NUTRITION

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Nutrition

- Intake of food.
- The study of food.
- It is the science that studies food and how food nourishes our body and influences health.
- The process of taking in food and using it for growth, metabolism and repair.

Energy Requirement of Human Body:-

- Energy is one of the prime requirement of humans.
- A major portion of food energy is derived from foods containing carbohydrates .
- Lesser amounts of energy are also available from fats & proteins in the foods.
- Energy is expressed in calories or kilocalories. It is also expressed in joules.

Calorific values of food

- The major dietary fuels are carbohydrates, proteins & lipids. when these are oxidised to Co_2 and H_2o, energy is released.
- Caloric value is defined as the amount of heat energy obtained by burning 100 gm of the food completely in the presence of oxygen.
- Caloric value is determined in a special apparatus called the "bomb Colorimeter".

Table:- Calorific Values of Foodstuffs

Foodstuffs	Energy Value (Cal/g) [In bomb Calorimeter]	In the body
Carbohydrate	4.1	4
Fat	9.4	9
Protein	5.4	4

- The Carbohydrates & fats are completely oxidised (to Co_2 and H_2o) in the body; hence their fuel values, measured in the bomb calorimeter or in the body; are almost in the same.
- Protein, however, are not completely to products such as urea, creatinine and ammonia, and excreted. Due to this reason, calorific value of protein in the body is less than that obtained in a bomb calorimeter.

Macronutrients :-

- Carbohydrates
- Fats
- Proteins

Micronutrients:-

- Minerals
- Vitamins

Classification of nutrients on the basis of their function

Nutrients	Functions
Carbohydrates	Energy production
Fats	Protection against infections
Proteins	Body building
Vitamins	Regulation of tissue functions
Minerals	
Water	

Respiratory Quotients

Respiratory Quotients (RQ) of Foodstuffs:-

RQ = Volume of Co_2 Produced/Volume of O_2 used

The RQ is the ratio of the volume of Co_2 produced by the volume of O_2 utilized in the oxidation of foodstuffs.

Factors affecting RQ

Role of diet:-

1) Carbohydrates:- The carbohydrates are completely oxidised & their RQ is close to 1.

[Because in Carbohydrates Diet, The volume of Co_2 produced is the same as the volume of O_2 consumed.]

2) Fats:- Fats have relatively lower RQ and is about 0.7. Since they have a oxygen content.

For this reason, fats require more oxygen for oxidation.

3) Proteins:- The chemical nature of proteins is highly variable and the RQ of protein is found to be around 0.8.

4) Mixed diet:- The RQ of the diet consumed is dependent of the relative composition of carbohydrates, fats & proteins.

For a normally ingested diet, it is around 0.85.

Muscular exercise:-

With moderate exercise, the RQ remains almost unaltered.

Because in exercise the body uses different foodstuffs in the same proportion as at rest.

Clinical Aspects :-

1) In acidosis:- During acidosis Co2 output is greater than O2 consumption, hence RQ increases in acidosis.

2) In alkalosis :- RQ will fall, because respiration is depressed and Co2 will be retained in the body i.e. less CO2 is produced.

3)In Diabetes Mellitus:- In advanced cases of DM, when little carbohydrates is burning, energy is supplied mainly by oxidation of fats. Hence RQ will fall.

Respiratory Quotient Represents types of respiration:-

- If Respiratory Quotient is smaller than 1 then it will be aerobic respiration.
- If Respiratory Quotient is equal to 1 then it will be aerobic respiration.
- If Respiratory Quotient is greater than 1 then it will be anaerobic respiration.

