Protein Calorie Malnutrition

Ms. Sainika H. Kanzaria
Assistant Professor
Department of Pharmacology & Pharmacy Practice,
Saraswati Institute of Pharmaceutical Sciences,
Dhanap, Gandhinagar

Definitions

- It is a nutritional disorder where the amount of nutrients taken are less than body requirement characterized by weight loss, oedema and retarded growth.

Causes

- **Worm infestation**: These compete with the child for the nutrients in foods that are consumed resulting in inadequate nutrient available for the body's metabolic processes
- **Infections:** When a child has an infection, it becomes febrile and burn up extra calories and a lot of proteins are used to fight off infection. This coupled with anorexia
- **Bad traditional practices**: Some traditional practices where children are disadvantaged during meals by being given bones while adults retain the meat, may lead to malnutrition.

Causes cont

- **Failure to increase the amount of food** intake as the child grows to correspond with the increase in demand (e.g. a child after 6 months needs extra food in addition to breast milk)
- **Lack of knowledge** on proper preparation of food: This may lead to over cooking with subsequent loss of nutrients.

Causes cont

- **Early weaning with no proper replacement** feeds: This may lead to development of malnutrition.
- **Early or sudden separation of the child from the mother** e.g. by death.
- **Diarrhoea:** This may lead to poor digestion and absorption of nutrients.
- **Poverty**; The family may be unable to affort the food to meet the child's demand leading to malnutrition.

Types of malnutrition

- Marasmus
- Kwashiorkor
- Marasimic kwashiorkor (presents with a combination of the above two)
- Obesity (this is a problem of the developed countries)

Marasmus

- It is a severe form of protein energy malnutrition which occur in children due to inadequate intake of primarily carbohydrates however there may also be inadequate proteins and fats intake and it is characterized by severe weight loss, and stunted growth.
- Marasmus usually develops between the ages of six months and one year in children who have been weaned from breast milk or who suffer from weakening conditions like chronic HIV/AIDS

Marasmus

Severe Marasmus

Pathophysiology

- The inadequate intake of carbohydrates leads to reduced available nutrients to the body tissues.
- This state of affairs makes the body to start adjusting metabolically and in terms of hormone secretion (reductive adaptation).
- By doing so it make the most efficient use of the available resources
- This ensures survival amid inadequate intake.
- The adjustment occurs in the following ways:
- The production of thyroxin is decreased in order to reduce the metabolic rate so that less energy is required
- The production of insulin reduces to try and maintain blood sugar levels

Pathophysiology cont

- As a result growth is suspended This accounts for the retardation that is seen in malnourished child.
- To meet the body's energy demand the body starts to break down the fats and muscles tissue to generate energy so that the essential metabolic activities are kept going despite the inadequate carbohydrate intake.
- This accounts for the severe wasting seen in a Marasimic child
- This efficient use body resources means that serum levels of proteins, glucose and amino acids remain normal in a Marasimic child

Pathophysiology cont

- The body literally digests itself to maintain the serum levels.
- As a result there is progressive loss of fat and muscle tissue as well as depletion of electrolytes.
- Therefore the child appears emaciated
- Cell-mediated immunity, phagocitic function, and the complement system are highly compromised which renders the child prone to infection which may further worsen the condition.
- Reductive adaptation causes the body not to respond in the usual way to presence of infection in form of inflammation and fever hence masking the infection that may be present.

Signs and symptoms of marasmus

- Severe wasting due to body fat and tissue decomposition. (Child looks a little old man or a monkey)
- Skin is thin flaccid, dry and wrinkled and seems to be too big for the body (baggy pants)
- Child has good appetite though emaciated.
- The child looks alert and may cry at the sight of food
- The serum proteins are normal
- Child may also have diarrhoea due to infection and impaired absorption

Signs and symptoms of marasmus cont

- There is stunting due to due to inadequate intake of carbohydrates
- There can be superficial formy spots on the conjunctiva (Bitot's spot) usually due to Vitamin A deficiency

