Basic Components of Food

Dr Suman Ahuja

Associate Professor

Department of Kriyasharir

1. The knowledge of food and nutrition has a direct bearing on the maintenance of sound health of an individual. Food is a complex mixture of various substances which help:

(i) the production of heat and energy for body work and activities;

(ii) the growth, repair and maintenance of body tissues;

(iii) the digestive system to work well.

2. Nutrition is a dynamic process in which the food that is consumed is digested, its nutrients are absorbed and finally distributed to all body tissue for proper utilization.

- **3. Essentials of a diet**

(i) An adequate diet has an energy value sufficient to provide for:

(a) the requirements of the basal metabolism

(b) the stimulating action of the food-stuffs, and

(c) the need of varying degrees of muscular work.

(ii) It must have adequate amount of the constituents of normal diet, all in suitable proportions.

(iii) Adequate additional provision must be made for children, requirements of menstruation, pregnancy, lactation, illness and old age.

- **CONSTITUENTS OF A NORMAL DIET**
- The dietary constituents of food are: proteins, fats, carbohydrates, vitamins, minerals, dietary fibre and water. Most of the foods contain all these constituents but in varying proportion.
- Food can be classified on the basis of their predominant function as:
  I. Energy yielding foods: These foods are rich in carbohydrates and fat, e.g., cereals, sugars, oil.

2. Body building foods: These foods are rich in proteins, e.g. milk and its products, pulses, meat, etc.

3. Protective foods: These foods are rich in proteins, vitamins and minerals, e.g., milk, egg, green leafy vegetables, fruits etc.

A. PROTEINS

- Complex organic nitrogenous compounds.
- Indispensable constituents of the diet because they are the only source of the amino acids including the essential amino-acids; these are: valine, lysine, leucine, isoleucine, phenylalanine, methionine, threonine, tryptophan, histidine and arginine
- **Functions**

1. Build up new tissues during the period of growth or pregnancy and lactation;

2. Are essential for repair and maintenance of worn out body tissues;

3. Provides the raw material for the synthesis of certain substances e.g., antibodies, haemoglobin, enzymes, hormones and plasma proteins;

4. Provide 10-15% of the energy during emergencies e.g., starvation, inadequate food intake.

- **Sources**

(i) Animal sources: milk and milk products, eggs, meat, fish etc.

(ii) Plant sources: pulses, cereals, dry frujts, nuts, beans, etc.

High biological value proteins(Grade I or first class proteins)

Proteins of animal tissues closely resemble those of human tissues in their amino acid composition and they can be employed more economically for repair and growth; thus, are called proteins of high biological value proteins.

Low biological value proteins(Grade II or second class proteins)

proteins of vegetable foods frequently have a very different type of amino-acid pattern and cannot be employed so economically built up into human tissues; such proteins are, therefore, called proteins of low biological value proteins.

- **Daily requirements**

1.0 gram/kg body weight for an adult, some of it in the form of animal protein.

1.5-2gm/kg body weight in: debiliating diseases; children and in pregnant and lactating women.

B. FATS

Fats are composed of fatty acids and contain carbon, hydrogen and oxygen. They are concentrated sources of energy. 1 gm of fat yields approx. 9 kcal of energy.

Functions

1. Improve the palatabilitv i.e., flavour and taste of food.
2. Are essential for absorption of fat soluble vitamins such as Vitamins A, D, E and K.
3. Provide support to body internal vital organs such as heart, kidneys, lungs, brain and liver.
4. Stored fats beneath the skin provides insulation, against cold i.e., prevents heat loss from the body.
5. Provide Essential Fatty Acids (EPA) which help in growth promotion, maintenance of skin integrity and reduce blood cholesterol. ('EFA' are: linoleic acid; linolenic acid and arachidonic acid.)

- **Sources**
- **(i) Animal sources:** ghee, butter, fish, oils. In general, they are poor sources of essential fatty acids but are good sources of retinol and cholecalciferol (vitamins A and D respectively).
- **(ii) Plant sources:** groundnut, mustard, cotton seed, rape seed and coconut oil. These are all rich sources of essential fatty acids.
- **Vanaspati oil/ghee (e.g., Dalda, Rath, etc.)**
- When vegetable oils are hydrogenated, the liquid oils are converted into semi-solid and solid fat, known as vanaspati oil/ghee . The disadvantage of hydrogenation is that the content of the valuable 'essential fatty acids' present in vegetable oils is drastically reduced.
- **Refined oils**
- When natural fats are treated with steam, alkalies etc., the free fatty acid, and rancid material present in oils are removed, the process is known as 'refining' and Refined oils are produced. Refining improves the quality and taste of oil. Refined oils are free from odour and colour and are as safe as raw oils.
- **Daily requirements**
- The fat should provide at least 20% of the total energy in a day. This could come to 10-20 grams of fat per day. Young children need 25% extra amount of fats.