Specific Dynamic Action

Specific Dynamic Action (SDA)

- **The phenomenon of extra heat production by the body, over and above the calculated caloric value, when a given food is metabolised by the body, is known as SDA.**
- **It is also called as Calorigenic Action or the Thermic Action of food or the thermogenic Action.**

Significance of SDA:-

- For the utilization of foods by the body, certain amount of energy is consumed from the body stores.
- This is actually an expenditure by the body for the utilization opf foodstuffs.
- It is highest for Proteins (30%) and lowest for the Carbohydrates (5%) and for a mixed diet around 10%.
- The highest SDA for protein indicates that it is not a good source of energy.
- Fat is the best Source of energy due to its lowering effect on SDA.
- However, excessive utilization of fat leads to ketosis.

The high SDA is due to two main factors:-

1) The energy required for deamination of amino acid which is again derived by the oxidation of other metabolites.

2) The energy required for the synthesis of urea which is obtained by the oxidation of other metabolites present in tissues.

Basal Metabolic Rate

Basal Metabolic Rate (BMR) or Basal Metabolism

- **BMR is the energy required by an awake individual during physical, emotional and digestive rest.**
- **It is defined as the minimum amount of energy required by the body to maintain life at complete physical & mental rest in the post absorptive state (i.e. 12 hr. after the last meal).**
- **It is the minimum amount of energy required to maintain life or sustain vital functions like the working of the heart, circulation, brain function, respiration, etc.**
- **The metabolic rate during sleep is less than BMR.**

Unit of BMR:-

BMR is expressed as calories per square meter of body surface area per hour i.e. Cal/Sq.m/hr.

Normal values of BMR:-

- **For adult man 35-38 Cal/Sq.m/hr**
- **For adult women 32-35 Cal/Sq.m/hr**

For adult man BMR is around 1600 Cal/day while for adult woman BMR is around 1400 Cal/day.

The basal conditions are as follows:-

- Person should be awake but at complete rest both physical and mental.
- Person should be without food at least 12 to 18 hrs. i.e. in the post absorptive state.
- Person should remain in normal condition of environment i.e. at normal temperature, pressure & humidity.

Factors That Affect BMR:-

Age:–

- BMR higher in youth. Lean body mass declines with age; physical activity can offset this effect.
- Decrease in BMR with increase in age.
- BMR inversely related to age.

Sex:-

- Men have marginally higher (about 5%) BMR than women. This is due to the higher proportion of lean muscle mass in men.

Physical Activity:-

- BMR is increased in persons (notably athletes) with regular exercise.
- This is mostly due to increase in body surface area.

Growth :–

- Children & pregnant women have higher BMR.

Surface Area:-

- Body weight affects BMR.
- The BMR is directly proportional to the surface area.
- Surface area is related to weight & height.
- Height – Tall people have larger surface area.

Temperature:-

- BMR increases in cold climates than hot.
- So, Eskimos have a higher BMR.

Exercise :-

- The increase in BMR during exercise is due to increased cardiac output.

Fever:-

- Fever raises BMR. 12% Increase in BMR is noticed per degree centrigrade rise in temperature.

Starvation:-

- Starvation lowers BMR. During the period of starvation, the energy intake has an inverse relation with BMR, a decreases up to 50% has been reported.

Disease State:-

- BMR is elevated in various infections:

  Leukemia (21-80%)

  Polycythemia (10-40%)

  Cardiac failure (25-80%)

  Hypertension (25%) etc.

- In Addison's Disease (adrenal insufficiency) BMR is marginally lowered.

Thyroid Hormones:-

- Since thyroid hormones have a general stimulant effect on rate of metabolism and heat production.
- BMR is raised in hyperthyroidism and lowered in hypothyroidism.

Significance of BMR:-

- BMR is important to calculate the calorie requirement of an individual and planning of diets.
- Determination of BMR is useful for the assessment of thyroid function.
- In hypothyroidism BMR is lowered while in hyperthyroidism is elevated.
- Starvation And certain disease conditions also influence BMR.

Dietary Fibre

Dietary fibres:-

- The unavailable or indigestible carbohydrates in the diet is called dietary fibre.
- The complex carbohydrates that are not digested by the human enzymes.
- These include-: cellulose, hemi-cellulose, pectin, lignin, gum and mucilage. Dietary fibre provides little energy but has several beneficial effects.

