!! JAY AMBE !!

11. NUTRITION AND HEALTH

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CHAPTER – 3: NUTRITION AND HEALTH

- Nutrition may be defined as the science of food and its relationship to health. It is concerned primarily with the part played by nutrients in body growth, development and maintenance.
- The word nutrient or "food factor" is used for specific dietary constituents such as proteins, vitamins and minerals.
- Dietetics is the practical application of the principles of nutrition; it includes the planning of meals for the well and the sick.
- Good nutrition means "maintaining a nutritional status that enables us to grow well and enjoy good health."

CLASSIFICATION OF FOODS:

- **Classification by origin:**
  - Foods of animal origin
  - Foods of vegetable origin
- **Classification by chemical composition:**
  - Proteins
  - Fats
  - Carbohydrates
  - Vitamins
  - Minerals
- **Classification by predominant function:**
  - Body building foods: Meat, milk, poultry, fish, eggs, pulses etc
  - Energy giving foods: Cereals, sugars, fats, oils etc.
  - Protective foods: Vegetables, fruits, milk, etc

NUTRIENTS:

Organic and inorganic complexes contained in food are called nutrients. They are broadly divided in to:

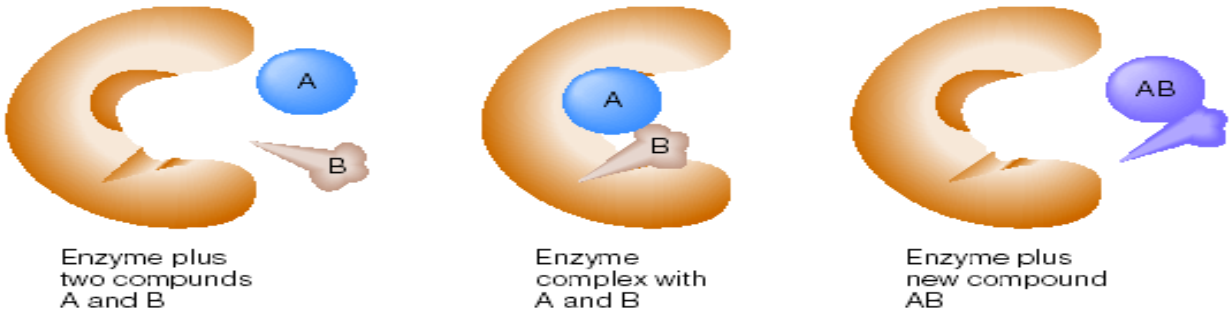
- **Macronutrients:**
  - Proteins
  - Fats
  - Carbohydrates
- **Micronutrients:**
  - Vitamins
  - Minerals

PROTEINS:

- Proteins are complex organic nitrogenous compounds.
- They also contain sulfur and in some cases phosphorous and iron.
- Proteins are made of monomers called amino acids.
- There are about 20 different amino acids which are found in human body.
- Amino acids can be divided into three categories: Essential amino acids, Non-essential amino acids and Conditional amino acids.
- Essential amino acids cannot be made by the body, and must be supplied by food.
- Non-essential amino acids are made by the body from essential amino acids or in the normal breakdown of proteins.
- Conditional amino acids are usually not essential, except in times of illness, stress or for someone challenged with a lifelong medical condition.
- Essential aminoacids are leucine, isoleucine, valine, lysine, threonine, tryptophan, methionine, phenylalanine and histidine.
- Non-essential amino acids include alanine, asparagine, asparticacid and glutamic acid.
- Conditional amino acids include arginine, cysteine, glutamine, glycine, proline, serine, and tyrosine.

Functions of Proteins:

- Body building
- Repair and maintenance of body tissues
- Maintenance of osmotic pressure
- Synthesis of bioactive substances and other vital molecules
- Protein helps keep skin, hair, and nails healthy.
- Proteins act as enzyme that catalyze chemical reactions without being used up or destroyed in the process. Used in – digestion, releasing of energy from nutrients for fuel, triggering reactions that build muscle and tissue



- Act as hormones which are chemical messengers that are made on one part of the body, but act on cells in other parts of the body. Eg. Insulin, Glucagon, Antidiuretic Hormone (ADH)
- Antibodies are blood proteins that attack and inactivate bacteria and viruses
- Protein maintains the fluid balance. Blood proteins like albumin and globulin help to regulate this balance by remaining in the capillaries and attracting fluid. Edema is the result of fluid imbalance
- Protein take part in acid base balance. Proteins help to maintain a stable pH level in our body fluid by picking up extra hydrogen ions when conditions are acidic, and donating hydrogen ions when conditions are alkaline. Otherwise, the resulting conditions of acidosis or alkalosis could lead to coma or death
- It also have important role in transport mechanism. Albumin transports a variety of nutrients such as calcium, zinc, and Vitamin B6. Transferrin transports iron (hemoglobin – a protein, contains iron, but it transports oxygen)
- Proteins may also acts as channels or pumps across the cell membrane
- Protein is the major energy source. If the diet does not provide enough energy, the body must begin to break down its own protein. The proteins are broken down into individual amino acids, then deaminated, and the remaining carbon, hydrogen, and oxygen compounds are used to make energy or glucose. If the diet contains too much protein, the excess will be converted to glucose, or stored as fat

Requirements of proteins:

Adults:

- 0.8 grams of protein per kilogram of body weight per day

Endurance Athletes:

- 1.2 to 1.4 g/kg/day

Heavy Weight Trainers:

- 1.7 to 1.8 g/kg/day

Source of proteins:

Almonds (1 cup)	24 grams	Whole Wheat Bread	3 grams
Pinto Beans (1 cup)	15 grams	Lean Hamburger	30 grams
Cheese (1 oz.)	7 grams	Peanut Butter (1 T)	4 grams
Ham (3 oz.)	18 grams	Salmon (3 oz.)	20 grams
1 Egg	6 grams	Tofu (4 oz.)	9 grams
2% Milk (1 cup)	8 grams	Yogurt (8 oz.)	10 grams
Clams (3 oz.)	60 grams	White rice (1 cup)	4 grams

Assessment of Protein nutrition status:

- Protein nutrition status is measured by Serum Albumin Concentration.
- It should be more than 3.5 g/dl.
- Less than 3.5 g/dl shows mild malnutrition.
- Less than 3.0 g/dl shows severe malnutrition.