Diagnosis

- This is normally made clinically (peripheral oedema)
- History taking may also review predisposing factors
- Serum protein may be normal
- Blood for urea and electrolyte will show imbalances
- Blood glucose must be done to rule out hypoglycaemia
- Blood slid to rule out malaria
- Blood for Hemoglobin to rule out anaemia
- Blood culture to rule out presence of bacterial infection in the blood
- X ray may be done to rule out pneumonia

Kwashiorkor

- It is a type of protein Energy malnutrition which usually occurs after 12 months and is due to inadequate or low proteins in the diet and is characterizes by oedema, apathy and moon shaped face .
- This condition usually appears at the age of about 12 months when breastfeeding is discontinued, but it can develop at any time during a child's formative years

kwarshiokor

Severe kwarshiokor

Pathophysiology of kwashiorkor

- Insufficient intake of protein will lead to poor tissue replacement and development
- There will also be reduced synthesis of digestive enzymes and plasma proteins
- Lack of digestive enzymes leads to GIT upset, atrophy of mucosa lining and intestinal vili where absorption take place
- This will culminate in mal-absorption leading to diarrhoea

Pathophysiology of kwashiorkor cont

- Diarrhoea will in turn lead to loss of electrolytes such as potassium
- In the liver protein content is reduced while fat is increase, therefore the liver increase in size leading to hepatomegally.
- Reduced plasma protein leads to reduced oncotic pressure
- This leads to fluid shift from the intravascular spaces to the extra vascular spaces causing Oedema

Signs and symptoms of Kwashiorkor

- Pitting oedema due of the feet, ankles and eventually spreading to the rest of the body due to inadequate due to reduced plasma protein
- The child has apathy and is anorexic due to inadequate food intake and impaired gastro intestinal mucosa respectively
- Child has a moon shaped face due to oedema
- The hair is dry, thin, sparsely distributed, brownish red and easily pulled out due to lack of protein which is essential for formation of hair

Signs and symptoms of Kwashiorkor cont

- There is hyper pigmentation of the skin with patches and in some cases there is epidermis peeling leaning a tender wet skin which may become infected.
- The temperature may be normal and sometimes hypothermic in the presence of infection due to low immunity and reduced metabolic rate
- Distended abdomen

Signs and symptoms of Kwashiorkor cont

- Weight loss due to under nourishment
- Stunted growth due to inadequate intake of food needed to facilitate growth
- Delayed puberty due to growth retardation
- Impaired immunity due to lack of protein which are needed for normal functioning of the immune system.

Table 8.3 Contrasting features of kwashiorkor and marasmus.

FEATURE	KWASHIORKOR	MARASMUS
Defnition	Protein defciency with sufcient calorie intake	Starvation in infants with overall lack of calories
Clinical features	Occurs in children between 6 months and 3 years of age	Common in infants under 1 year of age
	Growth failure	Growth failure
	Wasting of muscles but preserved adipose tissues	Wasting of all tissues including muscles and adipose tissues
	Oedema, localised or generalised, present	Oedema absent
	Enlarged fatty liver	No hepatic enlargement
	Serum proteins low	Serum proteins low
	Anaemia present	Anaemia present
	'Flag sign'—alternate bands of light (depigmented) and dark (pigmented) hair	Monkey-like face, protuberant abdomen, thin limbs
Morphology	Enlarged fatty liver	No fatty liver
	Atrophy of diferent tissues and organs but subcutaneous fat preserved	Atrophy of diferent tissues and organs including subcutaneous fat

Diagnosis

- This is normally made clinically (peripheral oedema)
- History taking may also review predisposing factors
- Serum protein may be low
- Blood for urea and electrolyte will show imbalances
- Blood glucose must be done to rule out hypothermia
- Blood slid to rule out malaria
- Blood for Hemoglobin to rule out anaemia
- Blood culture to rule out presence of bacterial infection in the blood
- X ray may be done to rule out pneumonia

NOTE

- When the signs and symptoms of marasmus and kwashiorkor are present are both present the condition is called MARASIMIC KWASHIORKOR (MARASIMIC KWASH)
- ALTHOUGH KWASHIORKOR AND MARASMUS HAVE DIFFERENT PRESENTATIONS THE TREATMENT IS THE SAME

WHO MANAGEMENT GUIDELINES

- The protocol for management of severely malnourished children developed by WHO consists of three phases:
  - initial treatment,
  - rehabilitation, and
  - follow-up.

