II YEAR – III SEMESTER
COURSE CODE: 7BHF3C1

CORE COURSE - V – PRINCIPLES OF NUTRITION

Objectives:

To enable the students to

1. Gain knowledge on nutrients and their functions
2. Understand nutritional needs of different age groups

Unit - I

Nutrition: Definition, nutritional status, nutritional requirements, malnutrition, balanced diet. Meal planning – factors affecting, nutritional classification of foods

Energy : Definition, Units, calorific value of foods – bomb calorimeter; energy requirements– basal metabolism, specific dynamic action of foods, energy balance, direct and indirect calorimetry, physiological energy value of foods

Unit – II

Carbohydrates, Proteins and Lipids: Food sources, biological functions, requirements, deficiencies – causes, symptoms, prevention and treatment of PEM - Kwashiorkor and Marasmus. Fiber: Definition, classification, nutritional role.

Unit – III

Vitamins: Vitamin A, D, E, K, C and B complex – Thiamine, Niacin, Riboflavin and Folic Acid – History, classification, chemistry, food sources, biological role, requirement, deficiency, causes, symptoms, prevention and treatment

Minerals and Water: Macro and micro minerals – Iron, Calcium, Phosphorus, Magnesium, Copper, Zinc, Sodium and Potassium – functions, food sources, biological role, requirement, deficiency – causes, symptoms, prevention and treatment

Unit - IV

Nutrition in Pregnancy and Lactation: Symptoms and complication in pregnancy, physiological needs and nutritional support, additional allowances; pre and post delivery nutritional care, nutritional requirements.

Nutrition in Infancy: Growth pattern of infants, nutritional requirements, breast milk Vs bottle milk, Weaning and supplementary foods.

Unit – V

Nutrition during Ages of Preschool, School going and Adolescence: growth and development during preschool period, good food habit formation, nutritional requirements for preschool, school going children and adolescents. Food fads, anorexia nervosa and bulimia

Nutrition for Adult and Old Age: Nutritional requirement – physical activity, physiological changes in old age – modification of diet.

Books for Reference:

1. Robinson C H (1986) **Normal and Therapeutic Nutrition** 17th Ed, Macmillan Pub Co, New York
2. Gopalan C Ramasastry and Balasubramaniam (2000) **Nutritive value of Indian foods**, NIN, Hyderabad
3. Srilakshmi B (2003) **Nutrition Science**, New Age International, New Delhi
4. Srilakshmi (2003) **Dietetics**, New Age International, New Delhi
5. Michelle McGuire Kathy A Beerman (2007), **Nutritional Science** Thomson Wordsworth
6. Gibney, M.J et al (2005) **Clinical Nutrition** I edition, Blackwell Science
7. Williams, M.H (2002) **Nutrition for health and fitness** Mc Graw Hill, Boston

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Unit - 1

Definition: Nutrition is the science of foods, the nutrients and their action, interaction and balance in relationship to health and disease; the process by which the organism ingests, digests, absorbs, transports and utilizes nutrients and dis-poses of their end products.
Antoine Lavoisier is the father of Nutrition. He designed a calorimeter which measured the heat produced by the body from work and consumption of varying amounts and types of foods
Nutrients are the constituents in food that must be supplied to the body in suitable amounts. They are classified as macronu-trients and micronutrients.

1. Balanced Diet

A balanced diet is one which provides all the nutrients in required amounts and proper proportions so that the need for calories, proteins, minerals, vitamins and other nutrients are adequately met. It can be easily achieved through a blend of four basic food groups. The nutrient require-ments vary with age, gender, physiologi-cal status and physical activity. A balanced diet provides **(i)** 50-60% of total calories from carbohydrates, **(ii)** about 10-15% from proteins **(iii)** and 20-30% from both visible and invisible fat. In addition, a balanced diet should provide other non-nutrients such as dietary fiber, antioxi-dants and phytochemicals.

2. Recommended Dietary Allowance (RDA)

The Recommended Dietary Allowances (RDA) presented are in estimates of nu-trients to be consumed daily to ensure that the requirements of all individu-als in a given population are met. The recommended levels depend upon the bio availability of nutrients from a given diet. The term bio availability indicates what is absorbed and utilised by the body. In ad-dition RDA includes a margin of safety, to cover variation between individuals, die-tary traditions and practices. The RDAs are suggested for all age groups such as infants, pre-schoolers, children, adoles-cents, pregnant women, lactating mothers and adult men and women taking into ac-count their physical activity. The RDA of an individual depends upon various fac-tors which are as follows:

Age:Adults require more total calories than a child, whereas a growing child requires more calories per kg of body weight than an adult.

Sex:Males with high Basal Metabolic Rate (BMR) require more calories than females.

Activity:The type of activity also determines the energy requirements . T h e activities are classified as sedentary, moderate and heavy based on the occupation of an individual as given in the table 1 below

Physiological stress: Nutrient requirements are increased in conditions of physiological stress such as pregnancy and lactation.

Table 1 Classification of Activity

	Activity		
Sex	**Sedentary**	**Moderate**	**Heavy**
Male	Teacher, Tailor, Barber, Executive, Peon	Fisher man, Basketmaker, Potter, Goldsmith	Stone cutter, Mineworker, Wood cutter
Female	Teacher, Tailor, Executive	House wife, Nurse, Servant maid	Wood cutter

Source: Gopalan C, Sastri B.V, & Balasubramanian S.C (2007)

3. Steps in Planning Balanced Diets or Menu Using Food Guide Pyramid and Exchange Lists

Menu planning is the process of planning and scheduling intake of meals for general or specific individual requirements. The four food groups suggested by ICMR given in unit-III (Food Science), permits an indi-vidual to plan a menu to achieve nutrient intake as specified by recommended die-tary allowances. There are certain princi-ples in planning menus. They are:

- A good menu plan should meet the nu-tritional requirements of each member of the family.
- Meal pattern must fulfill family needs.
- Meal planning should save time and energy.
- Meal planning should satisfy the bud-get of the family.
- Meal plan should give maximum nutrients.
- The meal planned should consider in-dividual likes and dislikes.
- Planned meals should provide variety.
- Meals should give satiety.
- Menus should include available foods.

There are three steps involved in planning a menu

Step1: Recommended dietary allowance:

To plan a balanced diet the first step is to know the recommended dietary allow-ances for different age groups.

The Recommended Dietary Allowance for Indians ICMR (2010) is given in the Table 2.

Table 2 Recommended Dietary Allowances for Indians (Macronutrients and Minerals)

Group	Particulars	Body wt. kg	Net Energy Kcal/day	Protein g/day	Visible Fat g/day	Calcium mg/day	Iron mg/day
Man	Sedentary work	60	2320	60	25	600	17
	Moderate work		2730		30		
	Heavy work		3490		40		
Women	Sedentary work	55	1900	55	20	600	21
	Moderate work		2230		25		
	Heavy work		2850		30		
	Pregnant Women		+350	82.2	30	1200	35
	Lactation 0 – 6 months		+600	77.9	30	1200	25
	6 – 12 months		+520	70.2	30		
Infants	0 – 6 months	5.4	92 Kcal/kg/d	1.16 g/kg/d	–	500	46 µg/ kg/day
	6 – 12 months	8.4	80 Kcal/kg/d	1.69 g/kg/d	19		5
Children	1 – 3 years	12.9	1060	16.7	27	600	09
	4 – 6 years	18	1350	20.1	25		13
	7 – 9 years	25.1	1690	29.5	30		16
Boys	10 – 12 years	34.3	2190	39.9	35	800	21
Girls	10 – 12 years	35.0	2010	40.4	35	800	27
Boys	13 – 15 years	47.6	2750	54.3	45	800	32
Girls	13 – 15 years	46.6	2330	51.9	40	800	27
Boys	16 – 17 years	55.4	3020	61.5	50	800	28
Girls	16 – 17 years	52.1	2440	55.5	35	800	26

Source: Dietary guidelines of Indians National Institute of Nutrition, Hyderabad, (2010).

Table 2 cont'd Recommended Dietary Allowances for Indians

Group	Particulars	Vit. A µg/d		Thiamin mg/day	Riboflavin mg/day	Niacin equivalent mg/day	Pyridoxine mg/day	Ascorbic acid mg/day	Dietary folate µg/day	Vit. B_{12} µg/day	Magnesium mg/day	Zinc mg/day
		Retinol	β-carotene									
Man	Sedentary work	600	4800	1.2	1.4	16	2.0	40	200	1	340	12
	Moderate work			1.4	1.6	18						
	Heavy work			1.7	2.1	21						
Women	Sedentary work	600	4800	1	1.1	12	2.0	40	200	1		10
	Moderate work			1.1	1.3	14						
	Heavy work			1.4	1.7	16						
	Pregnant Women	800	6400	+0.2	+0.3	+2	2.5	60	500	1.2	310	
	Lactation 0 – 6 months	950	7600	+0.3	+0.4	+4	2.5	80	300	1.5		12
	6 – 12 months			+0.2	+0.3	+3	2.5					
Infants	0 – 6 months	--	--	0.2	0.3	710 µg/kg	0.1	25	25	0.2	30	--
	6 – 12 months	350	2800	0.3	0.4	650 µg/kg	0.4				45	--
Children	1 – 3 years	400	3200	0.5	0.6	8	0.9	40	80	0.2 – 1.0	50	5
	4 – 6 years			0.7	0.8	11	0.9		100		70	7
	7 – 9 years	600	4800	0.8	1.0	13	1.6		120		100	8
Boys	10 – 12 years	600	4800	1.1	1.3	15	1.6	40	140		120	9
Girls	10 – 12 years			1.0	1.2	13	1.6				160	9
Boys	13 – 15 years			1.4	1.6	16	2.0	40	150		165	11
Girls	13 – 15 years			1.2	1.4	14	2.0				210	11
Boys	16 – 17 years			1.5	1.8	17	2.0	40	200		195	12
Girls	16 – 17 years			1.0	1.2	14	2.0				235	12

Source: Dietary guidelines of Indians, National Institute of Nutrition, Hyderabad, (2010).

Step 2: Food list

Food list is the list of quantities of various food groups to be included in the diet so that it is balanced and can meet the RDA. This can be done by:

- Selecting food from all the four food groups.

- Deciding the quantities of the selected as multiples of portion sizes.

Food list can be prepared either by using ICMR tables or exchange lists.

i. Using ICMR tables

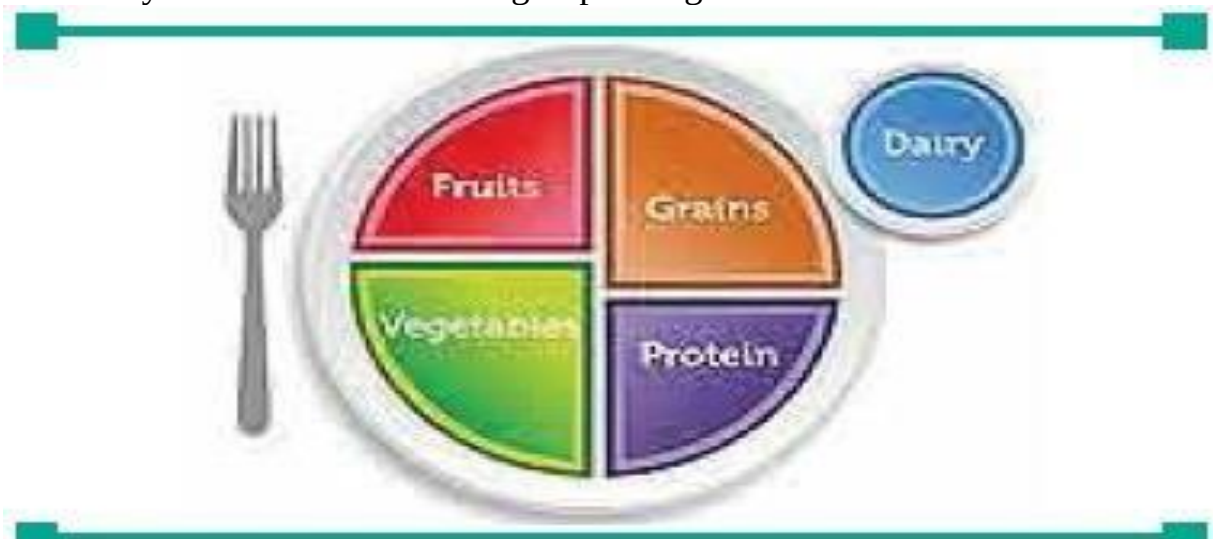
To make menu planning more con-venient ICMR has suggested the portion size and balanced diets for adults and for different age groups. The portion sizes are given in terms of raw food.

ii. The Exchange Lists

The Exchange Lists are the basis of a meal planning. Food exchange lists are groups of measured foods of the same calorific value and similar protein, fat and carbohydrate content. All foods of exchange lists make a specific contribution to a good diet. Food exchange lists help in manipulation of protein, calories and other nutrients.

Step 3: Meal plan

The foods that are listed are converted into recipes and distributed in various meals like breakfast, lunch and dinner. My Plate helps individuals to make better food choices and eat healthfully. It illus-trates the food groups using a familiar mealtime visual.



▲ Fig 1 My Plate

Table S Portion Size And Nutrient Content

	Portion	Energy	Protein	Carbohydmte	Fat
Food Groups	**G**	**Kcal**	**g**	**g**	**g**
Cereals and ozi1lets	30	f0D	3,0	20	D.8
Pulses	30	100	6.0	IS	0.7
Egg	50	85	7.0	-	7.0
Mzat/chlckezt or6sb	10D	10D	9	-	7.0
Milk(zal) aad mtlk product	100	70	3.0	5	3.0
Roots and tubers	100	80	1.3	19	
Green leafy vegetables	100	4S	5.6	-	0.4
other vegetables	100	30	1.7	-	0.2
Sugars	5	20		5	
Fats and oils	5	4S			5

Source: Dietary guidelines for Indians, National Institute of Nutrition, Hyderabad, (2011).

Preparation	Quantity of *one* serving	Calories
l. Cere:ils		
Uppma	1cup	270
Idli	2nos	150
Dosa	lno.	125
Kichidi	lcup	200
\S'heat porridpge	Ice(	220
2. Pulses		
Plain dhal	½ cup	100
Saiñbar	1cup	110
3. \"egetables		
\S"ith grail'	lcup	170
Dry	lan ›	150
4. Non-vegetari:in		
Mutton curry	-*/^ •r	260
Chicken curry	a/a <ii,›	240
Keelnakofta cure'	3/4 cup	240
i-ish fried	2 big pieces	190
Prawn curry	3/4 cup	220
S. Savoury snacks		
Bajji or (›akora	8 no's	280
Besankapura	l no.	220
Chat(dahipakori)	3 [nieces	220
Sainosa	1 no.	200
LlilSil)d COST	1 no.	200
6. Chutneys		
Coconut/ groundnuts/ til	2tbs(›	120
Toiiiato	ltbs[›	10
Tainarind(with jiggey)	l tbsp	60
. S›‹eets and ‹tcssrrts		
Bcsanbartt	2 small pieces	400
Rice [›uttu	½ cup	280
Haiu'a (kcsari)	½ cup	320
Srikhand	fiz CUp	380
Sandesh	2 no's	140
8. Bes'erages		
Tea (2tsp sugar + 50 ml toned liiilk)	1 cup	75
C.coffee(2tsp stigar + 100 ml	1 cu ›	110
Cow's milk (2 tsp. sugar)	1 cup	180
Lassi (2 tsp. sugar)	I cuy/gl:ss (200n I)	110

Table 5 Sample Meal Plan for Adult Man (Sedentary)

Meal time	Food group	Raw	Cooked recipe	Serving amounts
Breakfast	Milk	100ml	Milk or	½ cup
			Tea or	2 cups
	Sugar	15g	Coffee	1 cup
	Cereals	70g	Breakfast item	
	Pulses	20g		
Lunch	Cereals	120g	Rice	2 cups
			Pulkas	2 no's
	Pulses	20g	Dhal	½ cup
	Vegetables	150g	Veg-curry	¾ cup
	Milk	100ml	Curd	½ cup
Tea	Cereals	50g	Snack	
	Milk	50ml	Tea	1 cup
	Sugar	10g		
Dinner	Cereals	120g	Rice	2cup
	Pulses	20g	Pulkas	2nos
	Vegetables	150g	Dhal	½ cup
	Milk(curd)	50ml	Vegetables	¾ cup
	Vegetables	50g		
	Fruit	100g	Seasonal	1 medium

Source: Dietary guidelines of Indians, National Institute of Nutrition, Hyderabad, (2010).

