CHAPTER - IV

REVIEW OF RELATED STUDIES
4.1. NUTRITIONAL STATUS:

The term nutrition refers to the nutritional status of the individual whose body utilizes essential nutrients properly according to the body requirements. But before getting into the details about it, it is essential to know what is nutrition and what are nutrients? Donn (1983) said that, according to M.S. Rose, an outstanding nutritionist, "Nutrition deals with the scientific laws governing the requirements of human being for maintenance, growth, activity, reproduction and lactation," he also said that, according to another well known nutritionist E.N. Todhunter "Nutrition deals with all that makes a man a healthy, functioning, creative human being through a well chosen diet" (p.4).

Robinson (1966, p.206) has defined nutrition as "The science of foods, the nutrients and other substances therein; their action, interaction and balance in relationship to health and disease; the processes by which the organism ingests, digests, absorbs, transports utilizes, nutrients and disposes of their end products. In addition, nutrition must be concerned with social, economic, cultural, and psychological implication of food and eating".

Himsworth (1968) proposed that "Nutrition is the analysis of the effect of food and its constituents on the living organism." (p.18).

Nutrients are the constituents of food that must be supplied to the body in suitable amounts for maintenance of normal health with functioning capacity. The nutrients include water, proteins, carbohydrates, fats, minerals and vitamins.

Good nutritional status is very essential for the normal development and functions of the organs of the body, so that working efficiency, resistance against infections and ability to repair body damage or injury can be efficiently maintained for survival. Poor nutritional status is the
outcome of deprivation of adequate amount of essential nutrients for a prolonged period which is definitely a bar against normal development and function of the body.

When there is deficiency, excess or imbalance of nutrients in food the person suffers from malnutrition. Hence malnutrition is a term which includes undernutrition, or obesity. It is a condition resulting from disparity between demand of the body for a certain nutrient and its intake. The condition arising from deficient availability of nutrients according to the demands of the body denotes to undernutrition where tissue depletion, biochemical changes and lesion occur, finally leading to development of clinical signs and symptoms of nutritional deprivation. Where nutrients consumed in excess to demands of the body denotes to overnutrition or obesity.

When the quantity of nutrients in the food of the individual is inadequate or deficient utilization of nutrients available in the food occurs in the body due to diseases, nutritional status suffers. Nutritional status may be good, fair or poor depending on the intake of dietary essentials, on the relative need for them, and on the body's ability to utilize them.

Nutritional status in India at present is in jeopardy due to poverty, unemployment, disease, illiteracy, rapid population growth, rapid urbanisation, environmental degradation, superstitions, beliefs and taboos present in the society. Mostly, nutritional status has been hampered among the socio-economically deprived population. Nutritional deprivation may result in a tragic waste of human resources. So every country always thinks
of providing regular and adequate supply of body nutrients to each individual especially for growing children, so that the country can develop fast.

4.2. NUTRITION AND PHYSICAL DEVELOPMENT:

The word 'Development' denotes to increase in skill and function, whereas 'growth' denotes to increase in physical size of the body which can be measured in terms of kilograms for weight and centimeters for the length of body. Hence, growth and development are considered together because the child grows and develops as a whole. So growth and development not only imply physical aspects but also intellectual, emotional and social aspects (Park & Park, 1983, p. 465).

"Growth is the function of nutrition: undernourished children are shorter and lighter than well-fed ones" (Tizard, 1974). Physical growth of human beings can occur only if the tissues of the organs receive the nutrients needed for the synthesis of their protein. So it is dependent on an adequate diet and an insufficiency of energy and protein are the commonest cause of failure in growth of human beings and in affluent societies where excess nutrition is ingested disproportioned growth is seen.

In growth there are always two basic activities: increase in size and maturation. Full maturity stops growth. Current malnutrition retards maturation as well as increase in size (height). Rats malnourished for long periods following weaning grow more slowly, never attain their full size and do not stop growing at the normal age, the limit of their slow growth being their age and longevity (Ross, 1959, p. 1990).
There is however, a 'critical' period of development in animals before or immediately after birth. Rehabilitation following mal-nutrition during this period is accompanied by growth for age rather than growth for size and thus catch-up maturation does occur provided the diet remains fully adequate (the animal is allowed to eat as much as it wants), growth then ceases at normal age to give rise to a stunted normal animal (Widdowson, and Mc. Cance, 1963, p.329).

Growth is also impaired when diseases of alimentary canal prevents adequate absorption of nutrients. Many disorders in metabolism prevent normal utilization of nutrients resulting retarded growth and/or development. Diseases like diabetes and phenylaketonuria are best examples which retard growth and/or development. "Gastrointestinal and upper respiratory infection have high frequency of occurrence, increasing the risk of mal-nutrition and mortality". (Ashworth, 1982, pp.7-23; Chen and Scrimshaw, 1983, p.318).

Early in the foetal life the control system of physical growth becomes centred in the brain and it operates principally through the hypothalamus which regulates the trophic secretions of the anterior pituitary gland and other endocrine glands. These endocrine glands have a major role in controlling growth. In the early life of the child any disease affecting any one of these endocrine glands disrupts the pattern of growth in various ways, such as cretinism, due to failure of secretion of thyroid gland. Disturbances in growth occur most commonly in the period immediately after weaning. Before birth growth of the child is not affected unless mother’s diet is grossly insufficient or if the placenta
is abnormal. Lactation period, when the growth rate is rapid, supplies nutrition of early infancy. But a child may not be able to sustain his full potentials in height and weight if food at any time during childhood and adolescence is insufficient for a significant period (Passmore et.al., 1986, pp.11-12).