WHO MANAGEMENT GUIDELINES cont

- The initial phase is a critical time, with emphasis on treatment of hypoglycemia, hypothermia, and dehydration, and the detection and treatment of infection.
- Feedings are begun in this period and advanced after the first week as the rehabilitation phase begins.
- Deficiencies of electrolytes and vitamins are treated throughout initial and rehabilitation phases, except that iron supplementation is delayed until the beginning of rehabilitation.

WHO MANAGEMENT GUIDELINES cont

- The **Rehabilitation phase** lasts approximately two to six weeks. During this phase, the mother is trained to continue care at home and any social problems are addressed.
- Emotional stimulation and sensory development of the child extends throughout the initial and rehabilitation phases.
- In the follow-up phase, the physical, mental, and emotional development of the child are monitored after discharge.

Initial Phase

- The initial phase is a critical time that emphasizes treatment of disorders that may be life-threatening, including hypoglycemia, hypothermia, infection, and dehydration.
- The composition of the initial diet and the electrolyte solution are outlined below .
  - Hypoglycemia and hypothermia occur with fasting of four to six hours duration or can be precipitated by a serious systemic infection.
  - These conditions may be associated with apnea.
  - These disorders usually respond to early and frequent feedings and temperature control.

Initial Phase Cont

- Blood glucose should be monitored if hypothermia or apnea occurs. Treatment priorities are temperature control (warming), antibiotics for infection, and rehydration.
- Feedings are begun in this period. They are advanced after the first week as the rehabilitation phase begins.

  Warming — If the rectal temperature is <35.5 degrees C, the child should be warmed.
- This can be accomplished using a warm blanket or with an incandescent lamp directed on, but not touching, the child's body. Hypothermia may be a sign of sepsis.

Initial Phase Cont

- Antibiotics — Broad-spectrum antibiotics should be started because many children with severe malnutrition have systemic infections
- The WHO recommends the following choices of antibiotics for the initial treatment of malnourished children, based on likely pathogens and antibiotic availability in developing countries:
- If no apparent complications:
- - Cotrimoxazole (25 mg/kg sufamethoxazole with 5 mg/kg trimethoprim twice daily) orally for five days

- If there are complications (hypoglycemia, hypothermia, lethargy):
- -Ampicillin (50 mg/kg IM/IV every six hours) for two days, then amoxicillin (15 mg/kg orally three times daily) for five days

  - AND gentamicin (7.5 mg/kg IM/IV) once daily for seven days
- If the child fails to improve within 48 hours:
- - Add chloramphenicol (25 mg/kg IM/IV every eight hours) for five days

Initial Phase Cont (Rehydration)

- The malnourished child may have acute and persistent diarrhea and has reduced homeostatic capacity to cope with water and potassium deficits.

  Dehydration in the malnourished child should be treated with oral rehydration whenever possible.

- In the setting of severe malnutrition, intravenous

- As a result, IV infusion should be used only in the setting of severe hypovolemia or shock. ReSoMal — ReSoMal is an oral rehydration solution developed for use in severely malnourished children.
- It consists of the standard WHO rehydration oral solution (ORS) that has been modified by decreasing sodium and increasing potassium concentrations .

- This solution is used to correct the hypernatremia and potassium deficiency that occur in severe malnutrition.
- ReSoMal contains glucose (125 mmol/L), sodium (45 mmol/L), potassium (40 mmol/L), magnesium (3 mmol/L), zinc (0.3 mmol/L), and copper (0.045 mmol/L).
- This solution also can be made by diluting one packet of the standard WHO-recommended ORS in two, instead of one, liters of water and adding 50 g of sucrose (25 g/L) and 40 mL (20 ml/L) of mineral mix solution

Initial Phase (Rehydration) cont

- Volume replacement — A volume of 70 to 100 mL/kg body weight of ReSoMal usually is enough to restore normal hydration.
- This amount should be given over the course of 12 hours, starting with 5 mL/kg every 30 minutes for the first two hours, and then 5 to 10 mL/kg per hour.
- This rate is slower than the rate of rehydration for children without severe malnutrition.
- The child should be assessed at least hourly. The volume administered depends upon the amount the child will drink, the volume of ongoing losses in stool and/or emesis, and any signs of overhydration, especially heart failure.
- Oral rehydration should be stopped if an increase in respiratory and/or pulse rates, engorgement of the jugular veins, or increasing edema (eg, puffy