Bomb calorimeters

Bomb calorimeter

Bomb calorimeter

A bomb calorimeter is a type of constant-volume calorimeter used in measuring the heat of combustion of a particular reaction. Bomb calorimeters have to withstand the large pressure within the calorimeter as the reaction is being measured. Electrical energy is used to ignite the fuel; as the fuel is burning, it will heat up the surrounding air, which expands and escapes through a tube that leads the air out of the calorimeter. When the air is escaping through the copper tube it will also heat up the water outside the tube. The change in temperature of the water allows for calculating calorie content of the fuel.

In more recent calorimeter designs, the whole bomb, pressurized with excess pure oxygen (typically at 30 atm) and containing a weighed mass of a sample (typically 1–1.5 g) and a small fixed amount of water (to saturate the internal atmosphere, thus ensuring that all water produced is liquid, and removing the need to include enthalpy of vaporization in calculations), is submerged under a known volume of water (ca. 2000 ml) before the charge is electrically ignited. The bomb, with the known mass of the sample and oxygen, form a closed system—no gases escape during the reaction. The weighed reactant put inside the steel container is then ignited. Energy is released by the combustion and heat flow from this crosses the stainless steel wall, thus raising the temperature of the steel bomb, its contents, and the surrounding water jacket. The temperature change in the water is then accurately measured with a thermometer. This reading, along with a bomb factor (which is dependent on the heat capacity of the metal bomb parts), is used to calculate the energy given out by the sample burn. A small correction is made to account for the electrical energy input, the burning fuse, and acid production (by titration of the residual liquid). After the temperature rise has been measured, the excess pressure in the bomb is released.

Basically, a bomb calorimeter consists of a small cup to contain the sample, oxygen, a stainless steel bomb, water, a stirrer, a thermometer, the dewar or insulating container (to prevent heat flow from the calorimeter to the surroundings) and ignition circuit connected to the bomb. By using stainless steel for the bomb, the reaction will occur with no volume change observed.

- Based on the composition of carbohydrate, fat and protein the heat of combustion of the feed sample can be worked out using appropriate factors. • From the gross chemical composition of the feed samples the amount of energy yielding nutrients namely carbohydrate, fat and protein are estimated. • If the amount of each is known it is easy to workout the heat of combustion of the feed sample using appropriate factors. • The heat of combustion of individual carbohydrates, proteins and fats differ with their composition. (Eg.) As determined by Atwater GE of sucrose is 3.96 Kcal/gram and that of starch is 4.23 Kcal/gram. • Energy yield of butterfat was found to be 9.21 Kcal/gram and that of lard, 9.48 Kcal/gram. • For practical use individual figures were averaged to apply to the major food stuffs (carbohydrate, fat and protein) as gross energy of food.
- ATWATER PHYSIOLOGICAL FUEL VALUES • While carbohydrates and fats are completely oxidized to CO_2 and water in body cells after digestion and absorption, proteins are not completely oxidized by the cell. • Unoxidised protein matter is equivalent =7.9 Kcal/gram of nitrogen, which in terms of protein is 1.25 Kcal/g of protein: This energy represents metabolic loss and must be subtracted from the ‘digestible protein’. • After considering this Atwater has given factors for ME, which is also known as physiological fuel values. Atwater physiological fuel value factors Carbohydrate – 4.15 x 0.98 = 4 Kcal/g Fat – 9.40 x 0.95 = 9 Kcal/g Protein – (5.65 – 1.25) x 0.92 = 4 Kcal/g • In ruminants gaseous loss also costs much of energy thus these physiological fuel values are not applicable in the case of ruminants. • These values have been used in calculating the TDN of feedstuffs, but it is a crude procedure for ruminants.

- DIRECT CALORIMETRY • Calorimetry means the measurement of heat. • The heat production of animals can be measured physically using a procedure known as direct calorimetry. • Heat is lost from an animal body principally by radiation, conduction and convection from body surfaces Sensible HL • and by evaporation of water from the skin and lungs. Insensible HL • An animal calorimeter is essentially an airtight, insulated chamber. • SHL & IHL in animal body can be measured with two general types of calorimeters: – Adiabatic calorimeter – Gradient calorimeter
- INDIRECT CALORIMETRY • Animal body derives all of its energy from oxidation, the magnitude of energy metabolism can be estimated from the exchange of respiratory gases. • Such measurements of heat production are more readily accomplished than are measurements of heat dissipation by direct calorimetry. • A variety of techniques are available for measuring the respiratory exchange; all ultimately seek to measure oxygen consumption and CO_2 production per unit of time. Indirect Calorimetry: HP measurement

ENERGY BALANCE:

Energy balance is the difference between your energy input—or the number of calories that you put into your body—and your energy output, or the number of calories you burn each day. Some people refer to the energy balance equation as the "calories in, calories out" equation.

Unit -2

MACRONUTRIENTS

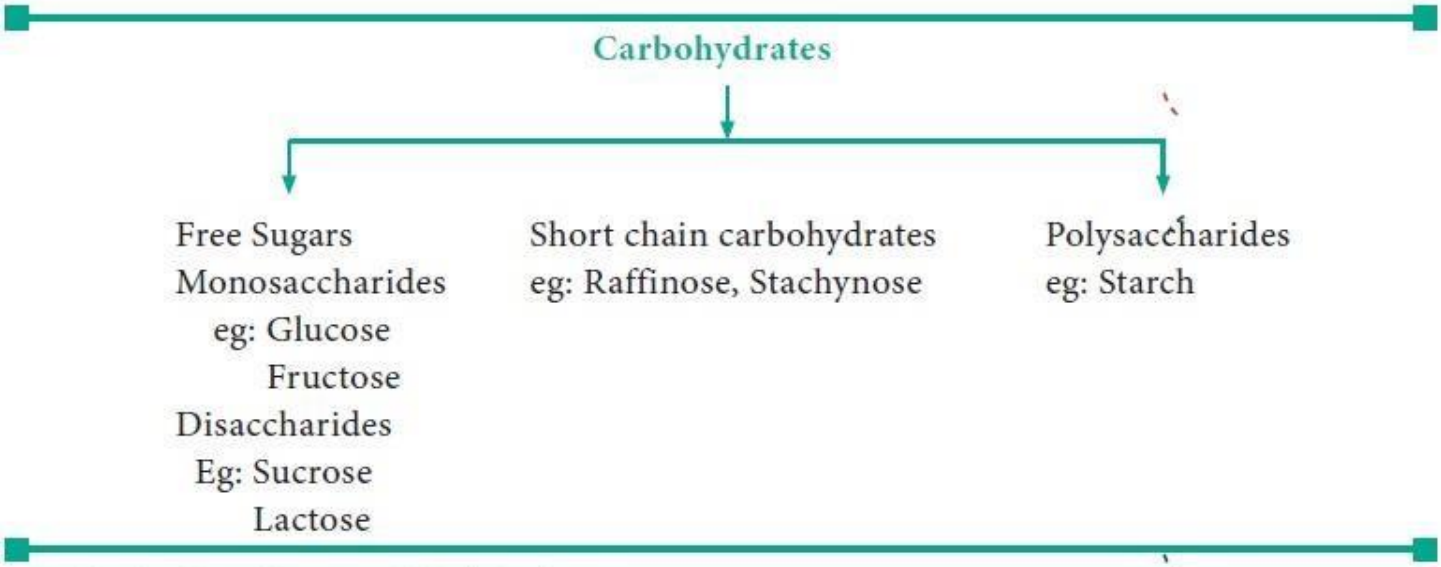
Macronutrients refer to the nutrients that are needed in large quantities. They are broadly classified as carbohydrates, pro-tein and lipids/fats.

1. Carbohydrates

Definition: Carbohydrates are sug-ars or polymers of sugars such as starch that can be hydrolyzed to sim-ple sugars by the action of digestive enzymes or by heating with dilute acids. Generally but not always, the hydrogen and oxygen in them are in proportion to form water, hence the term carbohydrate.

The predominant function of the carbohydrates is to provide energy needed by our body. Starch found in cereals and sugar in sugarcane and fruits are examples of carbohydrates in foods.

Classification: The dietary carbohy-drates are classified as:



▲ Fig. 1 Classification of Carbohydrates

- **Functions:** The functions of carbohy-drates include

- Carbohydrates are a source of energy. Each gram of carbohydrate yields 4 kilo calories

- Adequate supply of carbohydrate ensures that proteins are spared from performing the role of giving energy.

- Major source of energy for muscu-lar work.

- Detoxifying action and regulating influence of protein and fat metab-olism.

▲ Rice

▲ Wheat

- Source of energy for heart muscle

- Excess calories through carbohy-drate is stored as fat in the adipose tissue.

 Stimulates the peristaltic move-ment in the form of dietary fiber which helps in preventing heart diseases, diabetes mellitus and cancer.

Food Sources: Carbohydrates are found in cereals like Rice, Wheat, Bajra, Jowar. Fruits, Honey and Jag-gery are also rich sources of carbohy-drates

▲ Bajra

▲ Jowar

▲ Fruits

▲ Honey

▲ Jaggery

2. Proteins:

Definition

The word '**protein**' is derived from the Greek word protos meaning 'first'. Protein is the basic chemical unit of liv-ing organisms and is essential for nutri-tion, building of new tissues (growth) and maintaining and repairing of those already built. Casein from milk, albu-min in egg and gluten in wheat, are examples of proteins occurring in foods.

Classification: The proteins are classi-fied as:
Complete proteins e.g. Egg proteins
Partially complete proteins e.g. wheat proteins
Incomplete proteins e.g. Gelatin or zein

Functions: Proteins perform the fol-lowing functions;

- Necessary for growth

- Wear and tear of human body is repaired

For regular supply of raw materials for the formation of digestive juices, hormones, plasma proteins, hemo-globin, vitamins and enzymes.

- Each gram of protein supplies 4 Kcal of energy

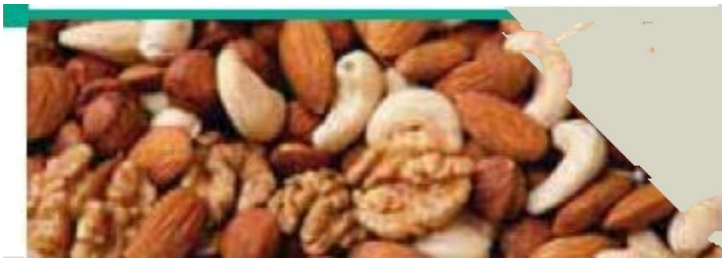
Food Sources: Animal foods like Meat, Fish, Eggs and Milk are excel-lent sources of Proteins. Plant Sources like Pulses, Oil seeds and nuts are also good sources of Protein

w l'ñeat

A Pule s

A t•1ilk

A Oil e eds



Deficiency: Deficiency of protein causes protein energy malnutrition which covers a wide spectrum of clini-cal stages ranging from the severe forms like kwashiorkor and marasmus to the milder forms like growth retardation. Protein energy malnutrition is due to "food gap" between the intake and requirement. The average energy deficit in Indian children is 300kcal/day. Defi-ciency of protein is discussed in detail in the section Protein energy malnutrition

3. Lipids/Fats

Definition: Lipids are organic sub-stances soluble in fat solvents such as alcohol, ether, and chloroform but not in water. The term includes fatty acids, soaps, neutral fats, phospholipids, ste-roids and waxes. Oils found in seeds, butter from milk, and lard from meat, are examples of fats found in foods.

Classification: Lipids are classified as follows

Table 1 Classification of Lipids

Simple Lipids	Compound Lipids	Derived Lipids
Fats and Oils	Phospholipids	Hydrolytic substances of simple and compound lipids
Waxes	Glycolipids	
	Lipoprotein	

Source: Swaminathan.M 2012, Foods and Nutrition, Bangalore Printing and Publishing Company, Bangalore.

- **Functions:** The functions of lipids are to
- Provide energy reserve and supply 9 kcal/gram.
- Serve as a vehicle for the absorp-tion of fat-soluble vitamins A, D, E, and K

Supply essential fatty acids neces-sary for growth and function

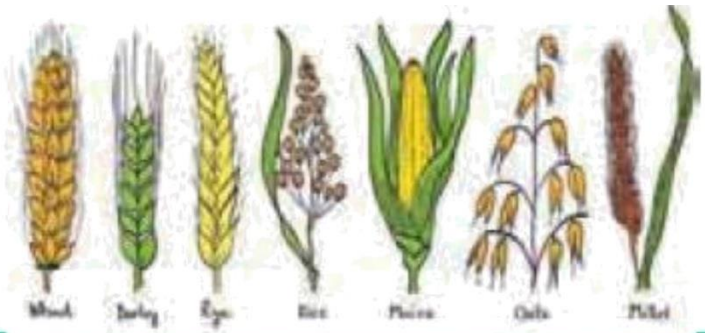
- Provide energy source so that pro-teins are spared for tissue growth and repair
- Gives satiety
- Act as insulators against heat and cold.

Food Sources: Visible fat sources are But-ter, Ghee and Oil, Invisible fat sources are Cereals, Pulses, Oil seeds, Milk and Egg.

1 Butter

A Ghee

Cereals



A Cei-eats

A Oil e eds

* Egg

▲ Pulses

▲ Milk

Protein

Protein is a macronutrient that is essential to building muscle mass. It is commonly found in animal products, though is also present in other sources, such as nuts and legumes. There are three macronutrients: protein, fats and carbohydrates. Macronutrients provide calories, or energy.

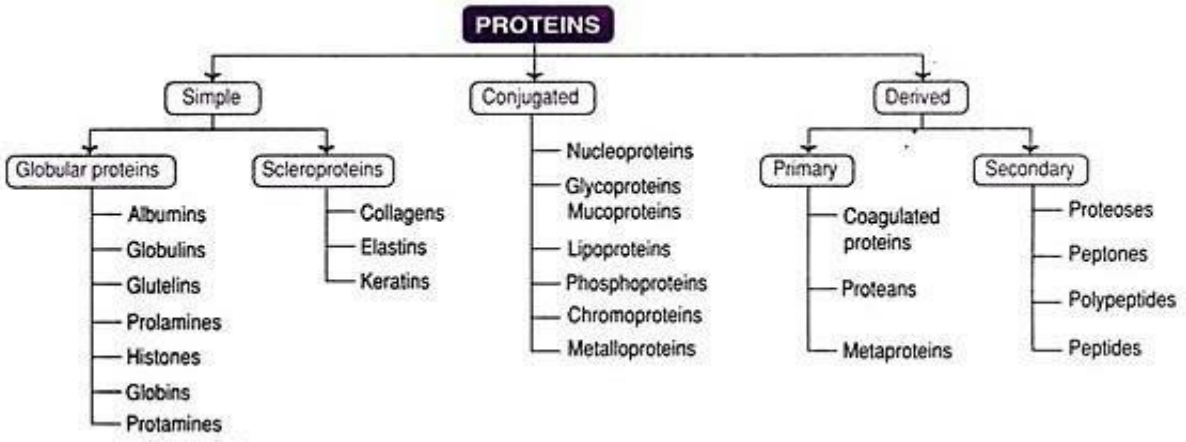
Classification of Protein

Classification based on the source of protein molecules

The proteins have been traditionally divided into two well-defined groups: **animal proteins** and **plant proteins.** **Animal proteins** are the proteins derived from animal sources such as eggs, milk, meat and fish. They are usually called higher-quality proteins because they contain (and hence supply) adequate amounts of all the essential amino acids.

On the other hand, plant proteins **are called lower-quality proteins since they have a low content (limiting amount) of one or more of the essential amino acids.**

Classification based on composition and solubility



This divides proteins into 3 types:

1. Simple Proteins or Holoproteins

These are of globular type except for scleroproteins which are fibrous in nature. This group includes proteins containing only amino acids, as structural components. On decomposition with acids, these liberate the constituent amino acids.

These are further classified mainly on their solubility basis as follows:

1. Protamines and histones
2. Albumins
3. Globulins
4. Glutelins
5. Prolamines
6. Scleroproteins or Albuminoids

2. Conjugated or Complex Proteins or Heteroproteins

These are also of globular type except for the pigment in chicken feathers which is probably of fibrous nature. These are the proteins linked with a separable nonprotein portion called prosthetic group. The prosthetic group may be either a metal or a compound.

On decomposition with acids, these liberate the constituent amino acids as well as the prosthetic group. Their further classification is based on the nature of the prosthetic group present. The various divisions are:

1. Metalloproteins
2. Chromoproteins
3. Glycoproteins
4. Phosphoproteins
5. Lipoproteins
6. Nucleoproteins

3. Derived Proteins

These are derivatives of proteins resulting from the action of heat, enzymes or chemical reagents. This group also includes the artificially-produced polypeptides.

I. Primary derived proteins

These are derivatives of proteins in which the size of protein molecule is not altered materially.

1. Proteans: Insoluble in water; appear as first product produced by the action of acids, enzymes or water on proteins. e.g., edestan derived from edestin and myosan derived from myosin.

