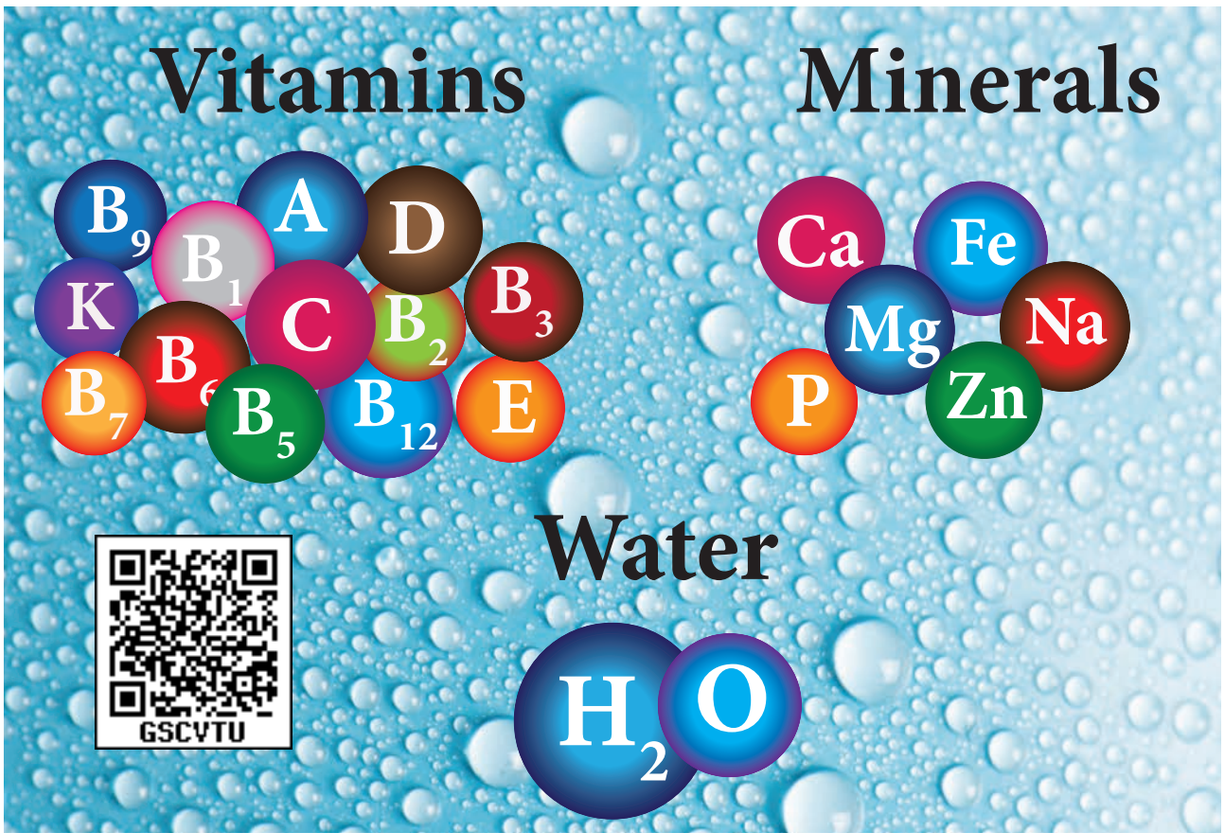
Unit 11

Vitamins, Minerals and Water

Vitamins and Minerals are micronutrients. They help to protect body from diseases. These micronutrients must be provided through the food we eat or through supplements. Vitamins are complex organic molecules that serve primarily as coenzymes or regulators of body metabolism. Minerals in contrast, are simple elements with important roles in both structure and function of the body. Water is one of the most important substances on earth's surface. All plants and animals depend on water for survival. Intake of water and loss must be balanced. Water is obtained through food and drinking water. Water balance in the body is regulated by minerals like sodium and potassium.

In this lesson, the students will be able to:

- understand different types of vitamins, minerals and their functions in the body.



Vitamins, Minerals and Water

DO YOU KNOW...?

Vitamins are the discovery of 20th century scientists. In the history of nutrition, the findings of Casmir Funk, 1911 was a turning point who propounded the 'Vitamine' theory by feeding animals purified diet. Takaki, a physician in the Japanese Navy, first demonstrated that fatal diseases like beriberi could be treated with rice bran, vegetables, fish and meat. Thus the study of vitamins brought to light about 17 different vitamins. Each one of them has its own history, chemistry, structure, function, sources, requirements and disorder symptoms.

- know the important sources and deficiency symptoms of vitamins, minerals and water.
- importance of water in day to day life.

11.1 Classification of Vitamins

Vitamins differ from each other in physiological function, chemical structure, and distribution in foods. Plants synthesize all vitamins they require and therefore vegetables and fruits are rich sources of vitamins. They are broadly divided into two categories, on the basis of solubility in fats or water.

11.2 Fat Soluble Vitamins

Fat – soluble vitamins are soluble in fats and fat solvents. They are insoluble in water. So these vitamins are utilized only if there is enough fat in the body.

11.2.1 Vitamin A

Vitamin A was discovered in 1909 and its chemical name is retinol. Vitamin A compounds include retinol, retinal and retinoic acid. It has a specific function in the retina of the eye. Vitamin A occurs only in foods of animal origin. Vitamin A activity is possessed by carotenoids found in plants. Hence carotenoids are called Provitamin A.

Provitamins are substances that are chemically related to a vitamin but it must be changed by the body into the active form of the vitamin. Carotene is known as precursor of Vitamin A.

Functions

- It provides the required stimulation for vision in the retina and is essential for maintaining normal vision.

Table 11.1 Classification of Vitamins

Fat soluble vitamins	A, D, E and K. Fat soluble vitamins are stored in the liver and fatty tissues. These are not readily excreted from the body.
Water soluble vitamins	B (B_1, B_2, B_3, B_5, B_6, B_{12}) and C Water soluble vitamins travel in the blood and are stored in limited amounts. These are readily excreted from the body through urine.

Fig 11.1: Food Sources of Vitamin A

- It helps in maintaining healthy skin and epithelial tissues.
- It is important for proper growth of bones.
- It helps in normal development of foetus
- It protects the mucous membrane of the digestive, respiratory and urinary tracts against infection.

Food Sources of Vitamin A

Vitamin A is present as retinol in animal sources such as egg yolk, fish (halibut, shark, cod), liver and cod liver oil. In plants, it is found in the form of carotene which gets converted to vitamin A in the body. Carrot, beetroot, turnip, papaya, mango, pumpkin, tomatoes, green leafy vegetables, drumstick, whole milk, butter, ghee etc., are very good sources of carotene.

Symptoms of Vitamin A deficiency

1. **Night blindness:** This is also called as Nyctalopia. Initially there is itching, burning and inflammation of eyelids and the person gradually loses vision in dim light.
2. **Keratomalacia:** This occurs due to poor intake or poor absorption of vitamin A. When conjunctival xerosis (conjunctival dryness) is not treated it may develop into a condition known as keratomalacia where the Cornea becomes dull and cloudy.
3. **Xerophthalmia:** The conjunctiva and corneaof the eyes become extremely dry, thickened and wrinkled followed by progressive cloudiness. This is due to keratinisation of the epithelial cells over the cornea. This condition

is extremely common among all age groups in India and other developing countries where the vitamin A intake is low.

4. **Bitot's spot:** These are silver grey foamy deposits on the delicate membranes covering the white of the eyes. Softening of the cornea may lead to corneal infection, perforation and degenerative tissue changes, which may result in blindness.
5. Skin becomes rough, dry and scaly. This condition is known as **toad's skin.**

ACTIVITY - 1

Why Xeropthalmia condition is extremely common among all age groups in India and other developing countries?

11.2.2 Vitamin D

Vitamin D is otherwise known as 'sunshine vitamin' as it can be synthesized from sunlight by our body. Hence, vitamin D requirements of Indians are considered to

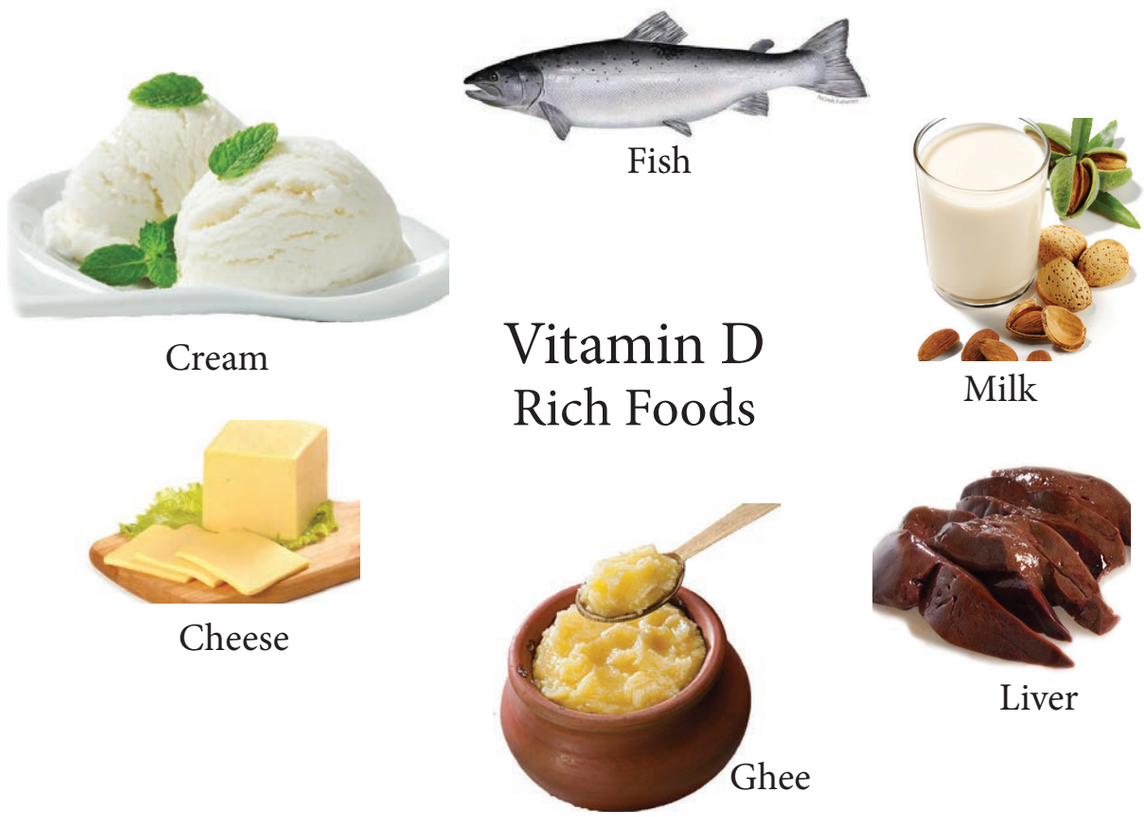


Fig 11.2: Food Sources of Vitamin D

be met entirely by exposure to sunlight. In the absence of exposure to sunlight a daily intake of 400 IU vitamin D is suggested. Vitamin D is produced under the skin after exposure to ultraviolet rays. Vitamin D is now considered as a pro hormone rather than a vitamin and is required for Calcium absorption and bone formation.