- **C. CARBOHYDRATES**
- Carbohydrates form the main bulk of diet and are the chief source of energy. They are also essential for the oxidation of fats and for the synthesis of certain non-essential amino acids. They are a cheap and readily obtainable food.
- **Sources**
- **(i)** Starches: these are 'complete sugar', present in abundance in cereals and millets, roots and tubers.
- **(ii)** Sugars:
- **(a)** monosaccharides e.g. glucose, fructose, galactose,
- **(b)** disaccharides e.g., sucrose, lactose and maltose.
- **(iii)** Cellulose or dietary fibre: This is the fibrous substance lining fruits, vegetables and cereals. It is the indigestible component of carbohydrate with hardly any nutritive value.

- **Dailv requirements**
- Carbohydrate intake should be in the range of 300-500gm (between 50% to 70% of total energy intake). It should be sufficient to prevent the need for protein breakdown to provide energy.

D. VITAMINS

- **Characteristic features**
- **1.** Vitamins are complex chemical organic substances of high biological activity, required by the body in very small amounts in normal metabolism and act as a catalyst in various body processes.
- **2.** They cannot be manufactured in the body in sufficient amounts, therefore, they have to be supplied through the diet
- 3. Vitamins are divided into two major groups as: (i) Fat soluble vitamins - Vitamins A, D, E and K; and (ii) Water soluble vitamins - Vitamins of B group (vitamin B-complex) and Vitamin C.

- **4.** Deficiency of a vitamin can arise in two ways:
- (i) primary deficiency, due to inadequate intake of vitamin or its precursor over a prolonged period of time; or
- (ii) conditioned deficiency, arising on an adequate diet through other factors which decrease absorption or prevent release, or increase utilization or excretion.
- **5** (i) Vitamin B-complex group consists of a series of water soluble organic substances which are found in all cells (the important ones are: thiamine (B1), Riboflavin (B2), Niacin (B4), Pyridoxine (B6) Pantothenic acid, Biotin, folic acid and cyanocobalamin (B12).
- (ii) They are involved in the oxidation of the foodstuffs, and are, therefore, indispensable for the normal functioning of all tissues.
- (iii) Most members of this group of vitamin can be synthesized by the intestinal bacteria.

- **1. Vitamin A Infants 300-400 µg (Retinol)**
- **Daily Requirements**
- Infants 300-400 µg (Retinol), Adults 750 µg; Children 400--600 µg; Pregnancy 750+400µg; Lactation 750+400 µg (one I.U. of Vitamin A= 0.3 µg of Retinol).
- **Sources**
- Yellow vegetables and fruits (carrots, pumpkin, mangoes, papaya, bananas, liver, egg yolk, ghee, cheese, milk and its products, eggs, fish liver oil.
- **Function/Action**

1. Constituents of visual pigment which helps in normal vision.
2. Maintains epithelial cells of skin and mucous membrane.
3. Associated with growth especially regulates skeletal growth.
4. Protects body against infections.

- **Deficiency Symptoms**

1. Resistance to infection decreases.

2. Dry Scaly Skin (Toad skin)

3. Night blindness i.e., inability to see in dim light.

4. Xerophthalmia (dry eye) characterized by

(i) dry conjunctiva.

(ii) Bitot's Spots (greyish, rough and raised patches on conjunctiva).

(iii) Cornea becomes dry, hazy like ground glass with ulceration.

(iv) Keratomalacia (softening of a part or whole of the cornea)

- **Prevention and control of deficiency**

l. Diet improvement regular intake of green leafy vegetables.

2. Oral administration of 200,000 I.U. of vitamin A drops every 6 months to pre-school children.

- **2. Vitamin D, Cholecalciferol; (antirachitic vitamin)**
- **Daily Requirements**
- Infants and children 10 µg; adults 7.5 µg; lactation 15 µg (1 µg of cholecalciferol = 40 I.U. of vitamin D)
- **Sources**
- Fish, liver, fish liver oils, eggs, butter, milk and its products; generated in the skin by actions of UV rays of sunlight
- **Function/Action**

1. Increases intestinal absorption of calcium and phosphate.
2. Mineralization of bones and teeth

Deficiency Symptoms

- Rickets in children and Osteomalacia in adults.
- Rickets is characterised by bony deformities in growing children. Osteomalacia is characterized by generalized body pain especially over bones.