Initial Phase (Rehydration) cont

- Rehydration is complete when the child no longer is thirsty and produces urine, and signs of dehydration have resolved.
- Fluids given to maintain hydration should be based upon the child's willingness to drink and the amount of ongoing losses in the stool.
- As a guide, children younger than 2 years of age should be given 50 to 100 mL (between one-fourth and one-half of a large cup) of ReSoMal after each loose stool; older children should receive 100 to 200 mL. This treatment is continued until the diarrhea stops.

Refeeding

- Feedings should be reinitiated using a formula containing 75 kcal/100 mL (F-75) . The energy intake should equal approximately 80 kcal/kg per day and not exceed 100 kcal/kg.
- The formula is fed in small amounts and at frequent intervals because intestinal motility and gastric acid production are decreased in severe malnutrition.
- Infants can be fed orally using a cup and spoon; a dropper or syringe can be used in weaker infants.

REHABILITATION PHASE

- The rehabilitation phase begins as the appetite improves. At this time, the formula is gradually changed to F-100, which contains 100 kcal/100 mL.
- The child should be fed at least five times daily during the rehabilitation phase. Feeding frequency can be decreased to three times daily when the child attains -1 SD of the median NCHS/WHO reference value.
- The adjustment of feeding frequency should take place under supervision before discharge. It is done by gradually reducing and then stopping the supplementary feeds of F-100 while adding or increasing the mixed diet until the child is eating a diet similar to what will be eaten at home.

Dietary supplements

- Dietary supplements of vitamins and mineral
- Providing supplementation with vitamin A, iron, and folate is especially important.
- Multivitamins are provided at approximately 1.5 times the dose given to a normal child.

  Vitamin A — Severely malnourished children have vitamin A deficiency that may result in blindness.
- Thus, a large dose of Vitamin A should be given on the day of hospital admission.
- Vitamin A is given orally in a dose according to age: younger than 6 months, 50,000 IU; 6 to 12 months, 100,000 IU; older than 12 months, 200,000 iu.

Dietary supplements cont

- Iron and folate — Nearly all severely malnourished infants have anemia.
- Supplementation with folic acid should begin on the day of admission (initial dose 5 mg, followed by 1 mg daily).
- Elemental iron (3 mg/kg per day in three divided oral doses) is begun as the rehabilitation phase starts and is continued for three months.
- Iron should not be given during the initial phase because it can overwhelm the body as it is in reductive adaptation phase.
- When making decisions regarding routine prophylactic iron and folic acid supplementation of children in developing countries, the local disease patterns and the availability and use of treatment services for common infectious diseases must be considered .

Summary of treatment

- AIMS OF TREATMENT:

¬ To treat hypothermia, hypoglycemia

¬ Supply nutritious diet

¬ Correct dehydration and electrolyte imbalance

¬ Treat precipitating infections e.g. TB, measles etc.

¬ Ensure attention and contact between mother, child and health care staff

¬ Teach the parents how to prevent relapse

Summary of treatment

- Admit child in a warm environment to treat and prevent hypothermia
- Give glucose to treat hypoglycemia 5ml/kg body weight of 10% dextrose.
- Offer F-75 a special formula for malnourished children until the condition stabilizes (Initial phase 1-7 days)
- After that start F-100
- Then Vitamin A replacement 50,000 or 100,000 iu

Summary of treatment cont

- Ferrous caliphate 200mg bd for 14/7 after the initial phase (giving iron too early in treatment may lead to free iron in the body which is highly reactive and promote formation of free radicals which may engage in uncontrollable chemical reactions with damaging effects, Free iron bacterial growth and make some infections worse.
- The body attempts to protect itself from free iron by converting it to ferritin ,this process requires energy and amino acids which may be diverted from other critical activities
- Antibiotic e.g. cotrimoxazole 5-10ml bd for 5/7
- Potassium chloride 10-30mg tds or 5mls tds
- Deworming vermox 100mg BD for 3/7 or 500mg start

Discharge Phase

- During rehabilitation, preparations should be made to ensure that the child is fully reintegrated into the family and community after discharge.
- The family must be prepared to prevent recurrence of severe malnutrition.
- If possible, the home should be evaluated by a social worker or nurse before discharge to ensure an adequate environment.