DO YOU KNOW...?

Vitamin D:

D_2 (ergocalciferol) and D_3 (cholecalciferol)

Functions

- It helps in the formation of bones and teeth.
- It also improves the calcification of bones.
- It helps to increase the absorption of calcium and phosphorus.
- It helps in increase of calcium content in bones and blood.

Sources of Vitamin D:

Sunlight: Exposure of skin to sunlight brings about synthesis of vitamin D from 7 dehydrocholesterol.

Food sources: Cod liver oil, liver, salmon and herring fish, fortified milk, egg yolk, butter, cheese, ghee, cream, fortified milk, etc., are the best sources of Vitamin D.

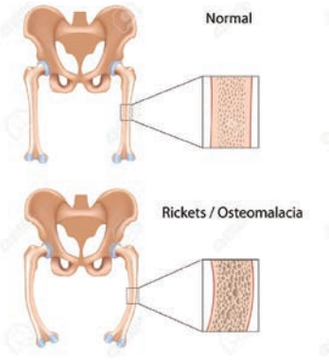
Vitamin D deficiency:

Deficiency in children

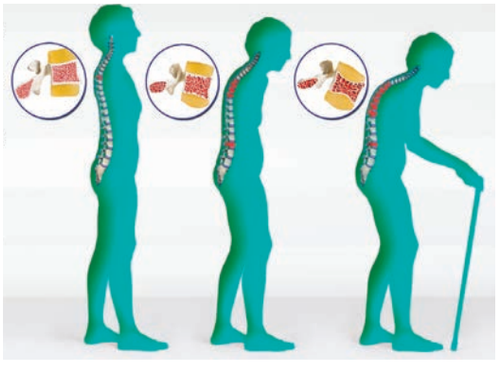
Rickets:

When children don't get enough vitamin D, they cannot absorb enough calcium and phosphorus to mineralize and harden the

A child with Rickets

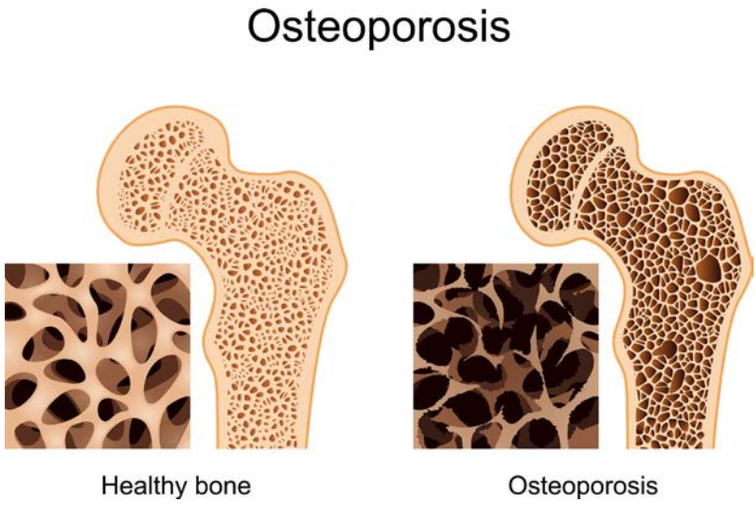


Osteomalacia



Osteoporosis

Fig 11.3: Symptoms of Vitamin D



World Osteoporosis day
October-20

Fig 11.4: Osteomalacia

bones and teeth. If enough calcium and phosphorus are not deposited in the bones, the bones become weak, bend and deformed. They are unable to support their body weight and therefore become bent under pressure. this condition is known as "Rickets"

Symptoms:

- Bow legs (legs bow outwards).
- Knock knees (legs bow inwards with knees touching each other).
- Enlarged joints (The ends of long bones enlarge), Pigeon's Chest (ribs become hollow and bulge out).
- Teeth become soft and irregular in shape.
- Head becomes abnormally large and with bulging sides.

Symptoms in Adults

Osteomalacia:

1. Adults develope osteomalacia. In this disease, the bones become soft, fragile and easily bendable. They are more prone to multiple fractures.
2. Cramps are common.
3. Spinal cord, thorax, limbs and pelvis may be deformed and back may be hunched. Person may suffer from lower back pain.

Symptoms in Oldage

Osteoporosis: It is a calcium related health problem and occurs frequently in old people. This disease is characterized

Table 11.2: Differences between Osteomalacia and Osteoporosis

S.No	Clinical Features	Osteomalacia	Osteoporosis
1.	Skeletal pain	Persistent	Associated with fracture
2.	Fracture	Occasional	Very common
3.	Fracture healing	Delayed	Normal
4.	Deformity	Common	Absent
5.	Response to Vitamin D treatment	Dramatic	Nil
6.	Urinary calcium	Low	Normal or High

by having light porous and spongy bones that break very easily. Severe bone pain is reported which is relieved by immobilization. Fractures occur due to brittle bones.

11.2.3 Vitamin E

Vitamin E protects all cell membranes They are called as tocopherol. This word is derived from the Greek word 'tocos' meaning child birth, and 'phenos' meaning to bear and 'ol' meaning alcohol. The vitamin is stored in all the tissues and the tissue stores can provide protection against the deficiency for long periods.

Functions

- Vitamin E is an important antioxidant.
- Promotes normal growth and development
- Promotes normal red blood cell formation
- Acts as anti blood clotting agent
- helps in absorption of vitamin A and vitamin C.
- Vitamin E dilates the capillaries and enables the blood to flow freely into the muscle tissue, thus strengthening both the tissues and the nerves supplying them.
- reduces the risk of heart diseases.

Food Sources of Vitamin E

The principle source of vitamin E is vegetable oils Eg- Corn, and peanut oil. Nuts and seeds Eg - Almonds, hazelnuts, sunflower seeds, safflower, soya bean oil and walnuts. Margarine, meat and fish, whole grains, wheat germ, spinach, lettuce, dark green leafy vegetables, black berries, apple, pears, legumes, eggs and milk are good sources of vitamin E. Human milk has more vitamin E than cow's milk and is sufficient for infants.

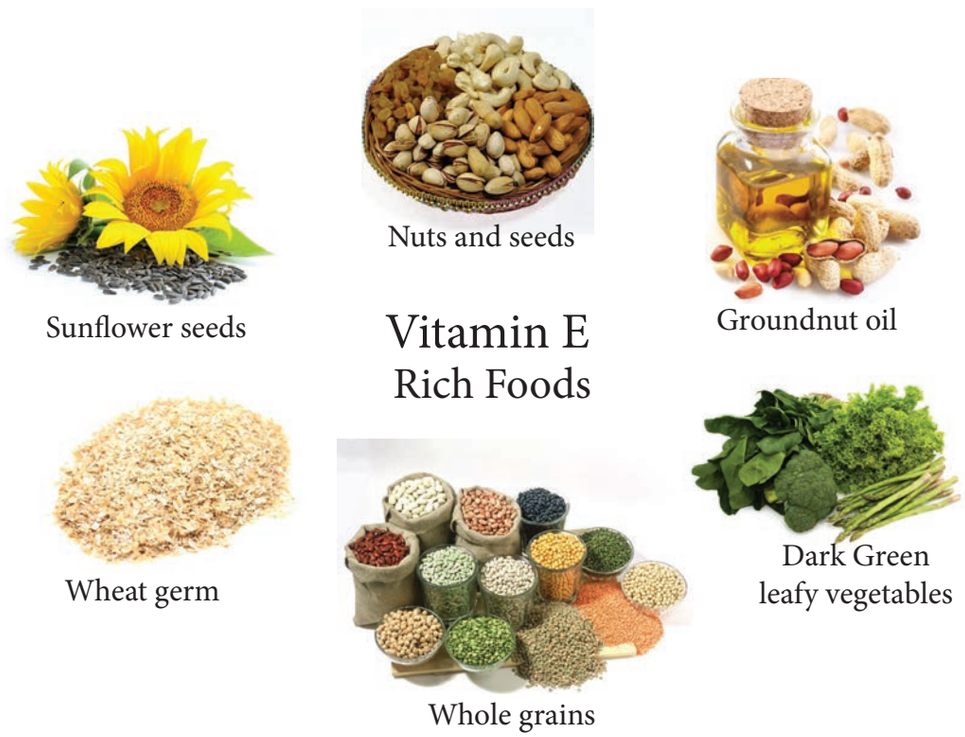


Fig 11.5: Food Sources of Vitamin E

Symptoms of Vitamin E deficiency

- Anaemia in premature infants.
- Increased risk of oxidative damage to body tissues.
- Vitamin E deficiency may lead to heart and lung disease and brain stroke.
- Frequent blood clots may occur which in turn play a role in the production of varicose veins.

11.2.4 Vitamin K

Vitamin K is called "coagulation vitamin". It is essential for the production of a type of protein called prothrombin and other factors involved in the blood-clotting mechanism. Prothrombin levels in the blood determine the rate at which the blood will clot. For blood to clot, fibrinogen a soluble protein must be converted into fibrin. Thrombin catalyses the proteolysis of fibrinogen to yield fibrin.