2. Metaproteins or Infraproteins: Insoluble in water but soluble in dilute acids or alkalies; produced by further action of acid or alkali on proteins at about 30–60°C. e.g., acid and alkali metaproteins.

3. Coagulated Proteins: Insoluble in water; produced by the action of heat or alcohol on proteins. e.g., coagulated eggwhite.

II. Secondary derived proteins

These are derivatives of proteins in which the hydrolysis has certainly occurred. The molecules are, as a rule, smaller than the original proteins.

1. Proteoses: Soluble in water; coagulable by heat; produced when hydrolysis proceeds beyond the level of metaproteins; primary proteoses are salted out by half saturation with (NH4)2.SO4 and precipitated by HNO3 and picric acid; secondary proteoses are salted out only by complete saturation with (NH4)2.SO4 but are not precipitated by HNO3 or picric acid. e.g., albumose from albumin; globulose from globulin.

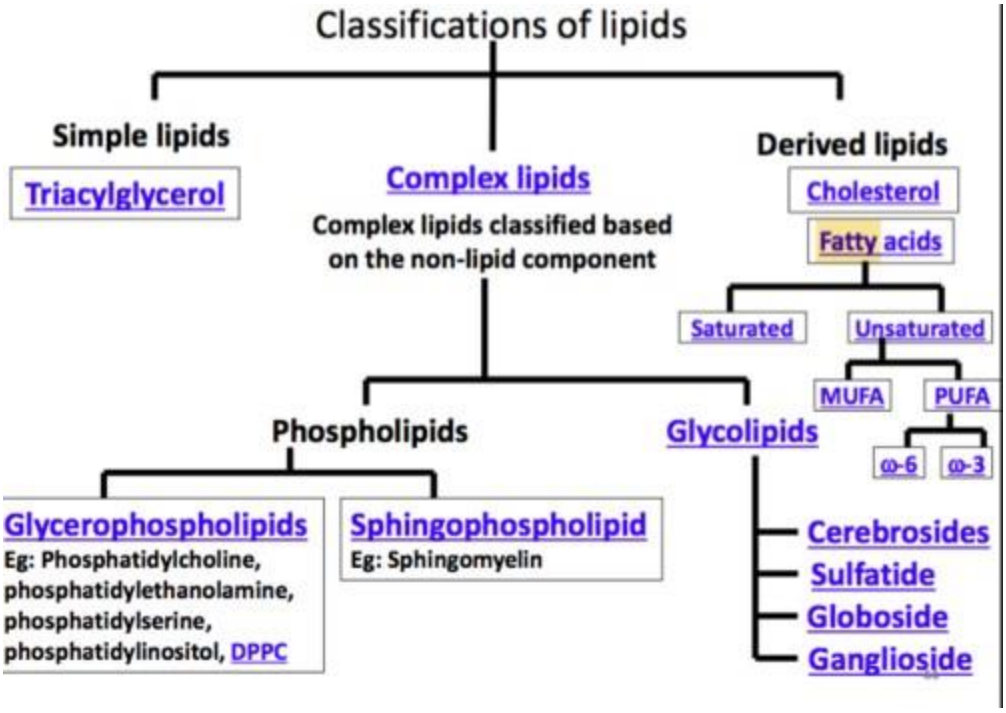
2. Peptones: Soluble in water; noncoagulable by heat; produced by the action of dilute acids or enzymes when hydrolysis proceeds beyond proteoses; neither salted out by (NH4)2SO4 nor precipitated by HNO3 or picric acid.

3. Polypeptides: These are combinations of two or more amino acid units. In fact, the proteins are essentially long chain polypeptides

Lipids

Lipids are molecules that contain hydrocarbons and make up the building blocks of the structure and function of living cells. Examples of lipids include fats, oils, waxes, certain vitamins (such as A, D, E and K), hormones and most of the cell membrane that is not made up of protein.

Lipids are mainly composed of hydrocarbons in their most reduced form, making them an excellent form of energy storage, as when metabolized the hydrocarbons oxidize to release large amounts of energy. The type of lipid found in fat cells for this purpose is a triglyceride, an ester created from glycerol and three fatty acids.



Malnutrition

Malnutrition is a condition that result from nutrient deficiency or overconsumption.

Type of malnutrition include :

- Undernutrition : This type of malnutrition results from not getting enough protein, calories and micronutrients.It leads to low weight-for-height-for-age(stunting)and weight-for-age (underweight).
- Overnutrition:overconsumption of certain nutrients,such as protein,calories or fat,can also lead to malnutrition or obesity.

People who are undernourished often havedeficiencies in vitamins and minerals,especially iron,zinc,vitamin A and iodine

However,micronutrient deficiencies can also occur with overnutrition.

It's possible to be overweight or obese from excessive calorie consumpotion but not get enough vitmins and minerals at the same time.

that's because foods that contribute to overnutrition,such as fried and sugary foods,tend to be high in calories and fat but low in other nutrients.

signs and symptoms

the signs andsympotoms of malnutrition depend on the type .

being able to recognize the effects of malnutrition can help people and healthcare providers identify and treat issues related to under -or overnutrition.

Undernutrition

Undernutrition typically results from not getting enough nutrients in your diet.

this can cause;

- Weight loss
- Loss of fat and muscle mass
- Hollow cheeks and sunken eyes
- A swollen stomach
- Dry hair and skin
- Delayed wound healing
- fatigue
- Diffculty concetrating
- lrritability
- Depression and anxiety

People with undernutrition may have one or serveral of these symptoms.some types of undernutrition have signature effects.

Kwashiorkor,a severe protein deficiency,causes fluid retention and a protruding abdomen.On the other hand,the condition marasmus,which results from severe calorie deficiency,leads to wasting and significant fat and muscle loss.

Undernutrition can also result in micronutrition deficiencies.Some of the most common deficiecies and their sympotoms include:

- Vitmin A:

Dry eyes,night blindness,increased risk of infection.

- Zinc:

Loss of appetite,stunted growth,delayed healing of wounds hair loss, diarrhea.

- lron:

Impaired brain function,issues with regulating body temperrature,stomach problem.

- Iodine:

Enlarged thyroid glands (goiters),decreased prodution of thyroid hormone,growth and development issues.

Since undernutrition leads to seious physical issues and health problems,it can increase your risk of death.

In facr,it's estimated that stunting,wasting and zinc and vitamin A deficiencies contributed to up to 45% of all child deaths in 2011.

Overnutrition

The main signs of overnutrition are overnutrition and obesity,but it can also lead to nutrient deficiencies.

Research shows that people who are overweigth or obese are more likely to have inadequate intakes and low blood leves of certain vitamins and minerals comared to those who are at a normal weight .

One study in 285 adolescents found that blood levels of vitmins A and B in obese people were 2-10% lower than those of normal-weight particapants.

This is likely because overweight and obesity can result from an overconsumption of fast and processed food that are high in calories and fat but low in other nutrents.

A study in over 17,000 adults and children found that those who ate fast food had significantly lower intakes of vitamin A and C and higher calorie,fat and sodium consumption than those who abstained from this type of food.

Assessing Malnutrition

Identifying nutrient Symptoms of malnutrition are assessed by healthcare providers when they screen for the condition.

Tools that are used to identify malnutrtion include weight loss and body mass index (BMI) charts,blood tests for micronutrient deficiencies.

Identifying nutrient deficiencies that result fron overnutrition,on the other hand can be more difficult.

If you're overweight or obese and eat mostly processed and fast foods, you may not get enough vitamins or minerals.To fine out if you have nutrients deficiencies,consider discussing your dietary habits with your doctor.

Nutrients

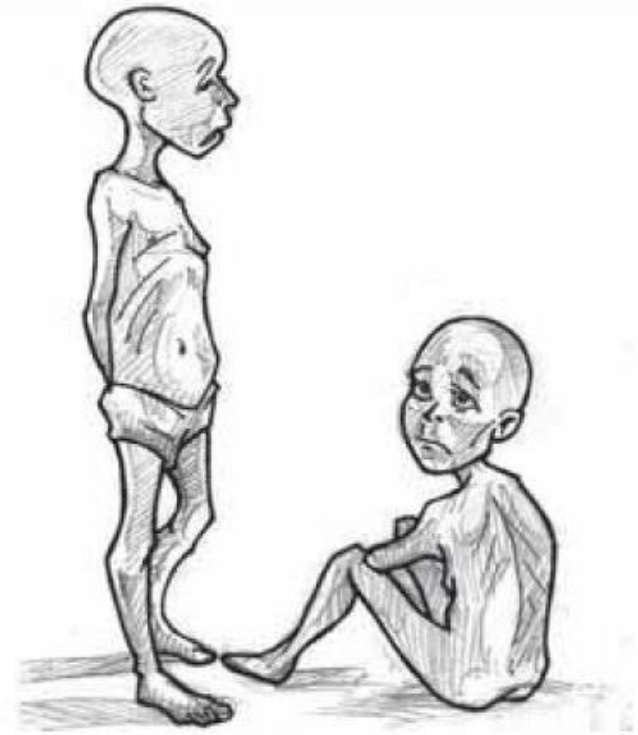
Macro nutrients

- Carbohydrates
- Proteins
- Lipids/fats

Micro nutrients

Vitamins

Minerals



Poorly nourished children

Wellnourished children

▲ Fig. 1 Poorly nourished children, wellnourished children

Unit – 3

Vitamins

Fat soluble vitamins A, D, E and K and also water-soluble vitamins C and B group are found in foods. These are needed for growth, normal function of the body and normal body processes.

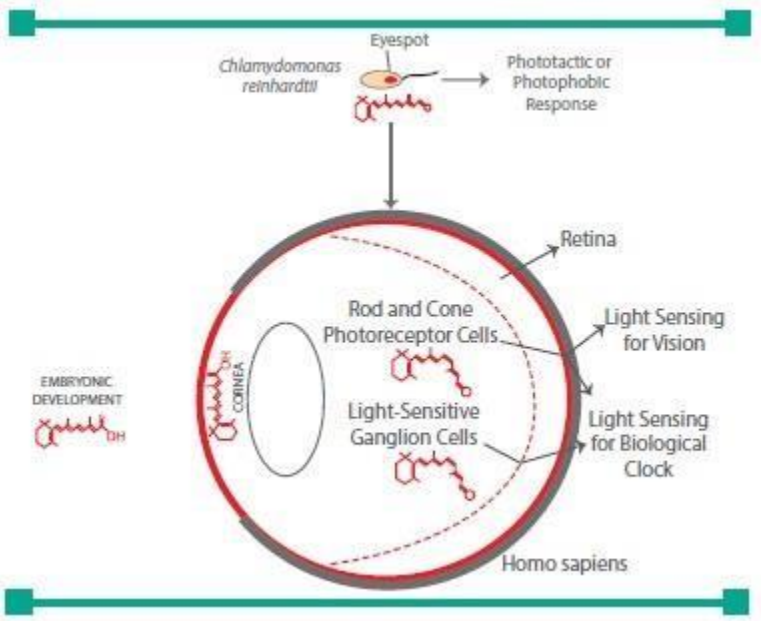
2. a. Fat Soluble Vitamins

(a) Vitamin A:

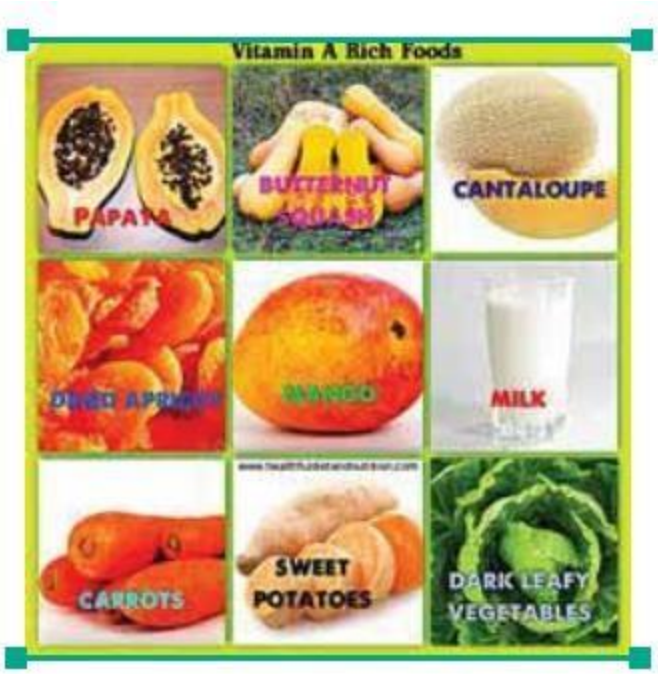
The vitamin A compounds include retinol, retinal and retinoic acid. Because it has a specific function in the retina of the eye and because it is an alcohol it was given the name ret-inol. Beta carotene is precursor of vita-min A and is found in large quantities in vegetables and fruits.

Functions: Vitamin A performs the following functions:

- Vitamin A is essential for vision in normal and dim light.
- Formation and maintenance of healthy functioning epithelial tissue.
- Glycoprotein and mucoprotein synthesis
- Cancer prevention
- Prevention of degeneration of myelin sheath
- Normal bone formation and reproduction.



Food sources: In the animal foods vitamin A is present in the form of retinol which are identified to be liver, cream, butter and egg yolk. Liver oils of fish like cod, halibut and shark are the richest sources of vitamin A. The main contribu-tors of beta carotene are the yellow and green vegetable fruit sources of carotene- carrots, papaya, mango, sweet potatoes, spinach and broccoli.



Deficiency: Decreased Vitamin A intake leads to vision problems

- **Night blindness:** People suffering from night blindness cannot see objects in dim light

- **Xerosis Conjunctiva:** The conjunctiva is dry, thickened, wrinkled and pigmented. This is due to the keratinization of the epithelial cells.

- **Xerosis Cornea:** This man ifests in the form of corneal dryness which gives the cornea a dull hazy and lusterless appearance.

- **Bitot's spots:** These are grey-ish or glistening white plaques occurring in the conjunctiva usually triangular in shape and are found in children.

- **Keratomalacia:** When Xerosis of the conjunctiva and cornea is not treated it may develop into the condition called ker-ato malacia which is character-ized by necrosis, ulceration and bacterial invasion of cornea leading to the total destruction of the eyeball and eventually total blindness.

Prevention of vitamin A deficiency

The strategy should be a combina-tion of long term nutrition educa-tion programme, enhanced intake of vitamin A rich food, improve-ment in household food security and availability of vitamin A rich foods and a periodic massive dose of vitamin A.

(b) Vitamin D:

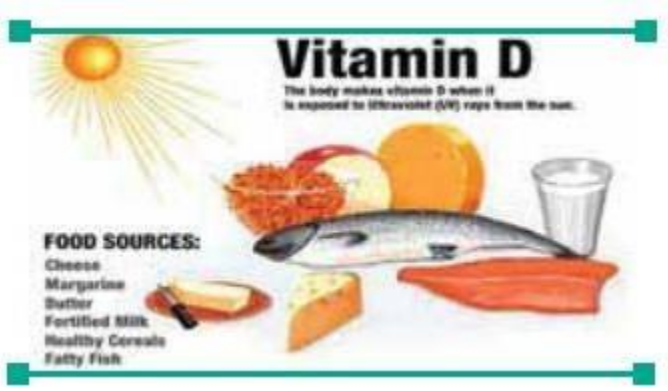
Vitamin D is known to be a prohormone of a sterol type and the synthesis of active form of vitamin D is known as the 1,25 – dihydroxycho-lecalciferol which is accomplished by the combined action of skin, liver and kidneys.

Functions

- Maintains balance with para-thyroid hormone to stimulate the active transport of calcium and phosphorus.
- Acts on the bones promoting calcification.
- Facilitates the absorption of calcium and phosphorus from the intestines.

Involved in widespread basic cell processes with targets in brain, kidney, liver, skin, repro-ductive tissues.

