

CHAPTER : 14

NUTRIENTS — MICRONUTRIENTS

Vitamins— vitamins are active organic elements which are important for good health of the body. Though these are required in minute quantities they are important for growth, development, vivacity and liveliness.

History— Before 19th century, scientists knew only about carbohydrates, protein, fat and mineral salts. At that time nobody knew about vitamins. In the beginning of the 20th century, some scientists experimented artificial food mixture containing carbohydrates, fat, proteins and mineral salts on mice and it was observed that growth was arrested because of this artificial food. Thus, it was concluded that some other element along with these four elements was also required in food.

The word ‘Vitamin’ was given in 1912 by Casimir Funk. Funk on observing that an element obtained from the upper shell of rice cured Beri Beri, thus confirming Eijkman’s assumption that beriberi was caused by the deficiency of a particular food element. This element is essential for life and nitrogen is present in the beriberi anti- element. This way the name ‘vitamine’ was given. Later on was found that nitrogen was not present in all the vitamins and thus ‘e’ was dropped from the name and only ‘vitamin’ came into Vogue.

If vitamin are not present in adequate quantities in the diet then vitamin-deficiency diseases develop. From the study of these diseases it has been found that a vitamin is not a single element but is a variety of elements.

Classification of vitamins— on the basis of solubility, vitamins can be divided into water-soluble and fat-soluble.

1. Water-soluble vitamins— water-soluble vitamins are not produced in the body but should be included in the diet. As these are soluble in water therefore excess of these vitamins is removed along with water from the body.

- (1) Vitamin B- complex
 - (i) Vitamin B₁ or thiamine
 - (ii) Vitamin B₂ or riboflavin
 - (iii) Nicotinic acid or niacin or nicotinamide
 - (iv) Vitamin B₆ or pyridoxine
 - (v) Pantothenic acid
 - (vi) Folic acid
 - (vii) Choline
 - (viii) Biotin
 - (ix) Para amino benzoic acid
 - (x) Vitamin B₁₂ or cyanocobalamin

- (2) Vitamin 'C' or ascorbic acid

2. Fat-soluble vitamins— some of these vitamins are produced in the body but not in adequate quantities. Therefore, for the requirement of these vitamin one has to depend on food.

- (i) Vitamin 'A' or carotene
- (ii) Vitamin 'D'
- (iii) Vitamin 'E'
- (iv) Vitamin 'K'

**Difference between water-soluble
and fat-soluble vitamins-**

Table : 14.1

Fat-soluble vitamins		Water-soluble	
1	Soluble in fat and fat solution.	1	Soluble in water.
2	Excess of these gets stored with fat.	2	Excess of these is removed from the body with water.
3	The symptoms of their deficiency appear slowly.	3	The symptoms of their deficiency appear fast.
4	In these vitamins only carbon, oxygen and hydrogen molecules are present.	4	In these vitamins along with carbon, oxygen and hydrogen, nitrogen is also present. Sometimes sulphur, cobalt is also present.
5	These are absorbed by lymphatic system.	5	These are absorbed by blood.

Fat-soluble vitamins

Vitamin 'A'

Vitamin 'A' is a fat-soluble vitamin. Vitamin A is present only in animal-based food products. In plant-based food products, carotenoids are present which get converted into vitamin A in the body. Carotenoids are thus also known as pro-vitamin A.

Types of vitamin A

Vitamin A is mainly of 4 types. In some food items more than 1 type of vitamin A is present.

- (1) **Vitamin A (Retinol)** — it is also called as Retinol. It is present only in animal-based food products.
- (2) **Vitamin A aldehyde**— it is also called Retinal. It is present in the Rhodopsin and Iodopsin pigment of rods and cones in the retina of eyes. This vitamin is helpful in providing eye sight.
- (3) **Vitamin A, retinoic acid**— it is produced in the body and is essential for the physical growth and development.
- (4) **Vitamin A₂**— it is present in the liver of fresh-water fish. It is a less-active vitamin.

β carotene— it is found in plant- based food sources. It is granulated and dark-red in color. It is very important and useful for health of the body. This gets converted into vitamin 'A' in the body.

Functions of vitamin 'A'—

- 1. **Providing normal eyesight to the eyes**— vitamin A is essential for the health of eyes. There are two types of cells present in the retina of eye. Rods and cones help in seeing in dim and bright light and also in identifying dyes. Color-providing pigments are also present in these rods and cones. Rhodopsin pigment is present in rods and Iodopsin in cones. A protein called Opsin is present in them. Vitamin A aldehyde combines with Opsin protein and changes into Rhodopsin which is also known as 'Visual Purple'. In the presence of light, Rhodopsin gets converted back into vitamin A aldehyde and Opsin. In this way, formation of Rhodopsin takes place in dim light and iodopsin in bright light. This cycle goes on uninterrupted.

Thus, the ability of eyes to see in light depends on vitamin 'A'.