Insufficient Dietary Protein:

Protein-Energy Malnutrition (PEM) can occur anywhere in the world, but is most common in developing countries

- Kwashiorkor
- Marasmus

1) **Kwashiorkor:**

- Related to protein deficiency but calorie intake is sufficient.
- Clinically it is characterized by apathy, edema, subcutaneous fat deposition, moon face, enlarged fatty liver and low serum albumin.
- Possible pathogenesis of edema are hypoproteinemia or electrolyte imbalance.
- Other future includes 'flaky-point' areas of skin hyper pigmentation or depigmentation, dusky erythemia, alter and thin texture of hair with flag sign (presence of bands of depigmentation in tuffs of hairs) and anemia.

2) **Marasmus:**

- Starvation in infant due to overall lack of calories.
- Marasmic children show stunted growth, total loss of subcutaneous fat, atrophy of muscles, broomstick arm and leg, hanging loose skin and pinched faces.
- They have no edema or enlarge liver.

CONTRASTING FEATURES OF KWASHIORKOR AND MURASMUS		
Definition	▪ Protein deficiency with sufficient calorie intake	▪ Starvation in infants with over all lack of calories
Clinical Features	▪ Occur in children between 6 months and 3 years of age. ▪ Growth Failure. ▪ Wasting of muscles but preserved adipose tissue. ▪ Oedema generalized or localized ▪ Enlarge fatty liver ▪ Serum Protein low ▪ Anemia Present ▪ "Flag Sign"- alternate band of light (depigmented) and dark (pigmented) hair.	▪ Common in infants with under 1 year of age. ▪ Growth Failure. ▪ Wasting all tissue including muscles and adipose tissue. ▪ Oedema absent. ▪ No hepatic enlargement. ▪ Serum Protein low ▪ Anemia Present ▪ Monkey like face , protuberant abdomen, thin limbs
Morphology	▪ Enlarge Fatty liver ▪ Atrophy of different tissues and organs but subcutaneous fat preservation	▪ No fatty liver ▪ Atrophy of different tissue and organs including subcutaneous fat

A classic sign of Kwashiorkor is edema.

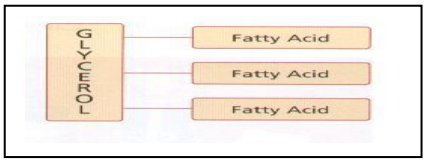
Marasmus results in an emaciated appearance.

Excess Dietary Protein:

- May strain the kidneys
- May cause mineral losses (especially calcium)*
- May increase risk of obesity*
- May increase risk of heart disease*
- May increase risk of cancer*

*only with animal protein

FAT:



Fats are made from glycerol and fatty acids

Each glycerol is attached to three fatty acids

Glycerol and fatty acids contain the elements carbon, hydrogen, and oxygen

Fats contain a lot of carbon. This is why they give us so much energy.

1 gram of fat gives us 9 kilocalories

Classification of Fats:

Fats are classified into three groups:

1. **Saturated Fats (SF):**
   - Contain no C=C double bonds
   - Generally are solids or semisolids at room temp
   - Come mainly from an animal source such as meat, eggs, milk and dairy produce e.g. cream and butter.
   - There is a lot of saturated fat in butter and lard
   - High consumption of SFs is a leading cause of Heart Disease along with various others.
   - e.g. lauric, stearic and palmitic acids.

2. **Unsaturated Fats (UF):**
   - Contain one or more C=C double bonds
   - Generally are liquids at room temp
   - Come mainly from plant and fish sources such as peas, beans and lentils, whole cereals, nuts, cooking oil, polyunsaturated margarine and oily fish
   - Monounsaturated (e.g. oleic acid) or polyunsaturated (e.g. linoleic acid).

It is further divided in to two types:

A) Monounsaturated Fats:(MUF)

- MUFs are usually liquids at room temperature.
- There is a good amount of research which suggests that MUFs are good for health.
- MUFs help in reducing the risk of Heart Disease by reducing levels of Low Density Lipoproteins (LDL) in the blood.

- They may also benefit people with Type 2 Diabetes by controlling insulin levels and blood sugar. Also MUFs are high in Vitamin E which helps maintenance and development of cells in the body.

Sources of MUFs

- Vegetable oils
- Canola oil
- Olive oil
- High oleic safflower oil
- Sunflower oil
- Avocado

B) Polyusaturated Fats: (PUF):

- PUFs are also usually liquids at room temperature.
- There are some PUFs that cannot be produced by the body, like, Omega-3 Polyunsaturated fats and Omega-6 Polyunsaturated fats.PUFs too help in reducing the risk of Heart Disease by reducing levels of Low Density Lipoproteins (LDL) in the blood.
- According to Mayoclinic they may also protect against irregular heartbeats and help lower blood pressure levels.
- PUFs also help in Brain Development.

Sources of Omega 6 PUFs:

- Soybean oil
- Corn oil
- Safflower oil

Sources of Omega 3 PUFs:

- Soybean oil
- Canola oil
- Walnuts
- Flaxseed
- Fish: trout, herring, and salmon

3. **Trans Fats: (TF)**

- Unlike other MUFs, PUFs and SFs, Trans Fats are mainly artificial in nature.
- They are made by the process of Partial Hydrogenation. Liquid Vegetable Oil (otherwise healthy MUFs and PUFs) are bombarded with Hydrogen Atoms and converted into solid Fats.

Essential fatty acids

- These are fatty acids which cannot be synthesised in the body.
- They are derived only from food. The essential fatty acids necessary for growth are linoleic acid, linolenic acid and arachidonic acid.

Functions of fats:

- They are high energy foods, providing as much as 9 kcal for every gram.
- Fats serve as vehicles for fat-soluble vitamins
- Fats in the body support viscera such as heart, kidney and intestine; and fat beneath the skin provides insulation against cold.
- Fat insulates the body. A layer of fat under the skin prevents heat loss from the body.
- Fat protects the delicate organs such as the kidneys and nerves. A layer of fat surrounds them.
- Fats provide the body with heat and energy. This helps to keep the body at the correct temperature (37o C).