Animal experiments, mainly on rats and pigs by Mc Cance and Widdowson (1974, pp.1-17) shows that severe distortions of the pattern of growth follow dietary restriction at various stages of development. Even if a new born pig is prevented from growing for a year by this means, rapid growth follows when a normal diet is given, although the animal does not reach quite a normal size and proportion. If good food is given, a short interruption of growth and development in man can be made good by catching growth. In general, children below the age of 5 years can be made up for a period of retarded growth very well, but their capacity to do so declines thereafter.

Dobbing (1968) formulated a general principle and stated that if a developmental process is restricted by any agency at the time of its fastest rate, not only will this delay the process but it will restrict the ultimate extent, even when the restricting influence is removed and the fullest possible rehabilitation obtained. Thus, the timing, severity and duration of nutritional deprivation, all contribute to the long-term effects.

Tizard (1974) in his studies on animals suggested that if a period of malnutrition is severe or is prolonged, or if it occurs at a "critical" period of growth, catch-up is not complete—the growth rate resumed a slope appropriate for the stage of development, but growth stops at the age appropriate for growth termination, i.e., at some point after puberty.
Cravioto et al. (1966) in their follow up studies of children who have treated for infantile marasmus and kwashiorkor have indicated that physical growth of children under study is quite rapid at first. However, if observation is continued over sufficiently long periods, the child will never completely catch up with his healthy peers, growth stops at the usual chronological age and the height of the adult is significantly shorter than that of his healthy peers. Head circumference is usual but not absolute indicator of brain size, is also smaller, though this measurement is not necessarily related to variations in intellectual capacity.

Easwaran et al. (1974, p.2) conducted a study on height and weight measurement of 2208 children of 7, 8 and 9 years old from 11 selected schools of Coimbatore city. The heights and weights of the children were taken every month, for a period of six consecutive months. The results showed that boys and girls with highest income group were tallest and heaviest. The differences due to income level between height and weight were significant at one percent level. This indicated the possible relationship between the income of the family and the type and amount of food available for the family members which ultimately reveals the nutritional status of the family. F. Mönckeberg (1968, p.269) studied 14 children with marasmus early in life. Even though the children had excellent care after hospitalization for marasmus, with 20 litres of free milk given to the mothers plus nutritional counsel, it was reported that at 6 years of age, the children's height, head circumference and intelligence quotient (IQ) were below the average as compared to the normal standards in that country. Improvement in nutrition have led to a long term increase in the mean height for age of the children in most parts of the world (Tizard, 1974).
Pollitt (1984) has stated that severe Vitamin-A deficiency results in night blindness and subsequently to complete blindness which may preclude the child from attaining the school regularly. Iodine deficiency can result in cretinism which is an extreme form of mental retardation. Protein-energy malnutrition (PEM), iron deficiency, vitamin-A deficiency are highly prevalent in many developing countries, though iodine deficiency exists in certain regions in the world. The four types of malnutrition can affect the behavioural development and adaptation of children. Protein energy malnutrition (PEM) generally caused by a deficient diet within a severely economically impoverished environment. Most children with PEM are generally born and developed in insanitary environment with few early opportunities for learning and psychological stimulation and are constantly exposed to various types of infectious diseases (p.10).

There is enough information to show that growth and physical development depend on food that is consumed, hence, the effect of food is a sensitive indication of growth and physical development. So malnutrition, undernutrition or overnutrition can be measured from the growth and physical development. Chavez and Martinez (1982) said that the most practical method for classifying the grade of malnutrition is termed as the Gomez classification, which compares the weight of a child with the norm for its age. Growth is quite sensitive to protein-energy deficiency. So measurement of body mass is a good indicator of nutritional deficiencies although there are other equal important factors like heredity since a child tends to grow according to his genes (p.56).
The parameters to assess the nutritional status of a child are discussed below:-

i) Clinical examination

ii) Anthropometric examination

iii) Laboratory biological examination

iv) Dietary examination.

i) Clinical examination:

It is the simplest and surest means of ascertaining nutritional status of the individual. There are a number of physical signs denoting to deficiency of nutrients in the diet of the individual. The physical signs of the individual can be ascertained by close examination from head to foot in good illumination. The World Health Organisation (WHO) has listed eleven clinical signs of PCM, but all these signs are not always present in mild to moderate malnutrition cases. Also the clinical methods of detecting early malnutrition are most variable, subjective and difficult to standardize, so each type of case requires to be confirmed by anthropometric measurements. Hence it will be difficult to diagnose mild to moderate protein-calorie-malnutrition only by clinical methods (Shah, 1981, p.18).

ii) Anthropometric examination:

It refers to the size and proportion of human body. The relationship between malnutrition and its effect on physical status and mental development, depends on the adequacy of methods used to detect the presence of malnutrition and its effect on school going children. Anthropometric
data have become increasingly employed as indicators of nutritional status at both the individual and population levels (McLaren, 1976). Anthropometric methods of detecting malnutrition are economical, safe and non-invasive and effective when used appropriately and accurately. At the same time, knowledge regarding the age of the child is important while interpreting the anthropometric measurement.