Prevention and control of deficiency

1. Infants and children arc exposed to the sun under appropriate conditions.
2. Prophylaxis vitamin D supplements during first two years of life.

- **Vitamin E (Anti-sterility vitamin)**

Daily Requirements

- 15 I.U. (= 10 mg) for normal adults.

Sources

Milk, oils, eggs, meat, leafy vegetables.

Function/Action

1. Antioxidant.
2. Cofactors in electron transport in cytochrome chain.

Deficiency Symptoms

Sterility, muscles wasting and Ataxia, foetal death, testicular degeneration and haemolysis of red blood cells in animals.

Prevention and control of deficiency

Widely distributed in foods, therefore, no deficiency symptoms are produced in humans.

Vitamin K (Anti- haemorrhagic vitamin)

Daily Requirements

- Average diet combined with that formed by intestinal bacteria (approx. 30 µgm)

Sources

- Green leafy vegetables, cereals, fruits; synthesized by bacteria in GIT.

Function/Action

Catalyzes gamma-carboxylation of glutamic acid to activate clotting factors especially prothrombin.

Deficiency Symptoms

Marked prolongation in blood clotting time leading to generalised bleeding tendencies.

Prevention and control of deficiency

Administration of single oral dose of vitamin K to premature infants

- **E. MINERALS**

1. The body contains some 50 minerals which serve specific functions in the body. The mineral constituents of the body amount to 4.3-4.4%, largely in the skeleton.

2. The important minerals include : Calcium, phosphorus, iron, sodium, potassium and magnesium.

3. Some minerals are required by the body in very small amounts e.g., iodine, zinc, manganese, copper, cobalt and fluorine. They form a part of every cell and fluid in the body and are required for growth, repair and regulation of vital body functions. For example:

(i) Zinc is present in insulin and in many enzymes; its deficiency causes skin ulcers, depresses immune response and hypogonadal dwarfism.

(ii) Copper occurs in blood combined with an alpha-globulin, forming the protein ceruloplasmin; its deficiency causes anaemia, changes in ossification and increases S.cholesterol.

(iii) Manganese is required in many enzyme systems.

- **4.** Conversely, some minerals produce toxicity when present in the body in excess e.g., iron overload causes haemochromatosis; copper excess causes brain damage.

F. DIETARY FIBRE

- The carbohydrates (e.g., pectin, cellulose, hemicellulose) and some non-carbohydrate substances (e.g., lignin) are collectively called dietary fibre .
- It resists digestion and is found in vegetables, fruits and grains. The fibre absorbs water, which increases the bulk of the intestinal contents and facilitates intestinal movements and thus the defecation.
- Fibres also have a role in weight reduction and cholesterol lowering. Its deficiency leads to constipation, cancer of colon, colonic diverticulosis, heart disease and gall bladder stones.

- The most practical way of including sufficient fibre in diet are:
- (i) Whole cereals should be preferred to refined cereals.
- (ii) Whole pulses should be preferred to those from which the husk has been removed.
- (iii) Fruits and vegetables that can be eaten with the skin intact should be eaten as such.
- **G. WATER**
- Water is an essential requirement for life. It is the medium in which most of the chemical activities in the body take place.
- Loss of water upto 10% of total body water, makes a person feel extremely tired and fatigued.
- More than 20% loss may result in death.
- Water occurs in all natural food, most of it comes from that we drink.

- **NUTRITIONAL NEEDS OF THE BODY IN TERMS OF CALORIES**

I. The physiological calorie value of food for different nutrients is:

Carbohydrate (sugar, starch) : 4 kcal/gm

Protein (mixed) : 4 kcal/gm 4 kcal/ gm

Fat : 9 kcal/ gm

(1 kcal = 4.2 kj)

2. There are wide variations in individual calories requirements even among persons living under similar conditions. The total calories requirements for Indian at 'rest' (i.e. under complete physical and mental rest called Basal Metabolic Rate - BMR) as given by ICMR (Indian Council of Medical Research) are:

(i) for men 38-40 kcal/ hour/ m2 BSA= 1500-2000 kcal/ day

(ii) for women : 33-35 kcal/ hour/ m2 BSA= 1200-1500 kcal/ day.