2. **For the health of epithelium tissues—** Vitamin A is helpful in maintaining activity and stability of epithelium tissues. All the external and internal organs of our body are covered with this epithelium tissue. This tissue secretes mucous and protects the organs from bacteria, viruses and germs. Vitamin A helps in this secretion and thus helps in keeping skin and organs soft, moist and gentle.
3. **Physical growth and development—** Vitamin A plays an important role in physical growth and development. Many researchers have proved that in the absence of vitamin A, cell division process is reduced by 30%. Therefore vitamin A helps in physical growth and development.
4. **Helpful in maintaining health of reproductive organs—** Vitamin A plays an important role in maintaining health and activity of reproductive organs. Deficiency of vitamin A leads to low secretion of sexual hormones. As a result disorders develop in male and female reproductive organs.
5. **Helpful in growth of bones—** Vitamin A is essential for normal growth and development of bones.
6. **Resistant to infections—** Vitamin A resists infections in the body. It provides strength to epithelium tissues as a result infection does not occur immediately.
7. **Maintaining health of nervous system—** Vitamin A is essential for activity of tissues of nervous system. In the absence of this myelin

sheath gets destroyed and disorders develop in nervous system.

8. **Synthesis of glycoprotein—** Vitamin A plays an invaluable role in the synthesis of Glycoprotein. In the absence of this vitamin, chances of stones in liver and kidneys increase.
9. **Maintaining health of white blood cells—** Vitamin A is essential for maintaining health of white blood cells. In the absence of vitamin A number of WBCs reduces or Leucopenia occurs.
10. **Synthesis of protein—** Vitamin A helps in synthesis of protein. In the absence of vitamin A metabolism of Ribonucleic acid does not take place properly. Consequently activity of protein is affected.

Effects of deficiency of Vitamin A—

1. **Night-blindness—** deficiency of vitamin A causes night blindness. It is a condition making it difficult or impossible to see in relatively low light, especially when the patient walks from light to darkness or from bright sunlight to a room.



Figure : 14.1 Night-blindness



Figure : 14.2 Bitot's spots

2. **Xerophthalmia—** It is abnormal dryness of the conjunctiva and cornea of the eye, with inflammation and ridge formation, typically associated with vitamin A deficiency. This is mainly due to keratinization of cornea because of which the internal part of cornea appears as

smoky cloud. Over a period eyes lose their sight.

3. **Bitot's spots**— Bitot's spots are the buildup of keratin located superficially in the conjunctiva, which are oval, triangular or irregular in shape
4. **Xerosis conjunctivae**— Deficiency of Vitamin causes conjunctiva to grow thick and dry. Sometimes it gets wrinkles or other injury.
5. **Xerosis cornea**— It is the dryness of the cornea because of lack of tears.
6. **Keratomalacia**—It is an eye disorder that results from vitamin A deficiency. In this disorder, cornea becomes soft, injured and infected with bacteria. The resulting cornea becomes totally opaque, which is one of the most common reasons for blindness.
7. **Phrynoderma**— Due to deficiency of vitamin A sweat glands do not work properly and so sweat is not formed and skin turns dry, rough and hard.
8. **Interrupted physical growth**— If the deficiency of vitamin A prolongs growth and development of bones does not take place properly.
9. **Decreased reproductive activity**— Vitamin A deficiency affects male reproductive organs. Hormone secretion lessens and less sperms are formed.

Effect of over-availability of vitamin A—

Over availability of vitamin is harmful as much as deficiency of vitamin A. Over-availability of vitamin is known as hypervitaminosis.

Effects of excess of vitamin A—

1. Loss of appetite

2. Joint pain
3. Bleeding in retina of eye
4. Liver enlargement
5. Swelling in bones of legs
6. Headache and irritation
7. Difficulty in breathing
8. Hair loss
9. Blisters and pimples on lips

Treatment of deficiency of vitamin A—

If there is deficiency of vitamin A then 10,000 µg of vitamin A should be given for 10 days. If there is over-deficiency then 50,000 µg of vitamin A should be given for a few weeks.

Sources of vitamin A—

Vitamin A is mainly present in liver oil of fish. Other sources are— fish oil, liver, eggs, butter, milk,



Figure : 14.3 (Sources of vitamin 'A')

etc. plant based sources are— leaves of Amaranth, coriander leaves, carrots, drumstick leaves, mint leaves, spinach, etc. are sources of β carotene.

Vitamin 'D'—

Vitamin D is an important fat-soluble vitamin. This vitamin works against bone deformities.

Types of vitamin D—

Rickets resistant substances and sterol compounds are combined together to form vitamin D.



Figure : 14.4 (Rickets)

Vitamin D is of two main types-

1. **Vitamin D₂**— It is called Ergosterol or pro-vitamin D. It reacts with ultraviolet rays of sun to form Calciferol. It is found in mold and yeast.
2. **Vitamin D₃**— It is also called 7-dehydrocholesterol. It is present under the skin and reacts with ultraviolet rays of sun to get converted into vitamin D.

Functions of vitamin D—

1. **Helpful in absorption of calcium and phosphorous**— Vitamin D controls the amount of alkaline phosphatase enzyme which helps in increasing the absorption rate of calcium and phosphorous by bones. In the absence of vitamin these mineral salts are not absorbed. As a result much of calcium and phosphorus gets removed from the body. Consequently bones and teeth do not develop properly.
2. **Controlling the amount of calcium and phosphorus in blood**— Vitamin D controls the amount of calcium and phosphorous in the

body. When both these minerals are in lesser quantity in blood, they move from bones into the blood and thus maintain the balance of calcium and phosphorous levels in blood.