Deficiency of fats:

- The deficiency of fat in human body causes dry, hair loss, scaly skin, and loss of menstruation, cold intolerance, power resistance to infection, and bruising, poor growth, poor wound healing and low body weight.
- Healthy diet must contain a certain amount of fat otherwise it can be responsible for many disorders.
- As many vitamins and antioxidants are fat soluble, therefore deficiency of fat affects the level and activity of vitamins and can impact whole body. The deficiency of fat and cholesterol can cause depression and suicide as fat involve in many biological process for the synthesis of different hormones and neurotransmitters in body.
- Most of the part of brain is composed of fat and a deficiency in fats may alter many brain functions. For example; omega-3 fats known as docosahexaenoic acid and eicosapentaenoic acid are sourced mainly from fish and are required for good functioning of brain signals.
- The absence of these types of fats could result in difficulty of concentration and practice. The low concentration of fat in body can causes high carb content i.e. if our diet is lacking in fat, this deficiency probably means that we are consuming excess carbohydrates foods. If we are sensitive to carbs, we may turn up gaining weight and also on the long run develop the tendency of insulin resistance along with metabolism

syndrome. Eating lesser carbs and more fats can help our body would function better by resisting weight gain, insulin sensitivity improvement and also decrease the risk of type - 2 diabetes suffering or eventual heart problems.

- Low fat level also caused depression due to serotonin dysfunction which is a neurotransmitter in the brain and contributes to feelings of calmness and well-being.

Excess amount of fats:

- Obesity, high cholesterol, heart disease, stroke, diabetes are all believed to be associated with over-consumption of some or all types of fat.
- In general trans fats (from some margarines, biscuits, cakes and other processed food) and saturated fats (from meat, dairy and palm oil) are considered to be least healthy, while unsaturated fats (from fish and almost all vegetable oils) are likely to have health benefits if consumed in moderation.

VITAMINS:

Definition: "A **vitamin** is an organic compound required as a nutrient in tiny amounts by an organism**"**

- There are two types of vitamins one is fat soluble and other is water soluble.
- Vitamins A, D, E and K are **fat soluble** while Vitamins B complex and C are **water soluble**.
- Vitamins are classified by their biological and chemical activity, not by their structure. Thus, each "vitamin" refers to a number of *vitamer* compounds that all show the biological activity associated with a particular vitamin. Such a set of chemicals are grouped under an alphabetized vitamin "generic descriptor" title, such as "vitamin A", which includes the compounds retinal, retinol, and four known carotenoids.
- Vitamers by definition are convertible to the active form of the vitamin in the body, and are sometimes inter-convertible to one another, as well.

1) Vitamin A (Retinol):

- Vitamin A can be found in two principal forms in foods Retinol and carotenes.
- The role of vitamin A in the vision cycle is specifically related to the retinal form. Within the eye, 11-*cis*-retinal is bound to rhodopsin (rods) and iodopsin (cones) at conserved

lysine residues. Rhodopsin is needed to see black and white as well as see at night. It is for this reason that a deficiency in vitamin A will inhibit the reformation of rhodopsin and lead to night blindness.

- Vitamin A, in the retinoic acid form, plays an important role in gene transcription. Once retinol has been taken up by a cell, it can be oxidized to retinal (by retinol dehydrogenases) and then retinal can be oxidized to retinoic acid (by retinal oxidase). The conversion of retinal to retinoic acid is an irreversible step, meaning that the production of retinoic acid is tightly regulated, due to its activity as a ligand for nuclear receptors. Retinoic acid can bind to two different nuclear receptors to initiate (or inhibit) gene transcription: the retinoic acid receptors (RARs) or the retinoid "X" receptors (RXRs). So it is useful for gene transcription.

Deficiency:

- Vitamin A deficiency can occur as either a primary or a secondary deficiency.
- A primary vitamin A deficiency occurs among children and adults who do not consume an adequate intake of yellow and green vegetables, fruits, and liver. Early weaning can also increase the risk of vitamin A deficiency.
- Secondary vitamin A deficiency is associated with chronic malabsorption of lipids, impaired bile production and release, low fat diets, and chronic exposure to oxidants, such as cigarette smoke.
- Zinc deficiency can also impair absorption, transport, and metabolism of vitamin A because it is essential for the synthesis of the vitamin A transport proteins and the oxidation of retinol to retinal.
- Vitamin A deficiency is impaired vision, particularly in reduced light - night blindness.

Toxicity:

- Excesses taken in through diet lead to nausea, jaundice, irritability, anorexia, vomiting, blurry vision, headaches, hair loss, muscle and abdominal pain and weakness, drowsiness, and altered mental status.
- Cell culture studies have linked increased bone resorption and decreased bone formation with high vitamin A intakes.

- The carotenoid forms (such as beta-carotene as found in carrots), give no such symptoms, but excessive dietary intake of beta-carotene can lead to carotenodermia, which causes orange-yellow discoloration of the skin.

Functions of vitamin A (Retinol):

- Maintenance of normal vision in dim light: Oxidation of retinol produce two pigment rhodopsin and iodopsin, in eye two types of cells are present rod cell and cone cell. Rhodopsin formed in Rod cells which are responsible for to view in dim light. While idopsin formed in Cone cells are responsible for to view in bright light. These both pigments adjust the bright view and light view by converting radiant energy in to nerve impulses.
- It is necessary for maintaining the integrity and the normal function of glandular and epithelial tissue which lines intestinal, respiratory, urinary tracts as well as skin and eye.
- It supports growth especially skeletal growth.
- It is anti-infective means deficiency of it reduces the immune power and increases the chances of infection.
- Newly it is suggested that it may protect against several cancer.

2) Vitamin B complex:

The **B vitamins** are water-soluble vitamins that play important roles in cell metabolism. They are available in various forms like Vitamin B_1, B_2, B_3, B_5, B_6, B_7, B_8, B_9, and B12.