Discharge criteria

- A child is considered ready for discharge when his or her weight-for-height has reached -1 SD (90 percent) of the median NCHS/WHO reference values.
- To achieve this goal, the child should eat four to six meals daily. Some children may be discharged before the target weight-for-height has been reached. In these cases, continued outpatient care is needed through full recovery.

Discharge criteria cont

- Other discharge criteria include completed treatment of all nutritional deficiencies and infections and initiation or continuation of the standard immunization schedule.
- The mother or caregiver should be willing to care for the child.
- She should be able to provide food, appropriate toys, and initial treatment for diarrhea and infections.
- A health worker should be available to provide follow-up of the child and support for the mother.

Complications of the disease

- Anaemia
- Hypothermia
- Dehydration
- Recurrent infections
- Hypoglycemia
- Mental retardation
- Growth retardation

Nursing care

- To treat hypothermia, hypoglycaemia
- Supply nutritious diet
- Correct dehydration and electrolyte imbalance
- Treat precipitating infections e.g. TB, measles etc.
- Ensure attention and contact between mother, child and health care staff
- Teach the parents how to prevent relapse

Environment

- I will nurse my patient in a malnutrition unit in order to ensure that the environment is suitable a patient with malnutrition.
- I will close the near by windows to prevent draught thereby prevent hypothermia
- I will nurse my patient in a clean environment to prevent acquisition of nosocomial infections because my patient has low immunity.

Environment

- The patient will be, reverse barrier nursed to prevent nosocomial infection.
- The room should be well ventilated to promote air circulation and prevent R.T.I.
- I will include the necessary equipment such as weighing scale to monitor patient weight, stadiometer for taking height of my patient because the height for age is affected by the condition. I will also include the drip stand for intra venous infusions

Environment cont

- Oxygen apparatus will be made available for use when in time of dyspnoea
- The room should be well lit for easy observation.
- Patient will be nursed in a railed bed to prevent fails as patient is dyspnic

Position

- The patient will be propped up to relieve dyspnoea.
- In case of shock the foot end of the bed will be elevated to promote blood supply to the brian.
- As the condition improves I will allow the patient to adopt any position of comfort

Prevention of nosocomial infections

- I will reverse barrier nurse the patient to acquisition of infection
- I will was hand before after attending to the patient to prevent infection spread.
- I will not allow people with infections to visit the patient because my patient ha low immunity and can easily get infected

Treatment and prevention of hypothermia

- I will nurse my patient in a warm room to treat and prevent hypothermia
- I will ensure that the patient is well covered with warm clean clothes to prevent hypothermia
- I will ensure that all health care providers warm their hands before touching the patient to prevent hypothermia
- I will close the windows to prevent draught thereby prevent hypothermia.

Promotion of mother child bonding

- I will encourage the mother to hold the child and play with it in order to promote mother child bonding.
- I will allow the mother free access to the child in order to promote bonding.
- I will involve her in the care of the child to promote cooperation and mother baby bonding

Rest and activity

- The patient will be on bed rest in the acute phase in order to reduce the demand for oxygen.
- In severe cases of anaemia, complete bed rest is necessary until HB is raised to prevent hypoxia.
- I will plan my nursing care in such a way that periods of rest are allowed in order to conserve patients energy.
- I will provide a quiet environment to promote rest.