3. **For physical growth**— vitamin D plays an invaluable role in physical growth and development. Deficiency of this vitamin reduces the absorption rate of calcium and phosphorus and physical growth is affected.
4. **Controlling parathyroid gland**— vitamin D controls and regulates the secretion of hormones from parathyroid gland.
5. **Vitamin D** helps in synthesizing the activity of protein in mucosa of small intestine.

Effects of deficiency of vitamin D—

Deficiency of vitamin D leads to increased levels of alkaline phosphatase in blood. As a result, calcium and phosphorous do not get absorbed properly in the intestines. Thus the bones and teeth become weak. Following disorders occur due to deficiency of vitamin D—

1. **Rickets**— It commonly affects children. In this disorder, there is an acute deficiency of vitamin D, calcium and phosphorous in the body. It mainly affects people living in populated, industrial areas where they do not get proper sunlight.
2. **Muscle twitching**— Deficiency of vitamin D causes irregularity in metabolism of calcium and phosphorus and this leads to muscle twitching.
3. **Teeth rotting**— Deficiency of vitamin D delays teeth growth in children. Calcium phosphate does not get deposited in enamel and dentin of teeth. Thus Healthy teeth are not formed.

4. **Osteomalacia**— it is a term for rickets in adults. In this disorder, due to deficiency of vitamin D or calcium thus calcification in bones does not take place properly. It is common in pregnant and feeding mothers who mostly take plant-based food and stay confined in houses.

In this disorder bones become soft and get bent. Bone breaking becomes common.

5. **Osteoporosis**— it commonly found in adults where bones grow weak and disabled. Bones break on slightest injury or fall.

Table : 14.2 Vitamin ‘D’ Defeciciency

Rickets	Tetany	Rotting of teeth	Osteomalacia
In children (6 months- 2-1/2 years)		In children	In adults
Symptoms:	Symptoms:	Symptoms:	Symptoms:
1. late filling of sinciput	1. sharp pain in limbs	1. rotting of teeth	1. weakness of bones
2. softening of bones of skull	2. pain and spasms	2. unhealthy teeth	2. pain in back and thighs
3. elongation of long bones		3. deformed teeth	3. bending of backbone
4. protuberance in rib bones		4. delayed growth of teeth	4. weakening of muscles
5. joint pain			5. under-developed pelvic cavity
6. disturbance of digestion process			
7. lethargy			
8. irritation			

Effects of excess of vitamin D—

Excess of vitamin D causes loss of appetite, nausea, vomiting, thirst and diabetes insipidus. A child feels lethargic and weak and deterioration of muscles. Excess of vitamin D causes calcium deposition in arteries, kidneys and lungs leading to death.

Sources of vitamin D—

Vitamin D is present in only some animal based food products. Vitamin D is obtained from sunlight and from sources such as liver oil of fish, fat-rich fishes, eggs, butter, cottage cheese, fat-rich milk, etc.

Vitamin E—

In 1922 Evans and Bishop experimented on mice and reported that a fat-soluble element is necessary for reproduction in mice. This element was

named as vitamin ‘E’ which is helpful in production of offspring. This vitamin is also known as infertility impeding vitamin. According to its chemical structure it is named as β tocopherol.

Types of vitamin E— this vitamin is mainly found in two forms—

- (1) Tocopherol
- (2) Tocotrienol

Between both these forms, tocopherol is more active. It is also of 3 types— alpha (α), beta (β), gamma (γ)

Functions of vitamin E—

1. **Preventing oxidization of vitamin A and carotene**— Vitamin E has anti-oxidizing properties. That is why vitamin E is able to

prevent oxidation of vitamin A and carotene in intestines. Thus, it prevents vitamin A and carotene from getting destroyed.

2. **Formation of red blood cells**— vitamin E plays an important role in formation of red blood cells. It prevents RBCs from getting damaged by oxidizing agents. Thus it increases the life span of RBCs.
3. **Maintaining integration of cells**— vitamin E helps in maintaining integration of cell covering. In the case of deficiency of vitamin E this creative integration gets damaged.
4. **Helpful in reproduction**— vitamin E helps in normal reproduction.
5. **Metabolism of nucleic acid and protein**— Vitamin E plays an important role in metabolism of nucleic acids and protein. It is helpful in synthesis of heme protein.
6. **Vitamin E** provides protection to liver against various poisonous substances. Different sexual hormones, cholesterol and vitamin D are affected by the presence of vitamin E.

Effects of deficiency of vitamin E—

1. **Reduction in reproduction capacity**— because of decreased vitamin E reproductive organs do not work properly. There is an imbalance and problems in secretion of sexual hormones. In females, foetus dies during gestation period and in males, sperm producing cells get destroyed.
2. **Liver necrosis**— Vitamin E protects liver against poisonous and harmful substances. When there is deficiency of vitamin E in the body, the harmful substances start depositing in liver. As a result, liver cells start getting damaged

3. **Erythrocyte hemolysis**— Deficiency of vitamin E causes damage of RBCs. Bone marrow is unable to produce RBCs rapidly and this gives rise to anemia.

4. **Muscle twitching**— Muscles become weak due to deficiency of vitamin E and they start contracting unnecessarily.

Sources of vitamin E— Many plant seed oils are main sources of vitamin E. vegetable oils and fats too are rich in vitamin E.

Vitamin 'K'

The presence of vitamin K was first reported by Dr. Dam. In 1934, experiments on chicken led to the knowledge that vitamin K helps in blood clotting. This vitamin is bleeding- resistant vitamin.