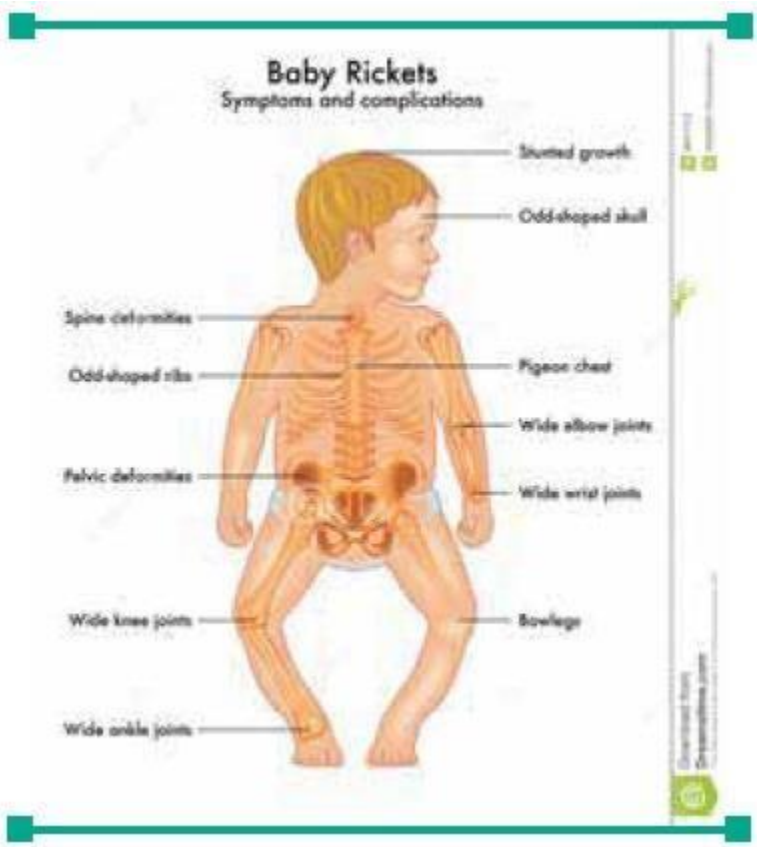
Food sources: Vitamin D is pres-ent only in some foods of animal origin. Certain marine fishes and fresh water fishes are known to be good sources of vitamin D. The most important sources are egg yolk, butter, cheese, milk.



Deficiency: Vitamin D deficiency occurs in children who are not ade-quately exposed to sunlight. It is characterized by inadequate min-eralization of the bone. In children the condition is known as rickets and in adults it is called Osteoma-lacia.

Rickets: In rickets there is soft-ening of the skull bones and the head is enlarged, elongated and flattened on the vertex. Softening of the ribs, sinking of the chest, beaded junctions of the ribs with cartilages (rickety rosary), pigeon chest, knock knees and bow legs. Deformities of the long bones spine, pelvis, muscles, and feet are observed. Dentition is delayed.

Osteomalacia: It is the adult counterpart of rickets. It occurs in women of child bearing age and in those who consume poor cereal diets deficient in vitamin D and calcium.



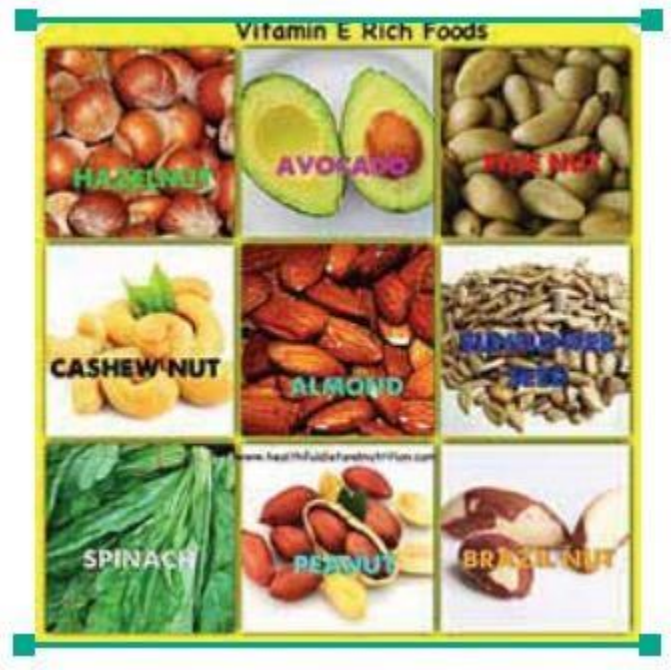
Besides it is found among those who stay indoors all day and seldom go out in the sun.

(c) Vitamin E:

Vitamin E is the generic name for a group of vitamins, three of which –alpha tocopherol, beta tocopherol and gamma tocopherol display the greatest biologic activity. Of these three, alpha tocopherol is the most significant form of Vitamin E

- **Functions**
- Vitamin E a major antioxidant which reduces the incidence of heart diseases.
- It is essential for normal repro-duction in man.
- It acts along with selenium in reducing the body's require-ment for each other.
- It plays a vital role in the immune function of the body.

Food sources: Vegetable oils, nuts and whole grams are the richest sources of vitamin E (eg. Wheat germ oil). It is present in small quan-tities in lettuce, grasses and embryos of many seeds. In general, plant foods are richer sources of vitamin E than animal foods.



Deficiency: Vitamin E deficiency has been associated with irritabil-ity, edema and hemolytic anemia among infants. Also Muscular dys-trophy is common to all species in which there is degeneration of skel-etal and cardiac muscle with vita-min E deficiency.

(d) Vitamin K

Vitamin K occurs in two forms.

- Phylloquinones (vitamin K1) - plant source and dietary form of vitamin K

Menaquinone (vitamin K2) - syn-thesized by intestinal bacterial flora.
Functions: The major functions of Vitamin K though not many are listed as follows:

- Vitamin K is essential for blood clotting.
- Required for the synthesis of blood clotting factors by the liver.
- Vitamin K is vital to maintain normal levels and activation of blood clotting factor like prothrombin,

Food Sources:

The major dietary source of vita-min K is Phyllo Quinone which is present in high concentration in most vegetables like cabbage, spin-ach and cauliflower. Animal food sources include cheese, egg yolk, and liver.

Deficiency: It manifests in the form of defective blood clotting. Low levels of prothrombin and hemor-rhage are seen in severe forms of deficiency.

2.b. Water Soluble Vitamins

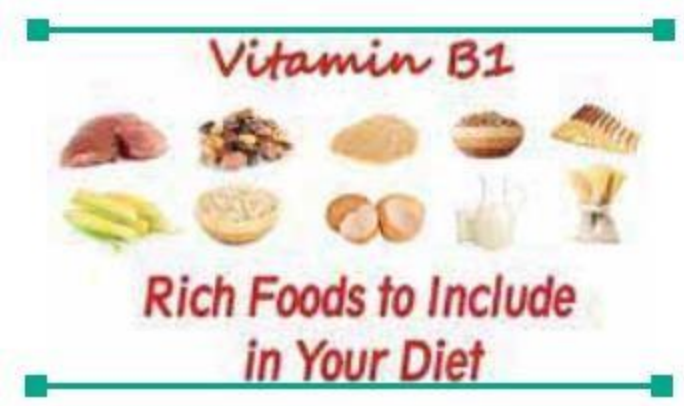
(a) Thiamin (B1):

Thiamin is the first member of the B complex vitamins which is essential to the body in its coenzyme form.

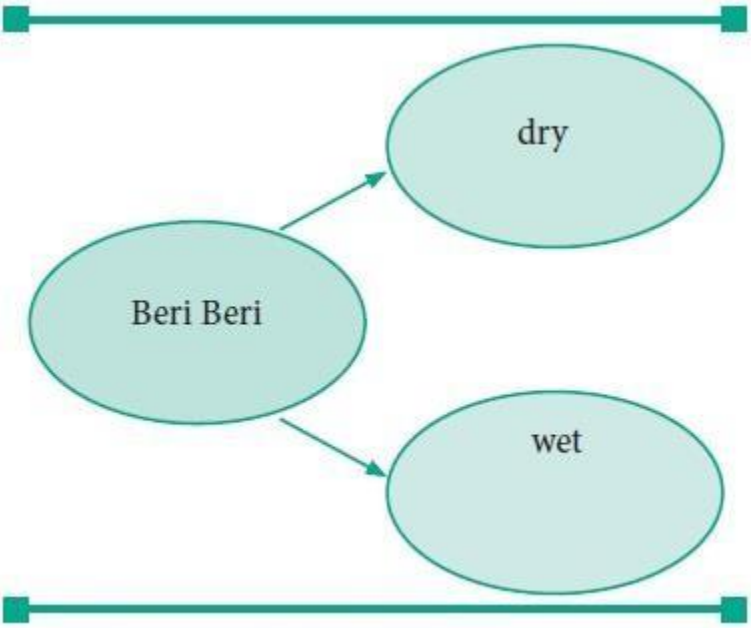
Functions: The coenzyme of thi-amin is Thiamin Pyro Phosphate (TPP). Thiamin is useful in our body for the following functions

- It enhances growth in human beings.
- It plays an important role as a coenzyme in carbohydrate metabolism
- Maintenance of nerves in nor-mal condition.

Food sources: Good food sources include lean pork, beef, liver, whole or enriched grams and legumes.

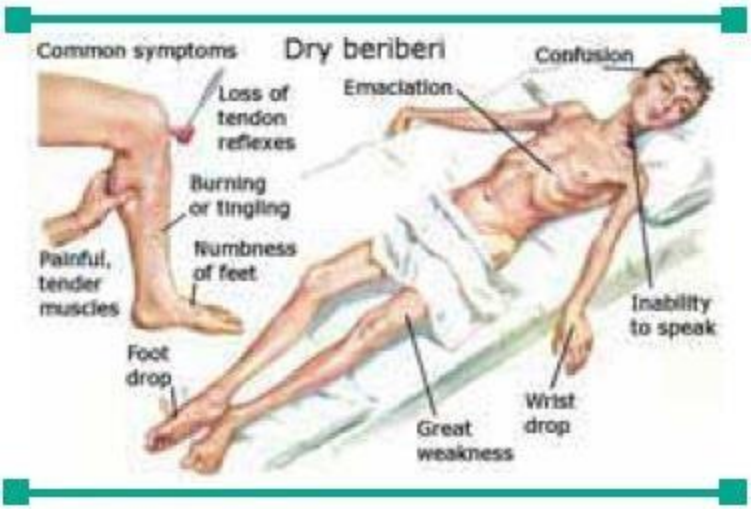


Deficiency of thiamin: The dis-covery of thiamin provided the answer to the puzzle of a nutri-tional problem called beri beri. The deficiency of thiamin causes beri beri in human beings. The Philip-pino word beri beri means “I Can’t” refers to the lack of neuromotor coordination in persons with the disease.



▲ Fig. 3 Types of Beri Beri

Beri Beri is of two types: dry and wet type. In dry beri beri the mus-cles become progressively wasted, weak and walking becomes dif-ficult. If not treated the patient becomes bedridden and will die. In wet beri beri edema is present which involves the face, trunk and serous cavities. Palpitation and breathless-ness are present. The heart becomes weak and death occurs due to heart failure. Infantile beri beri is seen in many South East Asian countries where the diets consist mostly of “polished rice”.



(b) Riboflavin (B2):

Riboflavin is a sta-ble vitamin which is resistant to acid, heat and oxidation. But it is unstable in the presence of alkali and light.

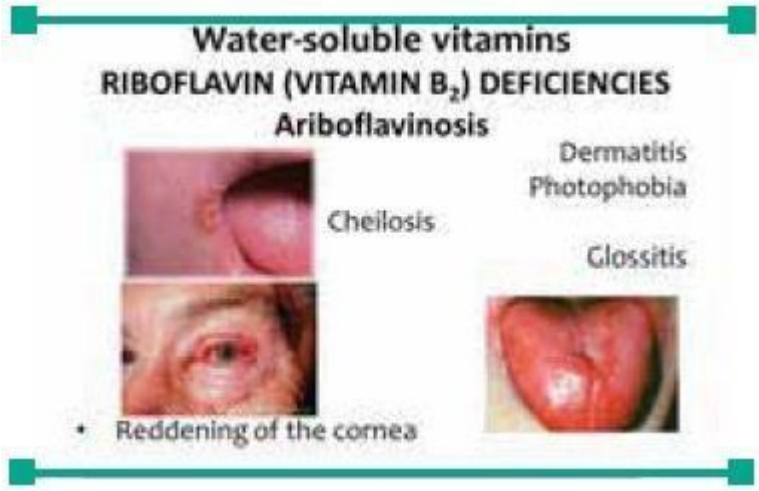
Functions:

The two coenzymes of Riboflavin Flavin Mono Nucleotide (FMN) and Flavin Adenine Dinucleo-tide (FAD) perform the following functions

- Formation of red blood cells in the bone marrow.
- Regulates the functions of hor-mones in carbohydrate metab-olism.
- Present in the retina in the free form which gets converted to a compound which stimulates the optic nerve.
- Release of energy from glucose, amino acids and fatty acids.

Food sources: Good sources of riboflavin are milk and milk prod-ucts, eggs, liver, whole or enriched grains and green leafy vegetables.

Deficiency: The deficiency of riboflavin (ariboflavinosis) leads to glossitis (swollen and reddened tongue), swollen lips, cheilosis (inflammation of the corners of the mouth, are some of the com-mon symptoms observed. Further deficiency states are marked by chronic conditions like tubercu-losis, prolonged fevers, malab-sorption, Hyperthyroidism and malignancy.



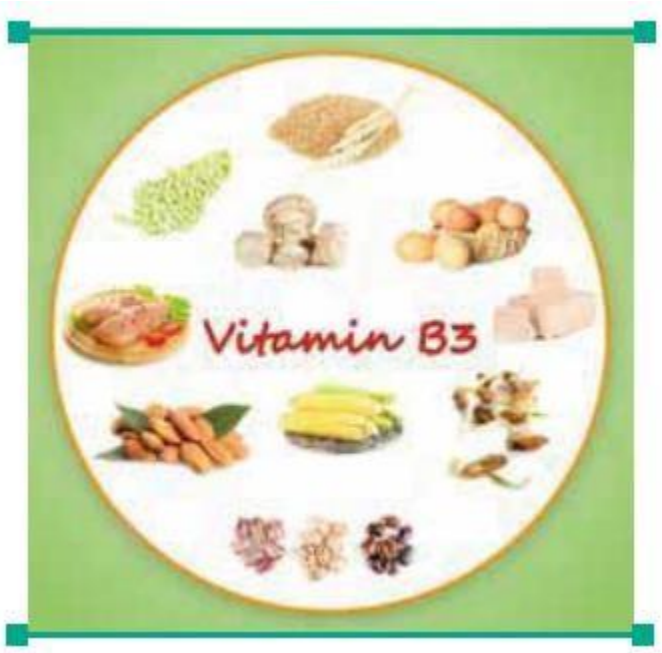
(c) Niacin:

Niacin formerly known as nic-otinic acid was obtained by the oxida-tion of nicotinic acid. Apart from the food sources, Niacin is also obtained from tryptophan (60mg) an essential amino acid which can be converted into niacin (1mg).

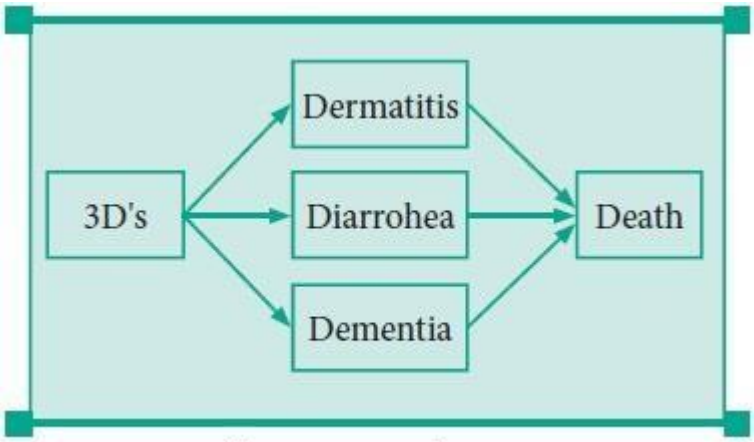
Functions: Two coenzymes of Nia-cin Nicotinamide Adenine Dinu-cleotide (NAD) Nicotinamide Adenine Dinucleotide Phosphate (NADP) are required for:

- Release of energy from all energy yielding nutrients like carbohydrate, protein and fat.
- Normal functioning of the skin, intestinal tract and the nervous system.
- Synthesis of protein and fat for the formation of DNA and RNA.

Food sources: Whole cereals, pulses, nuts and meat are good sources of Niacin. Groundnut is rich in Niacin. Milk is rich in Tryp-tophan the precursor of Niacin in the body.



Deficiency: Deficiency of Niacin causes Pellagra which is the 3D (Dermatitis, diarrohea, dementia or depression) disease leading to the fourth D (Death).



▲ Fig. 4 Pellagra or 3D die ae

Consumption of diets rich in corn can create amino acid imbalance as corn is rich in leucine and deficient in tryptophan. The typical features of pellagra are loss of weight and increasing weakness. Non- specific signs like anorexia, nausea, diges-tive disturbances and emotional changes like anxiety, irritability and insomnia may be present.

(d) Pyridoxine (B6):

Pyridoxine exists in the body in three forms: Pyridoxal, Pyridoxine and Pyridoxamine. Pyri-doxal 5 phosphate is the co-enzyme form of pyridoxine.

Functions: Pyridoxal 5 phosphate acts as a coenzyme in protein metabolism. Its functions include

- Amino acid transport.
- Essential for the growth of infants.

Food sources: Good food sources include grains, seeds, liver, kidney and other meats.