According to Vlray and Aguirrie (1969), growth is considered one of the most sensitive indicators of nutritional status in a child. Any nutrient deficiency in food of the child is reflected in alteration to body measurements (Chowdhury, 1984, p.72). The use of anthropometry is recommended for evaluating the biological impact of public health programmes in developing countries (Keller et al., 1976, p.591). The following body measurements have been widely used for detection of malnutrition in children.

a) **Height**

The height one attains is a genetic characteristic which is modified by dietary adequacy. A poorly nourished child might not achieve his potential stature (Robinson, 1978 p.340). Height is considered to reflect the intake of nutrients over a considerable period of time, especially protein nutrition. Beaton and Bengoa (1973) recommended that height for age is the practical indicator in terms of objectivity, relative ease of collecting information and sensitivity (Chowdhury, 1984, p.72). Height of a child is not affected by mild malnutrition, but changes in height are observed in prolonged malnutrition.
b) **Weight:**

Body weight has long been used as an index of PEM. Body weight is a composite of body water, lean mass and adipose tissue. It is influenced by dietary fluctuation so, it reflects quantity of food taken by the child. Even though the proportion of the body components change with age the degree of nutritional deprivation is determined by the relationship between usual age, body weight and theoretical weight for age in reference to Harvard Standard.

The weight gain during the first year of life of the child is the highest gain in his life. A normal newborn baby getting balanced diet usually doubles its birth weight by five months and trebles it by the 1st year of life (Shah, 1981, p.20). Park and Park (1983, p.466) described that while reckoning the weight of a child from age of 2 years of the normal growing child it increases its weight according to the following order.

By the end of 2nd year, the birth weight of a normally growing child becomes 4 x birth weight.

After the 2nd year, the increase is steady at the rate of about 2.25 to 2.75 kg. per year of age until the adolescent spurt occurs.

The growth spurt starts at the age of 10 to 11 years in case of girls and 12 to 13 years in case of boys. In this way the weight of the boys become 30.0 kg and that of girls become 29.7 kg, by the age of 9 years according to ICMR (1972).
The measurement of the weight of the child is relatively easy to take and in low weight or failure to gain it gives an adequate reliable indication of nutritional status of the child.

c) Mid-arm circumference:

The measurement of mid-arm circumference of the individual assesses the amount of muscle tissue reflecting the protein status. The arm circumference can give a fairly reliable assessment of nutritional status as deficit of muscles and fat is constant clinical feature in malnutrition. These measurement can be expressed as percentage of mid-arm circumference and can indicate the nutritional status of child with reference to standard weight. Children with mid-arm circumference below 80 percent of the average are taken to be malnourished (Shah, 1981, p.29). Arm circumference progressively increases with the age in both cases. In boys it increases from about 16 cm. at the age of 5 years to about 24 cm. at the age of 17 years and in girls from 16 cm. at 5 years to 21 cm. at the age of 17 years although this measurement appears to rise sharply between the ages 12 to 13 years in boys but not so in girls. It has been seen that arm circumference of boys and girls does not show any difference between the age group of 5 to 10 years, but the arm circumference in girls between the age group of 10 to 14 years has been seen to be higher than the boys and the same in boys has been seen to be more than the girls after the age of 14 years of age (Vijayaraghavan, 1974, pp.995).

Mid arm circumference is less than 12.6 cm. in malnourished children whereas children with normal physical status have been seen to have
mid-arm circumference of more than 13.6 cm. But in certain cases of malnutrition having I, II and III degrees have been seen to have mid-arm circumference more than 13.6 cm. as has been observed by Man Mohan et.al. (1980, p.504).

d) Head and chest circumference:

These measurements assess the rate of development of different parts of the body. Also these are guides to the degree of growth retardation. The measurement of head circumference has been shown to be associated with nutritional status in the first two years of life. There is evidence that head circumference may reflect more closely nutritional deficiency which occurred at an earlier age than does stature (Yarbrough et.al., 1974 pp.5-26) and it may be useful in identifying the timing of past malnutrition in population of older preschool children (Malina et.al., 1975, pp.1061-1070). Measurement of head circumference in assessment of nutritional status of children from 1st year to 9 years of age has very little values as compared to measurement of weight and height since maximum brain growth has already taken place by age of 2 years (Keet et.al., 1971, pp.1427-1449).

e) Skinfold thickness over Triceps:

Fat is the major store of energy. When there is a deficit of energy in the diet body fat is mobilised to maintain energy balance. Depletion of the subcutaneous fat stores being the indicator of energy deficiency can be assessed by the measurement of skin fold thickness.
iii) Biochemical Test:

All these biochemical tests for detection of malnutrition are based on the alterations which take place in protein malnutrition like Kwashiorkor and are not of much significance in marasmus and intermediary malnutrition. Just to enumerate, those investigations are;

a. Total serum protein and serum albumins,
b. Non-essential/essential aminoacid, ratio in urine and serum,
c. Hydroxy proline excretion in urine,
d. Urine creatine/height ratio,
e. Urinary urea/creatine ratio and,
f. Serum transferrin

These tests reflect on the stores of proteins in muscles and elsewhere, on their metabolism in liver and their transport. No matter how academic these tests may appear, there is hardly any reliable biochemical test which can easily be taken up for detection of malnutrition. Moreover, these investigations are influenced by factors like age, associated infections and timing and type of meal taken prior to the test. The major difficulty with these tests is the need for expressive equipment and skilled laboratory personnel. For a doctor working in a community, these are therefore, not of much significance or practical utility (Shah, 1981, p.32).

iv) Dietary Examination:

A dietary survey is not in itself a measure of nutritional status rather it helps in the evaluation of the result of anthropometric, clinical
and biochemical studies. Dietary survey means determination of the kinds and amounts of food eaten.

