**COURSE: - BCH 204**

**TOPIC: - NUTRITION**

**TARGET DEPARTMENTS: - MLS, PHYSIOLOGY, ANATOMY AND PHARMACOLOGY.**

**LECTURER IN CHARGE: - MR. A.B. AKAWA DATE: - 18TH MAY, 2020.**

**NUTRITION**

Nutrition is the science of food and the nutrients and other substances contained in food. It is the study of their actions, interactions and balance in relation to health and disease. Thus, nutrition is concerned with the digestion, absorption, transport, metabolism and functions performed by the essential nutrients.

Nutrients are the necessary constituents of food required by organisms for growth and the maintenance of life.

There are five classes of nutrients that contribute to an adequate diet. Each plays a special role.

These may be divided into **macronutrients** and **micronutrients.**

**Macronutrients**

These are **proteins, fats** and **carbohydrates*.*** They form the main bulk of food. In the Indian dietary pattern, they contribute to the total energy intake in the following proportions:

Proteins 7 to 15%

Fats 35 to 45%

Carbohydrates 50 to 70%

**Micronutrients**

These are vitamins and minerals.They are called micronutrients because they are required in small amounts which may vary from a microgram to several grams.

Vitamins and minerals do not supply energy but they play an important role in the regulation of the metabolic activity in the body and help in the utilization of **proteins, fats** and **carbohydrates.**

Minerals are also used for the formation of body structure and skeleton

**ROLE OF CARBOHYDRATES IN DIET**

Dietary polysaccharides or disaccharides cannot be utilized until digested to the monosaccharide stage. When introduced directly into the blood stream, they act as foreign bodies and are excreted, chiefly by the kidneys. Normally, 55 to 65% of the total food calories should come from carbohydrates as a moderately active man requiring 3000 C/ day should take about 450 gm carbohydrates daily.

Digestible carbohydrates yield 4 kcal/gm and provide about 50 to 70% of the energy requirement. In addition, these carbohydrates have **protein sparing effect.**

Protein sparing effect of carbohydrates simply means adequate amount of carbohydrates and fats in the diet may reduce the protein requirement. This may be due to:-

* Metabolic products of carbohydrates, e.g. oxaloacetate, Pyruvates and α- oxoglutarates provide the carbon skeletons for the formation of non-essential amino acids through transamination.
* Carbohydrates reduce the need for gluconeogenesis from amino acids.
* Both carbohydrates and fats are catabolized for energy and thus spare the proteins from being used for this purpose.

Carbohydrates are also related with Vitamin B Complex in that with diets rich in carbohydrates, the requirements for B-vitamins, particularly thiamine (Vit B1) increases because of the essential role of these in carbohydrate metabolism.

**ROLE OF PROTEINS AND AMINO ACID IN THE DIET**

Proteins are vital to any living organism.

* Proteins are important constituent of tissues and cells of the body. They form the important component of muscle and other tissues and vital body fluids like blood.
* The proteins in the form of enzymes and hormones are concerned with wide range of vital metabolic processes in the body.
* Protein as antibodies helps the body to defend against infections.
* Proteins supply **essential** and **nonessential amino acids** for the synthesis of protein and nitrogen forthe synthesis of several key compounds such asneurotransmitter and heme.
* Thus, proteins are one of the most important nutrient required by the body and should be supplied in adequate amounts in the diet.
* Proteins are primarily not meant for energy, their principal function is to synthesize tissue proteins of the body. The amino acids, which are not used for protein synthesis, are broken down to provide energy, which is a **wasteful** way of using proteins (this is not their primary function). **Hence, diet should contain** **adequate carbohydrate and fat to provide energy so** **that the proteins in the diet are most economically** **used for the formation of body proteins to fulfill** **other functions essential to life.**

**Essential amino acids**

* Any amino acid that humans either cannot synthesize or are unable to synthesize in adequate quantity is termed **“essential”** and rests of the amino acids are called **“nonessential”** as they can be formed in the body.
* An essential amino acid must be provided in the diet.
* An absence of an essential amino acid from the diet impairs protein synthesis and generally causes **negative nitrogen balance**, i.e. the total nitrogen losses in the urine, feces and sweat exceed the dietary nitrogen intake.