Types of vitamin K

Vitamin K is mainly of 2 types—

1. Vitamin 'K₁'— It is present in green leafy vegetables. It is also known as phyloquinone.
2. Vitamin 'K₂'— It is present in rotten fishes. It is also known as menaquinone.

Functions of vitamin 'K'—

1. **Blood clotting**— Vitamin K helps in blood clotting. It is helpful in formation of prothrombin. Prothrombin converts into Thrombin which gets converted into Fibrin. Fibrin clots the blood. Platelets and other blood factors from The blood with damaged tissues form Thromboplastin. These blood factors work in combination with calcium ions and blood plasma and make prothrombin active. Active Prothrombin reacts with blood factors to form a new substance called Thrombin. A soluble protein called Fibrinogen, present in blood plasma, reacts with Thrombin and converts

Fibrinogen into insoluble Protein fibrin. The blood cells get entrapped in this Fibrin and blood clots. In the absence of vitamin K Prothrombin is not formed. Therefore, blood clotting does not take place.

Effects of deficiency of vitamin K—

Low volume of Prothrombin in blood— deficiency of vitamin K decreases the volume of Prothrombin in blood, which prolongs the period of blood clotting. This causes excess of bleeding. When there is an internal or external injury, excessive blood flows caused by the rupture of a blood vessel. This is known as hemorrhage.

Effects of excess of vitamin K—

Vitamin K in excess causes damage of red blood cells which leads to hemolytic anemia. Symptoms of this anemia are— nausea, vomiting, dizziness, yellowing of skin, etc.

Sources of vitamin K—

Vitamin K is present in various plant-based food products. Some bacteria in our intestines also forms vitamin K. Green leafy vegetables are main sources of vitamin K. Cereals, lentils, eggs, milk, meat and fish are also good sources.

Water soluble vitamins—

Vitamin ‘C’ (Ascorbic acid)

Vitamin C is also known as Ascorbic acid. Vitamin C came into light when treatment and reasons for scurvy disease were discovered. These are white shaped crystals and are soluble in water. They are readily oxidized, especially in the presence of base, temperature, light and copper.

Functions of vitamin ‘C’—

1. Formation of collagen and intra-cellular

substances— Vitamin C forms intra-cellular substances which help in binding tissues such as cells, bones, teeth, connective tissue.

2. **Helpful in absorption of iron—** vitamin C converts ferric salts into ferrous salts which get absorbed in to the alimentary tract.
3. **As a co-enzyme—** vitamin C acts as a co-enzyme for various metabolic activities.
4. **Formation of bones—** vitamin C contributes in growth, development and formation of bones. Deficiency of this vitamin causes some changes in bones because bone matrix and other allied substances are not formed properly.
5. **As an anti-oxidant—** Vitamin C works as an important anti-oxidant. It helps in maintaining activity of white blood cells and protects the body against infections.
6. **Maintaining health of blood vessels—** Vitamin C keeps blood vessels healthy and provides strength and firmness to the walls of vessels.
7. **Healing of wounds—** vitamin C forms collagen which helps in healing of wounds.
8. **Increasing disease-resistance capacity—** Vitamin C protects cell damage during incidence of diseases such as tuberculosis, pneumonia etc. Vitamin C increases disease-resistance capacity.

Effects of deficiency of vitamin ‘C’—

Deficiency of vitamin C for a long time causes scurvy.

Scurvy is of two types—

- (1) **Scurvy in adults—** survey in adults occurs due to consumption of food lacking in vitaminC.

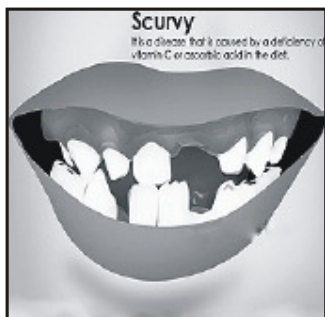


Figure : 14.5 (Scurvy)

Symptoms—

- (i) Weakness, weight loss
- (ii) Lethargy, laziness and fatigue
- (iii) Because of deficiency of vitamin C, iron is not absorbed properly leading to anemia.
- (iv) Skin becomes dry, rough, yellow and dull
- (v) Gums get dried and teeth weaken leading to tooth loss.
- (vi) Body muscles become inactive
- (2) **Scurvy in children**— deficiency of vitamin C in children causes scurvy. This disease does not occur in children below 6 months. It occurs in children between age 6-12 months. Scurvy is a very dangerous disease in children.

Symptoms—

- (i) Children become irritable, lazy and lethargic.
- (ii) Swelling and pain in legs
- (iii) Walls of blood vessels get damaged
- (iv) Healing of wounds takes place slowly
- (v) Swelling in gums, mouth seems to stink
- (vi) Chest bones curved in
- (vii) Difficulty in breathing, body turns blue, twitching of body occurs and the child dies.

Sources of vitamin 'C'—

Gooseberry and guava are best sources of vitamin C. all sour fruits such as lemon, oranges,



Figure : 14.6 (Sources of vitamin 'C')

sugarcane, mango, papaya and vegetable such as tomatoes, amaranth, cauliflower, coriander leaves, drumstick leaves, radish leaves are good sources of vitamin C. spouted grains and lentils also have good quantity of vitamin C.

Vitamin B₁ (Thiamine)

Thiamine was discovered while treating Beriberi. Mostly Beriberi is seen in people consuming polished rice as a staple diet.