- 3. Factors affecting calories requirement:
- (i) Age
- (a) Infants require about 750 kcal/ day during first 3 months of life, rising to 1000 kcal/ day at 10-12 months.
- (b) Children and young adults grow very fast and thus the following calories requirements have been proposed.

Age (years)	kcal/day
1-3	1500
4-6	1800
7-9	2200
10-12	2700
13-15	3100
16-20	3500

(c) Old age - with advancing age the BMR falls, and the amount of physical activity decreases, therefore, calories requirement decreases.

- (ii) Sex: Recommended daily requirements of calories of a woman are about 20% lower than those of a man of the same age.
- (iii) Body size and weight: Both BMR and the calories requirements of mechanical work are directly proportional to the body weight.
- (iv) Physical activity: Daily calories requirement increases with the type of physical activity

Table 68.2: Calories requirements of physical activity

Work level	Additional calories requirements
1. 'Light' work, such as most domestic work	10%
2. 'Moderate' work, such as gardening, tennis, cycling, carpentry etc.	20%
3. 'Heavy' work, such as coal mining, loading, football, athletics, etc.	30%
4. 'Very heavy' work, such as, black-smith work, swimming, hill climbing etc.	40%

- (v) Climate
- (a) People eat less where the environmental temperature exceeds 25°C, the energy intake should be reduced by 5-10%.
- (b) In cold climate, the calories requirements should be increased by only 3% for every 10°C of mean external temperature below the reference temperature since protection against cold is achieved by clothing and by heating.
- (vi) Specific dynamic action (SDA) of food - The SDA of a food is the obligatory energy expenditure that occurs during its assimilation into the body. Maximum heat production is seen after ingestion of proteins.
- (vii) thyroid hormones – high levels of thyroid hormones increase the BMR thus increase calorie requirement.

- **BALANCED DIET**
- A diet which contains different types of food in such quantities and proportions that the need for energy, proteins, fats, carbohydrates, vitamins and minerals is adequately met for maintaining health, is called balanced diet.

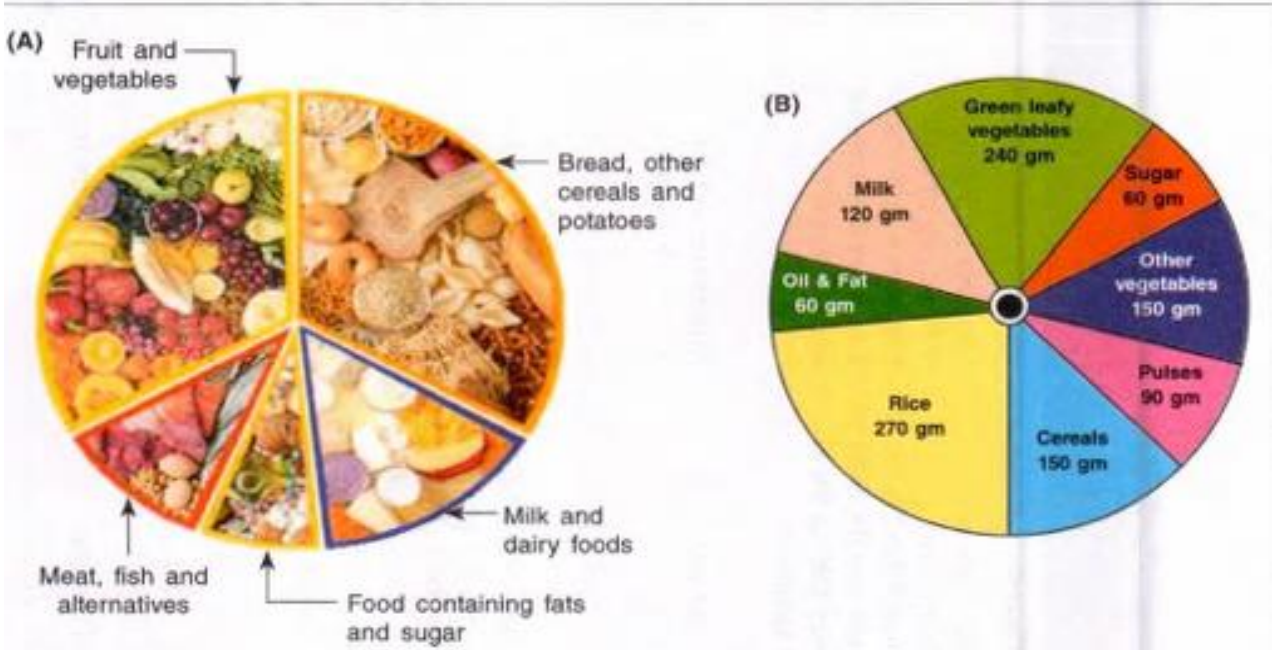

Fig. 68.6 Daily requirements of different types of food in an adult (A and B)

