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NUTRITION

15.1 INTRODUCTION

Nutrition is the requirement of the body from external sources to sustain life. The requirement comprises of foods that provide energy i.e. carbohydrates, fats, proteins, provide the building blocks such as proteins and amino acids or act as the functional molecules such as micro nutrients and vitamins acting as co enzymes and carrier molecules.

OBJECTIVES

After reading this lesson, you will be able to:

- define nutrition. basal metabolic rate
- explain factors affecting basal metabolic rate
- describe the nutritional aspects of carbohydrates proteins and fats
- enumerate the various essential amino acids
- explain the composition of food and what constitutes a balanced diet
- describe the causes, symptoms and treatment of protein energy malnutrition disease such as kwashiorkor and marasmus.

15.2 NUTRITION

As explained earlier nutrition is the requirement of the body from external sources to sustain life. Nutrition consists of intake of food that provides both macro as well as micro nutrients in the correct amount.

A reduced, unbalanced or excessive intake of nutrients can result in various health related problems. A reduced intake can cause deficiency disorders such as vitamin deficiency disorders

i.e scurvy, beri beri etc, or protein energy malnutrition disorders such as kwashiorkor, marasmus. Similarly over nutrition in general or of a certain nutrient can cause various diseases. Excessive intake of Vitamins can cause hypervitaminosis. Excessive intake of calories by any mean can cause obesity and associated disorders such as Diabetes mellitus, cardio vascular disease etc.

Hence we should have a complete knowledge of the nutritional requirement of the human body to prevent these disorders of over and under nutrition.

15.3 BASAL METABOLIC RATE (BMR)

Basal metabolic rate is the energy requirement of the body when the body as well as the brain is at rest i.e. Basal condition. It is the energy requirement of the body for its life sustaining processes such as respiration, circulation, peristalsis, maintenance of body temperature etc. It is expressed in K cal of energy consumed per hour by the person for ever square meter of the body's surface area. Its unit hence is Kcal/ hour/m^2.

BMR is calculated by measuring the consumption of oxygen by a person who is awake but at complete rest and at a comfortable room temperature. The oxygen consumption gives a good approximation of energy metabolism in our body. The oxygen consumption for 10 minutes is measured and then multiplied by 6 to get the oxygen use for an hour. This is done for 24 hours. For each litre of oxygen consumed it is calculated that and approximate amount of 4.825 Kcal of energy is used.

The body surface area can be calculated by the Du Bois formulae:

$$\text{Area } (m^2) = \frac{\{\text{Height (cm)}\ 0.725 \times \text{Weight (kg)}\ 0.425 \times 71.}{10{,}000}$$

Average BMR of an adult male is 40 Kcal / Hr/ sq m.

Average BMR of an Adult female is 36 Kcal/ Hr/ sq m.

BMR is not a static property of the body. It is dependent on various physiological and pathological states.

BMR is higher in 'hypermetabolic' states such as in pregnancy, fever etc. It is also higher in growing age groups such as children and adolescents. Athletes and individuals with higher muscle mass also have significantly higher BMR. So BMR is affected by age, sex, activity level, body mass and various pathological and physiological states.

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15.4 THERMOGENESIS

It is the process of heat production in the body to maintain the body temperature in warm blooded animals. It is done through various methods. Thermogenesis can be done by muscle movements. A proportion of the energy produced to support muscle action is leaked from the electron transport chain and results in thermogenesis. Similarly shivering also results in thermogenesis by this mechanism.

Brown adipose tissue also plays an important role in thermogensis. It has a unique protein that uncouples the electron transport chain resulting in leaking of electrons from the chain. In this case the energy is lost ion form of heat instead of being stored as ATP.

15.5 NUTRITIONAL ASPECTS OF CARBOHYDRATES

Carbohydrates are the most important sources of energy. Even though their calorific value at 4 Kcal/g is less than half of fats they form the chief source of energy in our body because they are easiest to digest also the most abundant and cheap source of energy.

Brain uses glucose exclusively as a source of energy. Almost 20 to 25% of our total energy intake is used by the brain and almost 50% of our carbohydrate intake.

The main forms of carbohydrate that we consume are:

1. **Starch:** It is the form of carbohydrate we consume the most and hence forms the most important source of energy in our body. It is present in all food grains, pulses, tuberous vegetables etc.
2. **Sugars:** Sugar is a term generally used for disaccharides and monosaccharides. They are present in fruits and vegetables in form of glucose, fructose, sucrose. It is also found in milk in form of lactose. Glucose and fructose are examples of naturally occurring monosaccharides. Lactose, Sucrose, Maltose are naturally occurring disaccharides.
3. **Cellulose:** Cellulose is a polysaccharide which is present in the structural elements of plants. It cannot be digested by humans but it plays a very important role as roughage. Roughage provides bulk to our food. The bulk helps in the movement of food through our digestive system and also has a role to play in digestion. It traps water in the large intestine and helps in its absorption.