Beneficial effects of Fibre:-

Prevents constipation:-

- Fibre helps to maintain the normal motility of gastro intestinal tract (GIT) and prevents constipation.

Eliminates bacterial toxins:-

- Fibre absorbs large quantities of water and also the toxic compound produced by intestinal bacteria that lead to increase faecal mass and its easier expulsion.
- Decrease GIT cancers-: The lower incidence of cancers of gastro intestinal tract in vegetarians compared to non-vegetarians is attributed to dietary fibre.

Improves glucose tolerance:-

- Fibre improves glucose tolerance by the body. This is mainly done by a diminished rate of glucose absorption from the intestine.

Reduces plasma cholesterol level:-

- Fibre decreases the absorption of dietary cholesterol from the intestine.

The role of dietary fibre in the body:-

- Dietary fibre is found in cereals, fruits and vegetables.
- Fibre is made up of the indigestible parts or compounds of plants; which pass relatively unchanged through our stomach and intestines. Fibre is mainly a carbohydrate.
- The main role of fibre is to keep the digestive system healthy.

Tips for increasing dietary fibre

Eat a wholegrain cereal in the morning.

Switch from white to wholemeal bread.

Serve a side salad

Eat porridge with a handful of dried fruit.

Add beans and pulses to the regular diet

Substitution for reducing fat intake

Instead of	Try
1. Whole milk	Skimmed milk
2. Ice cream	Ice milk
3. Butter or margarine	Yogurt, Olive oil
4. Fried chicken	Baked chicken without skin

Recommended Dietary Allowances (RDA):

RDA represents the quantities of the nutrients to be provided in the diet daily for maintaining good health & physical efficiency of the body.

Factors Affecting RDA:-

- Sex:-

- The RDA for men is about 20% higher than that for women.
- Iron is an exception as the requirement is greater in menstruating women.
- Additional requirement (20-30%) are needed for pregnant and lactating women.

- Age:-

- The nutrient requirement is much higher in the growing age.
- The protein requirement for a growing child is about 2g/kg body wt/day for adults.

Essential Fatty Acids

Essential Fatty Acids:-

The unsaturated fatty acids which the body cannot synthesize and therefore must be consumed in the diet & referred to as Essential Fatty Acids.

There are three Essential Fatty Acids. These are:-

- Linolenic Acid
- Linoleic Acid
- Arachidinoic Acid

Functions of Essential Fatty Acids:-

- They are useful in the treatment of atherosclerosis by help transporting blood cholesterol and lowering it and transporting triglycerides.
- The hormones are synthesized from them.
- They enter in structure of all cellular and subcellular membrane and the transporting plasma phospholipids.
- They are essential for skin integrity, normal growth and reproduction.
- They have an important role in blood clotting.
- Important in preventing and treating fatty liver.
- Important role in health of the retina and vision.
- They can be oxidized for energy production.

Essential Fatty Acids content of foods:-

- The Essential Fatty Acids, more frequently called Polyunsaturated fatty acids (PUFA), are present in vegetable oils and fish oils.
- The rich vegetable sources include sunflower oil, cotton oil, corn oil ,soya bean oil etc.
- The fat of animal origin contain less PUFA example. Butter, fat of meat and chicken. Sunflower oil and corn oil have increased PUFA content.
- PUFA have cholesterol – lowering properties.

Deficiency Of Essential Fatty Acids:-

- The deficiency of Essential Fatty Acids results in phrynoderma or toad skin which is characterized by the presence of horny eruptions (scally dermatitis) on the posterior and lateral parts of limbs and on the back and buttocks, loss of hair and poor wound healing.
- Symptoms:- Impairment in growth.
- Skin lesions- Skin becomes abnormally permeable to water.
- Increased loss of water increases BMR, abnormalities of pregnancy and lactation in adult females.