A dietary survey may be carried out by one of the following methods:

a. Weighment of raw foods
b. Weighment of cooked foods
c. Oral questionnaire method
d. Checking the stock inventory

A data that is collected by the surveyer is analysed for:

i) the mean intake of foods in terms of cereals, pulses, vegetables, fruits, milk, meat, fish and egg and,

ii) the mean intake of calories, proteins, fats carbohydrates, vitamins and minerals.

Growth is a fairly gradual process between the ages of two and twelve which varies from individual to individual. So the nutritional needs of children between this age groups must be given special attention. According to Forbes (1961, pp.527-529) growth and development are sensitive indicators of the level of nutritional intake. There is evidence that there is a correlation between height in babyhood and adulthood. Babies who suffer from malnutrition, which stunts growth, will under such circumstances be shorter adults than they would have been, had their nutrition been better during this critical period in growth (Mack et.al., 1974, pp.21-32). Even when the diet is improved as children grow older, they still tend to lag behind the norm in height. This is true also of intellectual development (Malina et.al., 1974).
The young growing school children should take increased amount of calories, there should be a generous supply of good quality of proteins, minerals and vitamins to maintain their rapid growth and increased physical activity, building and maintenance of new body tissue, and for emotional development. A child's muscle growth must develop along with the skeleton, which demands an abundance of the essential aminoacids and other nutrients. Specially a child's food should contain adequate calories so that it can spare the protein for tissue building otherwise the protein is used for energy.

When the physical growth and development of a well-nourished child is maintained by consumption of adequate amount of food containing good quality of proteins, fats, minerals and vitamins, the school performance becomes good and he can achieve the normal potential of his life. Unfortunately children of the developing countries lack in all these factors required for growth and mental development due to lack of knowledge in respect of their body requirements and necessities of these factors and different sources of availability of those food components, hence, nutritionist or a researcher feels essential to give a brief picture of daily nutritional requirements.

**Protein:**

The large molecules of proteins are made up of many aminoacids, usually proteins are digested and assimilated into the body in form of aminoacids. There are 22 aminoacids which are essentially required for existence of life. Out of these, 9 aminoacids are classified as essential aminoacids which are not synthesized in the body, but very essential
for normal growth and function of the body and these indispensable nutrients are required to be consumed through food. The non-essential aminoacids are very essential in the body in metabolism. These can be manufactured in the body when adequate proteins are consumed. A complete protein contains all the essential aminoacids needed by the human body for growth, maintenance and repair of body tissues. These can be manufactured in the body when adequate proteins are consumed. One gram of protein gives 4 calories of energy to the body.

When adequate amount of protein is not consumed the growth, maintenance and repair of body tissues are hampered, water balance is not kept in the body, hence proper acid-base balance within the body can not be maintained resulting oedema. In lack of protein, enzymes, antibodies and some hormones can not be synthesized in the body. Poor quality protein or insufficient amount of essential amino-acids can cause negative nitrogen balance in the body.

Carbohydrate :

An adequate amount of energy can not be obtained if sufficient fats and carbohydrates are lacking in the food. Carbohydrate is of primary importance to the human body as fuel and energy. One gram of carbohydrate provides 4 calories and also it serves as a protective function and assists in the normal process of metabolism of protein and fat. Vitamin B complex is very essential for the metabolism of carbohydrates and so vitamin B deficiency impairs carbohydrate metabolism in the body. The heart being a specialised organ of the body requires carbohydrate in the form of glycogen to function normally. The central nervous system
(CNS) is extremely dependant upon a constant supply of glucose from the blood since it does not store sufficient amount of glycogen.

Fat and Lipid:

Fat is an essential nutrient in the diet since it is the most concentrated source of energy in food. Also a small quantity of proper kind of fat is necessary to provide the necessary fat soluble vitamins and essential fatty acids. One gram of fat provides 9 calories of energy to the body. Fat provides flavour and satiety value to food and also it supports vital organs. A diet containing too much of fat generally produces obesity.

Vitamins:

Vitamins are required in small amounts for the body for normal growth, maintenance of life and reproduction. The deficiency of vitamins in the diet causes various specific diseases in regard to each kind. The fat soluble vitamins are A, D, E and K and are absorbed alongwith fats and lipids and are stored in the body whereas water soluble vitamins, i.e., B and C are not stored in the body and are normally excreted in small quantities in the urine, so they are required to be supplied daily to the body through diet.

Vitamin A:

Vitamin A or retinol is essential for maintenance of normal external epithelium, mucous membranes of mouth, eyes, respiratory tract and genitourinary tracts and it promotes normal body growth, particularly of bones and teeth, prevents night blindness and maintains normal vision.
Vitamin A deficiency which is a very common in the world occurs amongst the children. Its deficiency produces night blindness, blindness, Xerophthalmia, horny, dry and scaly skin, damaged mucous membranes leading to easy invasion of infection, diseased gums and deformed teeth and stunted growth. But when taken in excess produces some toxic effects.

