancy.
- The chest in a normally nourished child grows faster than head during the second and third year of life.
- As a result, the chest circumference overtakes head circumference by about one year age.
- In protein energy malnutrition due to poor growth of chest, the head circumference may remain to be higher than the chest even at the age of 2½ to 3 years.
- Flexible fibre glass tape is used. The chest circumference is taken at the nipple level preferably in mid inspiration.
- The head circumference is measured passing the tape round the head over the supra-orbital ridges of the frontal bone in front and the most protruding point of the occiput on the back of the head.

Assessment of children

- Weight, height and arm circumference are considered the most sensitive parameters for assessing nutritional status of under fives. Several methods have been suggested for the classification of nutritional status based on these measurements.

Weight for age

- The most widely used classifications of nutritional status are given below

IAP Classification

1st Degree 80 – 70%
2nd Degree 70 – 60 %
3rd Degree 60 – 50 %
4th Degree < 50% of Expected

Gomez Classification

Grade Weight for age

Normal >90%
Grade I 75-90%
Grade II 60-75%
Grade III <60%

Most often accurate assessment of age may not be possible. Weight for height is age independent.

Mid-upper Arm Circumference for Age

- Mid arm circumference varies little between the age of one and four years. It correlates well with weight and weight for height.
- Use of tricolor tape (Shakir Tape), QUAC stick (arm circumference and height) and arm circumference/head circumference ratio have been suggested for assessment of nutritional status.

ASSESSMENT OF PEM in Children

- Assessment can be made by using several indices. The following table gives commonly used indices of normal and PEM children.

Anthropometric Measurements of normal and PEM children

Measurement	Normal	PEM
Wt in kg • **Rao index** $\frac{\text{Wt}}{(\text{ht in cm})^2} \times 100$	>0.15	< 0.15
• Wt/age	Normal	80-60% kwashiorkar oedema <60% Marasmus without oedema
• Skin fold thickness	>10 mm	<6mm
• Bangle test-4.0 cm diameter	Does not pass	Passes above the elbow
• Mid arm circumference	16 mm	Mild - 12.5-13.5 cm
		Moderate - 12.5-13.5 cm
		Severe < 12.5 cm
• **Kanawati index:** Ratio of arm circumference to head circumference	> 0.32	Mild - 0.28-0.32
Mid arm circumference Head circumference		Moderate - 0.25-0.28 Severe < 0.25
Chest circumference • Head circumference	>1.0	<1.0

Prediction of Birth Weight of the Newborns

Maternal height and weight for height (%) are useful in predicting the birth weight of the newborn. Women with height of more than 145 cm and weight of 45 kg or more and good weight gain are found

to have babies with good birth weights. Prematurity rates are very low with better stature, body weight and weight / height2.

Assessment of adults

Body Mass Index (BMI)

After the cessation of linear growth around 21 years, weight for height indicates muscle fat mass in the adult body. The ratio of Weight in kg/ height2 m is referred to as Body Mass Index. BMI has good correlation with fatness. It may also be used as an indicator of health risk.

Table -17.1 BMI in relation to energy status

Presumptive diagonsis	BMI
Chronic energy deficiency-grade III severe	<16.0
Chronic energy deficiency-grade II moderate	16.0-17.0
Chronic energy deficiency –grade I mild	17-18.5
Low weight -normal	18.5-20.0
Normal	20.0-25.0
Obese grade I	25.0-30.0
Obese grade II	>30

For similar BMI, Indians have a greater proportion of body fat which renders them susceptible to morbidity.

Broka's Index

Broka's index = Ht is cms – 100 = ideal weight in kg.

Broka's index is simple and easy to use index for assessment of nutritional status of adults.

Broka's index correlates with BMI and wt/ht.

Waist and Hip Circumference Ratio

Waist-to-hip ratio gives distribution of fat in the human body. A waist hip ratio greater than 1.0 in men 0.8 in women is indicative of android obesity and increase the risk of atherosclerosis.