Deficiency:

- **Vitamin B1:** Deficiency causes beriberi. Symptoms of this disease include weight loss, emotional disturbances, Wernicke's encephalopathy (impaired sensory perception), weakness and pain in the limbs, periods of irregular heartbeat, and edema (swelling of bodily tissues). Heart failure and death may occur in advanced cases. Chronic thiamine deficiency can also cause Korsakoff's syndrome, an irreversible psychosis characterized by amnesia and confabulation.
- **Vitamin B_2:** Deficiency causes ariboflavinosis. Symptoms may include cheilosis (cracks in the lips), high sensitivity to sunlight, angular cheilitis, glossitis (inflammation of the tongue), seborrheic dermatitis or pseudo-syphilis (particularly affecting the scrotum or labia majora and the mouth), pharyngitis, hyperemia, and edema of the pharyngeal and oral mucosa.

- **Vitamin B_3:** Deficiency, along with a deficiency of tryptophan causes pellagra. Symptoms include aggression, dermatitis, insomnia, weakness, mental confusion, and diarrhea. In advanced cases, pellagra may lead to dementia and death.
- **Vitamin B_5:** Deficiency can result in acne and paresthesia, although it is uncommon.
- **Vitamin B_6:** Deficiency may lead to microcytic anemia (because pyridoxyl phosphate is the cofactor for heme synthesis), depression, dermatitis, high blood pressure (hypertension), water retention, and elevated levels of homocysteine.
- **Vitamin B_7:** Deficiency does not typically cause symptoms in adults but may lead to impaired growth and neurological disorders in infants. Multiple carboxylase deficiency, an inborn error of metabolism, can lead to biotin deficiency even when dietary biotin intake is normal.
- **Vitamin B_9:** Deficiency results in a macrocytic anemia. Deficiency in pregnant women can lead to birth defects. Supplementation is often recommended during pregnancy. Researchers have shown that folic acid might also slow the insidious effects of age on the brain.
- **Vitamin B_{12}:** Deficiency results in a macrocytic anemia, elevated homocysteine, peripheral neuropathy, memory loss and other cognitive deficits. It is most likely to occur among elderly people, as absorption through the gut declines with age; the autoimmune disease pernicious anemia is another common cause. It can also cause symptoms of mania and psychosis. In rare extreme cases, paralysis can result.

Toxicity:

- **Vitamin B_1:** No known toxicity from oral intake. There are some reports of anaphylaxis caused by high-dose thiamin injections into the vein or muscle.
- **Vitamin B_2:** No evidence of toxicity. Produce reactive oxygen species when riboflavin was exposed to intense visible and UV light.
- **Vitamin B_3:** Flushing (redness of the skin, often accompanied by itching or a mild burning sensation).
- **Vitamin B_5:** No known toxicity.
- **Vitamin B_6:** Sensory neuropathy and dermatological lesions.
- **Vitamin B_7, B_{12} & B_9:** No known toxicity.

Functions of Vitamin B complex:

- **Vitamin B1 (Thiamine)** after the absorption converts in to thiamine pyrophosphate by phosphorylation process. Which act as coenzyme for carboxylase for the production of ATP.
- **Vitamin B2 (Riboflavin)** is also known as cytochrom oxidase essential for cellular oxidation process.
- **Vitamin B3 (Niacin/Nicotinic acid)** is essential for the metabolism of carbohydrates, proteins and fat.
- **Vitamin B6 (Pyridoxine)** is essential for fat, protein and steroid metabolism as well as for synthesis of neurotransmitters and heam.
- **Vitamin B12 (Folate and cyanocobalamin)** is essential for gene expression, gluconeogenesis, fatty acid synthesis, catabolism of certain amino acids and carrier of CO2 in carboxylase enzyme.

3) Vitamin C (Ascorbic Acid):

- Vitamin C or L-ascorbic acid or L-ascorbate is an essential nutrient for humans.
- Vitamin C is purely the L-enantiomer of ascorbate; the opposite D-enantiomer has no physiological significance. Both forms are mirror images of the same molecular structure.
- In living organisms, ascorbate is act as an anti-oxidant, since it protects the body against oxidative stress.
- Vitamin C supplementation significantly reduced the frequency of the common cold.
- Ascorbic acid is absorbed in the body by both active transport and simple diffusion. Sodium-Dependent Active Transport - Sodium-Ascorbate Co-Transporters (SVCTs) and Hexose transporters (GLUTs) - are the two transporters required for absorption.

Deficiency:

- Deficiency of vitamin C produces scurvy. Scurvy leads to the formation of brown spots on the skin, spongy gums, and bleeding from all mucous membranes. The spots are most abundant on the thighs and legs, and a person with the ailment looks pale, feels depressed, and is partially immobilized. In advanced scurvy there are open, suppurating wounds and loss of teeth and, eventually, death.
- Smokers who have diets poor in vitamin C are at a higher risk of lung-borne diseases than those smokers who have higher concentrations of vitamin C in the blood.

Toxicity:

- There are no documented toxicity effects for vitamin C in relation to food and diet.
- At high supplemental doses involving 5 or more grams of vitamin C, diarrhea can result from the fluid in the intestine becoming too concentrated ("osmotic diarrhea").
- Large supplemental doses of vitamin C can also increase levels of uric acid in the urine, because vitamin C can be broken down into uric acid which increases the chances for kidney stones.

Functions of Vitamin C (Ascorbic Acid):

- It has anti oxidant properties so it prevents formation of free radicals.
- By the help of it prolin convert to hydroxyprolin which is essential component of collagen.
- It is useful for hydroxylation of dopamine to norepinephrine.
- Useful to prevent common cold.
- Gives protection against certain infections
- Facilitate the absorption of iron from vegetables.