**Vitamin D:**

Vitamin D regulates the metabolism of calcium and phosphorous and helps in their absorption from the intestine, and promotes proper mineralization of bones and teeth. Its excess intake can produce toxic effects. Its deficiency can cause rickets in growing bones which become weak and fragile, malformed skeleton, bow legs, knock knees, enlarged bones about the joints and narrow distorted chests.

**Vitamin E:**

Vitamin E otherwise known as tocopherol is essentially required in the body to protect Vitamin A, Vitamin C and unsaturated fatty acids from oxidation and to protect the cell structure. Deficiency of Vitamin E in diet may result in sterility, macrocytic anaemia, abnormal termination of pregnancy, muscular dystrophy, diabetes, coronary heart disease and skin disorders.

**Vitamin K:**

Vitamin K by forming prothrombin in the liver helps in the coagulation of blood. This vitamin is known to be synthesised in the intestines out of the available nutrients by bacteria. Deficiency of Vitamin K produces defective blood coagulation and internal haemorrhages.
Vitamin B :

The family of B complex vitamin consists of eight vitamins. Although the function of all the vitamin B complex family has similar in activity in the body still some of them have got specific function.

Thiamine (B1) is essentially required for metabolism of carbohydrate, fat and protein and to release energy for growth, activity, body maintenance and repair of body tissues. It also maintains normal muscle tones especially on the digestive system and in the heart. It has got important role in producing a healthy nervous system and mental function. Deficiency of vitamin B1 (Thiamine) produces low appetite, constipation, irritability, fatigue, beriberi, nervous disturbances, cardiovascular disorders, oedema and muscle cramps.

Vitamin B2 (Riboflavin) necessary for growth and reproduction and plays an important role in metabolism of carbohydrates, fats, lipids and proteins to release energy in the cells, hence this vitamin is essential for healthy body tissues, especially skin, eyes and CNS. It is more needed during pregnancy and lactation. Excess of this vitamin is excreted in urine and very limited quantity is retained in the muscle tissues, so regular supply of this vitamin in the diet is essential. When its deficiency occurs, especially in vegetarian persons it produces stunted growth, affects reproduction and possesses cheilosis, scaly, sore skin on the face, particularly around mouth and lips.

Niacin (Nicotinic acid) plays an essential role in cellular metabolism of carbohydrate and is found in circulating blood, heart, brain, muscles, kidney and liver. The deficiency of niacin (Nicotinic acid) produces pellagra
with reddish skin rash, a sore mouth and tongue and intestinal disorders, dermatitis, mental disorder. Normally amino acid tryptophan is converted into niacin in the human body (60 mg. tryptophan = 1 mg. of niacin).

Vitamin B₆ (Pyridoxine) also plays an important role in metabolism of amino acids, fats and carbohydrates. The body can synthesize non-essential amino acids with the help of this vitamin and also it is needed to convert tryptophan to niacin. Its deficiency produces anaemia, muscular and nervous disorders.

Pantothenic acid acts as a component of coenzyme involved in the metabolism of carbohydrates, fats and amino acids. The deficiency of this vitamin causes Gopalan's syndrome wherein the person complains of burning pain over soles of feet.

Biotin plays an important role in the metabolism of carbohydrate, fatty acids and amino acids. Its deficiency occurs when a person consumes large quantity of raw eggs daily since protein in egg white inactivates biotin.

Folic acid (Folacin) is required for normal growth and reproduction and to prevent one type of anaemia and is involved in cellular metabolism, particularly certain amino acids.

Vitamin B₁₂ is an important component of enzymes involved in metabolism of fat, carbohydrate and protein and is essential to prevent pernicious anaemia. It is necessary in less quantity for the growth of infants and children but in more quantities during pregnancy and lactation. Its deficiency causes pernicious anaemia with symptoms like sore tongue, weakness, loss of weight, anaemia, sensory and mental disorders.
Vitamin C :

Vitamin C (Ascorbic acid) prevents scurvy and is required in metabolism of aminoacids and in the formation of folic acid. It helps absorption of iron from the intestine, maintains healthy blood vessels and helps in formation of tooth and bone. Its deficiency causes scurvy characterised by swollen painful joints, delayed wound healing, spongy gums, loose teeth and haemorrhages, particularly near the bones, joints or under the skin.

Minerals :

There are many minerals known to have essential role to play in the formation of healthy human body. These minerals are present in human body in different quantity, some are in more quantity known to be macro-minerals and some are present in small quantity known as micro-minerals.

Marco-minerals :

Calcium and phosphorous play a major role in the formation of bones, hence essential for growth of human body. Calcium is required for clotting of the blood and normal functioning of nerve tissues and is necessary for muscle contraction.

Phosphorous is usually an accompaniment of calcium and both of them are required and stored in the body in equal proportion. Phosphorous increases the rigidity of bones and teeth. It plays an important role in cell metabolism and metabolism of carbohydrate, fat and protein. It is involved in normal growth and development of teeth and bone and in maintaining normal blood levels, metabolism of normal nerve tissues, muscle energy metabolism and is involved in many enzyme systems.
Magnesium is required in the body to catalyse chemical reactions, particularly of enzyme system. It also regulates body temperature and is involved in contractions of nerves and muscles and synthesis of proteins. Deficiency of magnesium mineral causes dysfunction of neuromuscular system with tremor and convulsion and sometimes behavioural disturbances.