Functions

- Helps in clotting of blood.
- Participates in bone formation and remodeling (synthesis of osteocalcin).
- It is necessary for the formation of bone matrix and mineral deposition.
- Vitamin K is essential for the prevention of internal bleeding and haemorrhages.
- It is important for the normal functioning of the liver.
- It is involved in energy producing activities of the tissues and nervous system.

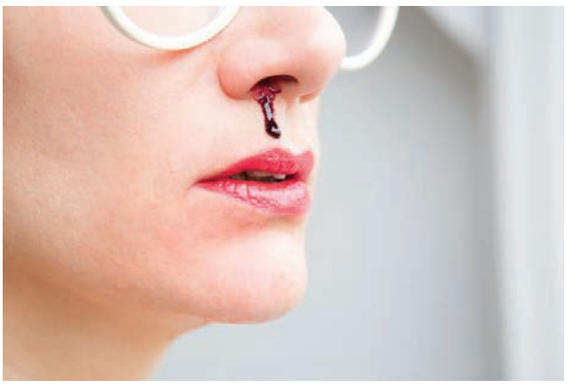
Food Sources of Vitamin K

The concentration of vitamin K in foods is highest in dark green leafy vegetables, especially spinach. It is also found in soyabean, yoghurt, wheat, oats, milk, meat,

Fig 11.6: Food Sources of Vitamin K

Vitamin K - Deficiency

Blood clotting



Bleeding in nose

Fig 11.7: Symptoms of Vitamin K deficiency

lettuce, cauliflower, cabbage, broccoli and liver.

Symptoms of Vitamin K deficiency

- Leads to increased tendency to hemorrhages.
- Defective blood clotting.
- Bleeding occurs in nose.
- Prothrombin levels are reduced.

11.3 Water Soluble Vitamins

Water soluble vitamins are soluble in water and so they cannot be stored in the body. Therefore, a day-to-day supply of these vitamins is essential.

The B vitamins have important metabolic roles as coenzyme partners with cell enzymes that control energy metabolism and build tissue. Eight vitamins are there in this group.

11.3.1 Vitamin B_1 (Thiamine)

Thiamine acts as a catalyst in the oxidation process which prepares glucose in the body to provide energy. Vitamin B_1 is a vital coenzyme for the metabolism of fats, carbohydrates and proteins. So, without B_1 the body cannot use the food to make energy. It is known as 'Appetite vitamin' and makes a person feel hungry.

Functions:

- Thiamine helps increase hunger. Thus aids normal growth.
- Thiamine controls mental and nervous fatigue, irritability and restlessness.
- Promotes growth, protects the heart muscle and stimulates brain action.
- The vitamin improves peristalsis and helps to prevent constipation.
- Improves circulation of blood and promotes a healthy skin.

Food Sources of Thiamine

Whole grain cereals, wheat, rice, oats, yeast, sunflower seeds, peanuts, Bengal gram, capsicum, turnip, beet, fish, liver, legumes, nuts, wheat germ, baked beans, whole grains enriched breads and cereals, egg etc.,

Fig 11.8: Food Sources of B_1

Symptoms of thiamine deficiency

- Loss of appetite, poor digestion.
- Muscular weakness and feeling tired
- Insomnia, mental depression,
- Loss of weight, leg cramps
- Digestive disorders
- Slow heart beat and
- Gastrointestinal problems

Deficiency Diseases

Thiamine deficiency causes Beriberi and there are three kinds of Beriberi

a) **Dry Beriberi** affects the nervous system, causing tingling and loss of sensation that may lead to limb paralysis and degeneration of nervous tissues. There is difficulty in walking. Foot and wrist drop also results.

b) **Wet Beriberi** affects the heart. There is difficulty in breathing. It enlarges the heart causing painful palpitations, disfunctioning of heart and heart attack.

c) **Infantile Beri** occurs in infants who cry without sound. Infants have difficulty in breathing, The body turns blue and may lead to death within 24-28 hrs.

It also leads to poor functioning of gastrointestinal tract and poor appetite.

11.3.2 Vitamin B_2 (Riboflavin)

Riboflavin is a water soluble and relatively heat stable vitamin. It is easily absorbed from the intestine and the excess is excreted through the urine. It is essential for the health of skin and for normal vision.

Functions

- Riboflavin plays an important role in the health of the eyes and alleviates eye strain and is essential for proper vision and healthy sight.

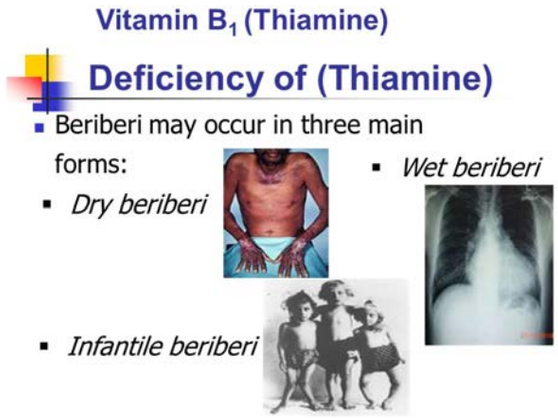


Fig 11.9: Symptoms of B_1 deficiency

- Riboflavin assists production of Red blood cells (RBC).
- It strengthens mucous lining of mouth, lips and tongue.
- It is required for normal growth and wound healing.
- Riboflavin is needed in every cell of the body. It helps cells to use oxygen so that the body can convert sources of energy into glucose.

Food Sources of Riboflavin:

Food Sources include yeast, milk, curd, cheese, eggs, chicken, liver, pork, spinach, carrot leaves, beets, brown rice, sprouts, beans and fruits like Apricots, papaya, custard apple. Nuts like almond and walnut are rich sources of riboflavin. Green leafy vegetables and enriched grains are moderate sources of Riboflavin.

Symptoms of Riboflavin deficiency

- Cracks and redness in corners of the mouth – Cheilosis.
- Painful, smooth, purplish red tongue – Glossitis.
- Sore throat.
- Inflamed eyes and eyelids, sensitivity to light.

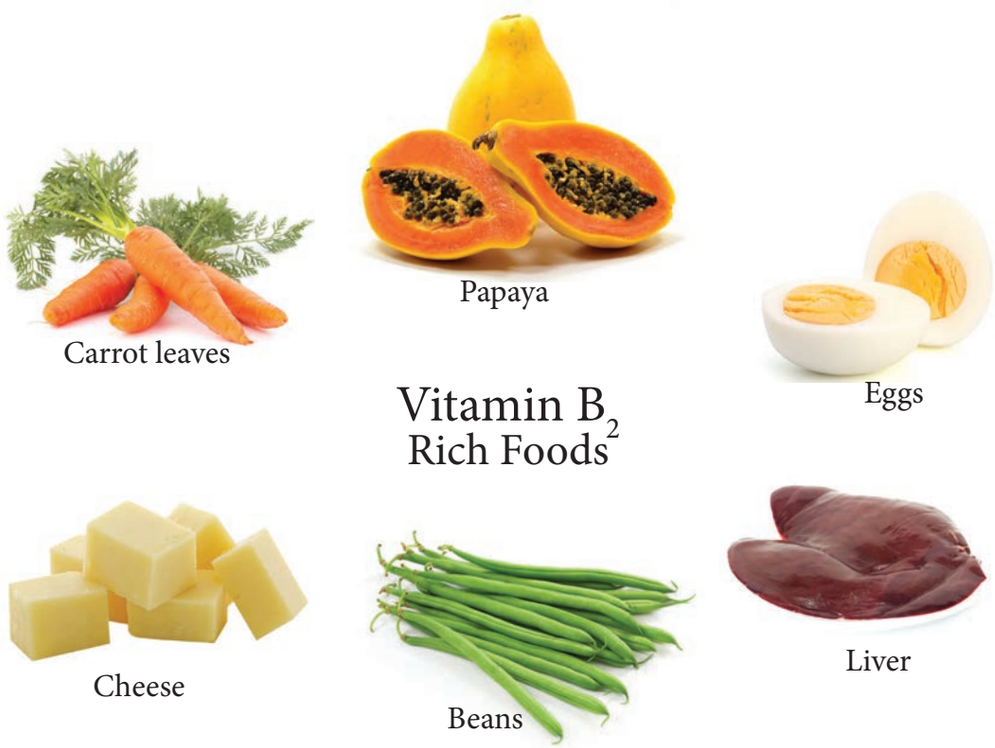


Fig 11.10: Food Sources of Vitamin B_2

Fig 11.11: Symptoms of B_2 deficiency

- Itching and burning eyes.
- Intolerance to bright light, dim vision, water in eyes.
- Skin rashes and
- Digestive disturbances.

11.3.3 Vitamin B_3 (Niacin)

Niacin is a water soluble vitamin which is also known as vitamin PPF (Pellagra Preventive Factor). Niacin exists in two forms: nicotinic acid and nicotinamide.

Functions

- Important for proper blood circulation and healthy functioning of the nervous system.
- Promotes the health of digestive track.
- It repairs DNA.

Fig 11.12: Food Sources of Vitamin B_3

- Regulates blood sugar levels.
- Lowers cholesterol levels.
- It is essential for normal functioning of skin and nerve system.

Food Sources of Niacin

Liver, chicken, meat, prawns, fish, legumes, cereal, mushroom, peanuts, green leafy vegetables, broccoli, dates, peas, groundnuts, almonds, sunflower seeds, avocado are rich in Niacin.

Symptoms of Niacin deficiency

- A mild deficiency of niacin may result in a coated tongue, sores in the mouth, irritability, nervousness, skin lesions, diarrhoea, forgetfulness, insomnia and headache.
- **Pellegra** - Niacin deficiency leads to Pellagra-a disease of 3D's- dermatitis, diarrhoea and dementia followed by death (if not treated).
- Dermatitis - This includes rough, scaly pigmented skin with rash on skin exposed to sunlight.
- Diarrhoea - loose stools and vomiting.
- Dementia - Symptoms include nerve damage, numbness in limbs, tingling in hands and feet, poor muscle coordination, disorientation and loss of memory.

11.3.4 Vitamin B_6 (Pyridoxine)

Pyridoxine is a colourless compound soluble in water and alcohol. It is well absorbed in the upper segment of the small intestine. It is stored in muscle but found in tissues throughout the body.