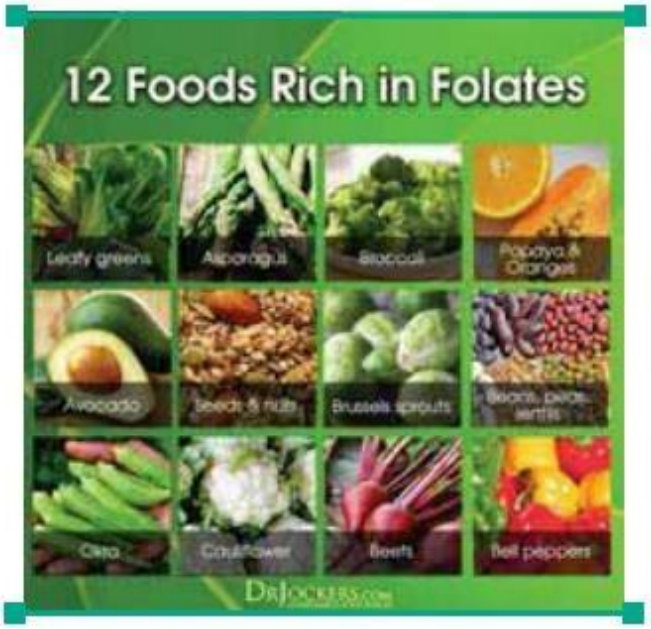
Deficiency: Clinical Symptoms of pyridoxine deficiency have not been clearly defined. Some types of angular stomatitis (cracking at the corners of the lips) and cer-tain types of anaemia have been reported due to decreased intake of pyridoxine.

(e) Folic acid:
The term folic acid was coined to as it was first extracted from dark green leafy vegetables such as spinach.

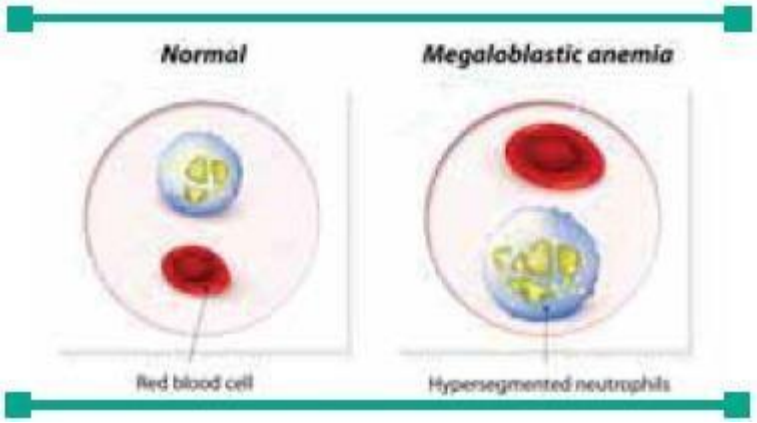
Functions: The different func-tions of folate include:

- Normal growth and division of all cells.
- Maturation of red blood cells.
- Vital role in the metabolism of some amino acids.

Food sources: The rich sources of folate are fish, mutton, liver, egg, chicken, green leafy vegetables and pulses.



Deficiency: Deficiency of folic acid causes megaloblastic anae-mia. Megaloblasts appear in bone marrow and peripheral blood. Poor dietary intake of folic acid, low absorption, increased losses, increased requirements, infes-tation, infection and drugs also cause folic acid deficiency. Symp-toms include weakness, tiredness, dyspnea, sore tongue, headache and palpitation. Folate deficiency during pregnancy can result in neural tube defects like spina bifida and anencephaly.



(f) Cyanocobalamin (B12):

The vitamin is named as cyanocobalamin because of the presence of cobalt and cyanide in its structure. It can be absorbed in the body only in the presence of Intrinsic Factor (IF).

Functions: Physiological func-tions and biochemical functions of cyanocobalmin are:

- Maturation of erythrocytes
- Synthesis of myelin (white sheath of lipoprotein) that sur-rounds many nerve fibres.
- Increase in White Blood Corpus-cle (WBC) count and platelet.
- Stimulation of appetite and general wellbeing of the people.
- Cures neurological symptoms of pernicious anemia.

Food sources: Cyanocobalmin is synthesized by bacteria and is found in foods of animal origin. Liver is the richest source of cya-nocobalmin. Meat, fish, kidney, brain and eggs are good sources of cyanocobalmin.

Deficiency: Inability to produce the intrinsic factor which binds cyanocobalmin leads to perni-cious anemia. The red blood cells are macrocytic and the count is often less than 2.5 million. Symp-toms include soreness and inflam-mation of the tongue, paresthesia (numbness and tingling) in fingers and toes, demyelination of the white fibres of the spinal cord and in severe cases degeneration of the spinal cord.

Other B complex vitamins include biotin, pantothenic acid which do have their vital functions as coen-zymes in various biochemical func-tions of the body

(g) Vitamin C (Ascorbic acid):

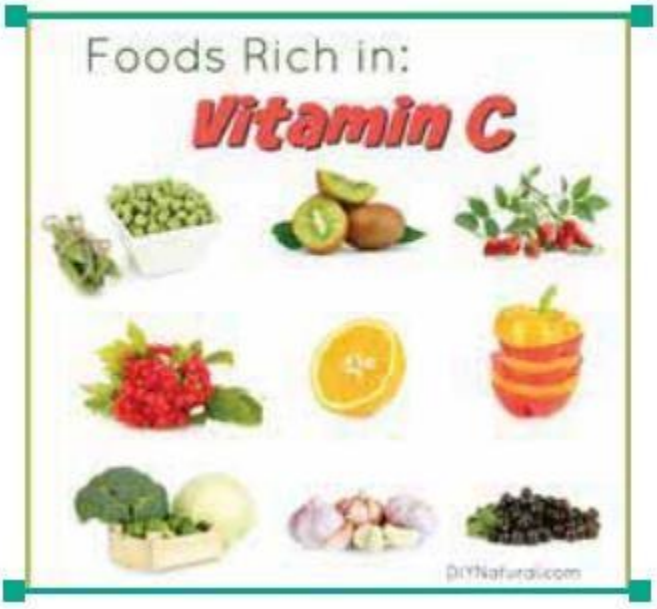
Ascorbic acid is the chemical name of vitamin C which can be synthesized from glu-cose but humans depend on their diet for vitamin C as they do not have an enzyme gulonolactone oxidase which catalyzes the conversion reaction.

Functions: Functions of vitamin C include:

- Collagen formation of bone, teeth, cartilage, skin and scar tissue.
- Formation of dentin layer of tooth
- Wound healing.
- Activation of calcitonin, gas-trin, oxytocin, thyrotropin, vasopressin.
- Drug detoxification
- Regulation of cholesterol, maintenance of the blood ves-sel structure and antioxidant effects.

- Conversion of inactive form of folic acid into its active form
- Reducing agent to keep iron in its ferrous form to facilitate iron solubility.
- Adrenal cortex function.
- Enhances calcium absorption.

Food Sources: Citrus fruits like orange, lemon, tomatoes, guava, watermelon are good sources of Vitamin C



Deficiency: Scurvy the most severe form of vitamin C deficiency arises mainly due to faulty cooking habits and inadequate intake of fruits and vegetables. The clinical features of scurvy are characterized by gin-givitis (bleeding gums) petechiae (small hemorrhagic spots), arthral-gia (pain in the joint), depression, postural hypotension, delayed wound healing. Main deficiency symptoms in infants include tender bones, cessation of bone growth, anaemia and pyrexia.

Scurvy

Scurvy leg

Scurvy

|MICRONUTRIENTS

Until the middle of the 19th century the importance of minerals and vitamins was not given adequate emphasis. It was observed that the macronutrients alone were not sufficient to promote and sustain growth.

This led to the discovery of the micronutrients namely the minerals and vitamins which are essential for growth and maintenance. Macro minerals are those which are present at levels more than 0.05 percent in the human body. Calcium, Phosphorus, magnesium, sodium and potassium belong to this category. Other minerals present at less than 0.05 percent in the human body are defined as micro min-erals. The micro minerals are also known as the trace elements. Some micro miner-als are iron, iodine, zinc, copper, fluorine, selenium, chromium, manganese, cobalt and molybdenum.

1. Minerals

The minerals calcium, phosphorus, iron iodine, sodium and others are found in various foods in combination with organic and inorganic compounds. Minerals are necessary for body building, for building bones, teeth and structural parts of soft tissues.

(i) Calcium

Distribution: Calcium makes up between 1.5 to 2 percent of body weight accounting for 1200-1600 g of the adult male body. Ninety percent of calcium is found in min-eralized tissues such as bones and teeth as calcium phosphate and calcium carbonate. The remaining 1% is found in blood, extracellular fluid (ECF), muscle and tissues.

Functions: The functions of cal-cium in humans are manifold:

- **Bone formation:** The import-

ant minerals within bone are calcium phosphate and magne-sium. There is 1 kg of calcium in the adult skeleton as a complete crystalline material with phos-phate.

 Tooth formation: The enamel and dentin of tooth contain considerable amounts of cal-cium which are dense and are present along with keratin.

Growth: It is required for growth as it forms an important part of the bones and teeth and proper functioning of every cell in the body.

 Blood clotting: Calcium con-tributes to clotting of blood.

 Contraction of the muscle:

Calcium ions are bound by the electrostatic forces to the pro-teins inside and outside the cells and to cell membranes. Proteins bound by calcium alter their configuration at the neuro muscular junction by the nerve

impulses causing free calcium to be released. The free cal-cium bound to troponin leads to an internal trigger and so the contraction of the muscle takes place

 Metabolic essentiality: Cal-cium acts as a activator for the enzyme renin present in gastric juice which aids the digestion of milk.

Food sources: Calcium is present in both animal and plant foods. The richest source of calcium among animal foods is milk and among the vegetable sources it is green leafy vegetables.

Among the green leafy vegetables, amaranth, fenu-greek and drumstick leaves are rich sources of calcium. Ragi among cereals is a rich source of calcium. Small dried fish, nuts and oil seeds like gingelly seeds, betel leaf with slaked lime are also a rich source.

Absorption:

- **Factors increasing absorption of calcium:** Vitamin D, acidity of digestive mass, lactose, protein and phosphorus are the factors which favor the absorption of calcium.

- **Factors decreasing absorption of calcium:** Oxalic acid, phytic acid, high fat diets including steatorrhea, emotional instability, increased gastrointestinal mobility, lack of exercise, ageing, caffeine and drugs decrease the absorption of calcium in the body.

Health Problems/ Deficiency:

 Osteoporosis: This is a condi-tion associated with a loss in bone density and bone mass which literally means “porous bone”. With the ageing process resorption predominates bone formation resulting in osteopo-rosis.

Risk factors for osteoporosis include

- Females who are fair complexioned are at eight times more at risk
- Asian Race
- Family history
- Prolonged dietary insuf-ficiency
- Poor absorption and uti-lization of calcium
- Restricted movement
- Decreased levels of estro-gen
- Hyper parathyroidism
- Vitamin D sufficiency

- **Osteomalacia:** It is a condition where the quality of the bone is diminished and the quantity of the bone is not compromised.

- **Osteopenia:** It refers to the bone density that is lower than nor-mal peak density but not low enough to be classified as osteoporosis. The difference between osteopenia and osteoporosis is a matter of severity of the loss of bone density.

- **Tetany:** A decrease in serum calcium levels gives rise to a condition called tetany. The symptoms of tetany are severe intermittent spasms of the mus-cles of hands and feet accompa-nied by muscular pain. Twitch-ing of facial muscles occurs.

(ii) Phosphorus

Distribution: It comprises 1 per-cent of total body weight along with calcium. An adult human body contains about 400-700 g of phos-phorus as phosphates. Bones and teeth contain 85 percent of phos-phorus and soft tissues contain15 percent of phosphorus.

Functions:

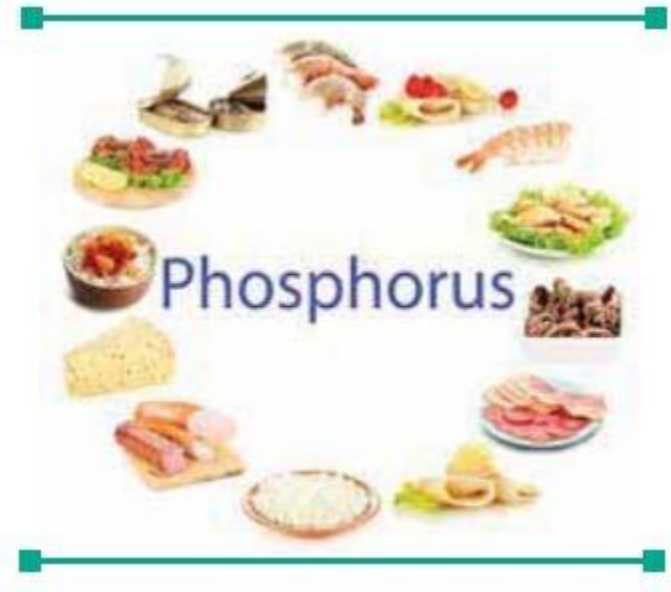
- Formation of bone and teeth along with calcium and magnesium.
- Formation of phospholipids which are integral parts of cell structure.
- Constituent of co enzymes like coenzyme I and co – carboxylase.
- Integral constituent of DNA and RNA (nucleic acids) and nucle-oproteins.

- Buffering of acid or alkali excesses to maintain normal pH.

- Temporary storage and transfer of the energy derived from met-abolic fuels.

- As part of enzymes needed for the metabolism of carbohy-drates, protein and fats.

Food Sources: Phosphorus is widely distributed in foods. Milk and meat are rich in phospho-rus. Whole grain cereals, legumes, nuts, carrots and fish are also rich sources of phosphorus.



Calcium Phosphorus ratio: Nutri-tionists recommend that a Ca:P ratio **between 1:1 to 2:1** should be provided by the total diet.

Deficiency: Phosphorus is so ubiquitous in various foods that near total starvation is required to produce dietary phosphorus deficiency. Inadequate phospho-rus intake is expressed as hypo-phosphatemia which manifests in the form of anemia, anorexia, muscle weakness, bone pain, rickets, osteomalacia, general weakness and increased susceptibility to infection.

(iii) Iron

Distribution: Iron content of nor-mal adult man is estimated to be about 4 grams. Iron is distributed as 60% in the circulating **hemoglobin,** 5% **myoglobin,** various **heme and non heme enzymes** (5%). The remaining iron is found in body storage as **ferritin** (20%) and **hemosiderin** (10%) the two major iron storage proteins

Forms of dietary iron

- **Heme iron:** Heme iron is the iron associated to the protein globin to form hemoglobin and is found in flesh foods only

- **Non heme iron:** This form is pres-ent in all plant sources in addition to 60% of animal sources.

- **Absorption:** Several factors favor and inhibit iron absorption

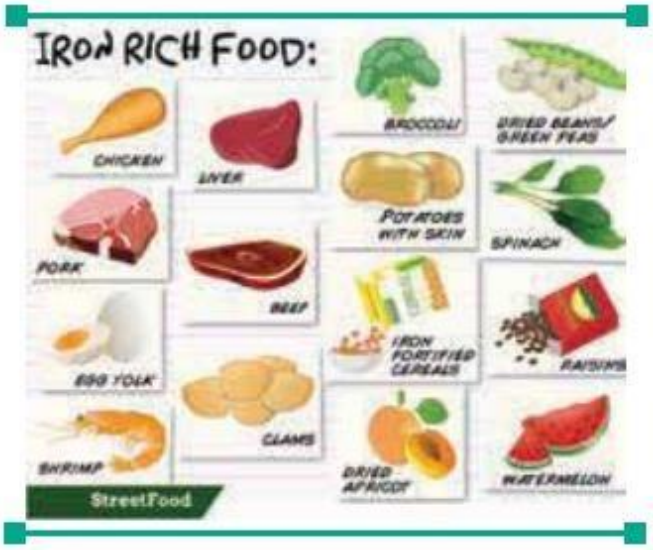
Factors favoring absorption of Iron:

Functions: Iron has varied signif-icant functions in human body. They include:

- Transport and storage of oxygen where each gram of hemoglobin contains about 3.34 mg of iron.
- As myoglobin iron is required for oxygen storage in muscle.
- Iron acts as a cofactor of enzymes.
- It is a component of cell enzyme systems that oxidize glucose and other energy yielding nutrients.
- Production of immune cells that attack foreign bacteria invading the body.
- Positive iron balance is neces-sary for continued growth.
- To build reserves for physio-logic stress during adolescence for both boys and girls.
- Necessary for brain develop-ment, cognitive function, the synthesis and breakdown of neurotransmitters.