Carbohydrates have a protein sparing effect which means that when adequate carbohydrates are taken in diet the amino acids in diet are spared from energy metabolism and used for synthesis of proteins in the body.

All carbohydrates required by our body from other sources hence there are no essential amino acids.

15.6 NUTRITIONAL ASPECTS OF LIPIDS

Lipids play many roles in our body. They act as a storage of energy, structural elements of cells and tissues. They act as hormones and vitamins. As a source of energy it has very high calorific value 9kcal/g.

Lipids as a group is composed of hydrophobic non polar organic compounds that are insoluble in water and soluble in organic solvents. They are composed of trigycerides (fats and oils), cholesterol, cholesterol esters.

Lipids can be divided in to saturated, mono unsaturated and poly unsaturated lipids based on the number of double bonds present in the fatty acid. All poly unsaturated fatty acids cannot be synthesized in our body hence certain lipids that have essential fatty acids need to be present in our diet to prevent deficiency disease. Essential fatty acids are alpha-linolenic acid, linoleic acid and arachidonic acid. These essential fatty acids should make up for at least 3% of the energy requirement in adults and 5% to 6% of energy requirements in children. These essential fatty acids are present in plant oils rich in poly unsaturated fatty acids. Fish oil is also a good source of poly unsaturated fatty acids.

Our diet should be rich in poly unsaturated fatty acids and low in saturated fatty acids as saturated fatty acids are linked to atherosclerosis and cardiac disorders.

Lipids also act as carriers of fat soluble vitamins. Certain fats also act as hormones such as steroid hormones.

Cholesterol is also an important component of our diet. It is responsible for the structural integrity of the cell membrane and hence some amount needs to be taken exogenously. The yolk of an egg is a rich source of cholesterol. But excessive cholesterol intake has been linked to atherosclerosis and cardiovascular disorders. The RDA for cholesterol intake in adults and children above four years of age is 300 mg / day.

15.7 NUTRITIONAL ASPECTS OF PROTEINS

Proteins form the main building blocks of our body both functionally and structurally. Almost all of our body is composed of proteins. Our muscles, bones, cartilages, blood vessels, connective tissues, skin, hair, nails etc are all mainly composed of proteins. Apart from these almost all functional elements of our body are also composed of proteins such as the actin myosin involved in

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movement, the enzymes responsible for all metabolic reactions in our body, the hormones, the cellular channels, the receptors for various signaling molecules etc. In cases of energy deprivation proteins can also be broken down as a source of energy. They have a calorific value similar to carbohydrates, i.e. 4 Kcal /g, but their metabolism is much less efficient than that of carbohydrates.

Proteins are composed of amino acids. They are polymers of the 20 amino acids that exist in our body. Of these 11 amino acids can be synthesized in the body from non protein sources and hence are deemed non essential in our diet. The rest 9 amino acids cannot be synthesized in the body and hence need to be taken in food to prevent any deficieny disorder from occurring. They are histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine.

Not all proteins are nutritionally equivalent when it comes to food. Certain proteins such as keratin undergoes almost nil digestion while proteins like albumin present in the egg undergo almost complete digestion. Hence the nutritional quality of proteins has to be decided depending upon the balanced presence of all essential amino acids, their digestibility (% of protein ingested digested known as digestibility coefficient, DC), and the biological value, BV (which is the percentage of protein retained by the body after digestion and absorption).

Net protein utilization (NPU) is a measure of the utilization of ingested protein for protein synthesis inside the body. It is calculated by:

$$NPU = \frac{(DC \times BV)}{100}$$

Animal proteins are superior biologically as they contain all essential amino acids in the needed amount and are better digested and absorbed. They have a high biological value and are termed as first class proteins. While vegetable proteins have a low biological value and are termed as second class proteins as they are generally deficient in one amino acid or the other and they are also more difficult to digest and absorb. Whole egg protein is taken as a reference protein due to its excellent bioavailability and completeness as far as amino acids are concerned.

This short coming of plant proteins can be overcome are mutual supplementation i.e. taking two kinds of plant proteins together. A perfect example is rice and pulses. This results in a complete protein diet being taken by using two proteins that are deficient in two different amino acids.