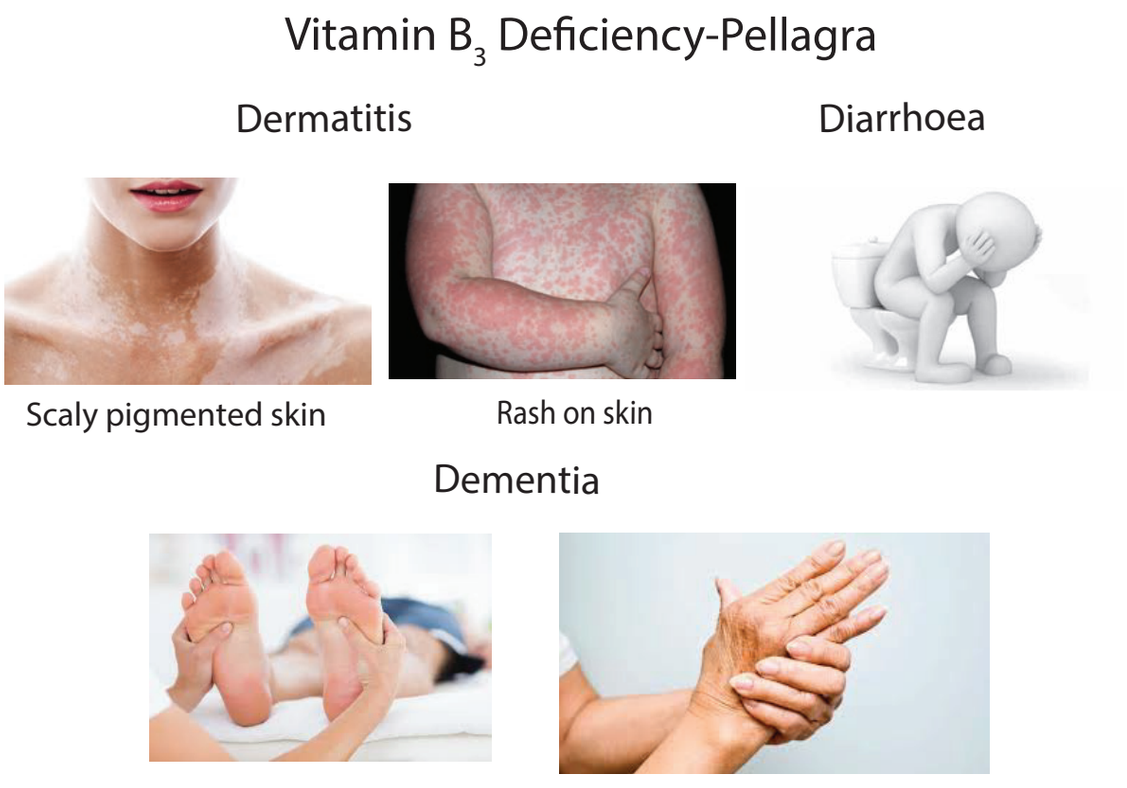


Fig 11.3: Symptoms of B_3 deficiency

Functions

- Production of red blood cells.
- It is readily absorbed from intestines.
- Improves immunity.
- Improves nervous system functions.
- Reduces muscle spasms, cramps and numbness.
- Maintains proper balance of sodium and phosphorous in the body.

Food sources of Pyridoxine: Good food sources include whole grains, legumes, bananas, potato, liver, kidney and other meats, fortified breads and cereals. Sunflower seeds, soya beans, walnuts and yeast are the richest sources of pyridoxine among plant foods.

Symptoms of Pyridoxine deficiency

- Nervousness, Insomnia, Anaemia, oedema, mental depression.
- Loss of muscle control, muscle weakness, tooth decay.
- Arm and leg cramps,
- Water retention,
- Skin lesions and skin disorder.

11.3.5 Vitamin B_9 (Folic Acid)

Vitamin B_9 includes both folate and folic acid and is important for several functions in the body. It is important for women who are pregnant to consume enough folic acid.

Functions of folic acid: The different functions of folate include:

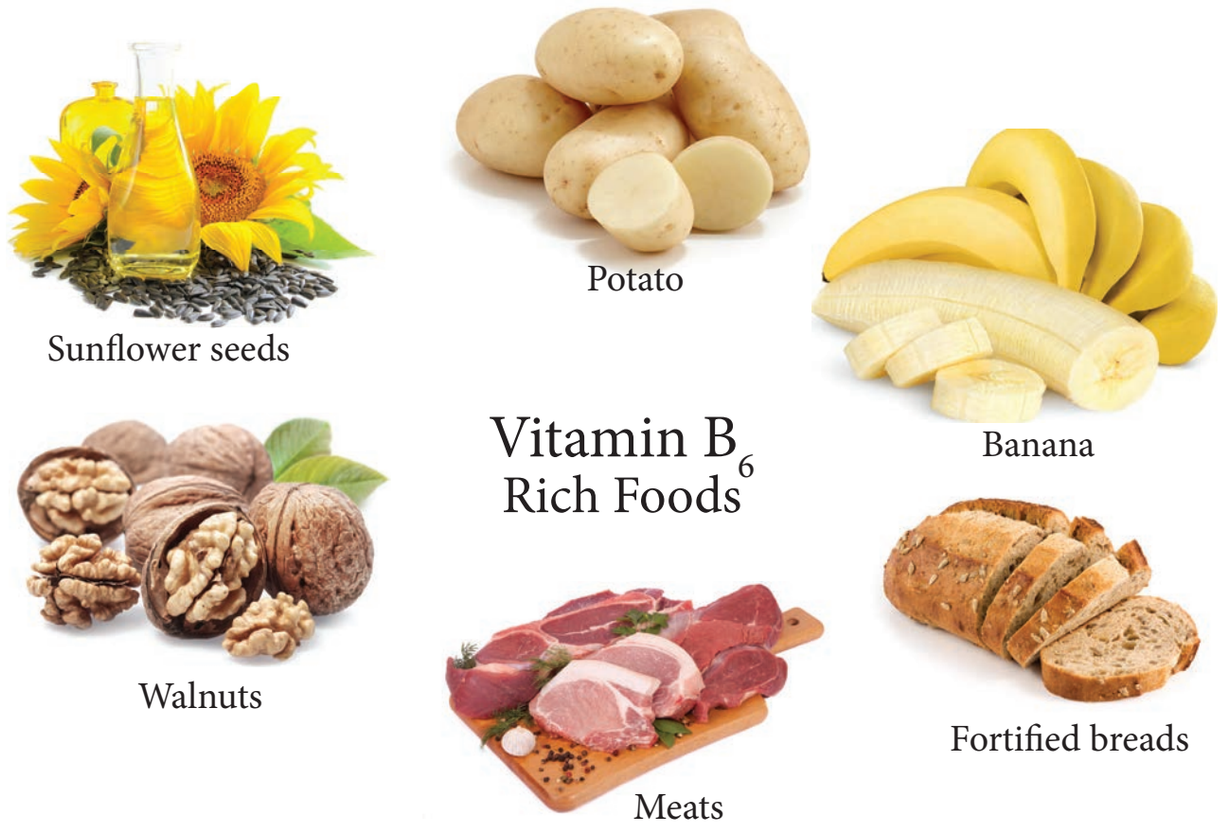


Fig 11.14: Food Sources of Vitamin B_6

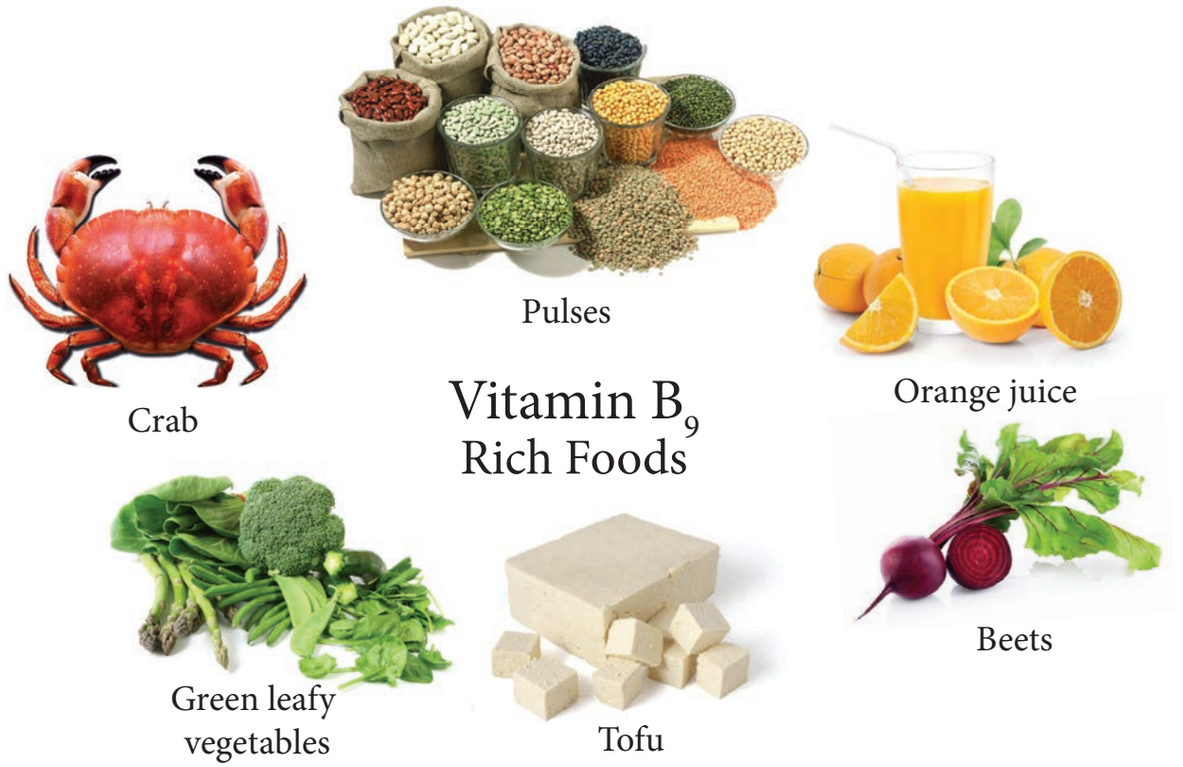


Fig 11.15: Food Sources of Vitamin B_9

- Folic acid helps the body to convert carbohydrates into glucose, which is used to provide energy.
- Folic acid helps in building of antibodies which prevent and heal infections.
- It helps in normal functioning of the nervous system and maintains the mental and emotional health.
- It helps in production of body's generic material - DNA and RNA.