Ten of the twenty amino acids found in proteins are essential for humans.

• Of the 10 essential amino acids, 8 are essential at all times during life. The other two namely **histidine** and **arginine** are required in the diet during periods of rapid growth as in childhood and pregnancy and called **semiessential.**

**NITROGEN BALANCE**

Catabolism of amino acids leads to a net loss of nitrogen from the body. This loss must be compensated by the diet in order to maintain a constant amount of body protein. **Nitrogen balance studies evaluate the relationship** **between the nitrogen intake (in the form of protein) and nitrogen excretion*.***

Three situations of nitrogen balance are possible as follows:

1. Nitrogen equilibrium

2. Positive nitrogen balance

3. Negative nitrogen balance.

**Nitrogen equilibrium**

• In normal adults, nitrogen intake = nitrogen excretion. The subject is said to be in nitrogen equilibrium or balance.

• In this situation, the rate of body protein synthesis is equal to the rate of degradation.

**Positive nitrogen balance**

• In this, nitrogen intake > nitrogen excretion, i.e. intake of nitrogen is more than excretion.

It shows that nitrogen is retained in the body, which means that protein is laid down.

• This occurs in growing **infants** and **pregnant women.**

**Negative nitrogen balance**

• In this, nitrogen intake < nitrogen excretion, i.e. nitrogen output exceeds input, this occurs during ***serious illness*** and **major injury** and **trauma,** in **advanced cancer** and following failure to ingest adequate or sufficient high quality protein, e.g. in **kwashiorkor** and **marasmus*.***

• If the situation is prolonged, it will ultimately lead to death.

**MUTUAL SUPPLEMENTATION OF PROTEINS**

* It is seen that generally animal proteins are of higher biological value than proteins from plant foods. Plant proteins are of poorer quality since essential amino acids (EAAs) composition is not well balanced and a few essential amino acids deviate much from the optimal level present in egg, e.g. In comparison with egg protein, cereal proteins are poor in amino acid lysine. Pulses and oil seed proteins are rich in lysine but they are poor in sulfur containing amino acids. Such proteins individually are therefore **incomplete** **proteins.**
* However, relative insufficiency of a particular amino acid of any vegetable food can be overcome by judicious combination with other vegetable foods, which may have adequate level of that limiting (deficient) amino acid.
* The amino acid composition of these proteins **complement** each other and the resulting mixture will have an amino acid pattern better than either of the constituent proteins of the mixture.
* This is the procedure normally used to improve quality of vegetable proteins. This phenomenon is called **mutual supplementation effect of amino acid.** Thus, a protein of cereals, deficient in lysine and pulses with adequate lysine content have a mutually supplementary effect, a deficiency of an amino acid in one can be made good by an adequate level in another, if both are consumed together.
* Thus, the habitual diets of vegetarians in India based on cereal and pulse helps to overcome the deficiency of certain essential amino acids in one food.

**ROLE OF FAT IN THE DIET**

Dietary fats are high energy yielding nutrients that provide 35 to 45% of the caloric intake. Fat yields 9 kcal/gm. Besides satisfying metabolic energy needs, there are two essential functions of dietary fat, namely, to provide:

* A vehicle for the absorption of the fat soluble vitamins (A, D, E and K).
* To supply essential fatty acids, **linoleic acid** and **linolenic acid** to the body.
* Dietary lipid also increases the **palatability** of food and produces a feeling of **satiety.**

**ROLE OF FIBRE IN THE DIET**

Dietary fiber is the name given collectively to indigestible carbohydrates present in foods. These carbohydrates consist of:

* Cellulose
* Hemicellulose
* Lignin
* Pectin
* Gums
* Mucilages.

• The dietary fiber is not digested by the enzyme of the human gastrointestinal tract, where most of the other carbohydrates like starch, sugars are digested and absorbed.

• Plant foods are the only sources of dietary fiber. It is found in vegetables, fruits, and grains.