CLINICAL EXAMINATION

The distinction between the well and poorly nourished might appear to present no difficulty. A well nourished person is strong and active with firm muscles, bright eyes and a smooth elastic skin. The poorly fed person is weak and lethargic, with feeble muscles and perhaps, a rough dry skin. Accurate recording of the incidence of major nutritional diseases and also the lesser stigmata of malnutrition is a valuable part of a nutritional survey. Whenever possible and particularly in the less developed countries where under and malnutrition are common the incidence of nutritional diseases should be determined by examining a satisfactory sample of the population by economic class, occupation, age and sex.

Pre-school children, their mothers and elderly people living alone are particularly liable to deficiency diseases and are overlooked by surveys of functional groups such as school children, factory workers, farmers or businessmen. The latter types of survey are easier to conduct.

A real difficulty arises in recognizing minimal signs of nutritional disorders. In examining the eyes and skin and observing and recording minor changes that are not pathological, care should be taken and the surveyor must be properly trained and should strictly follow the guidelines indicated for the purpose.

Record card	
No:	Date of birth or age:
Name:	Sex:
Father's name:	Anthropometric measurements:
Mother's name:	Weight:
Special conditions: Pregnancy Lactation Preschool	Height:
	Arm circumference
Hair	**Mouth**
Depigmentation	Angular stomatitis, glossites
Pluckability	Hypertrophic gums

Texture: Silky, Coarse, Rough	Pallor of buccal mucus membranes
Eyes	**Tooth**
Bitot's spots	Total no. of teeth present
Watering eyes	No. of caries teeth
Thyroid	**Skin**
Goiter: Gr:I- Palpable-not visible Gr:II- Palpable- visible small size Gr:III- Palpable-visible-large size nodules	Oedema
	Follicular hyperkeratosis (symmetrical)
	Posterior aspect of forearms
	Pigmented areas, neck, chest, forearms, hand, feet etc
Blood	**Deformed lower limbs**
Haemoglobin level (specify method)	Bandy legs, knock knees
Skeleton	**Other signs**
Rickety rosary, widening of epiphyses of wrists	Name of observer

Signs of protein energy malnutrition

Hair

Hair may become thin, fine and silky in texture and sparse, that is covering the scalp incompletely and with wider gaps between.

Discoloured

The hair shows a distinct lightening of its normal colour. Various changes of colour may be found. In subjects with normally black hair the changes usually seen are dark brown, coppery reddish and blonde. Allowance should be made in some communities like washermen, because of their practices, depigmentation may be present. It is suggested that it would be noted only when the complete scalp is affected.

Easy pluckability

In this sign a small clump or tuft of hair can be easily pulled out with a moderate force

and without pain. It is usually accompanied by the other hair changes such as depigmentation, thinness and sparseness occurs in kwashiorkor.

Moon face

This is a peculiarly round prominence of the cheeks which protrude over the general level of the nasolabial folds. The mouth presents a parched appearance. The condition is encountered mostly in the pre-school child with protein calorie malnutrition of the kwashiorkor type. Pitting or pressure does not occur.

Skin changes

Flaky point dermatosis / crazy pavement dermatosis, extensive, often bilateral hyper-pigmented patches of skin or superficial ulceration often resembling a second degree burn. It can occur anywhere but characteristically on the buttocks and the back of the thighs.

Oedema

First apparent over the wrinkles and feet, it may extend to other areas of the extremities. In early stages it can be detected by firm pressure for 3 seconds with one digit on the nodal surface of the tibia. The sign is taken as positive if there is a visible and palpable pit that persists after the pressure is removed. It is recorded only if present bilaterally.