Effects of Fat Deficiency on Humans

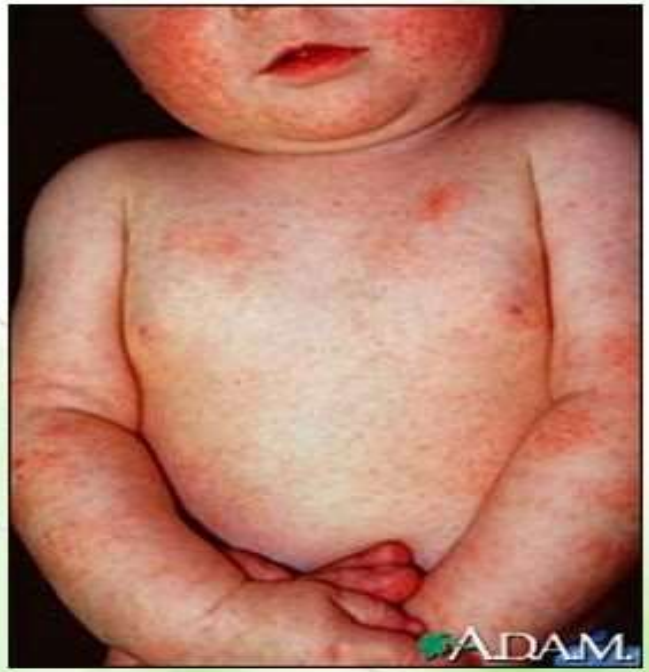
✓ SKIN PROBLEMS

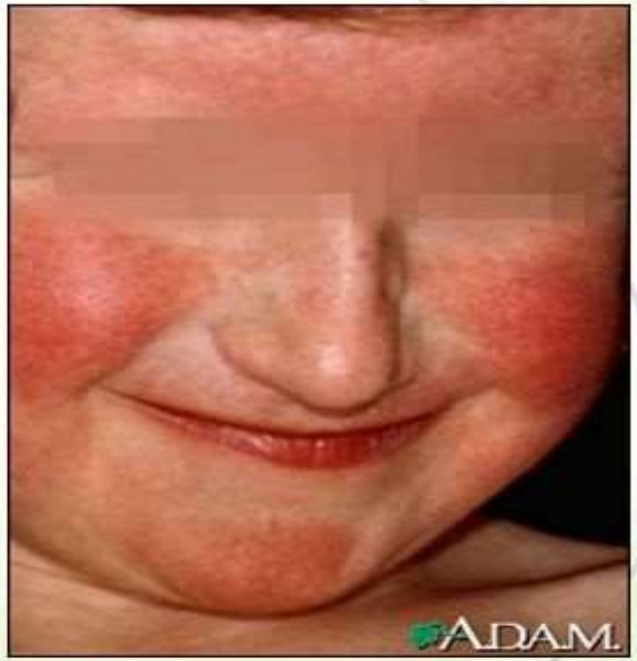
- When essential fatty acids are missing from our diet it can cause skin problems.
- An essential fatty acid deficiency increases the loss of water from your skin, which results in dry, scaly rash.

- This type of deficiency can also make it harder for your wounds to heal.

Deficiency of essential fatty acids in infants

- Infants grow poorly and develop severe skin lesions if fed a diet lacking these acids.





Role of proteins in diet:-

- Proteins have proved to be prime importance in human nutrition.
- Proteins are used for synthesis of protoplasm, enzymes and hormones.
- They are required for the supply of essential amino acids.

Nitrogen Balance:

- It is the relationship between the nitrogen intake and the nitrogen excretion.
- In normal healthy adults, nitrogen balance occurs when the amount of nitrogen consumed equals that nitrogen excreted in the urine, sweet and faeces.

$$I=U+F+S$$

- I= dietary intake
- U= urine, F= faeces, S= Sweat.

Dietary intake = to the loss through urine , faeces and sweat.