**Importance of fiber**

* **Water holding capacity*:*** The dietary fibers have a property of holding water and swell like sponge with a concomitant increase in viscosity. Thus, fiber adds bulk to the diet and increases transit time in the gut (gastric emptying time) due to high viscosity.
* **Adsorption of organic molecules*:*** The organic molecules like bile acids, neutral sterols, carcinogens, and toxic compounds can be adsorbed on dietary fiber and facilitates its excretion.
* **It increases stool bulk:**The fiber absorbs water and increases the bulk of the stool and helps to reduce the tendency towards constipation by increasing bowel movements.
* **Hypoglycemic effect of fiber*:*** Recent studies have shown that gum present in fenugreek seeds (it contains 40% gum) are most effective in reducing blood sugar and cholesterol levels.
* **Hypocholesterolemic effects of fiber:**Fiber has cholesterol lowering effect. Fiber binds **bile acids** and **cholesterol,** increasing their fecal exertion and thus decreasing plasma and tissue cholesterol level.

**Significance of dietary fiber in medicine**

High fiber diet is associated with reduced incidence of a number of diseases like:

• Coronary heart disease (CHD), colon cancer, diabetes, diverticulosis, atherosclerosis and hemorrhoids (piles).

**RECOMMENDED DAILY ALLOWANCE (RDA)**

The term ***‘*recommended daily allowance’**is defined as the amount of nutrient sufficient for the maintenance of health in nearly all individuals. Estimates of allowances are based on the defined minimum requirement plus a safety margin for most individuals. RDAs are now called dietary reference intake (DRI) or reference nutrient intake (RNI).

**MEASUREMENT OF ENERGY**

The energy value of food has long been expressed in terms of the kilo-calorie (kcal). All energy in the diet is provided by three nutrients which are carbohydrates, fats and proteins including alcohol, if it is consumed.

They supply energy at the following rates:

Proteins 4 kcal/g or 17 kJ

Fat 9 kcal/g or 38 kJ

Carbohydrate 4 kcal/g or 17 KJ

Ethanol 7 kcal/g or 29 KJ

The energy content of fat is more than twice that of carbohydrate or protein. If an adequate energy supply is not provided, some protein will be burnt to provide energy.

**ENERGY REQUIREMENTS**

Energy is the principle requisite for body function and growth. Total energy required by an individual depends on the three energy requiring body processes. These are:

* The basal metabolic rate (BMR)
* The thermogenic effect (specific dynamic actions SDA) of food
* Physical activity.

Besides the above three processes, extra provision of energy has to be made for growth, pregnancy and lactation.

**BASAL METABOLIC RATE (BMR)**

The BMR is the energy expenditure necessary to maintain basic physiologic functions, such as:

The activity of the heart, respiration, conduction of nerve impulses, ion transport across membranes, re-absorption in the kidney, metabolic activity such as synthesis of macromolecules.

**Definition of BMR**

It is defined as the energy expenditure at rest, awake (but not during sleep), in a thermo-neutral (warm) environment 8 to 12 hours after the last meal and 8 to 12 hours after any significant physical activity.

**Measurement of basal metabolism**

Basal metabolism can be measured by calorimeter directly by measuring the heat dissipated under basal condition and indirectly by measuring oxygen consumption.

**Factors affecting BMR**

BMR differs among different individuals. It depends on many factors as follows:

* **Gender or sex*:*** The BMR of the males is slightly higher than that of females, partly due to women’s lower percentage of muscle mass (lean body mass) and higher percentage of adipose tissue (that has lower rate of metabolism), when compared to men of the same body weight.
* **Age:**Decline in BMR with increasing age is probably related to loss of muscle mass (lean body mass) and replacement of muscle with adipose tissue that has lower rate of metabolism.
* **Nutritional state:**BMR is low in starvation and undernourishment as compared to well fed state. Starvation leads to an adaptive decrease in BMR, which results from a decrease in lean body mass.
* **Body size or surface area:**The BMR is directly proportional to the surface area of the subject. Larger the surface area, greater will be the heat loss and equally higher will be the heat production and BMR.
* **Body composition:**The BMR is proportionate to lean body mass, (LBM). LBM is the body weight minus nonessential (storage triacylglycerol) weight. Adipose tissue is not as metabolically active as lean body mass. BMR is often expressed as per kilogram of lean body mass or fat-free mass. Therefore, higher the percentage of adipose tissue in the body, lower the BMR/kg body weight.
* **Endocrinological or hormonal state*:*** In hyperthyroidism, the BMR is increased and in hypothyroidism it may be decreased by up to 40%, leading to weight gain.
* **Environmental temperature or climate*:*** In colder climate, the BMR is higher and in tropical climates the BMR is proportionally low. Stress, anxiety and disease states, especially infections, fever, burns and cancer also increase the BMR.
* **Drugs*:*** Smoking (nicotine), coffee (caffeine) and tea (theophylline) increase the BMR, whereas β-blockers tend to decrease energy expenditure.

**Clinical applications of BMR**

* Determination of BMR is useful for the diagnosis of disorders of thyroid. In hypothyroidism, BMR is low while in hyperthyroidism it is elevated.
* BMR is used in calculating caloric requirements of an individual and planning of diets

**THE THERMOGENIC EFFECT (SPECIFIC DYNAMIC ACTION, SDA) OF FOOD**

Another component of energy expenditure in man is diet induced thermogenesis, also known as **postprandial** **thermogenesis.** This is the energy expended in the digestion, absorption, storage and subsequent processing of food. This is called **thermogenic effect of food**because these processes require energy and generate heat. The thermogenic effect of food is equivalent to about 5 to 10% of total energy expenditure.

• This effect was originally attributed solely to the metabolic processing of protein and was termed ***‘*specific dynamic action’(SDA),** but it is now recognized as an effect produced by the consumption of all dietary fuels. The consumption of protein produces the greatest increase in energy loss compared to fat or carbohydrate.

**PHYSICAL ACTIVITY**

Physical activity is the largest variable affecting energy expenditure.

**BALANCED DIET**

A diet is said to be a balanced one, when it includes proportionate quantities of food items selected from the different basic food groups so as to supply the essential nutrients in complete fulfillment of the requirement of the body.

A balanced diet should be based on:

* Locally available foods.
* Should be within the economic means of the people.
* Should fit with the local food habits.
* Diet should be easily digestible and palatable.
* Should contain enough roughage materials.

**NUTRITIONAL DISORDERS**

When balanced diet is not consumed by a person for a sufficient length of time, it leads to nutritional deficiencies or disorders. This nutritional status is called **malnutrition*.*** The most common nutritional disorders are:-

**Protein Energy Malnutrition (PEM) or Protein Calorie Malnutrition (PCM)**

PEM is caused by protein and energy deficiency and has been identified as a major health and nutrition problem.

**Classification of PEM**

PEM can be classified as:

* Marasmus or nonedematous PEM
* Kwashiorkor or edematous PEM.

**Marasmus or nonedematous PEM**

* Marasmus is a chronic condition resulting from a deficiency of both protein and energy. Marasmus occurs in famine (extreme scarcity of food) areas when infants are weaned from breast milk and given inadequate bottle feedings of thin watery gruels (liquid food) of native cereals or other plant foods. These watery gruels are usually deficient in both calories and proteins.

Marasmus is characterized by:

* Growth retardation
* Anemia
* Fat and muscle wasting.
* Severe loss of body fat and muscle results in an **emaciated**appearance. Starvation adaptations cause serum protein and electrolyte concentrations to remain within their normal range and **do not show** **edema.**

**Kwashiorkor or edematous PEM**

* Kwashiorkor refers to conditions caused by severe protein deficiency in individuals with an adequate energy intake. Kwashiorkor is an African word that means ***“weaning disease”.*** When children are weaned from protein rich breast milk, they receive insufficient protein.

The clinical symptoms of kwashiorkor include:

* Anorexia
* Severe edema associated with hypoalbuminemia
* Moon face
* Depigmented hair and skin
* Fatty liver
* Distended abdomen (due to enlarged liver).
* The edema is due to low oncotic pressure in the plasma due to **hypoalbuminemia.**Synthesis of plasma proteins by the liver is also decreased; this in turn impairs the export of triglycerides and other lipids from the liver, resulting in a **fatty liver.**