Food sources:

Rich sources of iron are cereals, millets, pulses and green leafy veg-etables. Of the cereal grains and millets bajra and ragi are very good sources of iron. Other sources of plant foods include manathakali leaves, rice flakes, mint, soya bean, cow pea, gingelly seeds and dates. Animal food sources include red meat, and fishes like herring and mackerel



Deficiency

 Iron Deficiency anemia: When there is an insufficiency of iron for the formation of hemoglobin, the RBC's become pale and small. The resulting anemia is called hypo-chromic and microcytic anaemia which is the most common form of anaemia throughout the world affecting women mainly in their reproductive years, infants and children.

▲ Normal RBC

▲ Microcytic and hypochromic RBC

Causes: Low iron intake, blood loss, malabsorption chronic dis-eases, obesity

Signs of Iron Deficiency

- Fatigue
- Muscle weakness,
- Pale color
- Decreased resistance to infection
- Spoon nails(Koilonchyia)
- Angular stomatitis
- Dizziness
- Dimness of vision
- Insomnia
- Headache

- Regular consumption of iron rich foods, vitamin C rich foods, seasonal fruits and vegetables can definitely prevent anemia.

(iv) Iodine

Distribution: It is one of the essen-tial micronutrients required for normal growth and development of human brain and body. Human body contains a total of 15-20 mg of iodine. Thyroid gland contains 75% of iodine and is an essential constituent of thyroxine the active principle of thyroid gland

Functions: Iodine though required in small quantities is needed to per-form the following functions

- Synthesis of thyroxine which regulates growth, development and reproduction.
- Helps the thyroid hormones to increase and regulate the pro-cesses of brain function
- Enables the thyroid hormones to regulate the conversion of carotene to active vitamin A.

Food sources:

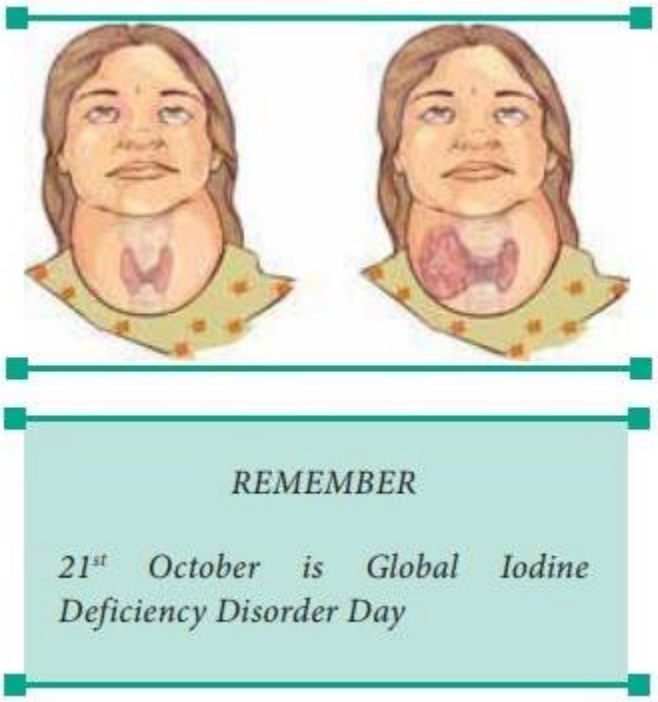
Marine fish and eggs are good sources of iodine. Based on the dietary pat-tern and analysis of raw foods, iodine content of various regional diets range from 170-300 µg/ day

Deficiency: It covers a collection of disorders at all stages of human growth and development.

 Goiter: Goiter is the enlargement of thyroid gland which results when iodine is not available in sufficient quantities to produce normal quantity of thyroxine. It also arises from eating foods (goitrogens) that inhibit the synthesis of thyroxine

 Cretinism: A congenital disease resulting from a lack of iodine and thyroxin secretion characterized by physical deformity, dwarfism, men-tal retardation and often goiters.

 Dietary improvement: Salt iodiza-tion remains the most cost effec-tive way to deliver iodine to both humans and livestock and is cred-ited with eradicating iodine defi-ciency.



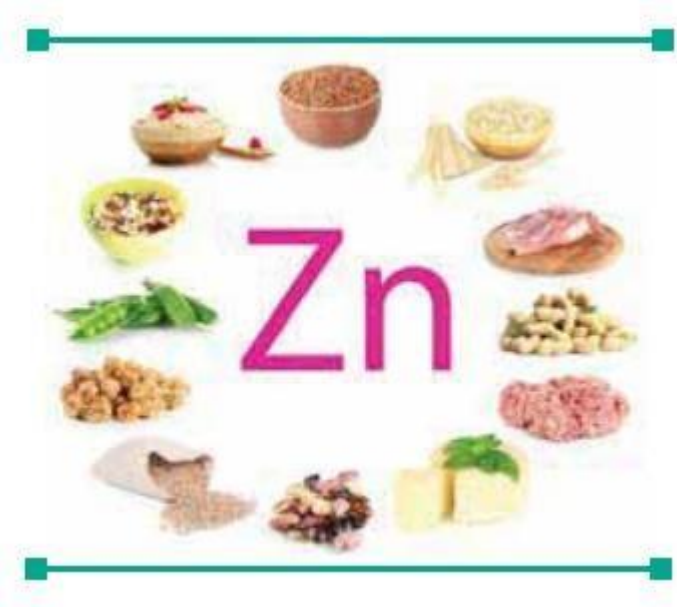
(v) Zinc

Distribution: Zinc is the most important intracellular trace element. An adult human contains 2g of zinc of which 60% is in skele-tal muscle, 30% in bone and 4-6% is present in zinc.

Functions: The functions of zinc include

- Important constituent of enzymes like alkaline phospha-tase and carbonic anhydrase.
- Required by protein kinases that participate in gene expression.
- Also a component of metallo-enzymes.

Food sources: Meat, seafood and liver are good sources of bioavail-able Zinc. In cereals most of the zinc is found in the outer fiber rich part of the kernel.



Deficiency: The clinical manifes-tations of severe zinc deficiency in humans are growth retarda-tion, dermatitis, hair loss, diarro-hea, increased infections, delayed wound healing, loss of appetite, hypoguesia (diminished taste) dys-guesia (altered taste) hyposmia (diminished smell). Decreased zinc intake is associated with increased risk of low birth weight and preterm delivery.

Unit - 4

- **NUTRITIONAL REQUIREMENTS OF PREGNANT AND LACTATING WOMEN**
-
- Nutrition requirements increase tremendously during pregnancy and lactation owing to the physiological changes.
- Wholesome nourishment before pregnancy has a greater impact on the long term health on the mother and foetus. A well nourished foetus enters life with good physical and mental health.
-

- **Physiological Changes in Pregnancy**
-
- Foetal development is accompanied by many physiological, biochemical and hor-monal changes which influence the nutri-ent needs and the efficiency with which the body utilizes them. The changes include
-

- ***i. Increased basal metabolic rate (BMR)***
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- Due to foetal growth the BMR increases.
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- ***ii. Gastro intestinal changes***
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- Gastro intestinal motility diminishes which may result in constipation.

- ***iii. Hormonal changes***
- During pregnancy there is increased secretion of the following hormones: i) Aldosterone ii) Progesterone iii) Thyroxin iv) Parathormone.
- ***iv. Changes in body fluid***
- The blood volume expands by 50 per-cent and this increased amount of blood is required to carry nutrients to the foe-tus and remove metabolic wastes from the foetus.
- ***v. Altered renal function***
- Increased blood volume and increased production of waste products like creati-nine, urea and other wastes due to foetal and maternal metabolism produces a high glomerular filtration rate (GFR).
- ***vi. Weight Gain during Pregnancy***
- Less than half of total weight gain resides in the foetus, placenta and amniotic fluid. Women with desirable body weight is 12.5 kg ranging between 11-13 kg.
- **Nutritional Needs during Pregnancy**
- In addition to the RDA for an adult women the nutritional needs increase during pregnancy.
- **Energy**
- Energy requirement during pregnancy is increased because of the additional energy required for growth and activity of foetus, growth of placenta and maternal tissues, increase in maternal body size and steady rise in BMR.
- **Protein**
- An additional protein intake is essential for:
- – Growth of the foetus.

- – Development of placenta
- – Enlargement of uterus, mammary glands
- – Increased maternal blood volume
- – Formation of amniotic fluid

- **Fat**

- ICMR expert committee has suggested an intake of 30g of visible fat/day during pregnancy.

- **Calcium**

- Additional calcium is needed for the growth and development of bones as well as teeth of the foetus and also for the pro-tection of calcium resources of the mother to meet the high demand of calcium dur-ing lactation.

- **Iron**

- The requirement of iron increases from 21mg/day to 35mg/day during pregnancy.
- The increased requirement is due to
- i. expansion of maternal tissues including red cell mass, iron con-tent of placenta and blood loss during parturition.
- ii. to build the iron store in foetal liver to last for at least 4-6 months after birth. This is because the baby's first food milk is deficient in iron.

- **Iodine**

- Due to increase in BMR, iodine needs are also enhanced during pregnancy.

- **Zinc**

- Deficiency of zinc adversely affects the outcome of pregnancy. Zinc deficiency leads to foetal mortality, foetal malfor-mations and reduced intra uterine growth rate.

- **Sodium**
- Normal sodium intake without restric-tion is advised during pregnancy. Sodium is restricted when there is oedema or hypertension.
- **Vitamins**
- An additional allowance of Vitamin A is needed during pregnancy. Vitamin D is essential as it enhances maternal calcium absorption. Vitamin K is required for syn-thesis of prothrombin which is essential for normal coagulation of blood. A liberal vitamin K level in the mother's blood is helpful in preventing neonatal haemor-rhage. Vitamin C, pyridoxine, and vitamin B12 needs are increased during pregnancy.
- **Folic acid**
- Folic acid is essential for increased blood formation i.e. haematopoiesis and for synthesis of essential components of DNA/RNA which increase rapidly during growth.
- **Problems during Pregnancy**
- Nausea and vomiting
- Constipation
- Heart burn
- Oedema and leg cramps
- Pica
- Anemia
- Pregnancy induced hypertension (PIH)
- Gestational diabetes
- **Lactation**
- Adequate nutrition for the mother during lactation is also of vital importance as the infant is dependent on mother's milk for its nutrition for the first few months of life. Inadequate nutrition during lactation is reflected on both the quality and quan-tity of milk secreted.

- **Physiology of lactation**
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- The Table 13 below gives the summary of hormonal control of lactation.
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- **Nutrient Needs during Lactation**
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- ICMR nutrient recommendations for a lactating mother are based on the com-position of breast milk and the fact that 850 ml of milk is produced daily. However, the milk secretion continues to increase in the early periods of lactation up to six months and then gradually decreases. Therefore the nutrient requirements are given for the two periods in lactation i.e. 0-6 months and 6-12 months.
-

- **Energy**
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- The lactating mother requires additional energy for the production of milk. Based on the optimal output of 850 ml/day, the additional allowance is recommended during first six months of lactation.
-

- **Protein**
-
- Due to production of milk, protein requirement also increases.
-

- **Fat**
-
- The total fat in breast milk is not influ-enced by the mother's diet. The fat also provides energy density to meet the higher energy requirement during lactation.
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-

- **Calcium**
-
- The requirement for calcium doubles dur-ing lactation.
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- **Iron**
-
- Since most mothers have lactational amenorrhea, it results in saving of nearly 1mg iron per day which otherwise would have been lost due to menstruation. There is a marginal increase in the iron intake.

Table 13 Summary of Hormonal Control of Lactation

S. No.	Hormone	Source	Function
1	Estrogen	Ovary	Stimulates breast development
2	Progesterone	Placenta	Prepares breast for milk production by changing glandular cells to secreting cells
3	Prolactin	Anterior pituitary	Stimulates milk production
4	Oxytocin	Posterior pituitary	Facilitates release of milk from alveolus

Source: Srilakshmi (2011)

Vitamins

- The additional need of vitamin A during lactation is based on the amount secreted in the mother's milk. As the calorie and protein requirements increase during lac-tation, the requirements of B vitamins also increase correspondingly. Ascorbic acid content increases during lactation.
-

- **Galactogogues**
-
- Galactogogues are foods that help to pro-duce more milk. Garlic, milk and almonds are considered to increase milk pro-duction. Studies carried out on nursing mothers have revealed that extra amounts of body building foods like fish and mut-ton increase the secretion of breast milk. Lactating mothers are also given special preparations containing ajwain and fen-ugreek seeds, which supply iron, protein, calcium and B- complex vitamins.

Nutritional Needs of Infants

Infancy is a period of rapid growth. The development during infancy is more rapid than during at any other period in the life time of an individual.

Growth and Development

The growth and development is accompa-nied by a number of physiological changes which include changes in body size and body composition, changes in the gastro intestinal system, excretory system and circulatory sys-tem. Nutrition is crucial and proper dietary modifications are vital during this period.

Immunization

Malnutrition during infancy leads to a high-er incidence of infant mortality. Besides malnutrition,infection causes mortality. Immunization protects the children against disease. Table 6 below presents the immuni-zation schedule for infants and children.

Good nutrition is essential for the growth and development that occurs dur-ing an infant's first year of life. As an infant's mouth, tongue, and digestive tract mature, the infant shifts from being able to only suckle, swallow, and take in liquid foods, such as breast milk or infant formula, to being able to chew and receive a wide vari-ety of complementary foods.

Table 6 National Immunization Schedule (NIS) for Infants, Children

Age	Vaccine
Soon after birth	Hepatitis B 1st dose, OPV 1st dose, BCG
6 weeks	Hepatitis B 2nddose,DPT 1stdose,OPV 2nd dose
10 weeks	DPT 2nddose,OPV 2nd dose
14 weeks	DPT 3rddose,OPV 4th dose
6 weeks, 10 weeks and 14 weeks	OPV 5thdose,Hepatitis B 3rd dose
9 months to 12 months	Measles
15 to 18 months	MMR
16-24 months	DPT, OPV 1st Booster
2 years	Typhoid vaccine
5 – 6 years	DPT, OPV 2nd Booster

DPT- Diphtheria, Pertussis, And Tetanus: OPV-Oral Polio Vaccine; MMR- Measles, mumps, and rubella

Source: https://mohfw.gov.in/sites/default/files/24545352106148966387 3.pdf

Energy: Infants need energy from food for activity, growth, and normal development. Energy comes from foods containing car-bohydrate, protein, or fat. A general indi-cator of infant consuming an adequate kil-ocalories per day is the infant's growth rate in length, weight, and head circumference.

Carbohydrate

The major type of carbohydrate normally consumed by young infants is lac-tose, the carbohydrate source in breast milk. Lactose-free infant formulas, such as soy-based infant formulas provide car-bohydrates in the form of sucrose. In later infancy, infants derive carbohydrates from additional sources including cereal and other grain products, fruits, and vegetables.

Protein

Breast milk and infant formula contains protein. The complementary foods such as meat, poultry, fish, egg yolks, cheese, yogurt, pulses, cereals and other grain products provide adequate protein.

Fat

Breast milk and infant formula are impor-tant sources of lipids, including essential fatty acids, during infancy.

Vitamin A

Breast milk and infant formula are major food sources of vitamin A. Additional sources of vitamin A or carotenes for infants consuming complementary foods include egg yolks, yellow and dark green leafy vegetables and fruits e.g., spinach, greens, sweet potatoes and liver.

Vitamin E

Infants receive vitamin E from breast milk and infant formula. Other vitamin E sources for older infants include green leafy vegetables, vegetable oils and their products, wheat germ, whole-grain breads, cereals and other fortified or enriched grain products, butter, liver, and egg yolks.

Vitamin K

Sources of vitamin K include infant formula, green leafy vegetables, pork, and liver.

Vitamin C

Breast milk and infant formulas are major food sources of vitamin C. Additional vitamin C sources include vegetables (e.g., tomatoes), fruits (e.g., citrus fruits, papaya, and strawberries), and regular fruit and vegetable juices which are natu-rally high or fortified with vitamin C.

Vitamin B_{12}

An infant's vitamin B_{12} stores at birth gen-erally supply his or her needs for approx-imately 8 months. Infants consuming appropriate amounts of breast milk from mothers with adequate B_{12} stores or infant formula receive adequate amounts of this vitamin. Complementary foods such as meat, egg yolks, and dairy products pro-vide this vitamin later in infancy as well.

Calcium

An infant can obtain sufficient calcium by consuming adequate amounts of breast milk or infant formula. Older infants can obtain additional calcium from complementary foods such as yogurt, cheese, cottage cheese (paneer), fortified or enriched grain prod-ucts, some green leafy vegetables (such as turnip and greens), and tofu.

Iron

Sources of iron for infants include breast milk, infant formula, meat, liver legumes, whole-grain breads, cereals, or fortified or enriched grain products, and dark
green vegetables. Heme iron is found primarily in animal tissues, including red meat, liver, poultry and fish and non-heme iron is found in breast milk, infant formula, cereals, or other grain products legumes, fruits and vegetables. Infants receive most of the iron in their diets as non heme iron.