Potassium being an important component of lean body tissue is very essential for human body. It also influences the ability of the muscles to contract and to affect response of nervous tissues. Its deficiency causes muscular weakness, nervousness, mental confusion and cardiac irregularities. Its deficiency occurs usually whenever there is muscle breakdown due to starvation, protein deficiency or injury or inadequate consumption, prolonged diarrhoea, abnormal kidney function due to renal disease or diabetic complications.

Sodium is an essential macro-mineral required for normal functioning of the body. It is the principal element in the extracellular fluid. It maintains acid-base balance in the body fluids. Its deficiency occurs rarely in healthy individuals. When its deficiency occurs in the body acid-base balance in the body fluid is deranged and the person becomes dehydrated.

Chlorides are required for formation of hydrochloric acid of the gastric juice which is essential for proper absorption of vitamin B\textsubscript{12} and iron. It also maintains acid-base balance in fluids throughout the body.

Sulphur is present in all body tissues and is required essentially as a component of B-complex vitamin as thiamine and biotin and certain amino-acids like cystine, methionine and cystene. It maintains rigidity of nails, skin and hair in the body.
Micro-minerals:

Chromium is necessary to maintain normal glucose metabolism. Its deficiency is normally found in old age, pregnancy and PEM.

Cobalt is a component of vitamin $B_{12}$, hence it is necessary in metabolism of vitamin $B_{12}$ in the body.

Copper is very essential to prevent anaemia and for normal development of the bones, healthy CNS and formation of connective tissues. With copper deficiency in human brain there is cerebellar ataxia and tremor (Evered et al., 1980). In children with deficiency of copper genetically there is retinal distrophy (Danks, 1980, pp.209-225).

Fluorine as a component of human body present in bones and teeth. It prevents dental caries, so it is essential for growing children for development of teeth and bones.

Iodine is very essential in the metabolism of thyroid hormones and its deficiency causes simple or endemic goitre.

Iron being a constituent of haemoglobin, myoglobin and number of enzymes plays an important role in transporting oxygen from the lungs. Iron is also a component of enzymes that are involved in cellular metabolism of glucose and fatty acids. Synthesis of haemoglobin of blood requires iron in the presence of copper and adequate amount of protein. In its deficiency anaemia results manifesting signs of pallor of skin and tissues, weakness, fatigue, tiredness, headache and softness of breath, lack of concentration and loss of memory. Hence, iron plays an important role in the growth, maintenance and the repair of the tissues of the body.
Manganese is essentially required for normal tendon and bone structure, reproduction and normal function of the CNS and plays a role in enzyme system in the body. Manganese deficiency in young animals results in defective otolith development in the utricle and saccule (Shradar, et.al., 1967 pp.453-460). There is ataxia, along with dysequilibrium, head retraction and tremor (Everson et.al., 1959 pp.49-57; Hurley et.al., 1958, pp.309-320).

Molybdenum is essentially required in the enzyme action of xanthine oxidase and aldehyde oxidase.

Selenium is considered to be an essential micro-mineral due to the fact that it appears to be related to Vitamin - E in its function and acts as an antioxidant to preserve the cellular membrane.

Pups born of nickel deficient rats are reported to be less active than controls (Pollitt et.al., eds., 1982 p.16).

Zinc deficiency in rats leads to impaired learning ability. In human being there is a defective taste acuity and poor appetite due to its deficiency (Hambidge, 1974, pp.171-182). As observed in Iranian and Egyptian males, this deficiency causes retardation in growth and hypogonadism with delayed or absent sexual maturation (Pollitt et.al., eds., 1982 p.16).

4.3. NUTRITION AND EDUCATIONAL ACHIEVEMENT:

The scientific evidences already put-forth show that nutritional deprivation in infants and children is a risk factor in the formal educational system. Hence nutrition is undoubtedly a determinant of school
performance and achievement in school going children. Poor nutritional status among school children has been seen to be showing significant adverse effects on school progress. Children who are undernourished show slow learning capacity and difficulties in mastering school materials and so among those children most of them are seen to be either repeaters in grades and/or drop outs early from school.

As per the statement of Mohanty et.al., a number of studies conducted in India and abroad have revealed a great relationship between academic achievement and socio-economic status. Bergan and Dunn (1976) in their studies stated that there can be little doubt that one socio-economic class membership is powerfully associated with educational opportunity and capability and the SES of the child is no doubt the best single predictor of the academic performance of the child. Prakash Chandra (1975) showed that economic and family conditions are correlated with academic achievements of school pupils (1988, p.5, 6). Socio-economic status, on the other hand determines the nutritional status of a child. So there is a direct relationship between the educational achievement and nutrition.

Good health is necessary for sound body and mind. A hungry child can never be expected to think and act well. According to Ross (1954, pp.34-35), Rao (1970, pp.73-74) and Barnes et.al. (1970, p.155), the physical damage can be remedied later with the supplementation of good diet but the damage done to the brain during the pre-school year is most irreversible and permanent.
Nutritional deprivation interferes with child's motivation, power of concentration and learning capacity and these children are handicapped in learning some of the academic skills which are very essential for learning. The hazards of malnutrition and undernutrition are serious obstacles to the promotion of physical and mental health of children. Poorer the nutrition the more difficult for the child to learn and cope up with the school life, hence, for children to learn effectively good health is essential.

Halder (1969, pp.155-157) had said that a malnourished child is weak, lathargic and can not concentrate in his subject. Study of Guthrie and Tyag (1968) on correlations between height and intelligence scores indicates that shorter children performed less than taller children of the same age. The study of Popkin and Lim (1976) showed that small body size (weight-for-age) was related to poorer scores in the science test. The association remained even after the effects of socio-economic conditions of the children were controlled (Dominguez, 1985, pp.3-5).