There are two other situations :-

- Positive nitrogen balance

- Negative nitrogen balance

Positive nitrogen balance :-

- This is a state in which the nitrogen intake is higher than the output.
- It is observed in growing children, pregnant women or during recovery after serious illness.

Negative nitrogen balance :-

- This is a situation in which nitrogen output is higher than the input .

Factor affecting Negative nitrogen balance:-

- Growth: During the period of active growth, a state of positive nitrogen balance exists.
- Hormones: Growth hormone, insulin promotes positive nitrogen balance, while corticosteriods cause a Negative nitrogen balance.
- Protein deficiency: The deficiency of even a single essential amino acid can cause negative nitrogen balance
- Prolonged starvation is another important cause.

Assessment Nutritional Values:-

Four methods:-

- Protein Efficiency Ratio (PER)
- Biological Value (BV) of Protein
- Net Protein Utilization (NPU)
- Chemical Score

Protein Efficiency Ratio (PER):-

- It is the weight gain per gram of protein taken.
- PER= Gain in body weight (g)/Protein ingested (g)

Biological Value (BV):-

- It is the ratio between the amount of nitrogen retained and nitrogen absorbed during a specific interval.
- BV= retained nitrogen/retained nitrogen × 100

Suppose 127 mg of protein ‘A’ was consumed by a rat in a day and 4 mg is recovered in faeces and 24 mg is seen in urine.

- Then
- Amount ingested = 127 mg
- Amount absorbed =127-4 =123 mg
- Amount retained =127-24 =99 mg
- Therefore BV =99/123 × 100= 81 %

Net Protein Utilization (NPU):-

It is defined as % of food N_2 that is retained in the body.

This depends on both

- Content of Essential amino acid.
- Digestibility and Absorbability of the protein.
- NPU= Nitrogen retained/Nitrogen ingested × 100

Chemical Score :-

- The chemical score is defined as the ratio between the quatity of the most limiting essential amino acid in the test protein to the quantity of the same amino acids in the egg protein, expressed as percentage.
- Chemical Score = (mg of limiting amino acid/g test protein)/ (mg of same amino acid/g egg protein) × 100

Malnutrition

Malnutrition is a stage arising from

- An insufficient calories intake causing undernutrition
- Insufficient intake of one or more of the essential nutrients specially proteins causing deficiency.
- The above two are “primary” causes and responsible for Marasmus and Kwashiorkor respectively.