Protein requirement is higher in growing years as well as in hyper metabolic states such as pregnancy, fever, infection etc. Protein requirement is expressed in

relation to body weight. In infants, upto 3 months of age, the protein requirement is about 2.5 gm per kg body weight. Then post this the protein requirement is between 2 to 1.5 gm/ kg body weight uptill adolescence. In adulthood, after 18 yrs of age, the protein requirement in about 1gm/ kg body weight. During pregnancy and lactation the requirement is higher nearly 2.5 to 2 gm / kg body weight.

15.8 BALANCED DIET

A balanced diet is a diet that provides all the nutrients in their correct proportion so as to fulfill the biological requirement of an individual. It neither creates a deficiency nor an excess of any of the nutrients. Balanced diet is different for different individuals and is dependent on the biological need of an individual. For example the biological demand for carbohydrates fats proteins as well of the vitamins required for their metabolism will be much higher in an athlete than in a person with a sedentary desk job.

A balanced diet should contain

(a) Cereals

(b) Pulses

(c) Vegetables and Fruits

(d) Milk and milk products

(e) Oils and fats

(f) Sugars

(g) In cases of non vegetarians it should also contain animal proteins and eggs on a regular bases.

A balanced diet should contain all the above said food groups in our daily diet in a balanced manner so that all the nutritional requirements of the body are fulfilled.

The cereals are energy rich and form a major source of carbohydrates in our diet. Their energy yield is about 350 kcal/100g.

They consist of staples such as wheat, rice, maize, sorghum, jowar, bajra etc. The cereals are deficient in proteins and the proteins present in them are generally deficient in one amino acid or another.

They contain adequate minerals but the absorption of minerals from them is inefficient.

Their outer covering is rich in vitamin B complex. But in most cases the outer covering is lost due to milling.

Pulses are a rich source of proteins among vegetarian food. But similar to other vegetable proteins they are deficient in certain amino acids but these deficiencies can be overcome by supplementing them with cereals. They have a energy density of about 350Kcal/100 gm and 20% to 25% of their mass is protein. Germinating pulses are an important source of vitamin C and vitamin B complex.

Vegetables and fruits are the most important source of water soluble and and certain fat soluble vitamins in our diet. Apart from that they are also an important source of fiber. They provide minerals and carbohydrates. Their contribution to proteins in our diet is negligible.

Dairy and its products form almost a complete diet. It contains almost all nutrients other than vitamin C and Iron. It is a specially good source of Calcium. Milk is rich in saturated fats.

The protein content of milk can be increased by converting to curd. Also curd can be eaten by those who are lactose intolerant as during the fermentation process most of the lactose is fermented.

Fats and oils form an essential part of our diet. They are obtained from the fats and oils we add to our food during cooking. Other than these lipids they are obtained also from lipids contained in food items such as dairy and its products, lipids present in cereals and pulses and fats present in meats and eggs. We should try to avoid saturated fats in our diet and include unsaturated lipids in form of oils in our diet. Refined sugars are used as flavoring agents in our diet but excess of these sugars should be avoided as they provide empty calories.

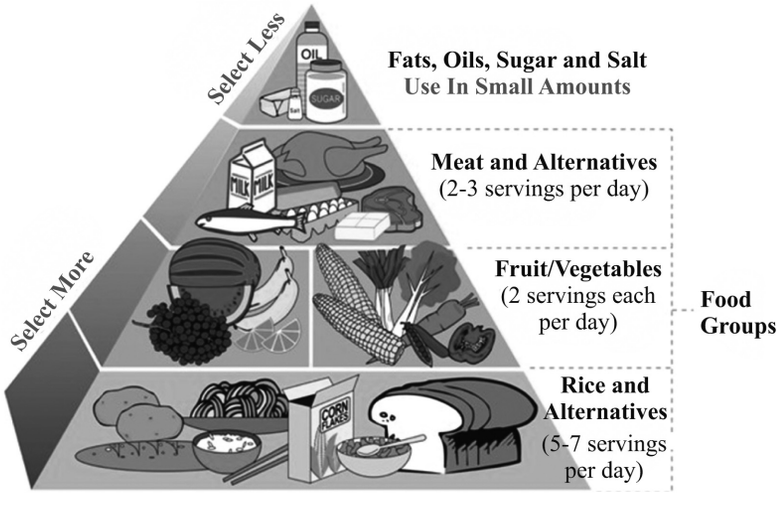

Fig. 15.1: Food pyramid showing the servings of various food items in a balanced diet

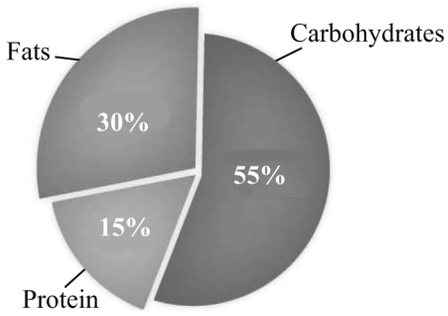

Fig. 15.2: This pie graph shows the percentage of energy that should be provided by the various macro nutrients in a balanced diet.