Thiamine is readily soluble in water. It is stable in acidic medium. In basic medium it gets destroyed even at room temperature. Using soda in food destroys thiamine.

Functions of thiamine—

1. Helpful in metabolism of carbohydrates— in our body, thiamine combines with phosphate to form thiamine pyrophosphate which helps in metabolism of carbohydrates.
2. Helpful in digestion— thiamine keeps the muscular motion of digestive system normal.

3. Helpful in maintaining normal rate of pulse—thiamine pyrophosphate is extremely important for carbohydrate metabolism. In the absence of pyrophosphate metabolism of carbohydrates does not take place properly as a result it cannot reach the muscles and tissues of pulses. As a result abnormality occurs.
4. Helpful in DNA and RNA formation—thiamine is important for the formation of DNA and RNA.
5. Thiamine increases germ killing capacity of white blood cells.
6. Thiamine plays an important role in keeping internal organs healthy and functional.

Effects of deficiency of thiamine—

Thiamine deficiency is common in people who consume alcohol. Also people who consume carbohydrates in large quantity and consume lentils, green vegetables, etc in less quantity.

Deficiency of thiamine causes Beriberi. It can be divided into 3 types—

- (1) Dry Beriberi (in adults)
- (2) Wet Beriberi (in adults)
- (3) Infantile Beriberi (in children)

1. **Dry beriberi**— it occurs in adults. It is known as dry beriberi because in this muscles get damaged severely and as a result a person becomes skinny.

Symptoms— the vascular system gets affected. There is decreased muscle function, loss of sensation in legs, mental confusion, irritation, suicidal tendency are some of the symptoms of abnormality of nervous system.

2. **Wet beriberi**— because of the occurrence of inflammation in the body this type of beriberi is

known as wet beriberi. Inflammation begins from legs and reaches arms, face and neck.

Symptoms— heart becomes weak and there is unnatural change in heart rate, breathing becomes difficult. If Beriberi is not treated on time it may result in death due to blockage in the heart.

3. **Infantile beriberi**— it occurs in children. If there is deficiency of vitamin B₁ in feeding mother or if the mother consumes polished rice in large quantity, deficiency of vitamin B₁ is seen in feeding mother's milk. As a result there occurs deficiency of this vitamin in feed consuming babies. This disease can also be found in children who consume thiamine deficient food.

Symptoms— muscles are damaged in this disease. Water gets filled up in the body. Heart and liver grow in size. Loss of appetite and damage to digestive capacity, vomiting, diarrhoea are some other symptoms.

4. **Wernicke-Korsakoff Beriberi**— this disease is a result of excess of thiamine deficiency, especially in people who daily consume large quantities of alcohol.

Symptoms— eye muscles weaken and the rate of moving of eyeball increases unusually. Walk becomes abnormal.



Figure : 14.7 (Beriberi)

Sources of thiamine— whole grains are main sources of thiamine. Thiamine is present in oil seeds, green vegetables, green peas, liver etc.

Vitamin B₂ (Riboflavin)

A pentose sugar called ‘ribose’ and an iso centre is present in riboflavin. It is readily soluble in water and gets damaged by light and ultraviolet rays of the sun.

Functions of riboflavin—

1. **Regulation and controlling of hormones**— riboflavin plays an important role in the formation of enzymes that are responsible for the metabolism of carbohydrate, fat and proteins. Riboflavin is important for activity of insulin hormone.
2. **Maintaining health of skin**— riboflavin helps in keeping skin beautiful, attractive, hydrated and glowing.
3. **Maintaining health of eyes**— riboflavin is essential for the health of eyes. In the absence of riboflavin, blood cells in eyes get damaged.
4. **Helpful in physical growth**— riboflavin provides nutrition to body cells. It is essential for releasing power in body cells.

Effects of deficiency of riboflavin—

1. **Skin injuries**— deficiency of riboflavin affects face, skin, eyes and vascular system. Skin becomes red and injured. Inflammation of the corners (angles) of the lips which sometimes bleed is known as angular stomatitis. Cheilosis is a painful inflammation and cracking of the corners of the mouth. Ulcers on the tongue is a common effect of deficiency. The color of tongue changes from natural to somewhat dark and it is known as glossitis.



Figure : 14.8 (Riboflavinosis)

2. **Effect on eyes**— deficiency of riboflavin affects eyes. Light resistance power of eyes reduces and a sticky substance is secreted from eyes permanently which if not treated may lead to loss of eyesight.
3. Physical growth is disrupted and there is loss of appetite. Digestive capacity reduces.
4. Riboflavin deficiency causes soreness of testicles in men.

Sources of riboflavin— riboflavin is found mainly in liver, dry yeast, eggs, meat, fish, whole grains, lentils and green leafy vegetables.

Vitamin B₃ (Niacin)

Niacin element was discovered because of pellagra disease. Niacin is also known as ‘pellagra preventing vitamin’. Pellagra is an Italian word and is formed from two words— ‘pelle’ meaning coarse and ‘agra’ meaning skin in Italian.



Figure : 14.9 (Pellagra)

Functions of Niacin—

1. Metabolism of carbohydrates, fat and protein— niacin plays an important role in the metabolism of carbohydrates, fats and proteins.
2. Maintaining health of vascular system— niacin is helpful in keeping vascular system healthy.
3. Helpful in physical growth— niacin is helpful in increasing the rate of physical growth.
4. Health of eyes— niacin is helpful in converting vitamin A in retinol and thus, is helpful in keeping eyes healthy and maintaining vision of eyes.
5. Niacin is important for keeping skin healthy.