Rest / activity

- I will nurse the patient in a quiet room to promote rest
- I will play the radio at low volume to promote rest
- I will answer all phone calls promptly to prevent disturbing the patient there by promote rest
- I will do related procedures in blocks to promote rest
- I will administer prescribed analgesics to relieve headache there by promote rest
- I will ensure that squeaking trolleys a oiled to prevent noise and there by promote rest

Observations

- I will do vital sign and BP to act as the base line data in order to know if the condition is improving or deteriorating
- I will observe for oedema whether improving or getting worse and report to the physician for appropriate interventions.
- I will observe Dyspnea if present will prop up the patient to or if too young to be propped in bed I will allow the mother to hold the child in her arms promote lung expansion and there by relieve dyspnea

Observations cont

- I will observe the pressure area to detect on set of pressure sore development
- I will observe the patient's skin for peeling and use aseptic technique to prevent infection and promote healing.
- I will observe the feeding pattern of my patient and take measures like giving small frequent meals to promote appetite
- I will observe the respirations to detect tachypnoea and report accordingly

Psychological care

- I will explain the disease process in order to raise the knowledge levels and thereby alley anxiety
- I will encourage the care giver and patient to ask question and I will answer accordingly those I cant answer I will refer to the physician to clear misconceptions and promote cooperation.
- I will explain all procedures done on my patient to the care giver in order to allay anxiety and promote cooperation

Psychological care cont

- I will involve a successfully managed case to come and talk to my patient's mother in order to allow her to ask pressing question and get answer this will improve the mother the out look on her child's condition
- I will involve the loved ones in his care in order for him not to feel neglected.
- I will provide diversional therapy in order to shift the patient's mind from the hospital routine and his condition
- I will involve him in planning his own care in order for him not to feel left out
- I will explain to him that as the health care team we are doing everything possible to ensure that he get better in order to promote co-operation

Elimination

- I will provide diet rich in roughage to prevent constipation
- I will prove copious fluids in order to promote renal wash out and there by prevent renal problems

Hygiene

- I will do mouth care with a soft brush to prevent halitosis and causing bleeding because patient has bleeding tendencies
- Any soiled linen and clothes will be changed to promote comfort
- I will offer baths to my patient in order to remove dead epithelium and promote comfort

Hygiene cont

- I will do hair care to promote self esteem and also prevent pediculosis
- I will do nail care to prevent auto infection and bruising self which can lead to bleeding

Nutrition

- I will provide F-75 in the initial 7day to stabilize my patient to provide necessary nutrients
- After my patient stabilizes in will offer F -100 to provide the needed nutrients to the patient and promoting recovery
- If the child is still breast feeding I will encourage the mother to continue breast feeding in order to promote recovery

Nutrition cont

- I will provide protein foods like fish and beans to promote replacement of worn out tissues
- Vegetables and fruits will be provided to raise the immunity and promote skin and mucous membrane
- I will provide a ReSomal to prevent dehydration due to excessive sweating and promote bringing up of phlegm

Nutrition cont

- I will serve small frequent meals to promote appetite
- I will provide Iron rich food such as liver, meat, green leafy vegetables to promote blood formation when the condition improves
- I will do regular mouth washes in order to promote appetite

Medication

- I will administer prescribed drugs like Septrin 5mg BD for 5/7 to promote recovery
- I will ensure that I offer my patient iron and folic acid to promote blood formation
- I will ensure that the drugs are swallowed in my presence to promote recovery.

Medication

- I will ensure that I sign for the drug to prevent over dosing the patient
- I will give the drug at the right time and frequency to ensure required plasma level are maintained thereby promoting recovery

Advise on discharge

- I will educate the patient's mother about his condition in order to create awareness and prevent recurrence of the condition
- I will explain the need for taking the medication in order to promote compliance and recovery.
- I will talk to the patient's mother about the need to giving the child a balanced diet using locally available foods in order to boost the immunity and blood formation.

Advise on discharge

- I will educate the patient about the need keep the review dates so that his progress is monitored to ensure full recovery
- I will advise the patient's mother on importance of dewormed at least twice a year in order prevent worms thereby prevent malnutrition worm infestation thereby prevent anaemia.
- I will advise my patient to have malaria promptly treated to avoid haemolysis which can lead anaemia and cause anorexia which may lead to malnutrition in the long run

Prevention

- Encouraging breast feeding for at least 2 years and avoid bottle feeding if possible to prevent diarrhoea and thereby preventing malnutrition
- Weaning should be done gradually and as breast milk becomes inadequate introduce new food to prevent inadequate intake which may lead to malnutrition
- I will teach the mother how to prepare a nutritious diet using locally available food to prevent malnutrition

Prevention cont

- I will discourage traditional practices that disadvantage children during meal thereby preventing malnutrition
- Encourage mother to be taking the children for growth monitoring for early detection and treatment of any condition that may lead to malnutrition
- Making maternal child health services available and affordable where mothers will be educated on proper health practices thereby preventing malnutrition.
- Encouraging food self reliance in communities can help to reduce malnutrition

VITAMIN

- SVitamins are organic substances which ***cannot be synthesised within the body*** and are essential for maintenance of normal structure and function of cells.
- Thus, these substances must be provided in the human diet.
- Most of the vitamins are of plant or animal origin so that they normally enter the body as constituents of ingested plant food or animal food.
- They ***are required in minute amounts*** in

- Vitamins are conventionally divided into 2 groups:

1. **Fat-soluble vitamins** There are 4 fat-soluble vitamins: A, D, E and K. They are absorbed from intestine in the presence of bile salts and intact pancreatic function.
2. **Water-soluble vitamins** This group conventionally consists of vitamin C and members of B complex group. Besides, choline,

biotin and flavonoids are new

Table 8.4 Vitamin deficiencies.

	VITAMINS	DEFICIENCY DISORDERS
I.	FAT-SOLUBLE VITAMINS	
	Vitamin A (Retinol)	Ocular lesions (night blindness, xerophthalmia, keratomalacia, Bitot's spots, blindness) Cutaneous lesions (xeroderma) Other lesions (squamous metaplasia of respiratory epithelium, urothelium and pancreatic ductal epithelium, subsequent anaplasia; retarded bone growth)
	Vitamin D (Calcitriol)	Rickets in growing children Osteomalacia in adults Hypocalcaemic tetany
	Vitamin E (α-Tocopherol)	Degeneration of neurons, retinal pigments, axons of peripheral nerves; denervation of muscles Reduced red cell lifespan Sterility in male and female animals
	Vitamin K	Hypoprothrombinaemia (in haemorrhagic disease of newborn, biliary obstruction, malabsorption, anticoagulant therapy, antibiotic therapy, difuse liver disease)
II.	WATER-SOLUBLE VITAMINS	
	Vitamin C (Ascorbic acid)	Scurvy (haemorrhagic diathesis, skeletal lesions, delayed wound healing, anaemia, lesions in teeth and gums)
	Vitamin B Complex	
	(i) *Thiamine (Vitamin B_1)*	Beriberi ('dry' or peripheral neuritis, 'wet' or cardiac manifestations, 'cerebral' or Wernicke-Korsakof's syndrome)
	(ii) *Riboflavin (Vitamin B_2)*	Ariboflavinosis (ocular lesions, cheilosis, glossitis, dermatitis)
	(iii) *Niacin/Nicotinic acid (Vitamin B_3)*	Pellagra (dermatitis, diarrhoea, dementia)
	(iv) *Pyridoxine (Vitamin B_6)*	Vague lesions (convulsions in infants, dermatitis, cheilosis, glossitis, sideroblastic anaemia)
	(v) *Folate/Folic acid*	Megaloblastic anaemia
	(vi) *Cyanocobalamin (Vitamin B_{12})*	Megaloblastic anaemia Pernicious anaemia
	(vii) *Biotin*	Mental and neurological symptoms
	Choline	Fatty liver, muscle damage
	Flavonoids	Preventive of neurodegenerative disease, osteoporosis, diabetes

OBESITY

- Dietary imbalance and overnutrition may lead to obesity.
- Obesity is defined as an excess of adipose tissue that imparts health risk; a body weight of 20% excess over ideal weight for age, sex and height is considered a health risk.
- The most widely used method to gauge obesity is body mass index (BMI).
- A cut-off BMI value of 30 is used for obesity in both men and women.

Formula for body mass index (BMI):

$$BMI = \frac{weight}{height^2} \times 703$$

Write a Python Program that asks the user for weight and height and then displays **weight class** based on BMI (use the table below for this).