Tofu, or bean curd, is a popular food derived from soya. It is a staple ingredient in Chinese cookery and is a good source of protein, containing all eight essential amino acids. It is also an excellent source of iron and calcium and the minerals man-ganese, selenium and phosphorous.

Zinc

Infants obtain zinc from breast milk, infant formula, meat, poultry, liver egg yolks, cheese, yogurt, legumes, and whole-grain breads, cereals, and other fortified or enriched grain products.

Sodium

Healthy, full-term infants consuming pri-marily breast milk or infant formula of standard dilution receive a relatively small amount of sodium but an amount ade-quate for growth.

Fiber

Breast milk contains no dietary fiber, and infants generally consume no fiber in the first 6 months of life. As complementary foods are introduced to the diet, fiber intake increases. Dietary fiber is found in legumes, whole grain foods, fruits, and vegetables.

Water

Infants' water needs are met from consum-ing breast milk, infant formula, and com-plementary foods. Water is also formed in the body in chemical reactions occurring to metabolize protein, fats, and carbohy-drates. Under normal circumstances, the water requirements of healthy infants who are fed adequate amounts of breast milk or properly reconstituted infant formula are met by the breast milk or infant for-mula alone.

Breast Feeding

Infants who are exclusively breast fed for the first 6 months of life grow well and breast feeding is beneficial not only during this period but also during later years of life. The infant is put on the breast within half an hour after a normal delivery.

American Academy of Paediatrics(2005) firmly adheres to the position that breast-feeding ensures the best possible health as well as the best developmental and psy-chosocial outcomes for the infants

Colostrum: During first two or three days colostrum is secreted in small quantities of about 10-40 ml. The composition of colostrum is as follows:

Table 7 Composition of Colostrum

Nutrient	Quantity / 100 ml
Energy (k cal)	58
Fat (g)	2.9
Calcium (mg)	31
Phosphorus (mg)	14
Iron (mg)	0.09
Protein (g)	2.7
Lactose (g)	5.3
Carotene (IU)	186
Vitamin A (IU)	296

Source: Guthrie (1989)

Colostrum contains an interferon like substance which has strong antiviral activity. It contains a B12 binding protein making it unavailable for the growth of ***E-coli*** and other bacteria. It also contains antibodies against viral infection.

Advantages of breast feeding

Breast feeding is the simple and best method of feeding and has the following advantages

1. Nutritional factor

The composition of human milk is best suited for infants. In human milk the pro-tein content is lower but the content of car-bohydrate, namely lactose is higher. The fat content is comparatively less. The pro-tein is present as lactalbumin which is bet-ter digested than the protein in cow's milk. Lactose provides natural sweetness and also helps in absorption of calcium and iron. Fat though less is highly emulsified and therefore better digested. When compared to animal milk, breast milk provides higher amount of vitamin C. Similarly calcium in breast milk though less when compared to cow's milk is better absorbed by the infant. The composi-tion of human milk is best suited for infants. The table 8 below shows the comparison of Human milk and cow's milk.

2. Hormones and growth factors: Breast milk is a rich source of hormones like Thyroid Stimulating Hormone (TSH), thyroxin, insulin and prolactin. It also contains growth regulating factors, growth promoters and growth modulators.

Table 8 Comparison Of Human Milk and Cow's Milk

Nutrient per 100 ml	Human milk	Cow's Milk
Water (g)	88	87.5
Energy (k cal)	65	67
Protein (g)	1.1	3.2
Carbohydrate (g)	7.4	4.4
Fat (g)	3.4	4.1
Calcium (mg)	28	120
Phosphorus (mg)	11	90
Iron (mg)	– –	0.2
Carotene (µg)	137	174
Thiamine (mg)	0.02	0.05
Riboflavin (mg)	0.02	0.19
Vitamin C (mg)	3	2
Caseinogen lactalbumin ratio	1.2	3.1

3. Immunological factors:

The following factors in breast milk pro-vide passive immunity.

- **Macrophages:** They can digest bac-teria and also develop immunity against infectious diseases.
- **Lymphocytes:** Lymphocytes produce antiviral substances like interferon.
- **Lactoferrin:** It is an iron binding protein that inhibits the growth of *E.coli* and other bacteria.
- **Enzymes:** Breast milk also sup-plies enzymes like lipase, amylase and lactoperoxidase which increase digestibility and also destroy the harmful microorganisms.
- **Immunoglobulin:** They are defen-sive proteins which include all types of antibodies.

4. Economic factors

Breast milk is the most economical food for the baby. Even after accounting the extra food cost required by the mother, breast milk is cheaper than any other type of artificial feed.

5. Psychological factors

Breast feeding is essential for a healthy, happy and emotional relationship between the mother and the infant.

6. Natural contraceptive

Breast feeding prevents the onset of another pregnancy and also prevents breast cancer.

7. Other advantages:

- Infants jaw is more fully developed.
- Breast milk is microbiologically sterile.
- Human milk is always fresh and at the right temperature.
- It is convenient to administer at any time.
- Breast fed babies have better cogni-tion and IQ later in life when com-pared to bottle fed babies.

Artificial feeding

Though breast milk is the best milk and there can be no substitute for it, there are certain circumstances during which the infant needs to be given artificial feeds.

Reasons

- Illness of short duration like fever, or severe illness like tuberculosis and heart disease.
- The mother is on steroids, antico-agulants or radioactive drugs.
- Insufficient milk secretion.
- Death of mother.

- Prev Page
- Next Page

- **Complementary Foods and Weaning Foods**
-

- Milk provides all the food a baby needs for at least the first four months of life. As babies gain weight and grow older they need a more varied diet. The change over from milk to more solid food is called weaning. The idea of weaning is the process of gradual introduction to a wide range of 'non milk' foods to infants in addition to breast milk. Weaning the baby from breast or bottle feed starts by four months.
-

- **Stages of Weaning**
-
- Weaning is a transition from breast milk or formula milk to solid foods. It is divided into the following stages:
- **STAGE I**- Babies are usually ready to start on solid foods between 4-6 months
-
- **STAGE II**- 6-9 months
-
- **STAGE III**- 9-12 months
-

- **Stage I**
-
- Babies cannot chew and the first weaning foods need to be similar in consistency to milk. Cereals such as rice or wheat flours mixed with milk is a suitable first wean-ing food. Food should be the same tem-perature as their usual milk feed. Mashed, pureed, starchy vegetables made to the same consistency are also suitable foods.
- e.g.potato, carrot. Foods should be salted or sweetened. Babies should have 600ml of breast or infant formula milk daily along with the weaning foods.

- **Stage II**
- Babies get used to spoon feeding and will take more solid foods. They can begin to have the same foods as the rest of the fam-ily, but in mashed or pureed form. They are able to chew foods at six months, so can be given hard foods to chew. These are called finger foods. These include foods such as raw soft fruits and vegetables, raw strips of carrot, cooked green beans and soft banana. Foods with increased quantity, dif-ferent texture and stronger tastes should be encouraged.
- **Stage III**
- At this stage babies will probably eat solid foods in addition to 500-600ml breast milk or infant formula after nine months. Wide variety foods should be given with a range of textures, because the baby can cope up with food that is lumpier in texture.
- **Important points to be considered while introducing supplementary foods**
- Introduce only one food at a time.
- Allow the infant to become familiar with the food before trying to give another.
- Fruit juice should be fed only by cup not by bottle.
- When the baby is able to chew, gradu-ally substitute finely chopped fruit and vegetables usually at 8 to 9 months.
- Variety in choice of foods is important.
- Infants may object to eat some foods by themselves but will take them willingly if one is mixed with another. Egg may be mixed with formula cereal or vegetable.
- The child can be fed with a spoon until the baby gets used to an adult method of feeding.
- Give freshly prepared food.
- Food should be given between breast feeds.
- The temperature of the food should not be hot or cold.
- **Supplementary Foods**

- Foods that are regularly fed to the infant, in addition to breast-milk, providing suf-ficient nutrients are known as supplemen-tary or complementary foods. These could be liquid foods like milk or semi-solid foods in the case of gruels or porridge or solid preparations like rice, which can be given to children over the age of one year.

- **Types of Supplementary Foods**

- ***Liquid Supplements***

- ***Milk:*** The frequency of breast feeding is reduced to 3 to 4 times a day and cow's milk is substituted in 6 months. Cow's milk is diluted with water in the proportion of 2:1 for the first feed. Sugar can be added to increase taste and calories.

- ***Juice of Fresh Fruits:*** Small quantities of fresh fruit juices should be given in the 3^{rd} and 4^{th} month of the infant. In early stages fruit juice is diluted with water and only a couple of teaspoons are fed and the amount is gradually increased.

- ***Soup from Green Leafy Vegeta-bles:*** Green leafy vegetables can be substituted as an alternative if fruits are not available.

- ***Solid Supplements***

- ***Mashed Foods:*** Mashed food should be given around the 7^{th} and 8^{th} month along with the liquid supplements for the infant.

- ***Cereal and Starchy Gruels*****:** Mashed cereals are rice, wheat and ragi which are usually eaten as porridge with the addition of vegetable oil.

- ***Vegetables:*** Cooked, mashed vegeta-bles like potato, green leafy vegeta-bles and carrots can be introduced to get vitamins and minerals in the diet.

- ***Fruits:*** Fruits should be stewed and sieved. Sugar and lime can be added for flavor.

- ***Non Vegetarian Food:*** Egg yolk is given as good source of protein and it is usually introduced in soft cus-tards. Egg white is not given until the infant is 10 months old, as it causes allergic manifestations. Minced, cooked meat or boiled fish with salt can be given.

- ***Pulses:*** Pulses along with cereals in the form of porridge can be given. Pulses and meat preparation can be given alternatively

- ***Unmashed:*** When the infant starts developing teeth, it is the time to give lumpy foods, cooked cereals and pulses solids like idly, idiappam, bread, chap-pathi and semi solids like rice and dhal. Vegetables can be chopped and boiled into small pieces. As the child grows, it is better to give fruit segments instead of juice. Fruit provides bulk in the diet and is good for bowel movement.

- **Problems of Weaning**

- Obesity

- Underweight

- Choking

- Food allergy

Unit – 5

- **NUTRITIONAL NEEDS OF PRESCHOOL AND SCHOOL GOING CHILDREN**
-

- The rapid growth during infancy is followed by a generally slow growth between one to six years. The child becomes more active and the social and environmental influences have a great impact on their food behaviour and eat-ing pattern. The need for nutrients is increased as growth and development continues.
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- **Growth Pattern**
-
- During the second year, the increase in height is about 10 cm and weight gain is 2 to 2.5 kg. After two years annual gain in height and weight is only 6 to 7 cm and 1.5 to 2 kg respectively. However, there is a wide variance in the physical develop-ment of children.
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- As growth proceeds, changes occur in a) proportion of water, b) muscle tis-sue, c) fat deposits and d) skeletal struc-ture. The body water gradually decreases and there is addition of adipose tissue and minerals to the bones.
-

- **Nutritional Needs During Preschool**
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- **Energy**
-

- The energy needs for the child is deter-mined by his basal metabolism and activ-ity. If the preschool child is not given proper complementary foods and supple-mentary foods, it may lead to protein and energy malnutrition.
-

- **Protein**
-
- Protein is a vital dietary component for pre-schoolers, as it is needed for optimal growth. Enough protein should be con-sumed every day for proper growth and development.
-

- **Fat**
-
- Adequate fat is required to provide the extra calories and reduce bulk in the diet.
-

- **Minerals**
-
- Calcium is needed for bone and teeth min-eralization and maintenance. The amount of calcium a child needs is determined in part by the consumption of other nutri-ents, such as protein, phosphorus and vitamin D, as well as the child's rate of growth.
-
- Iron requirement during childhood is needed for growth and for increase in the haemoglobin concentration. Dietary lack of iron accompanied by hookworm infestation can lead to anaemia. Zinc is essential for proper development. It is needed for wound healing, proper sense of taste, proper growth, and normal appetite.
-
- ***30%–50% of aneamia in children and other age groups is caused by iron deficiency (World Health Organization 2007).***
-

- **Vitamins**
-
- The incidence of Vitamin A deficiency is high. The recommended intake for B vita-mins is based on the energy intake. The dietary intake of vitamin C for pre-school-ers is the same as for adults i.e., 40 mg/day

Table 9 Balanced diet for preschool children

Food groups	g/portion	Quantity(portions)	
		1-3 years	4-6 years
Cereals and millets	30	2	4
Pulses	30	1	1
Milk (ml)	100	5	5
Roots and tubers	100	1	1
Green leafy vegetables	100	0.5	0.5
Other vegetables	100	0.5	1
Fruits	100	1	1
Sugar	5	3	4
Fats / Oils (visible)	5	5	5

Source: Dietary Guidelines for Indians - A manual, National Institute of Nutrition, ICMR, Hyderabad, India (2010)

- **Dietary Guidelines**

- Transition from an infant diet to a regular adult diet should be smooth and gradual. Factors that need to be considered while planning a diet for a preschool child are:

- The food should be interesting and attractive. For example, chapattis, poori and bread slices can be cut into interesting shapes to make eating interesting for a child.

- The diet should include enough quan-tity and quality of different nutrients. They should be encouraged to have milk every day. Milk can be given with delicious flavours.

- Plenty of fruits and vegetables are needed for proper elimination.

- Fruits are given raw or in the form of simple desserts.

- Unripe bananas and apples should not be given as they are difficult to chew and may choke the child.

- Candies and sweets should be in mod-eration. Foods like tea and coffee should not be given as they are more stimulating to the system.

- Foods should be seasoned so that they taste better and the child takes it well.

- Fried foods and concentrated foods should not be given as they are diffi-cult to digest.

- The Child should never be forced to eat more than what he can take and the atmosphere should be peaceful, pleas-ant and lacking distraction.

- People feeding the child should not show dislike of any food in front of the child; this may lead to the rejection of the food by the child.
-
- Regularity of meals is essential.
-
- Food preferences of the child should be taken into consideration.
-

- **Nutritional Problems among Pre-Schoolers**
-

- **Protein-Energy Malnutrition (PEM)**
-
- The primary cause of malnutrition is a faulty and inadequate diet. Besides diet and socioeconomic factors, various envi-ronmental factors aggravate the dietary deficiencies. These include chronic infec-tion, poor environmental sanitation, poor insanitary living conditions and poor per-sonal hygiene. The diseases that represent extreme forms of PEM are
-
- Kwashiorkor
-
- Marasmus, and
-
- *Marasmic Kwashiorkor*
-

- **Vitamin-A deficiency**
-
- Inadequate dietary intake of vitamin A or its precursor (E-carotene) is exhibited as Bitot's spots, kertomalacia in preschool children.

▲ Fig 2 Bitot's spot

▲ Fig 3 Keratomalacia

- The school-age, six to twelve years, has been called the latent time of growth. The rate of growth slows down and body changes occur gradually. The slow rate of growth dur-ing this period result in a gradual decline in food requirement per unit of body weight.

- **Energy**

- Energy needs vary with growth rate, body size and physical activity. The require-ment **for calories** increases during school age.

- **Protein**

  Girls require more protein than boys because they are reaching menarche. The protein requirements are slightly higher for girls than boys between 10-12 years.

Minerals

Calcium requirements are more to meet the need for skeletal development. They need to take 2-3 glasses of milk. Iron requirement is further increased by rise in the haemoglobin concentration.

Vitamins

Vitamin-A requirements of children is 600µg. Vitamin-C requirements are 40mg. Vitamin B complex requirements increase with calorie needs. The RDA of vitamins A and C are same as adult RDA.

Table 10 Balanced diet for School Going Children

Food groups	g/portion	Quantity(g)		
		7-9 years	10-12 years	
			Boys	Girls
Cereals and millets	30	6	8	10
Pulses	30	2	2	2
Milk (ml)	100	5	5	5
Roots and tubers	100	1	1	1
Green leafy vegetables	100	1	1	1
Other vegetables	100	1	2	2
Fruits	100	1	1	1
Sugar	5	4	6	6
Fats / Oils (visible)	5	6	7	7

Source: Dietary Guidelines for Indians - A manual, National Institute of Nutrition, ICMR, Hyderabad, India (2011)

Food Requirements

A natural increase in appetite is respon-sible for an increase in food consump-tion. Parents should encourage the child to eat appropriate portion sizes, eating a variety of food to meet their nutritional requirements.

Importance of breakfast

Children who skip breakfast do not make up for the nutrition and energy needs and tend to perform poorly in academics(NIN, 2003-2004)

Eating breakfast is a healthy habit.

An ideal breakfast should have all 4 basic food groups.

Dietary Guidelines for School Children

Nutritional requirements should meet their activity, growth and spe-cial requirements during sickness and injury.