Effects of deficiency of Niacin—

Prolonged deficiency of niacin in food for many months, gives rise to pellagra. Pellagra is also known as 3D's disease. This is so because there are 3 symptoms of this disease and all begin with a 'D'.

1. **Diarrhea**— diarrhoea is a result of abnormality in digestive system and its organs. The mucosa of lips gets damaged, as a result mouth does not open properly and tongue, and throat is affected. Tongue and lips darken and swallowing of food becomes difficult.
2. **Dermatitis**— deficiency of niacin causes dermatitis. The parts of body that are not covered and receive direct sunlight are affected more than the other parts. Skin becomes coarse and red, rashes appear and injury may occur.
3. **Dementia**— dementia is a serious symptom of pellagra. If pellagra becomes serious then dementia begins to appear. Vascular system becomes abnormal and patient remains tense. Memory of the patient reduces and fainting spells begin. Patient begins to involuntarily urinate and defecate.

Sources of Niacin— the main sources of Niacin are dry yeast, liver, groundnut, whole grains,

lentils, meat, fish, milk, eggs and other vegetables.

Vitamin B₁₂—

Vitamin B₁₂ is an important vitamin of vitamin 'B' group. In this vitamin cobalt, an important mineral salt is present. Because of the presence of cobalt, it is known as cyanocobalamin.

Functions of vitamin B₁₂—

1. Vitamin B₁₂ works like a co-enzyme.
2. Vitamin B₁₂ is essential for the maturity of RBCs.
3. It plays an important role in metabolism of carbohydrates, fats and proteins.
4. Vitamin B₁₂ increases hunger and prevents fat accumulation in liver.
5. It is helpful in metabolism of folic acid and other metabolic activities of vascular tissues.

Effects of deficiency of vitamin B₁₂—

Deficiency of vitamin B₁₂ causes pernicious anemia. When intrinsic factors are not present in adequate quantities in stomach juice, absorption of vitamin B₁₂ does not take place properly. This causes deficiency of vitamin B₁₂.

Symptoms of pernicious anemia—

1. Ulcers in mouth.
2. Loss of stomach cells that make intrinsic factor.
3. Changes in external form of bone marrow.
4. Acute decrease in number of RBCs
5. Reduction of hemoglobin levels in blood
6. Skin turns yellow
7. Abnormality in blood vessels

Sources of vitamin B₁₂—

Vitamin B₁₂ is mainly found in animal based food sources. It is completely absent in plant based food sources. Liver of sheep, goat, pig, ox, etc is a good source of this vitamin. Meat, fish, eggs also contain vitamin B₁₂ in good quantity. It is also found in milk.

Folic acid

Folic acid cures anemia due to innutrition in

humans, animals and birds. It acts as a growth factor in micro organisms.

Functions of folic acid—

1. Folic acid along with vitamin B₁₂ is essential for formation and maturity of RBCs in bone marrow.
2. Folic acid works as a co-enzyme in the formation of purines and pyrimidines.
3. Folic acid plays an important role in metabolism of histidine, tyrosine and tryptophan.
4. Folic acid has an important role in different biological and chemical processes of the body.

Effects of deficiency of folic acid—

Due to deficiency of folic acid formation of RBCs lessens and number of RBCs reduces. It is known as megaloblastic anemia. In megaloblastic anemia percentage of hemoglobin in blood reduces drastically and number of RBCs also decreases. This type of anemia is mostly seen in children belonging to under developed and developing nations.

Effects of excess of folic acid—

Folic acid is partially soluble in water. The extra quantity of folic acid is not excreted with urine. Consequently the excess of folic acid accumulates in kidney as stone.

Sources of folic acid—

Folic acid is found in dry yeast, liver, wheat embryo, upper layer of rice, whole grains, and lentils and green leafy vegetables.

Mineral salts—

In addition to carbohydrates, fat, protein and vitamins one more element is present in the body which is called mineral element. This element is helpful in the growth and formation of body. The leftovers after burning of plant and animal tissues are actually mineral

element. 4% of our body weight is made up of mineral elements. These mineral elements are inorganic, in other words carbon is absent in these mineral salts.

On the basis of quantity, mineral salts in the body can be divided into 2 parts—

1. Main minerals/ major mineral element— the mineral elements which are present in large quantities in the body are main minerals. These are taken up in the food substances that we eat.
2. Accessory minerals/ minor mineral elements— these elements are required in minor quantity in the body. These mineral elements play an important role in monitoring the physical activities.

Table No. 14.3: classification of mineral elements

Main mineral elements	Accessory mineral elements
Calcium	Iron
Phosphorus	Manganese
Potassium	Copper
Sulphur	Cobalt
Sodium	Aluminium
Chlorine	Selenium
Magnesium	Zinc
	Fluorine
	Bromine
	Iodine
	Chromium
	Cadmium
	Molybdenum
	Silicon
	Nickel
	vanadium

Calcium—

Calcium is present in large quantity in our body compared to other mineral salts. The quantity of calcium is the largest out of all mineral elements. Half the quantity of all mineral elements or 2% of our body weight is made of calcium. 99% of calcium in the body is present in our bones and teeth and the remaining 1% is present in soft tissues, blood serum and fluid substances.