- If the diet is deficient in any of these nutrients, malnutrition results and individual might suffer from physical and mental growth retardation.
- To stay healthy and strong, a person should eat food that provides adequate amounts (neither too little nor too much) of various nutrients according to nutritional requirements.
- Balanced diet requirements are closely related to age, sex, body build, occupation of the individual and in pregnant and lactating women.
- Balanced diets formulated by the ICMR are recommended by adopting universally energy requirements of an Indian reference man and woman. An Indian reference man is an apparently healthy individual between 20-39 years of age, weighing 55 kg. with body surface area 1.62 sq. metres, whereas a reference woman weighs 45kg with body surface area 1.40 sq. metres.

Table 68.3: Balanced diets according to Age and Sex (all values in grams) (Source: ICMR)

Food item	Children (either sex)			Reference man	Reference woman
	1-3 years	4-6 years	10-12 years		
1. Cereals	175	270	420	460	410
2. Pulses	35	35	45	40	40
3. Leafy vegetables	40	50	50	40	100
4. Other vegetables	20	30	50	60	40
5. Roots and tubers	10	10	30	50	50
6. Milk and milk products	300	250	250	150	100
7. Oil and fat	15	25	40	40	20
8. Sugar and jaggery	30	40	45	30	20

Notes

1. An additional of 10% allowances during 'pregnancy' or during 'light work' have been recommended.
2. An additional of 20% allowances during 'lactation' or during (moderate work) have been recommended.
3. An additional of 30% allowances during 'heavy work' have been recommended.

- **PRINCIPLES OF DIET PLANNING**
- No food is perfect though most foods contain more than one nutrient. In general, a mixed diet consisting of foodstuff from different food groups is likely to be adequate in protein, vitamins and minerals, if it is adequate as regards energy needs.
- In formulating diet for any individual, the following broad principles should be adopted:

1. It should be a 'fibre' rich balanced diet and must provide the required recommended daily calories.

2. Of the total calories requirements, at least 50% should be provided by carbohydrate; 25-30% from proteins and 20-25% from fats.

3. Cost of the diet should be reasonably low.

4. The diet should be such that it can be prepared easily.

5. As far as possible, locally and seasonally available foods should be used; this will reduce the cost of the diet.

6. The menu should be frequently changed to avoid monotony.

- **APPLIED ASPECT**

A. DEFICIENCY DISEASES

- Health is affected not only by diseases but also by an unbalanced food.
- A balanced diet is necessary for good health. Inadequate amount of food leads to insufficient nutrition.
- The condition coming out of this is called Malnutrition or Undernutrition.
- Malnutrition is more marked in vulnerable sections of the population i.e., pregnant women, nursing mothers, infants and children, especially in lower and middle classes.

Diseases due to Energy Deficiency

- It leads to so called Protein Energy Malnutrition (PEM). The term 'PEM' is misnomer because protein deficiency alone is very uncommon. The real deficiency is that of food energy which is measured in terms of 'calorie'. PEM is, therefore, referred to as Protein Calorie Malnutrition (PCM).
- Protein calorie (energy) malnutrition is the commonest form of malnutrition in India.
- Infants and young children between 1 to 3 years of age are the most frequent sufferers.
- It may lead to permanent mental and physical disabilities in children who survive.
- The most serious forms of PCM are **Kwashiorkor and Marasmus.**

Table 68.4: The main differentiating characteristic features of two forms of PCM

Principal Features	Kwashiorkor	Marasmus
1. Major causative factor	Gross protein deficiency	Severe calorie malnutrition
2. Weight as percentage of normal	60% to 80%	Below 60%
3. Oedema	Present all over the body	Absent
4. Muscular wasting	Occasionally seen	Severe
5. Growth retardation (physical and mental)	Less	Severe
6. Appetite	Poor	Usually good
7. Skin changes	Depigmentation of skin all over the body	Loose with loss of elasticity
8. Hair	Sparse, straight, greyish or reddish	Brittle (fragile)
9. Face	Swollen, *moon like face*	Small sunken; *monkey like face*
10. Diarrhoea	Often present	May be present
11. Anaemia	Present	May be present
12. Liver enlargement	Frequent, secondary to 'fatty liver'	Absent
13. Occurrence and outcome	Less common occurrence with serious outcome, may be fatal	Common occurrence with less serious outcome

Kwashiorkor

Marasmus

The major causative factors of PCM

- 1. An inadequate diet, both in quantity and quality; primarily due to poverty.
- 2. Infectious and pai-asitic diseases such as repeated diarrhoea and chest infections, worms infestation, measles.
- 3. Poor environmental conditions.
- 4. Adverse cultural practices like premature termination of breast feeding; use of over-diluted milk; late weaning of the child.