BMI	**Weight class**
below 18.5	underweight
18.5 - 24.9	normal
25.0 - 29.9	overweight
30.0 and up	Very overweight

ETIOLOGY of OBESITY

- Obesity results when ***caloric intake exceeds utilisation***. The imbalance of these two components can occur in the following situations:

1. ***Inadequate pushing of oneself away from the dining table causing overeating.***
2. Insufficient pushing of oneself out of the chair leading to inactivity and sedentary life style.
3. Genetic predisposition to develop obesity.
4. Diets largely derived from carbohydrates and fats than protein-rich diet.
5. Secondary obesity may result following a number of underlying diseases such as hypothyroidism, Cushing's disease etc.

PATHOGENESIS of OBESITY

- The lipid storing cells, adipocytes comprise the adipose tissue.
- Besides the generally accepted role of adipocytes for fat storage, ***these cells also release endocrine-regulating molecules.***
- These molecules include: energy regulatory hormone (leptin), cytokines (TNF-a and interleukin-6), insulin sensitivity regulating agents (adiponectin, resistin and RBP4), prothrombotic factors (plasminogen activator inhibitor), and blood pressure regulating agent (angiotensinogen).

- Adipose mass is increased due to enlargement of adipose cells due to excess of intracellular lipid deposition as well as due to increase in the number of adipocytes.
- The most ***important environmental factor is excess consumption*** of nutrients which can lead to obesity.
- However, underlying molecular mechanisms of obesity are beginning to unfold based on observations that ***obesity is familial and is seen in identical twins.***

EFFECTS OF OBESITY

1. Hyper insulinaemia
2. Type 2 diabetes mellitus
3. Hypertension
4. Hyper lipoproteinaemia
5. Atherosclerosis
6. Non alcoholic fatty liver disease (NAFLD)
7. Hypoventilation syndrome (Pickwickian syndrome)
8. Osteoarthritis

STARVATION

- Starvation is a state of overall deprivation of nutrients.
- Its causes may be the following:

i) deliberate fasting—religious or political

ii) famine conditions in a country or community

iii)secondary undernutrition such as due to chronic wasting diseases (infections, inflammatory conditions, liver disease), cancer etc.

A starved individual has lax, dry skin, wasted muscles and atrophy of internal organs.

PATHOGENESIS OF STARVATION

- Under normal metabolic conditions, the human body relies on free blood glucose as its primary energy source. The ***level of blood sugar is tightly regulated***; as blood glucose is consumed, the pancreas releases glucagon, a hormone that stimulates the liver to convert stored glycogen into glucose. ***The glycogen stores are ordinarily replenished after every meal***, but ***if the store is depleted before it can be replenished, the body enters hypoglycemia***, and begins the starvation response.
- After the exhaustion of the glycogen reserve, and for the ***next 2–3 days***, fatty acids become the principal metabolic fuel. At first, the brain continues to use glucose. If a non-brain tissue is using fatty acids as its metabolic fuel, the use of glucose in the same tissue is switched off. Thus, when fatty acids are being broken down for energy, all of the remaining glucose is made available for use by the brain. Basically the body will use up stored fat cells first, then move on to muscles.
- ***After 2 or 3 days of fasting***, the liver begins to synthesize ketone bodies from precursors obtained from fatty acid breakdown. The brain uses these ketone bodies as fuel, thus cutting its requirement for glucose. ***After fasting for 3 days, the brain gets 30% of its energy from ketone bodies. After 4 days, this goes up to 75%.***

- ***After several days of fasting, all cells in the body begin to break down protein***. This releases alanine and lactate produced from pyruvate into the bloodstream, which can be converted into glucose by the liver. Since much of human muscle mass is protein, this phenomenon is responsible for the wasting away of muscle mass seen in starvation. However, the body is able to selectively decide which cells will break down protein and which will not.
- About 2–3 g of protein has to be broken down to synthesize 1 g of glucose; about 20– 30 g of protein is broken down each day to make 10 g of glucose to keep the brain alive. However, this number may decrease the longer the fasting period is continued in order to conserve protein.

- Starvation ensues when the fat reserves are completely exhausted and protein is the only fuel source available to the body. Thus, after periods of starvation, the loss of body protein affects the function of important organs, and death results, even if there are still fat reserves left unused. (In a leaner person, the fat reserves are depleted earlier, the protein depletion