Eggs are an excellent source of protein and cholesterol in our diet. An average egg is about 100 k cal in energy value. Similarly non vegetarian diet such as meat, poultry and fish are an excellent source of high quality proteins. They are also a good source of fat soluble vitamins as well as vitamins of the B complex except for vitamin C.

A balanced diet should take care of the energy and nutrient requirement of the body and these should be provided by a mix of food items.

The energy requirement of an individual has to provide for the energy requirement for the various activities as well as growth and repair of wear and tear of the body. Hence the energy requirement is dependent on the sex, built as well as the life style of an individual. The following are the average energy requirements for various population groups

Group	Particulars	Body Wt.kg	Net EnergyKcal
Man	Sedentary	60	2320
	Moderate	”	2730
	Heavy work	”	3490
Woman	Sedentary	55	1900
	Moderate	”	2230
	Heavy work	”	2850
	Pregnancy	55kg + GWG	+350
	Lactation (0-6 m)	55kg + WG	+600
	Lactation (6-12 m)	”	**+520**

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Daily energy requirement for an average Indian man and woman as per ICMR guideline (2010)

Energy requirement of infants and children according to ICMR (2010)

Group	Age	Weight	Energy requirement (Kcal)
Infants	0-6 months	5.4	500
	6-12 months	8.4	670
Children	1-3 y	12.9	1060
	4-6 y	18.1	1350
	7-9 y	25.1	1690
Boys	10-12 y	34.3	2190
Girls	10-12 y	35.0	2010
Boys	13-15 y	47.6	2750
Girls	13-15 y	46.6	2330
Boys	16-17 y	55.4	3020
Girls	16-17 y	52.1	2440

15.9 PROTEIN ENERGY MALNUTRITION

Protein energy malnutrition is generally seen in children being weaned off mother's milk. It presents as specific syndromes depending on whether the protein deficiency is more severe or carbohydrate deficiency.

(a) Kwashiorkor: It is a disorder seen in children weaned off milk onto a diet that is deficient in proteins but adequate in calories. It results in the child developing a protein deficiency. This results in muscle wasting and retarded growth. Patchy areas of hyper and hypo pigmented skin are seen and also brittle hypo pigmented hair with flagging sign.

A classical feature of kwashiorkor is a child with a distended belly and edema. The distended belly and edema are due to loss of plasma oncotic pressure and may completely mask muscle wasting. This loss is seen due to loss of plasma albumin. Fatty liver caused by deficiency of apo-lipoproteins also causes distention of abdomen. Also there is anaemia caused by decreased globin synthesis.

Fig. 15.3: A classical picture of kwashiorkor

Kwashiorkor can be easily prevented by adding protein rich food to the diet of the child being weaned off mother's milk. This can be done by add undiluted animal milk, eggs, pulses, groundnuts, bengal gram, cotton seed flour etc.

(b) Marasmus is a disorder of both protein as well as calorie intake. Because of deficiency in calorie intake most of the protein in diet is used for energy.

There is gross muscle wasting with loss of subcutaneous fat. The child shows growth retardation.

There are frequent infections that put a further stress on the metabolism. Diarrhea results in loss of further nutrients.

Fig. 15.4: A marasmic child

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A marasmic child

Marasmus can be corrected by :

1. Increasing protein and energy intake.
2. Supplementing Vitamins and minerals.
3. Correcting dehydration.
4. Correcting the infections.

TERMINAL QUESTIONS

1. What is nutrition?
2. What is basal metabolic rate (BMR)?
3. How is Basal metabolic rate calculated?
4. What are the various factors that influence BMR?
5. Define thermogenesis. How does it happen?
6. What are nutritional aspects of carbohydrates?
7. What is the importance of roughage in diet?
8. What is the importance of protein in diet?
9. What are the essential amino acids? Enumerate the essential amino acids
10. What does the Bioavailability of a protein mean. How is it sued to calculate net protein utilization?
11. What is the nutritional importance of lipids?
12. What are essential fatty acids?
13. Define balanced diet. What are the factors that determine the balanced diet for an individual.
14. What is Kwashioko? What are its symptoms and how can it be prevented.
15. What is marasmus? What are its symptoms and how can it be corrected.