Preventive Measures

1.Health promotion/ health education.

- (i) promotion of breast feeding and correct feeding practices;
- (ii) better mother health care during pregnancy;
- (iii) family planning and spacing of births.

2. Provision of specific protection (immunization) against infectious diseases.

3. Early detection and treatment of diarrhoea, chest infections and PCM.

4. Rehabilitation of the sufferers by providing fo!Jow-up care.

- **B. UNDERNUTRITION AND STARVATION**

Undernutrition and starvation lead to wasting of the body with marked loss of adipose tissue and of muscle.

Causes

1. Insufficient food in the diet.
2. Severe disease of the GIT such as malabsorption syndrome. This prevents absorption of nutrients even if the dietary supply is adequate.
3. Infection and toxaemias. They reduce appetite or interfere with normal metabolism.

- **Body changes**
- During starvation, even if no physical work is being done, approx. 1500 kcal will be needed daily.
- During the first few days the glycogen stores of the liver are called upon. The main source of energy is the fat reserves and tissue proteins. So as long as fat is available tissue protein is 'spared’.
- Death occurs after about 4 weeks, when the body weight is reduced by 50%.
- The major effects of undernutrition and starvation on the body are:

1. Blood sugar - this is maintained at a 'steady state' level almost to the end. It is formed in the liver from amino acid residues, glycerol (from fats) and lactic acid (from partial catabolism of muscle glycogen).

- **2. Body fat**
- (i) The neutral fats (triglycerides) which are found in adipose tissue are used in starvation. The increased breakdown of fat in the adipose tissue depots releases free fatty acids (FFA) which can provide energy for m uscuJar contraction and thus help to conserve the blood glucose for the brain which cannot utilize FFA.
- (ii) The mobilized FFA are taken to the liver, where it is either completely catabolised or transformed into ketone bodies. The 'complex lipid' which forms part of the cell structure is spared till the end.
- (iii) Owing to the lack of carbohydrate, ketogenesis is stimulated and ketone bodies pass into the blood from the liver faster than they are disposed off by the tissues. There is thus a ketosis and ketone bodies appear in the urine

- **3. Tissue protein**
- (i) Tissue protein is hydrolyzed to amino acid. The increased breakdown of 'endogenous' protein occurs chiefly in the muscles and glands; the brain and heart lose only 3% of their bulk; muscle, liver and spleen lose 30, 55 and 70% respectively. This is controlled through the action of adrenal cortex.
- (ii) The amino acids which enter the 'common pool' serve:
- (a) to maintain the structure and so functional efficiency of the essential organs;
- (b) to preserve the normal blood sugar level; the conversion of amino acids to sugar occurs in the liver.
- **4. Water**
- Intracellular water is decreased but extracellular water is not correspondingly reduced so that a relative excess accumulates, producing oedema.

- **5. Failure of hormone and enzyme production**
- Many of the body's hormones and all enzymes are proteins (except Ribozyme). Therefore, during prolonged starvation the synthesis of protein hormones and enzymes is reduced causing:
- (i) delayed puberty and amenorrhoea in girls;
- (ii) loss of libido and impotence in males;
- (iii) marked atrophy of the thyroid gland due to reduced secretion of 'thyrotropic' hormone;
- (iv) diarrhoea due to reduced formation of digestive enzymes.

- **6. CVS**

(i) The marked bradycardia due to thyroid deficiency;

(ii) peripheral blood flow and venous pressure and systemic arterial B.P. are reduced.

- **7. Metabolic rate -** the BMR is reduced, partly due to smaller mass of active tissues and partly due to thyroid deficiency. Thus, energy amounting to about 400 kcal is saved daily.
- **8. Hunger**

In 'semi-starved' people, the hunger sensation becomes progressively increased (strong contractions of the empty stomach give rise to a sense of hunger - 'hunger pains)

THANKS