4) Vitamin D (Calcitriol):

- Vitamin D is a group of fat-soluble secosteroids, the two major physiologically relevant forms of which are vitamin D_2 (ergocalciferol) and vitamin D_3 (cholecalciferol). Vitamin D_3 is produced in the skin of vertebrates after exposure to ultraviolet B light from the sun or artificial sources, and occurs naturally in a small range of foods. Vitamin D is carried in the bloodstream to the liver, where it is converted into the prohormone calcidiol. Circulating calcidiol may then be converted into calcitriol, the biologically active form of vitamin D, either in the kidneys or by monocyte-macrophages in the immune system.
- When synthesized by monocyte-macrophages, calcitriol acts locally as a cytokine, defending the body against microbial invaders.
- When synthesized in the kidneys, calcitriol circulates as a hormone, regulating, the concentration of calcium and phosphate in the bloodstream, promoting the healthy mineralization, growth and remodeling of bone.
- Vitamin D also modulates neuromuscular function, reduces inflammation, and influences the action of many genes that regulate the proliferation, differentiation and apoptosis of cells.

Deficiency:

Deficiency results in impaired bone mineralization, and leads to bone softening diseases including:

- Rickets, a childhood disease characterized by impeded growth and deformity of the long bones which can be caused by calcium or phosphorus deficiency as well as a lack of vitamin D.
- Osteomalacia, a bone-thinning disorder that occurs exclusively in adults and is characterized by proximal muscle weakness and bone fragility.
- Deficiency may produce certain cancers, multiple sclerosis, rheumatoid arthritis, juvenile diabetes, Parkinson's and Alzheimer's disease.

Toxicity:

- Vitamin D overdose causes hypercalcemia and the main symptoms of vitamin D overdose are those of hypercalcemia: anorexia, nausea, and vomiting can occur, frequently followed by polyuria, polydipsia, weakness, nervousness, pruritus, and ultimately renal failure.
- Hypercalcaemia during pregnancy may increase fetal sensitivity to effects of vitamin D and lead to a syndrome of mental retardation and facial deformities.
- Exposure to sunlight for extended periods of time does not normally cause vitamin D toxicity. This is because within about 20 minutes of ultraviolet exposure in light skinned the concentrations of vitamin D precursors produced in the skin reach equilibrium, and any further vitamin D that is produced is degraded.

Functions of Vitamin D (Calcitriol):

- In intestinal, promotes absorption of calcium and phosphors.
- In bone, stimulate normal mineralization and enhance bone resorption.
- In kidney, increase tubular reabsorption of phosphate.
- It shows antiproliferative action on parathyroid cells.

5) Vitamin K:

- Vitamin k have two natural and three synthetic forms vitamins K_3, K_4, and K_5, which are used in many areas including the pet food industry (vitamin K_3) and to inhibit fungal growth (vitamin K_5).

- Within the cell, vitamin K undergoes electron reduction to a reduced form of vitamin K (called vitamin K hydroquinone) by the enzyme vitamin K epoxide reductase.
- Another enzyme then oxidizes vitamin K hydroquinone to allow carboxylation of Glutamate to Glaycine; this enzyme is called the gamma-glutamyl carboxylase or the vitamin K-dependent carboxylase.
- The carboxylation reaction will only proceed if the carboxylase enzyme is able to oxidize vitamin K hydroquinone to vitamin K epoxide at the same time; the carboxylation and epoxidation reactions are said to be coupled reactions.
- Vitamin K epoxide is then re-converted to vitamin K by vitamin K epoxide reductase. These two enzymes comprise the so-called vitamin K cycle. One of the reasons humans are rarely deficient in vitamin K is that vitamin K is continually recycled in our cells.

Deficiency:

- Average diets are usually not lacking in vitamin K and primary vitamin K deficiency is rare in healthy adults.
- Deficiency mainly seen in who suffer from liver damage or disease (e.g. alcoholics), people with cystic fibrosis, inflammatory bowel diseases or those who have recently had abdominal surgeries.
- Several drugs may also produce the deficiency of Vitamin K like as salicylates, barbiturates, and cefamandole, although the mechanism is still unknown.

Toxicity:

- There is no known toxicity associated with high doses of the phylloquinone (vitamin K_1) or menaquinone (vitamin K_2) forms of vitamin K and therefore no tolerable upper intake level (UL) has been set.
- But some times allergic reaction from supplementation is possible.

Functions of vitamin K:

- Essential for coagulation process.

6) Vitamin E (α-Tocopherol):

- Vitamin E is a generic term for tocopherols and tocotrienols.
- Naturally occurring vitamin E exists in eight chemical forms (alpha-, beta-, gamma-, and delta-tocopherol and alpha-, beta-, gamma-, and delta-tocotrienol) that have varying

levels of biological activity. But Alpha- (or α-) tocopherol is the only form that is recognized to meet human requirements.

- vitamin E is involved in immune function, cell signaling, regulation of gene expression, and other metabolic processes
- Vitamin E is a fat-soluble antioxidant that stops the production of reactive oxygen species formed when fat undergoes oxidation.

Deficiency

Vitamin E deficiency can cause:

- Premature babies of very low birth weight (<1,500 grams) might be deficient in vitamin E.
- Deficiency symptoms include peripheral neuropathy, ataxia, skeletal myopathy, retinopathy, and impairment of the immune response.

Toxicity:

- Vitamin E has no any adverse effects from consuming in food.
- However, high doses of α -tocopherol supplements can cause hemorrhage and interrupt blood coagulation, and high doses inhibit platelet aggregation.

Functions of Vitamin E (α-Tocopherol):

- It prevents the degradation of cell because it has anti oxidant properties.
- Inhibit the formation of free radicals so maintain the integrity of cells.
- Inhibit the prostaglandin synthesis.
- Inhibits the activity of protein kinase C, an enzyme involved in cell proliferation and differentiation in smooth muscle cells, platelets, and monocytes
- Suppress arachidonic acid metabolism, dilates blood vessels and inhibits platelet aggregate.