Webb and Oski (1973, pp. 827-830) observed lower scores for anaemic students in a test of scholastic performance.

Nearly 300 million children in the world today are retarded physically and perhaps mentally due to malnutrition which is proven killer of young children (Boerma, 1971, p.7).

In developed countries there is low prevalence of undernutrition of specific nutritional deficiencies and of diseased conditions which place at risk the school progress of children and are major causes of public
health concern. In developing countries among the low income segment of population infections and malnutrition are often endemic. Among them the prevalence of protein energy malnutrition and micronutrient deficiencies are generally extremely high (Pellet, 1983, p.115-125).

According to Birch (1972) three possible mechanisms to account for any association between diet and intellect; malnutrition causes damage to central nervous system which influences mental capacity; dietary deficiency leads to ill-health and/or hospital admission which interferes with learning opportunities and impairs responsiveness; inadequate food intake at critical times causes abnormalities in the direction and sequencing of development (Chowdhury, 1984, p.24).

There is a direct causal relationship between early PEM and impaired learning, in some instances intellectual development is found to be associated with irreversible mental retardation (Ricciuti, 1970; Scrimshaw and Gordon, 1968).

Malnutrition or malnourishment is a problem in developing countries. Early malnutrition is more harmful in influencing later behaviour which may include absence from school, apathy while in school or reduced potential (Srikantia, 1979, pp.6-10; Devdas, 1979, pp.30-33; Smart, 1972).

Each organ of the body develops during gestation and after birth according to a specific time. The brain at birth is closer to its adult size than any other organs of the body. It comprises 10 percent of the body weight at birth, by six months of age the brain is 50 percent of its weight in adulthood, at one year of age it is 60 percent and at 5 years 90 percent and at 10 years of age it is 95 percent of the total brain.
weight at adulthood (Sen, 1985, p.37). The head circumference of a child at birth is 63 percent of the adult circumference of head (Robinson, 1978, p.475).

Cell division in the brain occurs during the gestation period and is complete at about 12 to 15 months of age. The cell division in the cerebrum and cerebellum is complete at about 12 months to 15 months of age (Winick, et al., 1973). Myelination and the development of synaptic connections usually occur after birth of the child and this development becomes complete normally by the 3rd year of age. Consequently, nutritional deprivation during this time could adversely affect the development of these specialized structures of the nervous tissue (Review, 1975, pp.6-7). PEM reduces the cell number and affects adversely myelination, brain size is also reduced (Ghosh, et al., 1979, p.6). So maternal rejection of an infant through failure to breast feed leads to further impairment of brain growth and intellectual poverty (Devdas, 1980, p.66).

In rats, malnourished during the period of their brain growth spurt, the peak growth velocity of the brain is curtailed but not delayed (Dobbing, 1974a, p.565). According to Smythe (1955) early retardation of brain growth might never be recouped once the most-rapid growing period had passed (Stoch and Smythe, 1963, p.546). Much evidence has since accumulated to support this assumption (Dobbing, et al., 1973, p.757; Martin, 1973, p.766; Latham, 1974, p.541).

According to Winick and Rosso (1968), the reduction in brain weight in childhood is more likely related to reduction in the number of neurons. This in turn is likely to lead to more damaging result of poor learning, memory
and behaviour or a subclinical mental functioning in the child due to neuronal deficiency. Since reduction in brain weight appears to be permanent due to poor nutritional condition, reduction in brain size will likely lead to future functional impairment of the brain.

Synthesis of brain neurotransmitters requires, adequate levels of certain amino acids (Pardridge, 1977), vitamins (Thomas and Kemp, 1977, pp.663-665; Dakshinamurthi, 1977) and metals (Sourkes, 1982), deficit in any of these nutrients might be a limiting factor in supplying related transmitters for brain function.

Coursin (1965, p.65) in his recent review of studies of the functional effects of undernutrition on the central nervous system function in children, has proved that the findings of Cravioto (1963, pp.1803-1809) and Stoch and Smythe (1963, p.546) were correct: undernutrition may impair the normal maturation of the brain permanently. Coursin concludes that although deficiency may not produce serious mental retardation in children with undernutrition, the damage so caused may suffice to limit the individual's ability to realise his inherent potential.

Studies on experiment on animals under controlled conditions have shown that even moderate malnutrition imposed at a time when the CNS is developing, if persistent enough, interferes with neuronal division, adversely affecting myelination, impairing learning ability and also leading to abnormal behaviour. The experimental data to man is always hazardous. Nutritional deprivation during early childhood has been found to be associated with smaller head circumference, lower brain weights and altered biochemistry of the brain, but the functional significance of these
neurochemical alteration is, as yet, far from clearly understood. However, malnourished children have been found to perform poorly in intelligence test and on that basis it has been held that protein calorie inadequacy during childhood can lead to irreversible impairment of mental function in later life. It is not possible to make up loss in growth by most energetic supply of nutritious food later in life (Sen, 1985, p.36-37).

The studies in India and other parts in the world such as Mexico, Africa and Caribbean have shown that chronically under-nourished children tend to lag behind in terms of behavioural development. Apathy and reduced curiosity have also been associated with early malnutrition while primary deficits appear to involve motor integrative performance, reading ability, concentration and motivation (Sen, 1985 p.39).