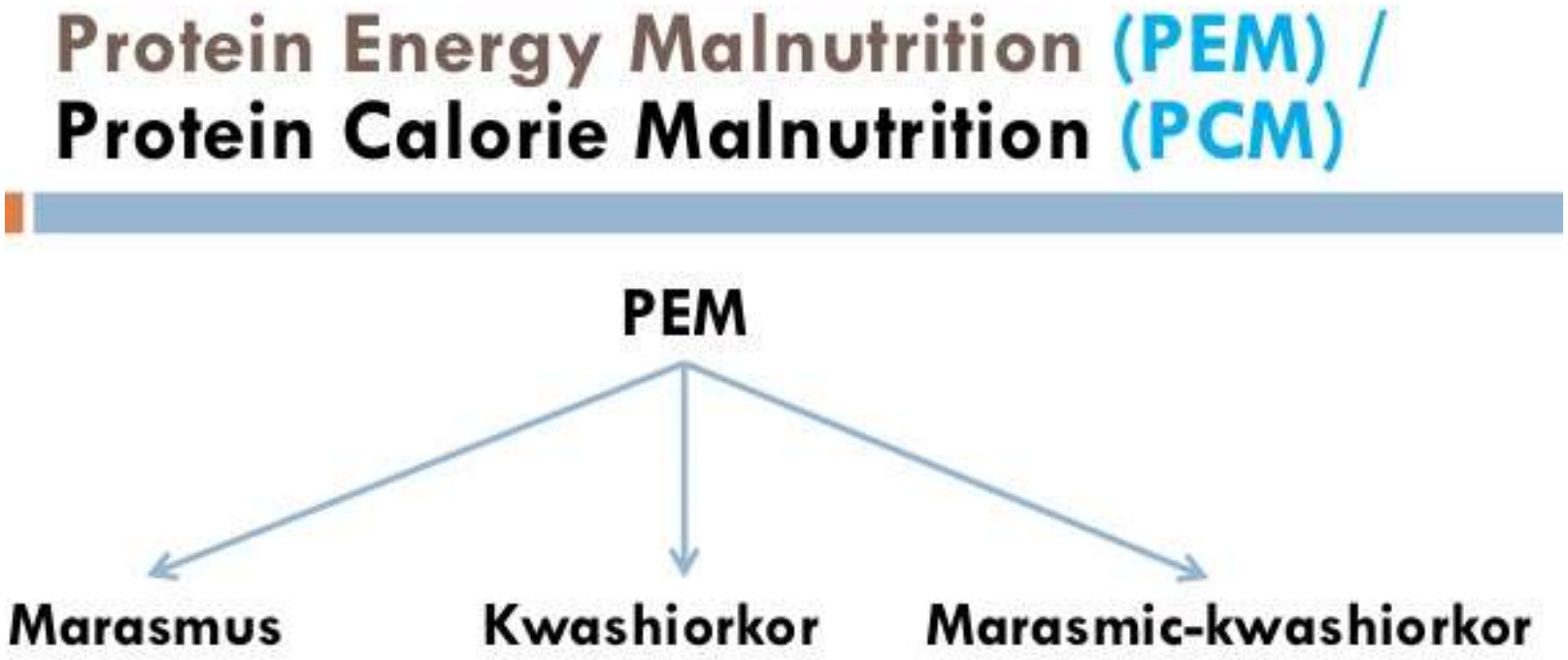
Other causes lead to “secondary” malnutrition.

- Due to inadequate absorption or utilization of essential nutrients (malabsorption syndrome).
- Due to increase in their requirement, destruction or excretion.

Protein Energy Malnutrition (PEM)

- PEM is a form of malnutrition
- It is defined as a range of pathological conditions arising from coincident lack of dietary protein and energy.
- This condition has mild, moderate and severe degrees.
- PEM is widely prevalent in the infants and pre-school children.

Types of PEM


Protein Energy Malnutrition (PEM) /
Protein Calorie Malnutrition (PCM)
PEM
Marasmus
Kwashiorkor
Marasmic-kwashiorkor

PEM are mainly of three types:-

- Marasmus
- Kwashiorkor
- Marsamic-Kwashiorkor

Two are extreme forms i.e. Marasmus and Kwashiorkor

Marasmus

- Due to deficiency of calories.
- Marasmus of primary or dietary origin is most common in tropics, result of starvation in small children.

Causes:-

- Exclusively breast fed infant of a malnourished mother.
- Milk supply is grossly reduced.
- Prolonged breast feeding with inadequate supplementation of other foods.
- Artificial feeds inadequate, less nutritive in proteins and calories.
- Fear of diarrhoea, less feeding.

Age:- Usually seen in infants less than one year.

Clinical features:-

Growth :-

- Retarded growth, child is grossly emaciated, and underweight.
- Infant is very hungry and cries continuously.

Diarrhoea and vomiting :-

- The infant may present small dark green mucous stool of hungry diarrhoea. It aggravates the disease further. Vomiting is more common.
- Diarrhoaea is almost always present. It becomes chronic and remittent.

- Skin and mucous membranes:- Skin is thin, attached to bone, wrinkled.
- Oedema:- No oedema is present.
- Hairs :- usually thin and lusterless.
- Dehydration and electrolytes imbalance.