BELOW TABLE SHOWS BRIEF SUMMARY OF VITAMINS

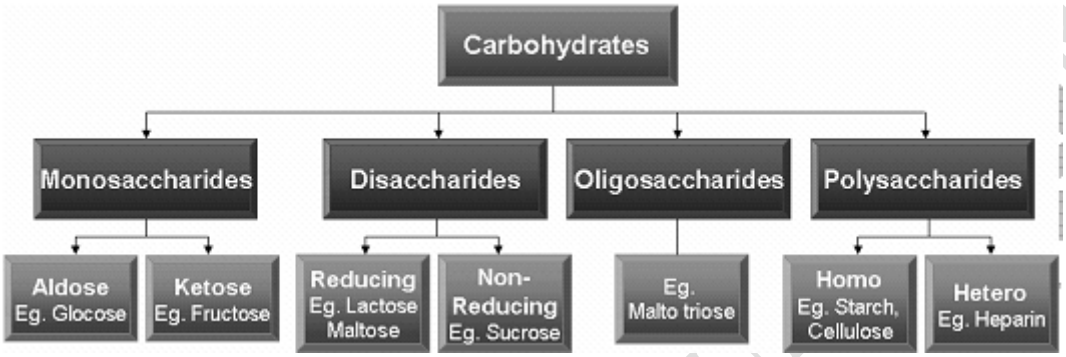
Vitamins	Food Source	Deficiency disease	Symptoms of deficiency	Recommended dietary allowances (male, age 19–70)
Vitamin A (Retinol)	Cod liver oil, carrots, Milk, butter, eggs, liver, margarine, tomatoes,	Night-blindness and Keratomalacia	Susceptibility to infection; poor vision in twilight, Retarded growth	900 µg
Vitamin B_1 (Thiamine)	Rice bran, Meat, especially pork, wholemeal bread and cereals, milk, vegetables	Beriberi, Wernicke-Korsakoff syndrome	Loss of appetite; nerve disorders; fatigue; poor digestion Retarded growth	1.2 mg
Vitamin B_2 (Riboflavin)	Meat, milk, green vegetables, eggs, poultry	Ariboflavinosis	Sores at corners of the mouth; other skin and membrane disorders	1.3 mg
Vitamin B_3 (Niacin)	meat, eggs, grains	Pellagra	Dermatitis, Diarrhea, Dementia	16.0 mg
Vitamin B_5 (Pantothenic acid)	Meats, whole grains, in many foods	Paresthesia	Numbness and tingling of skin	5.0 mg
Vitamin B_6 (Pyridoxine)	Meat, dairy products.	Anemia, peripheral neuropathy.	Vogues lesion produce convulsion in infants, dermatitis, cheilosis, glossitis	1.3–1.7 mg
Vitamin B_7 (Biotin)	Meats, dairy products, eggs	Dermatitis, enteritis		30.0 µg
Vitamin B_9 (Folic acid)	Leafy green vegetables	Megaloblastic anemia	Deficiency during pregnancy is associated with birth defects, such as	400 µg

			neural tube defects	
Vitamin B_{12} (Cobalamins)	Liver, eggs, animal products	Megaloblastic anemia		2.4 µg
Vitamin C (Ascorbic acid)	Citrus, most fresh foods, especially the citrus group, and vegetables, tomatoes, melon	Scurvy	Slow healing; tendency to bruise and bleed easily; sore gums	90.0 mg
Vitamin D (Calciferol)	Fish liver oils, liver, fortified milk and baby cereals, irradiated margarines, etc., sunshine	Rickets and Osteomalacia	Poor bone and tooth development; dental decay; Rickets	5.0 µg–10 µg
Vitamin E (Tocopherol)	Wheat germ oil, unrefined vegetable oils	Deficiency is very rare; mild hemolytic anemia in newborn infants	Infertility	15.0 mg
Vitamin K (Phylloquinone/phytolnaphthoquinone)	Leafy green vegetables, Meat, poultry, fish, potatoes, peanuts; whole grain cereals	Bleeding diathesis	Faulty clotting of the blood Bleeding	120 µg

CARBOHYDRATES:

A **carbohydrate** is an organic compound which has the empirical formula $(CH_2O)_n$; that is, consists only of carbon, hydrogen and oxygen, with a hydrogen: oxygen atom ratio of 2:1 (as in water).

Classifications of carbohydrates:



1. Monosaccharides:

- Simple sugars with multiple OH groups.

Classified by:

a. Based on the number of carbons:

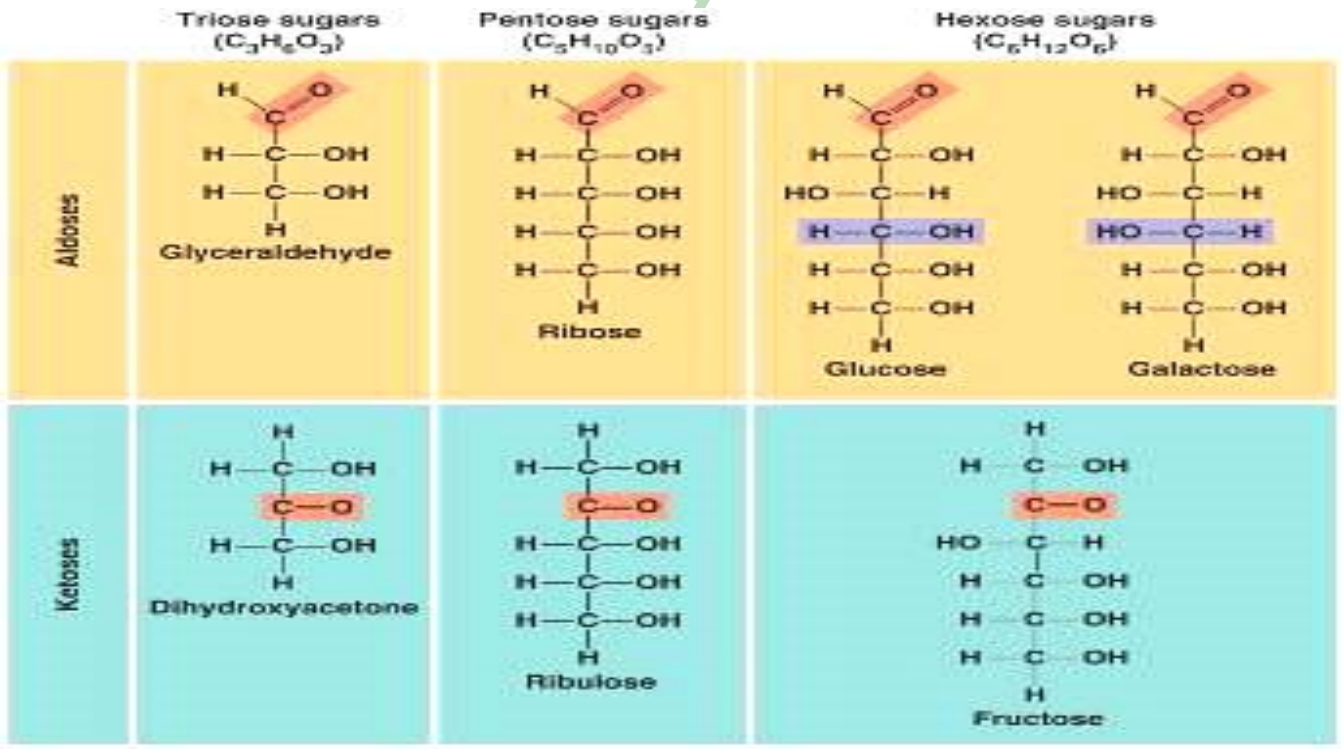
– Based on number of carbons (3, 4, 5, 6), a monosaccharide is a triose, tetrose, pentose or hexose.