Although there are a few data on biochemical changes in the human brain during severe malnutrition, disturbances in learning ability, memory and behaviour are obvious (Cravioto, et.al., 1966, p.319; Meneghello, 1949). Graham (1967, pp.139-143) in his study on 53 malnourished children in Peru over a period of 34 months has concluded that severe deficits over a prolonged period of time could not be made up, particularly with respect to size of the head. If short term deficit occurs in the 1st year, the permanent effects can be prevented by a good diet. The older the child, the longer he can endure severe malnutrition without permanent damage (Robinson, 1978, p.476).

Cravioto and coworker (1963, 1965, pp.449-464) had studied in central America and described the changes in CNS function that occur with malnutrition. According to Cravioto's conclusion, if the malnutrition has
persisted for four months or more in early months of life nutritional rehabilitation may not fully correct the retardation. On the other hand, the infant who has had the benefit of reasonably good nutrition during the 1st year of life who then develops Kwashiorkor is not likely to have permanent intellectual damage.

Observations of Dobbing (1968, p.181) had shown that brain weight can be improved with nutritional rehabilitation of animals when they are put on normal diet. Probably the same thing will happen in human beings if adequate nutritional rehabilitation can be carried out (Kuglemass et al., 1944 p.631). Brown (1966, pp.512-522) has also reported brain weight deficit in malnourished Ugandan children.

The studies of Stoch and Smythe in South Africa (1963), Cabak and Najdanvic in Serbia (1965, p.532), Cravioto in Mexico (1966) and Patel et al., (1968) at paediatric centre, Bombay are strongly suggestive of impairment in the intellectual functioning, lowering of development quotient and perceptual defects in malnourished children particularly when significant malnutrition occurs early in infancy.

It is universally agreed that children exposed to the whole environment of disadvantage associated with PEM perform significantly less well when compared with control children from a reasonably good environment who have not been malnourished (Alleyne et al., 1988, p.129).

Children at Capetown who had been severely malnourished in the 1st year of life had at the age of 7 years a smaller head circumference, reflecting reduced brain growth and a lower IQ than a control group.
(Stoch et al., 1963). Cabak and Najdanvic (1965) Stoch and Smythe (1967, p.1027), Champakam et al., (1968, p.844) have provided convincing evidence that the malnutrition syndrome does impair a child's performance on a number of different tests of mental or psychomotor function.

A majority of the results from relevant experimental studies conducted with U.S., Israel, Guatemala, Indonesia and Egypt over the last decade indicate that iron deficiency with or without anaemia interferes with cognitive functioning. Among school age children, iron deficiency might be an obstacle to school achievement (Pollitt, 1985, p.21). Iron deficient school children also have obtained lower educational achievement test scores than iron replete subjects (Pollitt et al., 1985 p.158) and Palti et al., 1985 pp.217-223). Following iron repletion their achievement scores increased significantly above those of iron deficient children treated with a placebo. Iron deficiency among nine to ten years old children has also been related to deficit in attention and in concentration, however, these deficits disappear following treatment. The significance of these findings are obvious given that the scholastic progress of the iron deficient child is in jeopardy (Pollitt, 1985 p.22).

Anaemia due to iron deficiency has been seen to be the associated condition of malnutrition. Usually young children with anaemia appear to show decreased attentiveness and ability to focus on, orient to and sustained interest in learning a task (Howell, 1971). Also both children and adolescents who are anaemic have been reported to show poorer school performance and to score lower IQ and other tests of mental ability (Sulzer et al., 1973 and Webb et al., 1973, p.827-830). It has been
suggested however that school performance might in fact be compromised by disturbances in attention and perception in anaemic children (Webb et al., 1974, pp.153-156).

Lozoff and coworkers in their recent study in Guatemalan infants have suggested that changes in the alertness, responsiveness and reactivity due to iron deficiency. Lozoff has also demonstrated that iron deficient infants were hesitant and fearful, less active and responsive, had shorter attention spans and were less persistent at certain tasks than the non-anaemic children. Pollitt and coworkers have also reported this finding in his behavioural tests. Studies on iron deficient animals have also shown reduced responsiveness to environmental stimuli (Pollitt et al., eds. 1982, p.119). In view of the above studies iron deficiency anaemia also plays a part to make the school going children to become hesitant and fearful, lack in activeness, responsiveness, concentration and enthusiasm to perform certain task.

Coursin (1972, pp.177-202) has said "Malnutrition may produce structural and metabolic derangements in the central nervous system that can limit its capabilities and performance".

Singh et al., (1977, pp.15-18) studied 204 male school going children, aged 5-9 years, who were divided into well nourished and malnourished groups. They found that, it was not only the intellectual potentials but "intelligence at work" measured in terms of the scholastic performance, that was affected by nutritional status. Well-nourished children have superior learning capacity than the malnourished children. Children suffering from even milder forms of malnutrition underwent changes in their
mental functions which may be responsible for their failure to profit from the school exposure.

In developing countries malnutrition as a risk factor of the educational future of infants and children should be a major concern for health, nutrition and educational policies. Malnutrition or under-nutrition or nutritional deprivation in school going children is undoubtedly a potent contributor to school wastage but, there is a lack of conceivable information on the effects that nutrition and health have on academic progress of school children. The present research is mainly aimed at effects of nutrition and undernutrition on physical development and educational achievement.