Haematological and Biochemical alterations:-

- Anaemia :- Hb and haematocrit values are slightly reduced.
- BMR usually subnormal.
- Serum Proteins :- Total serum proteins and their fractions are reduced.
- Total serum protein usually ranges 5 to 6 gm% and albumin α 3.0 gm%.
- A:G ratio maintained.

- Plasma lipids:- Not much affected.
- Fatty liver not common.
- Other electrolytes:- Not much affected.
- Serum Enzymes :- Not much affected.

Physical features of Marasmus

Kwashiorkor (Kw)

- Deficiency of protein causes Kwashiorkor.
- Kw is primarily due to diet very low in proteins.

Causes :-

- Kw seen in artificially fed and weaned children.
- Occurs weeks or months after weaning.
- Proteins of low quality are fed e.g. cereals grains, starchy foods and roots. No milk, eggs etc.

Predisposing factors:-

- Kw seldom occurs as a consequence of an improper diet alone.
- In almost all cases an infections disease acts as the precipitating factor. This may be:-
- Acute diarrhea.
- A respiratory infection.
- Measles.

Age :-

- Usually seen in infants less than one year.
- In second / third year of life.

Clinical features of Kw

Growth:-

- Retardation in growth.
- Child is not like marasmus rather looks blown up due to Oedema.
- Pitting Oedema is the main clinical characteristics on which diagnosis is made. It is soft, painless.

Hair:-

- Hair usually dry and thin. Black hairs become brown or reddish yellow.

Haematological and Biochemical alterations:-

- Anaemia :- Some degree of anaemia is always found, it is mild to moderate. Type of anaemia varies, usually serum Fe and Cu are low.
- BMR may be low.
- Serum Proteins:- Total serum proteins are always reduced.
- Plasma lipids:- Unlike marasums fallin plasma levels of cholesterol, TG and lipoproteins seen.

- Fatty liver may be seen.
- Hypoglycemia frequently found.
- Serum Enzymes:- The serum activity of various enzymes like Amylase, Alkaline phosphatase are reduced.

Marasmic - Kwashiorkor

- Symptoms of both Marasmus and Kwashiorkor are sometimes produced in a mixed way depending on the relative degree of protein and calories deficiencies. Marasmus and Kwashiorkor may follow each other in some patients.
- Symptoms of deficiencies of vitamins and minerals may also be found in these deficiency, e.g. hypoprothromobinaemia (Vit k deficiency), Pellegra (Niacin Deficiency) etc and Anaemia.

MARASMIC-KWASHIORKOR

A severely malnourished child with features of both marasmus and Kwashiorkor.

- The features of Kwashiorkor are severe oedema of feet and legs and also hands, lower arms, abdomen and face. Also there is pale skin and hair, and the child is unhappy.
- There are also signs of marasmus, wasting of the muscles of the upper arms, shoulders and chest so that you can see the ribs.