Menus should provide dishes that are quick to eat, nutritious and variety is needed.

Weather conditions should also be considered-in hot season more of liq-uid should be included.

Snacky meals should be given at inter-vals which can be easy to handle.

Fruits and dry fruits can be given for snacks.

PACKED LUNCH: GUIDELINES FOR PREPARING NUTRITIOUS PACKED LUNCH FOR SCHOOL CHILDREN

Packed lunch has become a necessity for school children as it is not possible to have lunch at home. Packed lunch is a lunch in a tiffin box to be eaten by the child while away from home.

Points to be considered while planning packed lunches are:

It should meet one third of the day's nutritional requirements.

It should include food from all the four food groups though the number of dishes may be less.

Food stuffs providing good quality protein like egg, milk or milk products like paneer or curd would improve overall protein quality in combination with vegetable protein.

At least one serving of green leafy veg-etables should be included.

One fruit or vegetable salad may be in-cluded every day.

Variety should be present.

Preferably the food packed should be different from that prepared for breakfast.

The dishes should be packed in the right consistency so as to avoid leakage or food becoming dry during lunch which may not be appetising to the child.

Following are two examples of a packed lunch.

Vegetable peas pulao, onion raita, boiled egg, banana.

Vegetable dhal rice, amaranth porial, soya gravy, and butter milk.

NUTRITIONAL REQUIREMENTS DURING ADOLESCENCE

Adolescents is the period between child-hood and adulthood. It is a period of rapid growth after infancy and it reaches its peak between 11^{th} to 14^{th} years for girls and 13^{th} to 16^{th} years for boys. Adolescence require more food for the following reasons:

a. this period (teenage) is spread almost over a decade,

b. it is characterized by rapid increase in height and weight, hormonal changes, sexual maturation and wide swings in emotion,

c. development of critical bone mass is essential during this period as this forms the ground for maintain-ing mineral integrity of the bone in later life,

d. the pattern and proportion of var-ious body components like body water, muscle mass, bone and fat increase during the entire child-hood and adolescence to reach adult values by about 18 years.

Adolescent girls are at greater physiological stress than boys because of menstruation. Their nutritional needs are of particular importance as they have to prepare for motherhood.

Nutritional Needs of Adolescents

Good nutrition is critical during the teen-age years to ensure healthy growth and development. A healthy diet must meet the changing nutritional needs of a grow-ing teenager.

Energy

Calorie needs is influenced by activ-ity level, basal metabolic rate, increased requirements to support pubertal growth, development and energy expenditure. The energy requirements for boys are more than that of girls.

Protein

Protein needs of adolescents are influ-enced by the amount of protein required for maintenance of existing lean body mass and accrual of additional lean body mass during the adolescent growth spurt. When protein intakes are consistently inadequate, reductions in linear growth, delays in sexual maturation and reduced accumulation of lean body mass may be seen.

Fat and Essential Fatty Acids

The human body requires dietary fat and essential fatty acids for normal growth and development. The intakes of total fat and saturated fat should not exceed RDA.

Calcium

Calcium needs during adolescence are greater than they are in either childhood or adulthood because of the dramatic increase in skeletal growth. Milk provides the greatest amount of calcium in the diets of adolescents.Ragi, green leafy vegeta-bles, milk and milk products are excellent sources of calcium.

Iron

Iron is vital for transporting oxygen in the bloodstream and for preventing anaemia. For both male and female adolescents, the need for iron increases with rapid growth and the expansion of blood volume and muscle mass. The onset of menstruation imposes additional iron needs for girls.

Zinc

Zinc is important in adolescence because of its role in growth and sexual matura-tion. Males who are zinc deficient expe-rience growth failure and delayed sexual development.

Vitamins

Vitamin A is important for normal vision and plays a vital role in reproduction, growth, and immune function. The most obvious symptom of inadequate vitamin A consumption is vision impairment, espe-cially night blindness. The low intake of fruits, vegetables and milk and dairy prod-ucts by adolescents contributes to their less than optimal intake of vitamin A.

Vitamin E is well known for its anti-oxidant properties, which become increas-ingly important as body mass expands dur-ing adolescence. Fortified breakfast cereals and nuts are good sources of vitamin E. Vitamin C is involved in the synthesis of collagen and other connective tissues

Fibre

Dietary fibre is important for normal bowel function, and plays a role in the prevention of chronic diseases, such as certain cancers, coronary artery disease, and type 2 diabe-tes mellitus and reduces the risk of obe-sity. Increased intake of fruit, vegetables, and whole grains increases the fibre intake. Adolescents who skip breakfast or do not routinely consume whole grain cereals are at high risk for having an inadequate con-sumption of fibre.

Table 11 Balanced Diet for Adolescents (Number of portions)

Food groups	g/Portion	10-12 Years		13-15 Years		16-18 Years	
		Girls	Boys	Girls	Boys	Girls	Boys
Cereals & millets	30	8	10	11	14	11	15
Pulses	30	2	2	2	2.5	2.5	3
Milk & its products	100	5	5	5	5	5	5
Roots & tubers	100	1	1	1	1.5	2	2
Green leafy veg.	100	1	1	1	1	1	1
Other vegetables	100	2	2	2	2	2	2
Fruits	100	1	1	1	1	1	1
Sugar	5	6	6	5	4	5	6
Fat/oil (visible)	5	7	7	8	9	7	10

Source: Dietary Guidelines for Indians, National Institute of Nutrition, Hyderabad, 2011.

Dietary Guidelines for Adolescents

Diet in adolescents is very significant because it influences the nutritional status later in life.
– Adequate well balanced nutritious food should be taken to prevent obesity or under nutrition.

– An adolescent girl should take enough calcium rich foods in her diet to increase bone density anddelay the onset of osteoporosis.

– Should not miss breakfast.

– Junk food should be avoided.

– Avoid empty calorie foods such as carbonated beverages.

– Iron rich foods may be included in the diet to prevent anaemia.

– Calorie and protein rich foods should be taken to support the growth spurt.

– Include fruits and vegetables in the diet to meet the vitamin, mineral and fibre requirement.

– Home based diets are best for chil-dren’s growth.

– Adolescents need to be encouraged to do physical activity particularly outdoor games. Physical activity regulates appetite.

Nutrition Related Problems

Acne Vulgaris

Anaemia

Obesity

Eating Disorders

a. Anorexia Nervosa

b. Bulimia Nervosa

c. Binge Eating Disorder

Predisposition to Osteoporosis

NUTRITIONAL NEEDS OF ADULTS

When an individual reaches adulthood, body growth especially in terms of height and body status stop to a certain extent, but tissue breakdown and repair of body tissues continue even among adults. Therefore adequate amount of essential nutrients need to be provided for main-tenance of physical and mental health in adults.

Energy-Kilocalories

There is a gradual loss of functioning body cells and reduced physical activity so adults generally require less energy intake as they grow older. The basic fuels required to supply these energy needs are primarily carbohydrates with moderate fat.

Protein

The RDA for an adult necessities a protein intake of 0.8g/kg of body weight making the total protein. This amount of protein provides about 13-15% of the total calorie.

Carbohydrates

About 50-60% of the total diet calories should come from carbohydrate foods, with the majority being mostly complex carbohydrates such as starches. Easily absorbed sugars may also be used for immediate energy.

Fat

It provides a back-up energy source. Sufficient fat makes food taste better, aids appetite and provides needed kcal to pre-vent excessive weight loss.

Calcium and Phosphorus

In adults, calcium is required for replac-ing calcium lost from body through urine, feces, sweat and bile. Of the dietary calcium only 20-30% is absorbed and this is facilitated by vitamin D. A desirable intake of phosphorus is recommended. The elemental Ca:P ratio in the diet should be maintained at 1:1.

Iron

The loss of iron through sweat, gastroin-testinal tract and urine is estimated to be 14 mg/kg body weight. Apart from this women have additional loss due to men-struation. Thus the iron requirements for women are more than men.

Vitamins

Studies have revealed that 600 mg of reti-nol daily would be sufficient to maintain a normal serum vitamin A level. The requirement for B Vitamins is based on calorie intake. Requirement of folic acid among Indians is 200µg.A daily intake of 20 mg vitamin C is sufficient to main-tain ascorbic acid status. Since 50 percent vitamin C is lost during cooking 40 mg of vitamin C per day is recommended.

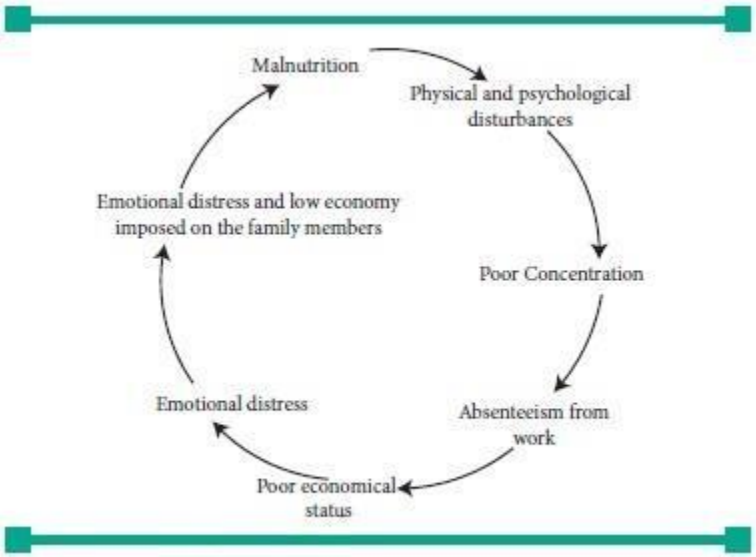
Table 12 Balanced Diet for Adults - Sedentary/ Moderate/ Heavy Activity

S. No	Food Groups	Portion g/Day	Activity					
			Sedentary		Moderate		Heavy	
			Man	Women	Man	Women	Man	Women
			Number Of Portions					
1.	Cereals And Millets	30	12.5	9	15	11	20	16
2.	Pules	30	2.5	2	3	2.5	4	3
3.	Milk	100ml	3	3	3	3	3	3
4.	Roots And Tubers	100	2	2	2	2	2	2
5.	Green Leafy Vegetables	100	1	1	1	1	1	1
6.	Other Vegetables	100	2	2	2	2	2	2
7.	Fruits	100	1	1	1	1	1	1
8.	Sugar	5	4	4	6	6	11	9
9.	Fats/ Oil Visible	5	5	4	6	5	8	6

Source: Dietary Guidelines for Indians A Manual, NIN, Hyderabad (2011).

- **Nutritional Problems for an Adult**
  Osteoporosis
  Anemia
  Chronic Disease
  Diabetes Mellitus
  Underweight
  Coronary Heart Disease (CHD)
  Poor Nutritional Status

  Many of the health problems of older adults are not only due to general aging but also due to states of malnutrition.



▲ Fig. 6.4 Malnutrition

Nutritional Needs and Challenges During Old Age

Individuals above the age of 60 years con-stitute the elderly.

NUTRITIONAL NEEDS AND CHALLENGES DURING OLD AGE

Individuals above the age of 60 years con-stitute the elderly. Health and well-being of the elderly is given more importance and has paved way for a specific field of study called “Geriatric Nutrition”.

Aging

Aging is an irreversible biochemical change that occurs throughout an individual’s life cycle and continues until death. In old age, the nutritional status is determined by the state of nutrition of an individual’s cell. Conditions like dietary deficiency, improper digestion and absorption, insuf-ficient distribution of nutrients, accumula-tion of excess waste products lead to poor nourishment of cells.

Table 14 A Balanced Vegetarian Diet For Pregnant and Lactating Mother Doing Sedentary Work

S.No	Food group	Pregnant mother Quantity (g)	Lactating mother Quantity (g)
1	Cereals millets	300	330
2	Pulses	60	90
3	Milk(ml)	500	500
4	Roots and tubers	100	100
5	Green leafy vegetable	150	150
6	Other vegetable	100	100
7	Fruit	200	200
8	Sugar	20	20
9	Fats and oil(visible)	30	30

Source: Dietary Guidelines for Indians - A manual, NationalInstitute of Nutrition, ICMR, Hyderabad, India, (1999)

With increasing age, cell function-ing is slowed down and their response to hormones and synthesis of enzymes decreases. These changes are associated with a decrease in the number of function-ing cells. Since the cells are interdepend-ent, if one cell dies, others of the same or different organ lose their ability to func-tion resulting in malfunctioning of the organ. This in turn gradually affects the total body functioning leading to death.

NUTRITIONAL NEEDS DURING OLD AGE

Energy

The calorie intake should be adjusted to maintain weight. The energy requirement decreases due to the following reasons:

Decreased physical activity

Reduction in lean body mass and increase in adipose tissue

Decrease in resting metabolic rate by 15-20 percent due to changes in body composition and physical inactivity

Protein

The protein requirements do not change during old age. It is the same as adults i.e. 1g/kg of body weight.

Carbohydrate

Since the calorie requirement is reduced, the carbohydrate content should also be proportionately reduced. Due to impaired glucose tolerance and gastro-intestinal disturbances like constipation, emphasis should be on taking complex carbohydrates.

Fat

The fat requirements are also reduced, corresponding to the energy require-ments. The intake of saturated fats and cholesterol should be less and unsaturated fat should be used in cooking.

Minerals

Calcium needs increases during old age due to increasing mobilization of calcium from bones and incidence of osteoporosis. During old age 1000mg of calcium is rec-ommended per day because of the follow-ing reasons.

Limited availability of calcium from foods

To compensate age related bone loss and to improve calcium balance

To prevent fractures and tooth decay

To compensate decreased efficiency of calcium absorption

Aging does not affect iron needs. Hence iron needs are same as that for adults. Mild anaemia may affect the health of old people due to inefficient circulation. Therefore iron intake should be adequate during old age.

Vitamins

Vitamin A requirements remain the same i.e., 600 μg of retinol. Inadequate expo-sure to sunshine may affect vitamin D lev-els. The antioxidant vitamins such as vita-min E, carotenoids and vitamin C have been identified to promote health of the elderly. Vitamin B6 requirements are also increased due to gastritis which interferes with absorption.

Besides these various nutrients, water should be consumed in plenty as such or as fluids like buttermilk, fruit juice and soups. Intake of sufficient fluids reduces the load on kidneys and relieves from con-stipation by stimulating peristalsis.

Table 15 Sample Menu

Time	Food Items
Early morning	Milk/tea/coffee
Morning	Idli/dosa Tomato chutney or vegetable sambar Fruit-1 slice
Mid-morning	Butter milk/soups/boiled eggs/ fruit salads
Lunch	Rice, sambhar, greens kootu, vegetable poriyal
Evening	Fruit yogurt/boiled sundal/custard
Dinner	Idiyappam/ idly/ dosa,vegetable stew/dhal,fruit.
Bedtime	Milk

Nutrition Related Problems of Elderly

The elderly are at risk of poor nutrition due to economic pressure, poor dentition, aging tissues and inadequate diet, which may be compounded with the incidence of chronic disease. The commonly preva-lent nutrition related problems among the aged include:

Osteoporosis

Obesity

Anaemia

Malnutrition

Constipation

Diabetes Mellitus

Cardiovascular disease

Iron deficiency anemia is a serious public health problem throughout Central America, Like in India, Rice a staple food in Central America. It is typically pol-ished and rarely iron-fortified.

DIETARY MODIFICATION DURING OLD AGE

Table 16 Modification of Diet For Elderly

Dietary modifications	Reasons
Foods must be soft and easily chewable	Problems of dentition -fallen teeth or dentures
Foods should be easily digestible	Decreased production of digestive enzymes
Restricted fat in diet, inclusion of Poly unsaturated fatty acid (PUFA)	Susceptible to heart diseases
Foods rich in fibre should be given	To prevent constipation, reduce cholesterol levels. Also to prevent colon cancer
Coffee, tea, cold beverages should be restricted	May result in insomnia
Foods rich in calcium such as is milk should be given	To compensate bone loss and prevent osteoporosis
Green leafy vegetables can be given liberally	Source of nutrients like: iron riboflavin, folic acid, vitamin c, antioxidants, carotene, and fibre
Familiar foods should be included (others difficult to digest) New foods are difficult to accept	Unfamiliar or changes in the food pattern- may lead to Psychological problems-depression and anxiety
Clear soup can be given at the beginning of the meal	Aids digestion
Small and frequent meals should be given instead of 3 heavy meals	Favours complete digestion, prevents distress
Glass of milk can be given before sleep	Induces sleep
Heavy meal-lunch Light meal-dinner	Sleep is less likely to be disturbed
Too many sweets with lots of fats and sugar should be avoided	Too much of sugar may cause fermentation, discomfort-due to indigestion and causes tooth ache and increases cholesterol level. May lead to obesity
Plenty of fluids	To prevent constipation and dehydration