Clinical signs as means of judging nutritional status

The nutritional status of a child may be judged by a physician either (a) on his estimate of the child's general nutritive intake or (b) on specific evidence of nutritional deficiency symptoms. The physician's estimate of a child's nutritional status is usually based mainly on the overall appearance and bearing of the child, on the amount of his subcutaneous tissue and on his growth record. A well nourished happily adjusted child has the general appearance of vitality and well being that is a characteristic of all healthy young animals whose bodies are functioning normally and efficiently. His eyes are clear and bright with no dark circles beneath them; his hair is smooth and glossy. His skeleton is well grown and sturdy with strong straight arms and legs, well shaped head and chest. His teeth are sound and well formed and are set in well shaped jaws with room enough to prevent any crowding or overlapping. The tissues around the teeth are firm and faint and cling to the teeth closely. There are no signs of easy bleeding.

Biochemical Estimation

Data accumulated on human response to diet under controlled conditions, that is, metabolic studies, have been used to establish standards for evaluation of the nutritional status of nutrients. Just as biochemical analysis are limited primarily to blood in human

metabolic studies, so are analysis for surveys limited to blood and urine. Collection of urine samples obviously presents more problems than blood. Most often a single blood sample is analyzed and may be a fasting sample, collected in the morning before any food is eaten or a random sample taken at any time during the day. The techniques most commonly used in surveys are measurement of thiamine, riboflavin, and u-methyl nicotine amide in urine and haemoglobin, vitamin A, carotene and ascorbic acid in blood. Serum proteins are often determined than some other measurements. The determination of plasma amino acids appears to be useful.

Diet Survey

It is an indirect method of understanding the quantity and quality of foods consumed by and individual. Different methods of diet survey are indicated below;

Methods of Diet survey

Oral questionnaire method

Oral questionnaire or interview is the most commonly used method of diet survey. This method is also called as 24hrs recall method. The investigator has to formulate a diet survey questionnaire depending upon the purpose. After conducting a pilot study with the questionnaire changes can be made on the pattern of the questions. Then the investigator goes from door to door and collects information regarding the types and qualities of foods consumed. The data is not very perfect, only approximate amounts can be collected through this method. Therefore, this method is suitable only to collect information on the general dietary patterns or an approximate picture of dietary habits of a large section of population, general ideas like choice of foods, foods avoided in certain conditions, foods included in special conditions or in festivals, food fads and fallacies, are to be collected. The advantages of the questionnaire method are that it is not a time consuming method, therefore a large number of families can be covered within a specific time.

Food inventory or log book method

This method can be used only with a literate group because a book with question is entrusted to the head of the family or to the housewife. The person entrusted must enter all purchases in the book. Full cooperation from the householder is essential because reliability of the data depends upon the entry. Therefore at times the data may not be authentic.

Weighment of raw and cooked foods

This method is the most reliable one. But it is time-consuming and therefore it is not

used for a large sample. As the investigator cannot leave the questionnaire with the householder she has to stay near and record the amount of various foods before and after cooking. The amount of food used can be recorded by weighing the leftovers after consumption. Often the housewife shows more raw foods to give a wrong impression about their food intake. Therefore the investigator must have some practical knowledge about the quantities of cooked foods of various sources.

Study of vital statistics

Most countries keep at least some vital statistics and from them it is usually possible to draw certain inferences about the nutrition of people. The most used statistics for this purpose has been the infant mortality rate. It has been suggested that the neo-natal mortality and the still birth rate may give a more precise index of nutrition. The manifestations and effects of malnutrition are well known to be severe in toddlers (1-4years). Death rate from infectious diseases has been used in the past as indications of nutritional status of a population. They are, however, of little practical value in most countries at the present time because of the use of specific remedies either against the diseases or their complications. In times of food scarcity, daily, weekly and monthly crude death rates may give valuable information about changes from conditions of hardship to conditions of famine.

Nutritionally relevant disorders

The manifestation of nutritionally relevant disorders namely anemia, goiter and blindness due to vitamin A deficiency gives an indication of the nutritional status by pointing out the particular nutrients absent in the diet.