Food sources of Folic acid: The rich sources of folate are fish, mutton, liver, egg, chicken, green leafy vegetables, pulses, Lentils, beans, asparagus, lettuce, Parsley, avocado, sunflower seeds, beets, broccoli, spinach, orange juice, tofu, fish, meat, fortified cereals, milk, cheese, eggs, oysters, crab etc.,

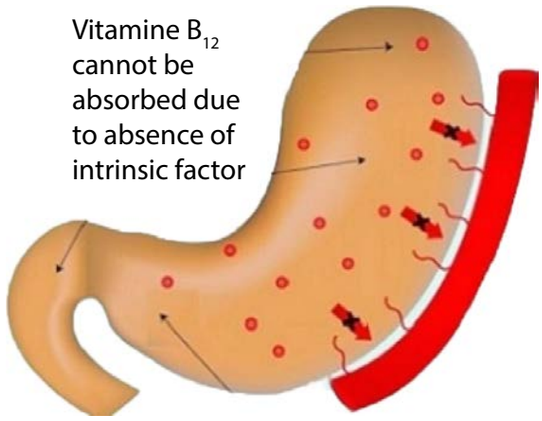
Symptoms of folic acid deficiency

- A recent study connected folic acid deficiency with autism.
- Loss of memory, severe and irreversible damage to nervous system and brain.
- Deficiency of folic acid causes megaloblastic anaemia.

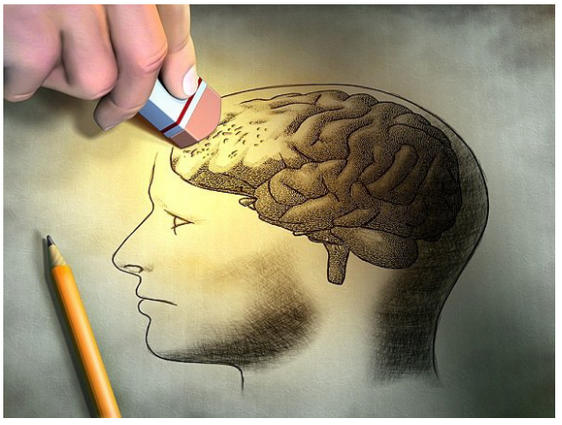
11.3.6 Vitamin B_{12} (Cyanocobalamin)

The vitamin is named as cyanocobalamin because of the presence of cobalt and cyanide in its structure. It can be absorbed in the body only in the presence of intrinsic factor (IF).

Vitamin B_{12} Deficiency



Pernicious Anaemia



Loss of memory

Fig 11.16: Symptoms of B_{12} deficiency

Functions

- It is essential for the production and regeneration of red blood cells.
- It improves concentration, memory and balance.
- It synthesises and regulates DNA.
- It plays an important role in normal functioning of brain and nervous system.
- It also helps to absorb folic acid.

Food Sources of Cyanocobalamin

Cyanocobalamin is synthesized by bacteria and is found in foods of animal origin. Liver is the richest source of cyanocobalamin. Meat, chicken, oysters, eggs, fish, milk, curd, cheese are good sources of Vitamin B_{12}.

Symptoms of Cyanocobalamin deficiency:

- Loss of memory
- Fatigue
- Anemia
- Severe and irreversible damage to the nervous system and brain
- Pernicious anaemia is caused due to its deficiency in the body which is an immune system disease.

DO YOU KNOW...?

Vitamin B_{12} is unique among all essential nutrients in having a highly specialised mechanism for its absorption. Its absorption from the intestines requires a factor called 'intrinsic factor (IF)' secreted by the stomach. It is a specific protein secreted by the mucosal cells lining the stomach. IF binds and absorbs vitamin B_{12}.

Fig 11.17: Food Sources of Vitamin B_{12}

DO YOU KNOW...?

To prevent anaemia, two factors are required: an intrinsic factor produced by gastric parietal cells and the extrinsic factor of vitamin B_{12}.

11.3.7 Vitamin C

Vitamin C is also known as ascorbic acid. It is an antioxidant and a water soluble vitamin. It is destroyed by light, heat and when exposed to air and metals. During cooking much of it is destroyed. Iron and copper act as catalysts and cooking in these vessels increases the loss of vitamin C. When the vegetables are cut into fine pieces more enzymes are released and it causes more loss. Vitamin C is essential in cholesterol metabolism.

Functions:

- It is helpful in the formation of collagen, the cementing material between cells that holds them together.
- Vitamin C builds up natural body defence and helps provide immunity to the body.
- It helps the body to absorb more iron from plant sources.
- It aids in the healing of wounds.
- It helps to keep gums healthy.
- It helps body to fight infections.
- Improves bone formation.
- It prevents the deposition of cholesterol on the walls of the arteries and prevents heart diseases.

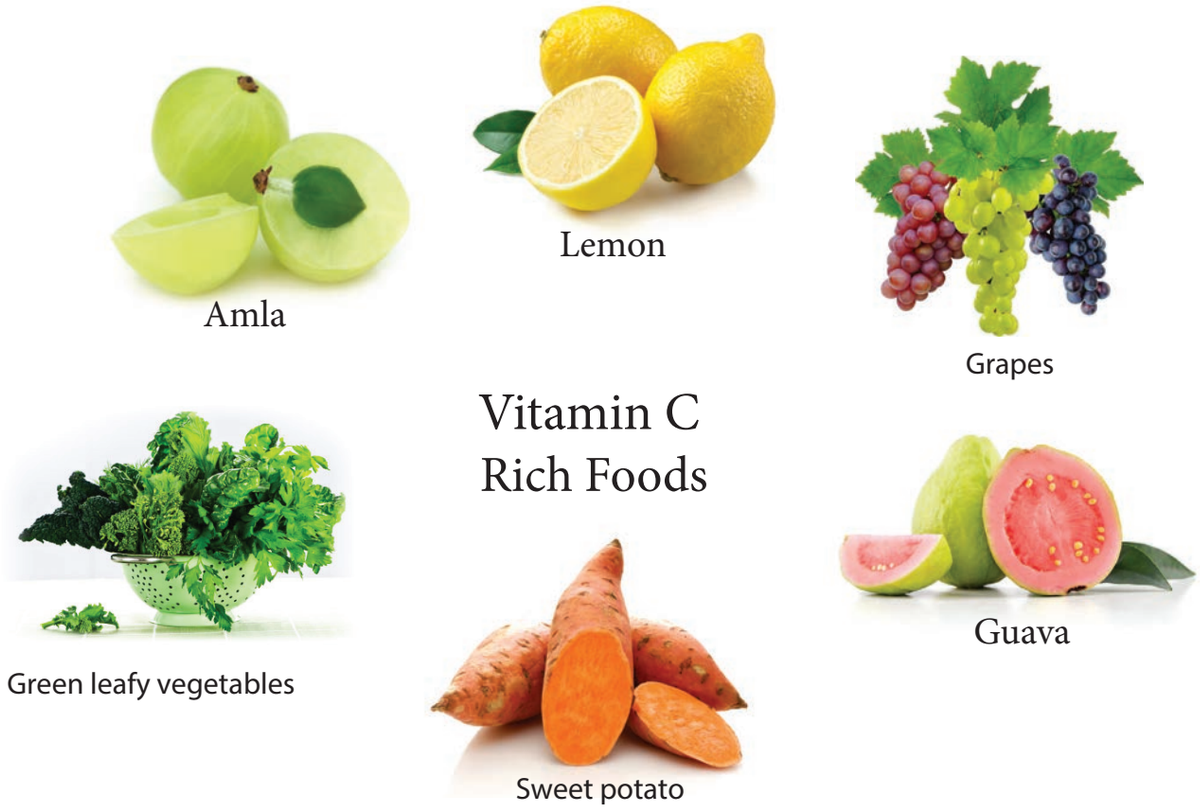


Fig 11.18: Food Sources of Vitamin C

Food Sources of Vitamin C: Amla, kiwi, strawberry, raspberry, grapes, berries, guava, citrus fruits like sweet lime, lemon, oranges, green leafy vegetables, spinach, hot chillies, turnip greens, broccoli, red bell pepper, tomato juice, raw tomato, sweet potato etc.,

Symptoms of Vitamin C deficiency

- Gums swell and bleed and become purple and spongy. This is known as pyorrhoea. Foul smell emits from the mouth.
- Deficiency can lead to scurvy in which a slight injury produces excessive bleeding and large hemorrhages are seen under the skin.
- There is tenderness, swelling and pain in the limbs.
- Reduced immunity causes simple infections like common cold, flu-viral, etc.,
- Irritability, aneamia, poor wound healing and Diarrhoea.
- Gastrointestinal discomfort.
- Weight loss, fatigue and joint pain.

11.4 Minerals

The body contains about 24 minerals, all of which must be provided by the diet. These are required by the body in very minute amounts and are often referred to as trace elements. The important ones are iron, iodine, calcium, zinc and sodium.

11.4.1 Iron

Iron was first recognized as a constituent of the body by Lernery in 1713. It is now known that all the iron in the body exists in combination with protein molecules.

Vitamin C- Deficiency

Scurvy

Pyorrhoea

Fig 11.19: Symptoms of C deficiency

Overall the body contains 2.5g to 4.0g of iron. Most of the iron in the body is found in the blood, but some is present in every cell bound to iron containing enzymes. Iron is present in Haemoglobin which contains ferrous iron. It is essential for carrying oxygen to different tissues.

Functions

- Iron is an important mineral needed for the formation of haemoglobin which is responsible for carrying oxygen from the lungs to different cells and tissues of the body in the form of oxyhaemoglobin. Thus iron helps in the oxidation process.
- It acts as a co-factor for enzymes and other proteins.
- It is required for the formation of red blood cells.

Food Sources of iron:

Haeme iron from animal foods is better absorbed than non-haeme iron present in plant sources. Liver is the best source of iron. Iron is also absorbed well from red meat like lamb. Non-haeme iron is present in cereals, millets, pulses and green leafy vegetables. Of the cereal grains, wheat and millets like bajra and ragi are very good source of iron. Inclusion of about 50g of green leafy vegetables which are rich in iron in our daily diet can help meet a fair proportion of iron needs.