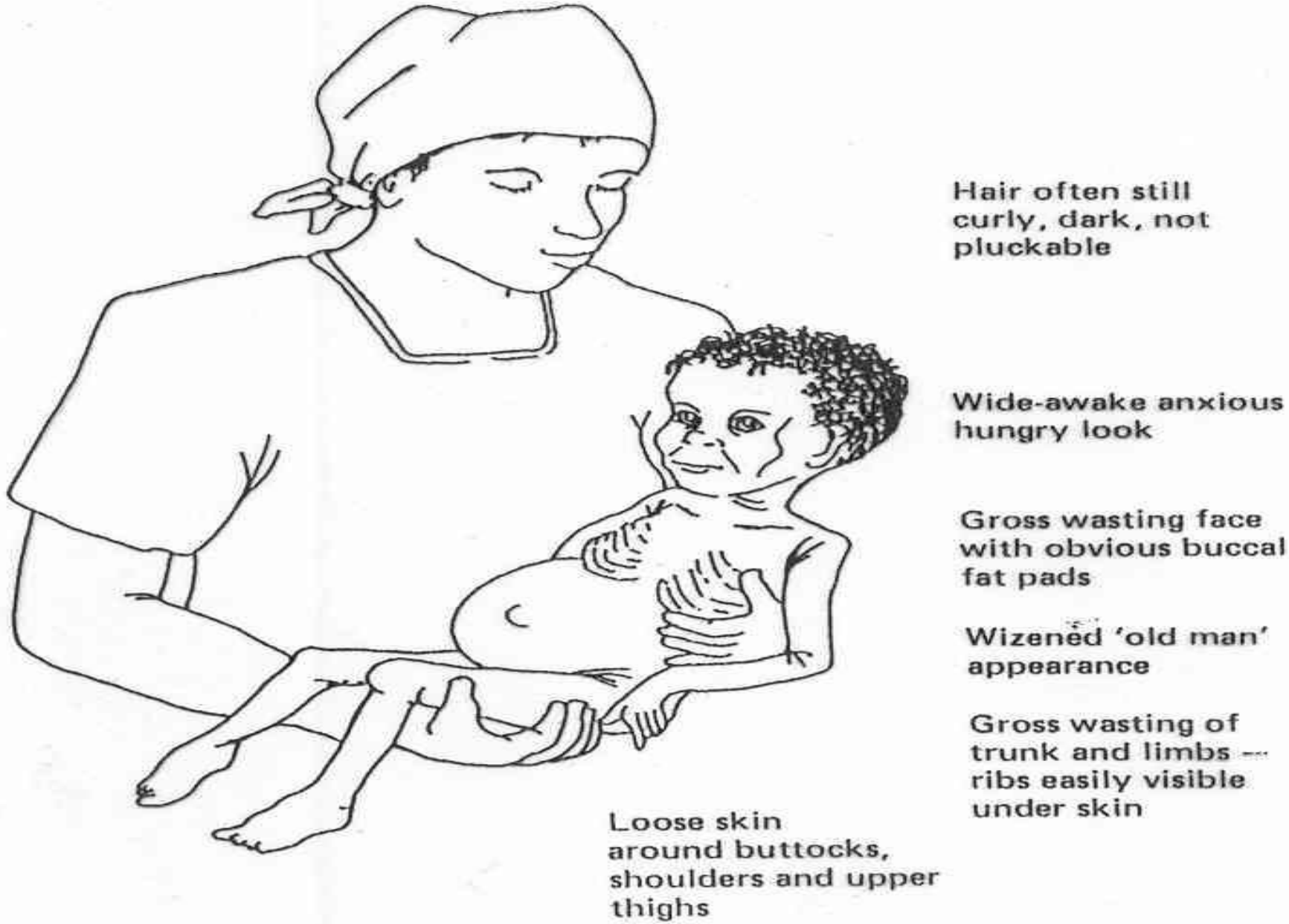


Figure 8.2 Clinical features of marasmus.

Sparse, straight, readily pluckable hair

Puffy eyes, mooned face

Apathy, misery, anorexia, anaemia

Wasting upper arms and upper trunk

Hepatomegaly

Oedema of lower arms and legs and lower trunk

Crazy paving scaly skin rash with areas of depigmentation

Ulceration on lower limbs

Figure 8.3 Clinical features of kwashiorkor.

Physical features of Kwashiorkor

Signs and symptoms of malnutrition

- Loss of fat (adipose tissue)
- Breathing difficulties, a higher risk of respiratory failure
- Depression
- Higher risk of complications after surgery
- Higher risk of hypothermia - abnormally low body temperature
- The total number of some types of white blood cells falls; consequently, the immune system is weakened, increasing the risk of infections.
- Higher susceptibility to feeling cold
- Longer healing times for wounds
- Longer recover times from infections
- Longer recovery from illnesses
- Lower sex drive
- Problems with fertility
- Reduced muscle mass
- Reduced tissue mass
- Tiredness, fatigue, or apathy
- Irritability

Thank you