Functions of calcium—

1. Formation of bones and teeth— during foetal development a strong but flexible protein matrix starts forming for bone formation. With aging calcium gets deposited in cartilage which changes into bones. This is so because with aging calcium, phosphorus and other mineral salts start depositing in the protein matrix and the matrix becomes stiff. Consequently bones become rigid. Like in bones, in teeth also large quantity of calcium is present.
2. Physical growth and development— the deficiency of calcium affects protein in the body. Protein is essential for physical growth and development of the body.
3. Helpful in blood clotting— calcium is helpful in blood clotting.
 Blood platelets → thromboplastin
 Thromboplastin + calcium + vitamin K + tryptan enzyme = prothrombin
 Prothrombin + Ca^{++} + vitamin K + blood factor CV & VIII = thrombin
 Thrombin + fibrinogen = fibrin
 Fibrin + blood cells = blood clot
4. Monitoring of muscular contraction— calcium helps in monitoring of muscle contraction and relaxation and thus helps in keeping them active.

5. Balancing heart rate— for heart muscles, calcium has to be present in adequate quantity in the fluid substances of covering fibers.
6. Calcium is helpful in activating enzymes.
7. Calcium regulates movement of fluids across cell membranes.

Effects of deficiency of calcium—

1. Growth is disrupted in the absence of calcium. Because of calcium deficiency process of calcification cannot take place. Weakening bones and their malformation is known as ‘rickets’.
2. Deficiency of calcium in adults causes ‘osteomalacia’. In this disease, dissolution of calcium from bones increases. As a result a slight injury results in breaking of bone.
3. Deficiency of calcium during pregnancy leads to absorption of calcium by the foetus from mother’s body. As a result, pelvic girdle in pregnant lady becomes narrow.
4. In old age, due to calcium deficiency bones become weak. This condition is known by the name of osteoporosis.

Effects of excess of calcium—

Excess of calcium in body is called ‘hypercalcemia’. Excess of calcium can be seen both in children and adults. In this situation, there is loss of appetite. Nausea, vomiting, muscle fatigue are common symptoms. Calcium increases in blood and levels of urea, plasma, cholesterol also increase.

Sources of calcium— all milk products (fresh butter, powder milk, buttermilk, etc) are good sources of calcium. Other sources are green leafy vegetables, cabbage, cauliflower, turnip, mustard, lentils, dry fruits, etc.



Figure : 14.10 (Fluorosis)

Phosphorous—

After calcium, quantity of phosphorous is the highest. 1% of our body weight consists of phosphorous. 80% of total phosphorous combines with calcium to form calcium phosphate which forms bones and teeth.

Functions of phosphorous—

1. Formation of bones and teeth— phosphorous combines with calcium and forms calcium phosphate which is an insoluble salt and plays an important role in formation of bones and teeth.
2. Phosphorous is an important and essential mineral salt in the formation of nucleoprotein and nucleic acid.
3. It plays an important role in metabolism of carbohydrates.
4. It acts as a buffer because of its capacity to combine with more hydrogen ions.
5. Phosphorous is helpful in producing energy the process of .
6. It helps in formation and development of cells.
7. Phosphorous increases calcium absorption in the body.

Effects of deficiency of phosphorous—

Phosphorous is present freely in most of the food items therefore there are no effects of deficiency. But those who consume more, and have deficiency of phosphorous. The symptoms of this type of deficiency

are fatigue, loss of appetite, demineralization of bones.

Sources of phosphorous—

The food which contains calcium and protein in adequate quantities will also contain calcium in good amount. Milk, eggs, meat, fish, chicken, wheat, sesame, oat flour are good sources of phosphorous. Cereals, lentils, dry fruits, peas, beet root, almonds etc are other sources of phosphorous.

Iron—

In our body, Iron is present in small quantity but it is an important element for our body. In the body of a normal person, 4-5 grams iron is present. It is an essential element for keeping body healthy.

Functions of iron—

1. Iron is an important mineral salt for the formation of hemoglobin in blood. Heme iron and globin protein is present in hemoglobin. In the absence of heme iron hemoglobin formation does not take place.
2. Iron is present as myoglobin in muscles which is essential for contraction process.
3. Iron is important for the formation of enzymes participating in respiratory process.
4. It forms immune cells.

Effects of deficiency of iron—

Deficiency of iron causes anemia. Anemia is a condition that develops when your blood lacks enough healthy red blood cells or hemoglobin. This disease is more prevalent in pregnant mothers and infants of 1 year who have stopped taking mother's milk. Because of anemia skin of baby turns yellow. Growth and development of children slows down. During pregnancy more iron is required for blood formation in foetus. If the demand of iron is not fulfilled symptoms like difficulty in breathing, dizziness, yellowing of skin, etc appears.

Sources of iron—

Eggs, meat, liver, dry fruits like raisins, plum are good sources of iron. Green leafy vegetables, lentils,

millet, jaggery, sesame, mint, *ragi*, etc are good sources of iron.