Symptoms of Iron deficiency:

Iron deficiency leads to Anaemia which has the following symptoms:

- Eyes, tongue and nails become pale.
- Person feels extremely tired and fatigued.
- Decreased physical activity and breathlessness on exertion.
- Tingling sensation in fingers and toes.
- Nails become brittle and become concave and appear like a spoon.
- Loss of appetite and giddiness.
- Poor coordination of body functions.

Fig 11.20: Food Sources of Iron

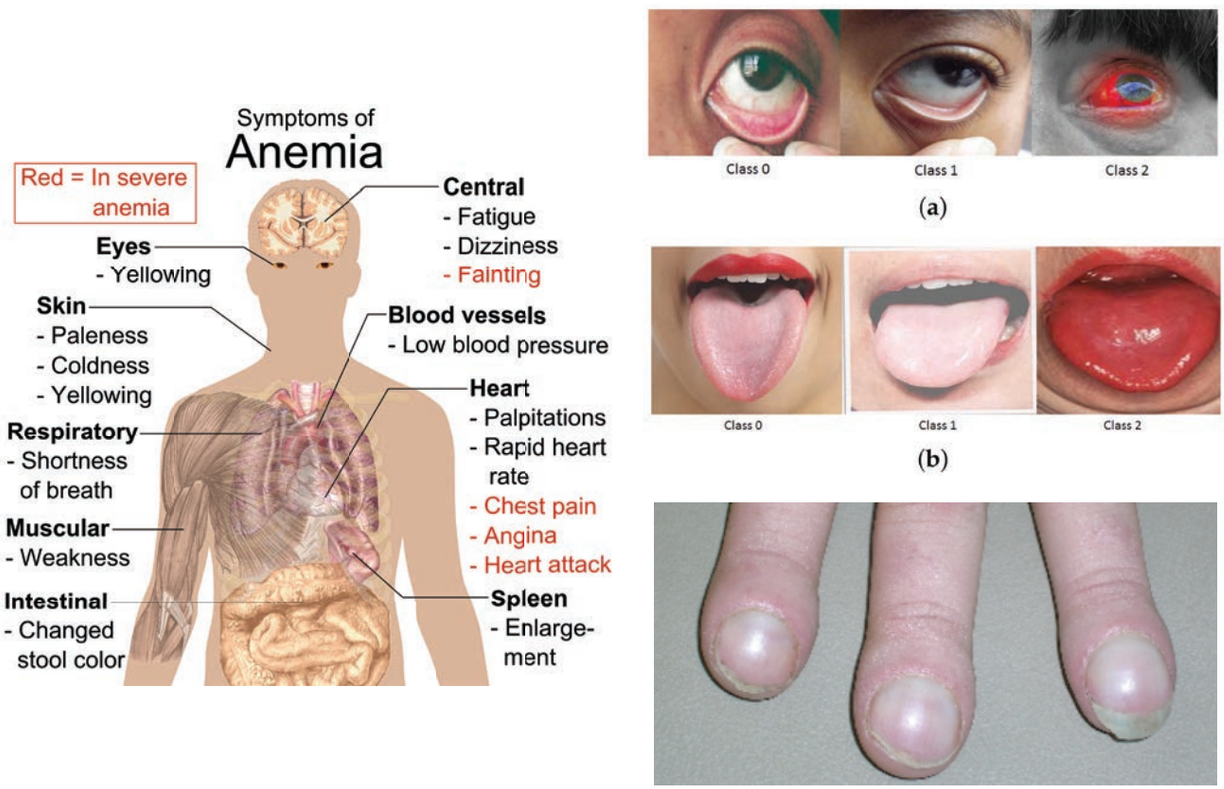


Fig 11.21: Symptoms of Iron deficiency

11.4.2 Iodine

The significance of Iodine as an essential trace element lies in its role in thyroxine production. Iodine is a constituent of thyroxine, the active principle of the thyroid gland. The thyroid gland plays an important role in energy metabolism and in the growth of the body.

Functions

- It is essential for the production of thyroid hormone called thyroxin which is secreted by the thyroid gland.
- Thyroxin controls the basic metabolic rate in the body as it controls the metabolism of all nutrients.
- Thyroxin regulates the rate of oxidation within the cells.
- It stimulates the physical and mental growth.
- It regulates the functioning of nerve and muscle tissue.

Food Sources of Iodine:

Iodine is present only in small amounts in common foods, the quantity of iodine present depending on the iodine content of the soil. Iodised salt, sea salt, vegetables grown in the sea shore, garlic, onion, cheese and sea fish are good sources of iodine.

Symptoms of Iodine deficiency:

- Wide variety of physical and neurological disorders associated with iodine deficiency are called **"Iodine Deficiency Disorders - IDD".**
- **Goitre:** It is characterized by swelling of thyroid gland.
- **Cretinism:** Person is deaf and has a shuffling gait, retarded mental and

Garlic

Salt

Seafish

Iodine Rich Foods

Onion

Cheese

Fig 11.22: Food Sources of Iodine

Fig 11.23: Symptoms of Iodine deficiency

physical growth, thus shorter in stature (dwarf).

- **Myxoedema:** Face of patient becomes expressionless.

11.4.3 Calcium

Calcium is the major element in the body and an adult man weighing 60 kg has nearly one kilogram of calcium. Almost 99% of this calcium is found in the hard tissues of the body, namely the bones and teeth. Vitamin D is essential for the absorption of calcium. In vitamin D deficiency, calcium absorption is impaired.

Functions

- It is essential for the formation of bones and teeth.

Fig 11.24: Food Sources of Calcium

- It is essential for clotting of blood.
- It regulates the permeability of capillary walls.
- It is essential for the contraction of heart and muscle.
- It regulates the excitability of nerve fibres and nerve centres.
- It acts as an activator for the enzymes present in the gastric juice.
- It plays an important role in maintenance of health.
- Required for proper foetal growth.
- It speeds up all healing process.
- It is essential for proper utilization of phosphorus and vitamins A, C and D

Food Sources of calcium:

The richest source of calcium among animal foods is milk and among vegetables it is green leafy vegetables. Among green leafy vegetables, amaranth, fenugreek and drumstick leaves are particularly rich in calcium. Ragi is the main source of calcium. Sesame seeds with husk and small dried fish are also good sources of calcium.

Symptoms of Calcium deficiency:

- Bone mass is reduced when calcium deposit is less.
- Rickets in children, Osteomalacia in adults, Osteoporosis in old age occurs.
- Decreased growth rate.
- Very often fractures occur due to brittle bones.

11.4.4 Zinc

Zinc is an essential trace element which plays an important role in our body. Our body contains 2-3 grams of zinc. It has been found to be present in the hormone insulin. It plays an essential role in the formation of DNA and RNA. It aids in the healing of burns and wounds.

Functions:

- It plays a vital role in cell division and growth especially during pregnancy and prevents congenital abnormalities and premature delivery.
- It plays an important role in maintaining fertility in males.
- It provides immunity to our body.
- It helps in healing cuts, wounds, acne and rashes.
- It is important for healthy vision and prevents night blindness and cataracts.

Food Sources of Zinc:

Seafoods, meat, eggs are good sources of Zinc. Milk and milk products, whole cereals, pumpkin seeds, cashewnuts, spinach, legumes contain considerable amounts.

Symptoms of Zinc deficiency:

- Stunted growth.
- Loss of appetite.
- Dry and rough skin.
- Dull brittle hair.
- Brittle nails with white spots.
- Loss of memory.
- Reduced sense of taste and smell.
- Delayed healing of wounds.
- Frequent infections and acne.
- Diarrhoea and pneumonia can be fatal.

Fig 11.25: Food Sources of Zinc

11.4.5 Sodium

Sodium is a plentiful mineral in the body. It is essential in the recommended quantity for the body. A 50kg person would contain around 200g of sodium chloride Sodium is easily absorbed in the small intestine. Sodium is lost in sweat during exercise or in hot environments. Sodium and chloride compound is table salt.

Functions:

- Sodium is the most abundant cation in the extracellular fluid of the body.
- It acts with other electrolytes, especially potassium, in the intracellular fluid to regulate the osmotic pressure and maintain proper water balance within the body.
- It is the major factor in maintaining the acid-base equilibrium, in transmitting nerve impulses and in relaxing muscles.
- It maintains normal mineral content of extra and intra cellular fluid.

Food Sources of Sodium:

Vegetables like dry lotus stems and green leafy vegetables, dried fruits, roots like beetroot, carrot and radish are rich in sodium. Animal foods like milk, egg white, fish and meat contain substantial amount of sodium.

Symptoms of Sodium deficiency:

- Deficiency of sodium is caused by excessive sweating, prolonged use of diuretics, chronic diarrhoea.
- Deficiency may lead to nausea, muscular weakness, heat exhaustion and mental apathy. Oversupply of sodium is a more common problem because of overuse of dietary sodium chloride or common salt.

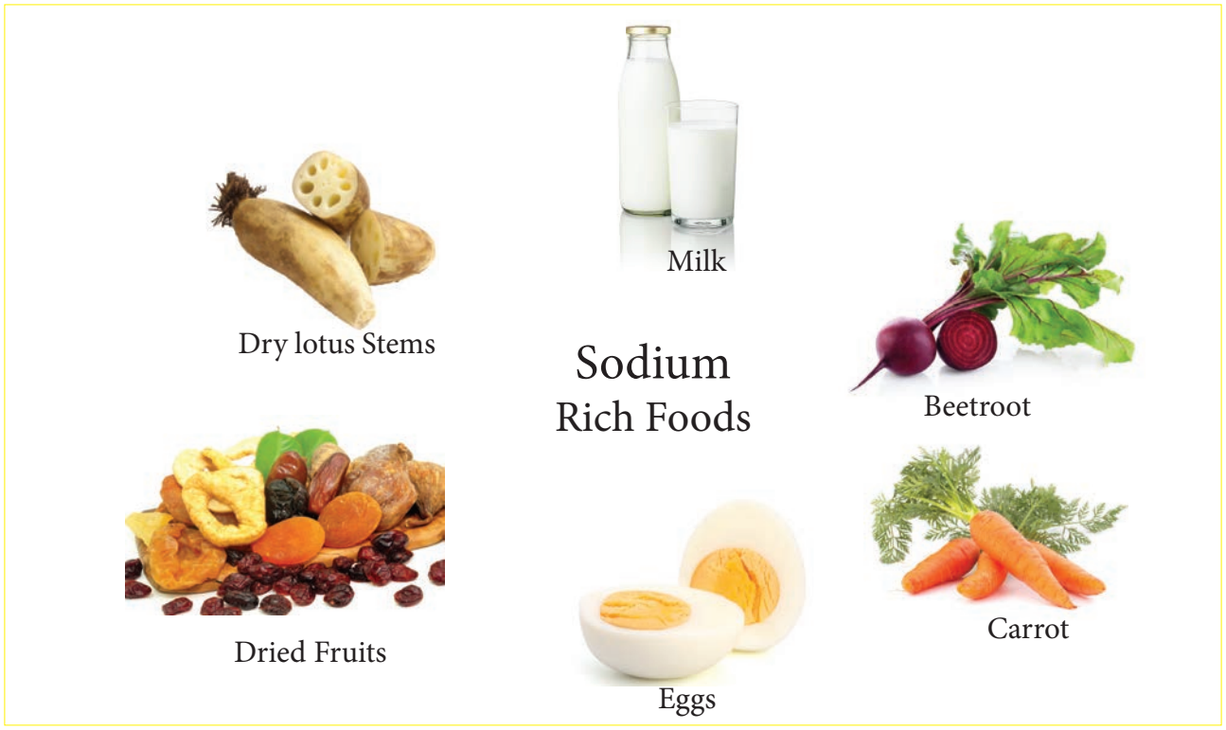


Fig 11.26: Food Sources of Sodium

- Too much sodium may lead to water retention, high blood pressure and even stomach ulcers.

11.5 WATER

Water is vital for human existence. Water is the largest component of the human body, making up to 60 to 70 percent of the total body's weight. This percentage of water in human being is required to be maintained. Infants have greater percentage of water than adults. Ageing declines the water percentage of the body. Water is second only to oxygen in its vital importance to the body. One can live without food for a longer time than one does without water. Water is colourless, calorie less compound of hydrogen and oxygen that virtually every cell in the body needs to survive.

Substances dissolve in water as ions with positive and negative charge. They are called electrolytes. The common electrolytes in our body are sodium, potassium and chloride. Because of this, water can dissolve most substances and in doing so, it enables minerals and other chemicals to undergo biological reactions in the body.

DO YOU KNOW...?

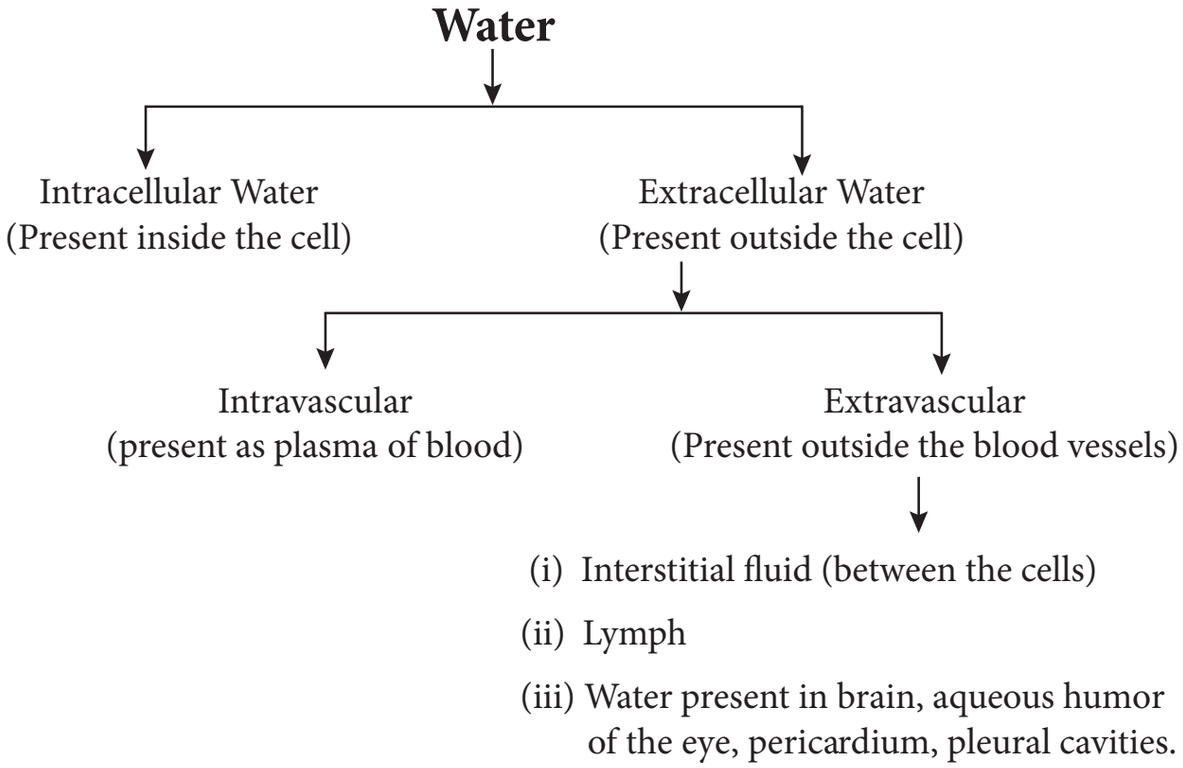


Fig 11.27: Distribution of water in the body

11.5.1 Distribution of water in the body

Total body water content is mainly determined by total amount of salt in the body. Salt and water concentration in the body is controlled by the kidneys.

11.5.2 Water in the body – Intracellular and Extracellular fluid

Water flows in and out of the body cells through cell membranes.

Intracellular fluid:

This is fluid contained within a cell represents about two thirds of all body fluids.

Extracellular fluid:

This is fluid present outside the cells, and represents about one-third of all body fluid.

Extracellular fluid is further divided into interstitial fluid which is water between cells and intravascular fluid which is water in the blood stream and lymph. Interstitial fluid forms a transport link between tissue cells and the blood.

11.5.3 Sources of water

The body has three sources of water. Besides drinking water, the following are the sources of water.

1. The water contained in food, eg. Fruits and vegetables contain 80-90 percent water. Milk contains 80-88 percent, meat contains 40-75 percent, flour, crackers and bread contain 5-35 percent of water.
2. In addition to water ingested fluids such soups and beverages also supply essential minerals and vitamins.
3. Metabolic water is formed by the metabolism of food in the body. It may amount to about 450ml per day.

11.5.4 Functions of Water

Major functions of water :

1) **Carrier of nutrients:** Every nutrient in soluble form in water is carried from intestines to tissues through blood.

2) **Constituent of body fluids:** Water is the major constituent of all body fluids such as blood, urine, sweat, lymph.

3) **Regulation of body temperature:** Water helps to regulate and control body temperature. Heat is produced when food is burnt for energy. Water is evaporated through respiration and sweat and body temperature is maintained normal. Body's heat is lost through the skin, lungs, urine and faeces.

4) **Protection of delicate organs:** Water found around lungs, heart and brain protects them from outer injury.

5) **Water as lubricant:** Water acts as a lubricant in joints. Water around joints helps in normal movement.
It is an essential constituent of all the cells of the body and the internal environment.

11.5.5 Requirements

Requirement of water varies with climate, dietary constituents, activities and surface area of the body. As a rule a person should take enough water to excrete about 1200 –1500 ml of urine per day. In tropics because of greater water loss through perspiration, increased water intake is required to maintain urine volume. Normal intake of water ranges between 8 – 10 glasses per day.

Water is lost through feces, urine, lungs (expiration) skin (invisible perspiration and visible perspiration) amounting to about 2-3 liters per day. During infections and fever, the liquid intake should be increased as losses are higher. A moderate amount of water taken with or preceding a meal aids in digestion.

11.5.6 Dehydration

Dehydration results in extreme deficiency of water and fluids. Symptoms of dehydration are fatigue, headache, sullenness and in extreme cases, collapse.

The steps in the progression of dehydration are as follows.

1. Thirst
2. Decreasing blood volume, impaired physical performance.
3. Increased effort for physical work, nausea.
4. Failure to regulate excess temperature.
5. Muscle spasms.
6. Failing renal function, less or no urine formed.

Excessive loss of water takes place due to vomiting, diarrohea, haemorrhage, excessive perspiration, exudating, burns, uncontrolled diabetes mellitus, fever and hot weather. It can be fatal and can be easily avoided by proper fluid intake or oral rehydration therapy.

Fig 11.28: Symptoms of dehydration

11.5.7 ORT: (Oral Rehydration Therapy)

Oral rehydration therapy is a method of treating dehydration by making the patient drink a solution which can be prepared by dissolving salt and sugar in boiled and cooled water.

11.5.8 Water Intoxication

Water intoxication results due to excess intake of water. This results in an increase in the volume of intracellular fluid. This condition can lead to headache, nausea, vomiting, muscle twitching and convulsions. It can even be fatal.

DO YOU KNOW...?

Mention the disease conditions that need ORS?

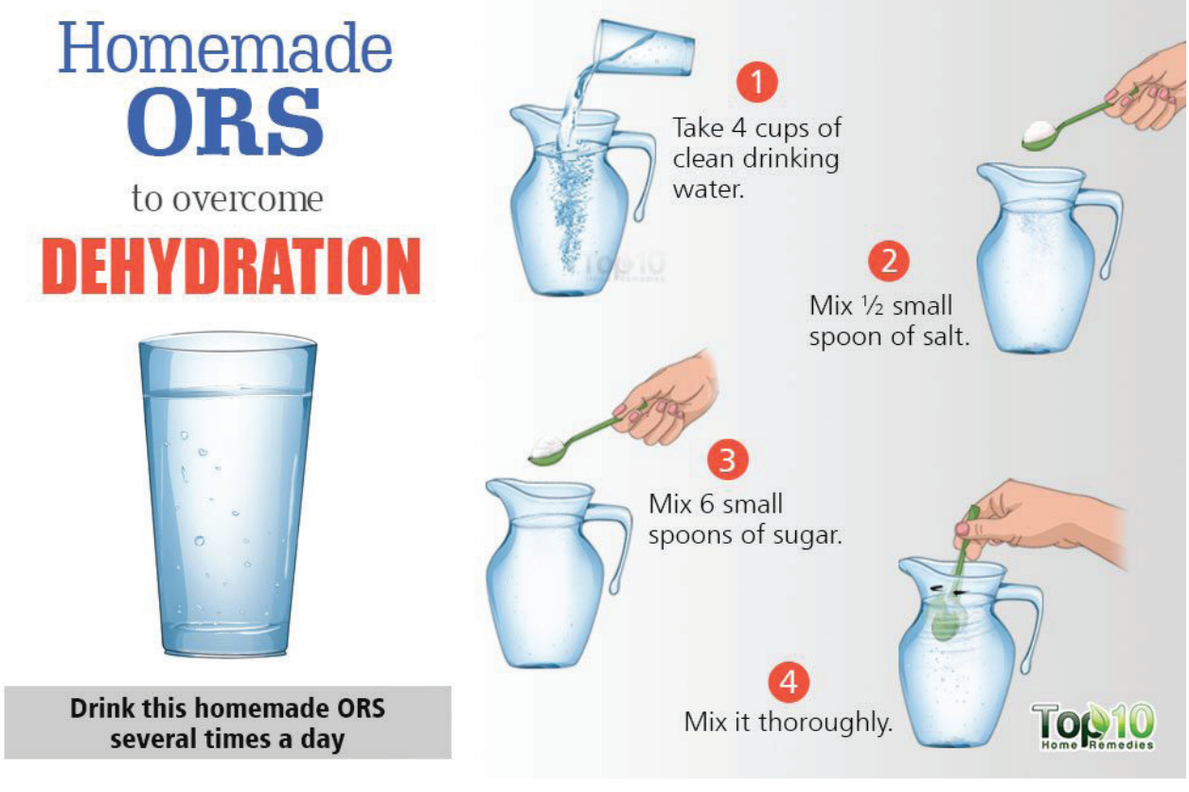


Fig 11.29: Oral Rehydration Therapy

Summary

- Vitamins and Minerals are micronutrients which are present in small quantities. They help to protect body from diseases.

- They are broadly divided into two categories, on the basis of solubility in fats or water. Fat soluble vitamins - A, D, E and K. Fat soluble vitamins are stored in the liver and fatty tissues. These are not readily excreted from the body. Water soluble vitamins - B (B_1, B_2, B_3, B_5, B_6, B_{12}) and C. Water soluble vitamins are stored in limited amounts and are readily excreted from the body through urine.
- Vitamin A occurs only in foods of animal origin. Vitamin A activity is possessed by carotenoids found in plants. Hence carotenoids are called provitamin A.
- Vitamin D is otherwise known as 'sunshine vitamin' as it can be synthesized from sunlight by our body.
- Vitamin E protects cell membranes. They are called as tocopherol. Vitamin K is called coagulation vitamin. It is essential for the production of a type of protein called prothrombin and other factors involved in the blood-clotting mechanism.
- The B vitamins have important metabolic roles as coenzyme partners with cell enzymes that control energy metabolism.
- Vitamin C is also known as ascorbic acid. It is an antioxidant and water soluble vitamin. It is destroyed in light, heat and when exposed to air and metals.
- The body contains about 24 minerals, all of which must be provided by the diet. These are required by the body in very minute amounts and are often referred to as trace elements. The important ones are iron, iodine, calcium, zinc and sodium.
- Water is vital for human existence. Water is the largest component of the human body. Normal intake of water ranges between 8 – 10 glasses per day.
- Dehydration results in extreme deficiency of water and fluids. Oral rehydration therapy is a method of treating dehydration by making the patient drink a solution which can be prepared by dissolving salt and sugar in boiled and cooled water.

Glossary

Terms	Meaning
Coenzymes	A compound that is essential for the functioning of an enzyme.
Enzyme	A substance produced by a living organism that assists in chemical processes.
Precursor	A forerunner
Nyctalopia	A condition characterized by an abnormal inability to see in dim light or at night, typically caused by vitamin A deficiency.
Antioxidant	A substance that counteracts oxidation.

Fibrinogen	A soluble protein present in blood plasma, from which fibrin is produced by the action of the enzyme thrombin.
Fibrin	An insoluble protein formed from fibrinogen during the clotting of blood. It forms a fibrous mesh that impedes the flow of blood.
Haemorrhage	An escape of blood from a ruptured blood vessel.
Intrinsic Factor	A substance secreted by the stomach which enables the body to absorb vitamin B_{12}.
Lymph	A colourless fluid containing white blood cells, which bathes the tissues and drains through the lymphatic system into the blood stream.
Exudating	A mass of cells and fluid that has seeped out of blood vessels or an organ, especially in inflammation.
Intoxication	Water poisoning or hyper hydration
Convulsions	A sudden uncontrolled movement of the body
Twitching	Make a short, sudden jerking movement

GSVMX5

Questions

part - A

I. Choose the correct answer: (1 mark).

1. _____ are complex organic molecules.
   a. Vitamins b. Minerals
   c. Water d. Vitamin A
2. _____ founded vitamine theory.
   a. Takaki b. Casmir Funk
   c. Water d. None
3. _____ are closely associated with body lipids and are easily stored.
   a. Fat soluble vitamins
   b. Water soluble vitamins
   c. Water
   d. Vitamins
4. _____ are called provitamin A.
   a. Carotenoids b. Retinol
   c. Vitamin A d. Vitamin E
5. _____ deposits on the delicate membranes covering the whites of the eyes.
   a. Bitot's spot b. Xeropthalmia
   c. Keratomalacia d. Vitamin D
6. _____is required for Ca absorption and bone formation.
   a. Vitamin D b. Vitamin A
   c. Vitamin C d. Vitamin B
7. Vitamin ____ dilates the capillaries and enables the blood to flow freely into blood.
   a. E b. A
   c. B d. K
8. _____levels in the blood determine the rate at which the blood will clot.
   a. Prothrombin b. Provitamin
   c. Intrinsic Factor d. Probiotic

9. _____ enlarges the heart causing painful palpitations, disfunctioning of heart and heart attack.
   a. Wet Beri Beri
   b. Dry Beri Beri
   c. Infantile Beri Beri
   d. Wet and Dry Beri Beri
10. _____ includes rough, scaly pigmented skin with rash on skin exposed to sunlight.
   a. Dementia b. Diarrhoea
   c. Dermatitis d. Dieases
11. _____ is essential for carrying oxygen to different tissues.
   a. Iron b. Iodine
   c. Calcium d. Sodium
12. Oral rehydration therapy is a method of treating _____ by making the patient drink readily available preparations.
   a. Dehydration
   b. Water intoxication
   c. Hyponatraemia
   d. Dieases
13. This is vital for human existence _____
   a.Water b. Honey
   c. Sugar d. Jaggery
14. the normal intake of water amounts to _____
   a. 8-10 glasses b. 18-20 glasses
   c. 10-12 glasses d. 10-11 glasses

Part - B

Write shot answer (2 Mark)

1. List out the signs of Xeropthalmia.
2. Write the sources of Vitamin E.
3. Write the sources of Vitamin D.
4. Mention the iron rich foods.
5. List out Zinc rich foods.
6. What is mean by scurvy?
7. Give the full form of IDD.
8. How is water distributed in the body?
9. Differentiate between Goitre and Cretinism.
10. Write short notes on Provitamins.

Part - C

Answer in brief (3 Marks)

1. Give clinical symptoms of vitamin A deficiency
2. Explain the role of vitamin K in blood clotting.
3. Explain the deficiency diseases of Vitamin D in children, adult and oldage.
4. Explain vitamin E as an antioxidant.
5. Give the functions of Vitamin K.
6. What is pernicious anaemia?
7. List the functions of vitamin B_{12}
8. Discuss the deficiency symptoms of pyridoxine.

Part - D

Answer in detailed (5 Marks)

1. Elaborate on the functions of vitamin A.
2. List the functions of folic acid in the body.
3. Give the functions of vitamin C.
4. Discuss the functions of Iodine.
5. List the functions of Zinc.
6. Discuss the types of Beri Beri.
7. Explain the 3 D's of deficiency diseases.
8. Enumerate the functions of water in our body.

ACTIVITY - 1

Essential vitamins!

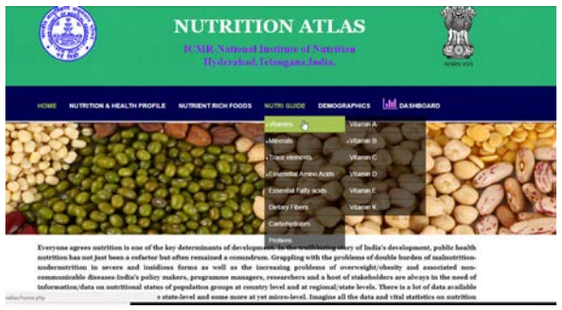
List food that contain these important vitamins.

A Retinol	**Needed for healthy bones,teeth,skin,eyes,and nervous,resptratory and digestive systems.**
B_1 Thiamine	**Helps to release energy from food.Benefits heart and nervous system.**
B_2 Riboflavin	**Promotes healthy skin and helps body cells use oxygen.**
Niacin	**Essential for cell metabolism and use of carbohydrate.**
B_6	**Needed for protein, fat, and carbohydrate metabolism**
B_{12} Cobalamin	**Needed for development of red blood cells and healthy functioning of the nervous system.**
Folate	**Helps to produce red blood cells.**
C Ascorbic Acid	**Needed for sound teeth and bones.Helps the healing process.**
D Cholecalciferol	**Needed for calcium and phosphorus metabolism.**
E Tocopherol	**Helps restore cell membranes and other body structures.**
K Phylloquinone	**Essential for normel blood clotting.**

ICT CORNER

(VITAMINS & IT'S DEFIENCY DISEASES)

A **vitamin** is an organic compound and an essential nutrient that humans requires in limited amount This activity shows vitamins in food and food suggestions. It also shows what happens when the vitamin taken is less than adequate.



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