Eg.:

– Glyceraldehyde : 3 carbons : Triosis.
– Ribose : 5 carbon : Pentoses.
– Glucose : 6 carbon . Hexoses.
– Fructose, Glucose, mannose, and galactose are all isomers of each other, having the same chemical formula, C6 H12 O6.

b. Based on functional groups:

Eg.: Aldoses or Ketoses.



2. **Disaccharides:**
   - Disaccharides are composed of 2 monosaccharides joined together by a condensation reaction.

   Eg.:
   - Sucrose (table sugar) is composed of glucose and fructose
   - Lactose is found in milk. It is formed when glucose bonds to galactose.
3. **Oligosaccharides:**
   - A few monosaccharides covalently linked.

   Eg.: Inulin
4. **Polysaccharides:**
   - Monosaccharides may be bonded together to form long chains called polysaccharides.
   - Eg.: Cellulose, Starch and Glycogen
   - Starch and glycogen are polysaccharides that function to store energy.
   - They are composed of glucose monomers bonded together producing long chains.

- The digestion of carbohydrates typically involves hydrolysis reactions in which complex carbohydrates (polysaccharides) are broken down to maltose (a disaccharide). Maltose is then further broken down to produce two glucose molecules.

Functions:

- Sources of energy 70-80% human energy needs
- Intermediates in the biosynthesis of other basic biochemical entities (fats and proteins) Associated with other entities such as glycosides, vitamins and antibiotics)
- They are the structural components of many organisms. Cellulose forms cell wall of plant cell along with hemicelluloses and Pectin. Chitin forms cell wall of fungal cell and exoskeleton of arthropods.
- Participate in biological transport, cell-cell recognition, activation of growth factors, modulation of the immune system

Diseases related to carbohydrates:

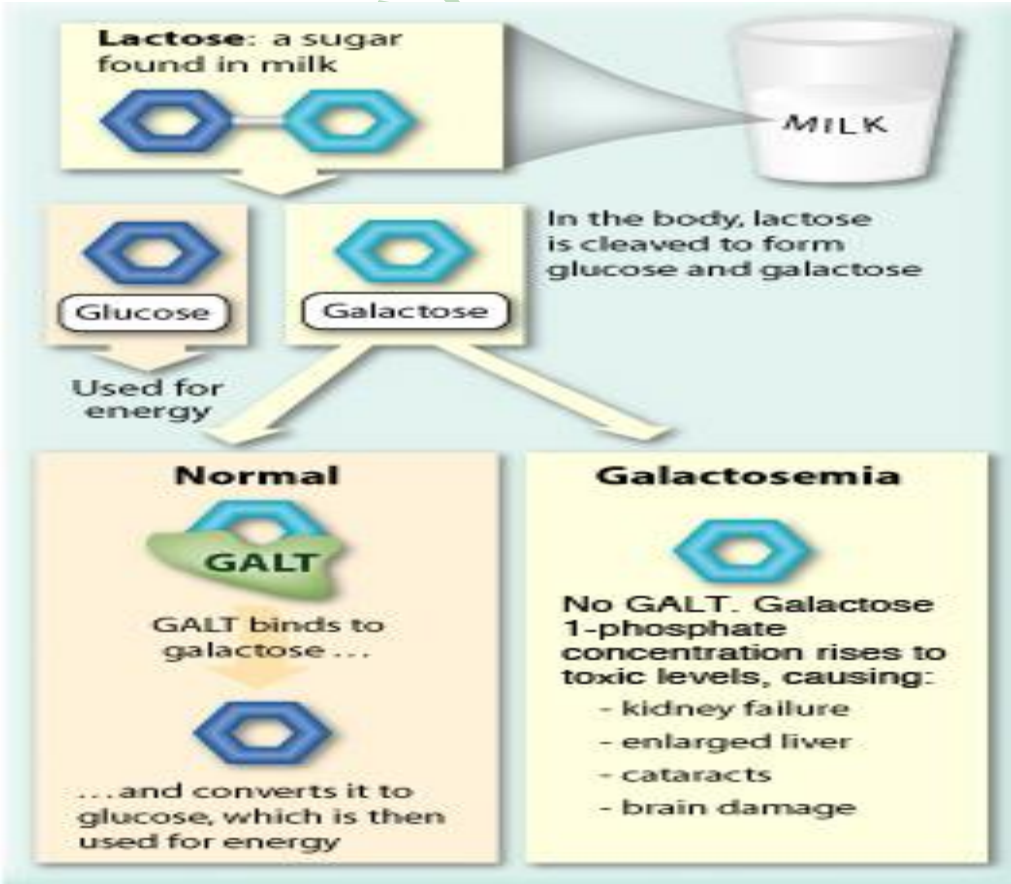
1. Lactose Intolerance

- Lactose intolerance, also called lactase deficiency and hypolactasia, is the inability to digest lactose, a sugar found in milk and to a lesser extent milk-derived dairy products.
- It is not a disorder as such, but a genetically-determined characteristic.
- Lactose intolerant individuals have insufficient levels of lactase, an enzyme that catalyzes hydrolysis of lactose into glucose and galactose, in their digestive system. In most cases this causes symptoms which may include abdominal bloating and cramps, flatulence, diarrhea, nausea, borborygmi (rumbling stomach), or vomiting.