Type	Mineral salt	Functions	Effects of deficiency	Sources
Main mineral elements	Potassium	<ul style="list-style-type: none"> • Regulation of acid-base balance • Balancing fluid substances in body • Helpful in muscle contraction • Synthesis of glycogen • Helpful in growth and development of body 	<ul style="list-style-type: none"> • Painful muscle contraction • Irritation and anger • Lethargy • Imbalance in heart beat rate • Weakening of muscles 	Lentils, oil seeds, milk, cottage cheese, eggs, meat, fish, chicken, vegetables and fruits
	Sodium	<ol style="list-style-type: none"> 1. regulating heart beat rate 2. helpful in water balance 3. helpful in nerve stimulus 4. helpful in absorption of amino acids and carbohydrates 5. helpful in muscle contraction 	<ol style="list-style-type: none"> 1. nausea 2. weakness, lethargy 3. intense painful muscle contraction 4. muscle spasm 	Milk, meat, fish, eggs, curd, lentils, dry fruits, green vegetables
	Sulphur	<ol style="list-style-type: none"> 1. helpful in the growth of hair & nails 2. keeping skin soft and healthy 3. helpful in formation of digestive juices, enzymes, hormones, vitamins, etc. 4. helpful in digestion, absorption and metabolism of proteins 	<ol style="list-style-type: none"> 1. physical growth in children disrupts 2. skin becomes dry and dull 3. hair and nail growth disrupts 	Chicken, fish, eggs, milk, mil products, cottage cheese, groundnuts, <i>masur</i> lentils.

	magnesium	<ol style="list-style-type: none"> 1. helpful in metabolism of calcium and phosphorous 2. helpful in activating enzymes 3. balancing sensation power of vascular system 	<ol style="list-style-type: none"> 1. muscle fatigue 2. insensibility 3. painful contraction of muscles of arms-legs 4. feeling depression 	Cereals, lentils, oil seeds, dry fruits
	iodine	<ol style="list-style-type: none"> 1. physical growth and development 2. mental development of child 3. reducing cholesterol level 4. milk formation in nursing mother 5. control and regulation of basic metabolism 	<ol style="list-style-type: none"> 1. goitre 2. cretinism 3. myxedema 	Sea salt, sea fish, sea grass, eggs
	fluorine	<ol style="list-style-type: none"> 1. mineralization of bones 2. for good health of bone fibers 3. for good health of teeth 	<ol style="list-style-type: none"> 1. dental fluorosis 2. skeletal fluorosis 	Milk, cottage cheese, eggs, potato, sea fish, meat
	copper	<ol style="list-style-type: none"> 1. absorption and metabolism of iron 2. formation of RBCs 	<ol style="list-style-type: none"> 1. improper physical development 	Liver, meat, lentils, kidney,

		1. normal development of bones 2. formation of enzymes 3. formation of melanin	1. formation of connective tissues does not take place	Roots vegetables, dry fruits
	zinc	1. in wound healing 2. development of bones 3. development of brain 4. helpful in normal growth 5. development of reproductive organs	1. delayed wound healing 2. normal growth and development is disrupted 3. hair loss 4. wounds on skin	Herrings and oyster, meat, eggs, wheat bran, oat flour, lentils, dry fruits
	manganese	1. physical growth and development 2. in reproductive functions 3. secretion of hormones 4. helpful in metabolism 5. for good health of liver	1. reproductive organs do not develop fully 2. deposition of fats in liver 3. development in animals is disrupted	Wheat bran, maize bran, groundnut, dry peas, blackberry, tea, coffee, dry fruits.

IMPORTANT POINTS:

1. The word 'vitamin' was given by Casimir Funk in 1912.
2. Vitamin A is of 4 types— retinol, aldehyde, retinoic acid, vitamin A₂
3. Vitamin A plays an important role in physical growth and development.
4. Vitamin A is mainly found in carrots, mint, spinach, amaranthus leaves.

5. Due to deficiency of vitamin D in body, alkaline phosphatase increases in blood.
6. Vitamin K mainly helps in blood clotting.
7. Deficiency of vitamin C causes scurvy.
8. Riboflavin regulates and controls hormones.
9. Deficiency of calcium weakens bones and growth recedes.
10. In a normal person, 4-5 grams of iron is present.

EXERCISE:**1. Choose the correct option:**

- (i) Which disease is caused by deficiency of iodine?
 - (a) Goitre
 - (b) Rickets
 - (c) Night blindness
 - (d) Fluorosis
- (ii) How much iron is present in the body of a normal person?
 - (a) 5-6 grams
 - (b) 4-5 grams
 - (c) 3-4 grams
 - (d) 6-7 grams
- (iii) Which is severe symptom of pellagra disease?
 - (a) Skin disease
 - (b) diarrhea
 - (c) Dementia
 - (d) none of these

- (iv) Which disease is caused by deficiency of thiamine?

(a) Beriberi (b) night blindness

(c) Anemia (d) pellagra

2. Fill in the blanks:

- (i) Vitamin K is necessary for _____
- (ii) Keratomalacia is caused by the deficiency of _____
- (iii) Bone softness is also known as _____
- (iv) Excess of fluorine causes _____ disease.
3. How many types of vitamin exist? Explain.
4. What is the importance of folic acid in food?
5. Explain functions of vitamin A.
6. Write the effects of deficiency of thiamine in body.
7. Explain functions and effects of deficiency of iron.
8. What are the effects of deficiency of niacin?

ANSWERS:

1. (i) a (ii) b (iii) c (iv) a
2. (i) blood clotting (ii) vitamin A
(iii) rickets (iv) fluorosis