2. Galactosemia:

- It is a rare genetic metabolic disorder that affects an individual's ability to metabolize the sugar galactose properly.
- Although the sugar, lactose, metabolizes to galactose, galactosemia is not related to and should not be confused with lactose intolerance.
- Galactosemia follows an autosomal recessive mode of inheritance that confers a deficiency in an enzyme (GALT) responsible for adequate galactose degradation.

- Defects in galactose metabolism can cause several severe symptoms like kidney failure, an enlarged liver, cataracts (clouding of the eye lens), poor growth, and mental retardation.



2. **Diabetes mellitus or diabetes**:
   - It is a group of metabolic diseases in which a person has high blood sugar, either because the pancreas does not produce enough insulin, or because cells do not respond to the insulin that is produced.
   - High blood sugar produces the classical symptoms of polyuria (frequent urination), polydipsia (increased thirst) and polyphagia (increased hunger).
   - There are three main types of diabetes mellitus (DM).

   A. Type 1 DM results from the body's failure to produce insulin, and currently requires the person to inject insulin or wear an insulin pump. This form was previously referred to as "insulin-dependent diabetes mellitus" (IDDM) or "juvenile diabetes".

B. Type 2 DM results from insulin resistance, a condition in which cells fail to use insulin properly, sometimes combined with an absolute insulin deficiency. This form was previously referred to as non insulin-dependent diabetes mellitus (NIDDM) or "adult-onset diabetes".

C. The third main form, gestational diabetes, occurs when pregnant women without a previous diagnosis of diabetes develop a high blood glucose level. It may precede development of type 2 DM.

4. Hypoglycemia:

- Hypoglycemia means abnormally diminished content of glucose in the blood. Simply low blood sugar.
- Epinephrine is among the major hormones released during hypoglycemia. Epinephrine causes the majority of the early symptoms of hypoglycemia.
- Common symptoms of hypoglycemia include the following:
  - trembling,
  - clammy skin,
  - palpitations (pounding or fast heart beats),
  - anxiety,
  - sweating,
  - hunger, and
  - irritability.
- When the brain remains deprived of glucose, a later set of symptoms follows:
  - difficulty in thinking,
  - confusion,
  - headache,
  - seizures, and
  - coma.
- Ultimately, after significant coma or loss of consciousness, death can occur.

MINERALS AND TRACE ELEMENTS:

- There are two groups of minerals, major minerals and trace minerals.
- Major minerals are needed in the diet in amounts of 100 milligrams (mg) or more each day.
- The major minerals are calcium, phosphorus, magnesium, sulfur, potassium, sodium, and chloride.
- We need the trace minerals in smaller amounts (less than 100 mg each day).

- Some trace minerals are iron, iodine, zinc, fluoride, selenium, copper, chromium, manganese, and molybdenum.

Uses of Minerals

- The body contains many different minerals. Minerals by themselves are inactive chemical elements, like the iron in a pan or calcium in a rock. But in the body, calcium is used to make the bones and teeth, and iron is used to make the hemoglobin in red blood cells. The body uses this iron to carry oxygen to its cells. Additional minerals help in many other body processes:
- Minerals become part of tissue structure, like in bone and teeth.
- Minerals help maintain acid-base balance, to keep the body pH neutral.
- Minerals help regulate body processes, such as in enzyme systems.
- Minerals function in nerve impulse transmission and muscle contraction.
- Minerals help release energy from food.
- Sodium, potassium and chloride are minerals that are called "electrolytes." In the body, they work to maintain water balance and provide the correct pressure between cells and their surrounding fluids.

Minerals: Sources and Functions

Major Minerals		
Mineral	**Function**	**Food Sources**
Calcium (Ca)	Aids in formation of bones and teeth, normal blood clotting, muscle contraction and relaxation, heart function, and nerve function	Milk and other dairy products, greens, broccoli, salmon, sardines, legumes.
Phosphorus (P)	Aids in formation of bones and teeth. Regulates release and use of body energy. Helps carry fat in the body as a part of phospholipids. Helps maintain normal acid/base balance in the body.	Meat, fish, poultry, eggs, milk, cereal products.
Magnesium (Mg)	Necessary for muscle contraction and nerve function.	Meat, seafood, nuts, legumes, dairy products, whole grains
Sodium (Na)	Important component of body fluids mostly outside cells.	Table salt, meat, seafood, milk, cheese, eggs, baking soda, baking powder, bread, vegetables, processed foods.
Potassium (K)	Important component of body fluids mostly	Potatoes, melons, citrus fruit, banana,

	inside cells.	and most fruits and vegetables, meat, milk and legumes.
Some Trace Minerals		
Mineral	**Function**	**Food Sources**
Iron (Fe)	Found in hemoglobin in red blood cells and myoglobin in muscle cells. Needed to carry oxygen.	Liver, meats, egg yolks, nuts, enriched or whole grains, legumes.
Iodine (I)	Part of thyroid hormones (thyroxin and triiodothyronine).	Seafood, iodized salt.
Selenium (Se)	Acts as an antioxidant.	Grains, meat, poultry, fish, dairy products.
Zinc (Zn)	Part of important enzyme systems. Found in the hormone insulin.	Meat, Seafood, whole grains.
Chromium (Cr)	Helps body use insulin.	Liver, brewer's yeast, whole grains, nuts, cheeses.
Copper (Cu)	Part of many enzymes.	Legumes, grains, nuts, seeds, organ meat.
Fluoride (Fl)	Part of teeth and bone. Helps prevent cavities in teeth.	Fluoridated drinking water, fish, tea.

FOOD GUIDE PYRAMIDE: