Vitamins

- Vita= Life
- Amine= amine group but proven to be false since some of the vitamins do not have an amine group.
- Microgram/Milligram requirement
- Good source of minerals

Water Soluble Vitamins

Vitamin C (Ascorbic acid)

- formation of intercellular material
- Vitamin C is a cyclic ester in which the carbon 1 carbonyl group has reacted with a carbonyl 4 hydroxyl group, forming the ring structure.
- Vitamin C is derived from the biosynthesis of L-gulose using lactonase, then with oxidase producing L-ascorbic acid.
- Chemical name is L-ascorbic acid, correctly indicating that vitamin C is a weak acidNot an enzyme cofactor precursor.
- It functions as cosubstrate in the formation of the structural protein collagen (which makes up much of the skin, ligaments, and tendons) and also serves as the matrix on which bone and teeth are formed.
- It functions as a general antioxidant for water soluble substances in the blood and other body fluids. **Because of its antioxidant properties vitamin C is often added to foods as preservative.**
- deficiency causes scurvy in man
- source: citrus fruits, tomatoes, cabbage, spinach

Thiamine (B1)

- Antineuretic
- The name thiamine comes from “thio” which means “sulfur” and “amine” which refer to the numerous amino groups present.
- The coenzyme form of thiamine is called thiamine pyrophosphate (TPP), a molecule in which a diphosphate group has been attached to the side chain.
- The coenzyme TPP functions in the decarboxylation of α-keto acids.
- Necessary for carbohydrate metabolism; acts as a coenzyme to carboxylase
- Deficiency causes beriberi, loss of appetite, cessation of growth
- Source: yeast, germ of cereals, egg yolk, nuts, lean pork

Riboflavin (B2)

- concerned with oxidative process and intermediate metabolism of food; hydrogen acceptor and donator for cellular synthesis
- Riboflavin is derived from monosaccharide “ribose” and the Latin word “flavin” which means “yellow”. Riboflavin was once called the “yellow vitamin” because of its color.
- Two important riboflavin-based coenzymes exist:
- **1. flavin adenine dinucleotide (FAD)**
- **2. flavin mononucleotide (FMN)**
- deficiency causes stunted growth, dermatitis, cheilosis (inflammation of mouth corners}
- source: green leaves, eggs, meat, cheese, milk liver

Niacin (nicotinic acid) – B3

- antipellargic
- essential to cellular functions, constituents of certain coenzymes
- Nicotinic acid + vitamin Ni + ac + in
- Niacin occurs in food in two different, but similar forms:
- **1.nicotinic acid**

The nicotinic acid form of niacin was first described in 1873, long before the concept of vitamins was known. It was prepared by oxidizing nicotine using nitric acid; hence the name nicotinic acid.

- **2.nicotinamide**
- Both forms convert to the same coenzyme:
- **1. nicotinamide adenine dinucleotide (NAD+)**
- **2. nicotinamide adenine dinucleotide phosphate (NADP+)**
- deficiency causes pellagra in man, degeneration of nerve cells
- source: green leaves, egg yolk, wheat germ, liver yeast

Pantothenic Acid (vitamin B5)

- The name Pantothenic acid is based on the Greek word “pantothen” which means “from everywhere”.
- This vitamin is found in almost every plant and animal tissue.
  1.Coenzyme A (CoA), one of the most used of all vitamin B coenzymes, contains pantothenic acid as part of its structure.
  2.Coenzyme A is required in the metabolism of carbohydrates, lipids and proteins, where it is involved in the transfer of acetyl groups between molecules.
- Another pantothenic acid containing coenzymes is Acyl Carrier Protein (ACP), which may be regarded as a “giant coenzyme A molecule”. ACP is important in the biosynthesis of fatty acids.

Pyridoxine (B6)

- functions as coenzymes of some transmitting enzymes
- **1.pyridoxine (found in foods of plant origin)**
- **2.Pyridoxal and pyridoxamine (found in foods of animal origin).**
- Vitamin B6 coenzymes participate in reactions where amino groups are transferred between molecules. Such transfer occurs repeatedly when protein molecules are metabolized.
- deficiency results in failure to grow, together with anemia and dermatitis
- source: yeast, meat, eggs, nuts, cereals

Biotin (B7)

- Forms coenzyme necessary for carbon dioxide utilization
- Biotin is derived from biotin-producing bacteria present in the human large intestine, microbiota (hence, the name biotin).
- Biotin is unique among the B vitamins in that it can be obtained both from dietary intake and also via biotin-producing bacteria. “Free” biotin is biologically active.
- The coenzyme form of biotin is formed by the **carboxyl group of biotin’s pentanoic acid attachment forming an amide linkage with residue of the amino acid lysine present at the enzyme’s active site**.
- As coenzyme, **biotin is a carrier for CO2 ; it has a specific site (a nitrogen atom) where CO2 molecule can be attached**
- Source: egg yolk, meat, molasses, fresh fruits and vegetables, yeast, cereal grains

Folic acid (B9)

- essential for growth and formation of blood cells
- The name folate comes from the Latin word “folium”, which means “leaf”.

- Dark green leafy vegetables are the best natural source for folate. Several forms of folate are found in foods.
- All of them have structures that consist of three parts:
- **1.pteridine, a nitrogen-containing double ring system 2.para-aminobenzoic acid (PABA) 3.one or more residues of the amino acid glutamate**
- **The active coenzyme form of folate, which is known as tetrahydrofolate (THF) has only one glutamate, and four hydrogen atoms have been added to the double-ring nitrogen system.**
- **The THF is needed in methylation reactions, reactions in which one or more methyl groups are transferred from one molecule to another**
- deficiency causes anemia and sprue in man
- source: green leaves, soybeans, yeast, egg yolk

Cyanocobalamin (B12)

- extrinsic factor of antianemic factor
- The name cobalamin comes from the fact that an atom of the metal cobalt and numerous amino groups are present in the structure of vitamin B12, which is by far the most complex of all vitamin structures.
- Vitamin B12 is unique in that it is the only vitamin that contains a metal atom. “Free” vitamin B12 and coenzyme vitamin B12 differ only in one attachment to the cobalt atom:
- **1.the free form is cyanocobalamin 2.the coenzyme form is methylcobalamin**
- **Functionally, vitamin B12 coenzymes participate in the transfer of alkyl groups and hydrogen atoms from one molecule to another.**
- Vitamin B12 is also unique among vitamins in that only microorganisms can produce it: it cannot be made by plants, animals, birds or humans.
- Grazing animals acquire vitamin B12 by ingesting some soil during the grazing process. Bacteria present in the multi- compartment stomachs of cows and sheep can also produce vitamin B12.
- deficiency causes pernicious anemia
- source: milk, egg yolk, liver, oysters

Fat Soluble Vitamins

Vitamin A (retinol)

- provitamin is beta carotene from plants
- for maintenance of epithelial cells of skin, eye, and mucous membrane; regenerates visual purple of eye
- deficiency causes xerophthalmia, night blindness, retardation of growth
- source: butter, eggs, milk, carotene of plant, cod-liver oil

Vision

- In the eye, **vitamin A (as retinal)** combines with the protein opsin to form the visual pigment rhodopsin (participates in the conversion of light energy into nerve impulses that are sent to the brain).

Regulating Cell Differentiation Cell

- differentiation is the process whereby immature cells change in structure and function to become specialized cells.
- Retinoic acid

Maintenance of the Health of Epithelial

- Epithelial tissues cover outer body surfaces in addition to lining internal cavities and tubes.

- It includes skin and linings of the mouth, stomach, lungs, vagina, and bladder.
- Lack of **vitamin A (a retinoic acid)** causes such surfaces to become drier and harder than normal.
- Vitamin A's role here is related to cellular differentiation involving mucus-secreting cells.

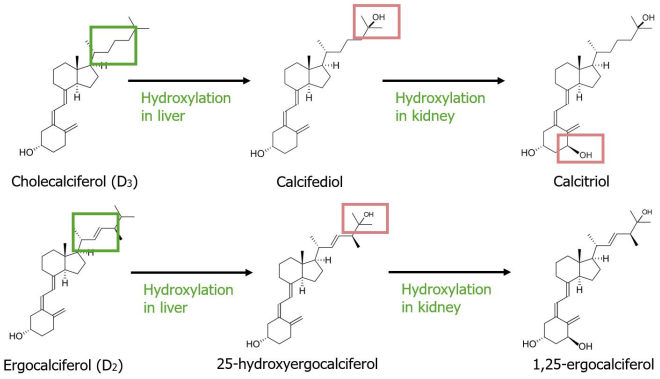
Reproduction and Growth

1.In men, vitamin A participates in sperm development.

2.In women, normal fetal development during pregnancy requires vitamin A.

Vitamin D (calciferol)

- provitamins are ergosterol from plants and yeasts and 7-dehydrocholesterol from skin
- Vitamin D3 (cholecalciferol) is produced in the skin of humans and animals by the action of sunlight (ultraviolet light) on its precursor molecule, the cholesterol derivative 7-dehydrocholesterol (a normal metabolite of cholesterol found in the skin).
- Absorption of light energy induces breakage of the 9, 10 carbon bond; a spontaneous isomerization (shifting of double bonds) then occurs.
- regulates calcium phosphorus metabolism
- deficiency causes rickets in young
- source: eggs, fish oil, beef fat, skin (exposure to ultraviolet radiation)



- The principal function of vitamin D is to maintain normal body levels of calcium ions and phosphate ions so that bones can absorb these ions.
- Vitamin D stimulates absorption of these ions from the gastrointestinal tract and aids in their retention by the kidneys.
- Vitamin D triggers the deposition of calcium salts into the organic matrix of bones by activating the biosynthesis of calcium-binding proteins

Vitamin E (alpha-tocopherol)

- for nuclear growth and activity
- The primary function of vitamin E in the body is as an antioxidant (compound that protects other compounds from oxidation by being oxidized itself).
- Vitamin E is particularly important in preventing the oxidation of polyunsaturated fatty acids in membrane lipids. It also protects vitamin A from oxidation.
- deficiency causes sterility in some animals, death of embryos
- source: green leaves, vegetable fats, meat, eggs

Vitamin K (anti-hemorrhagic vitamin)

- synthesizes prothrombin in liver, essential for blood clotting

- deficiency results in failure of blood to clotVitamin K is essential for the formation of prothrombin (a protein present in blood plasma which is converted into active thrombin during clotting process) and at least other proteins involved in the regulation of blood clotting.
- Vitamin K is sometimes given to presurgical patients to ensure adequate prothrombin levels and to prevent hemorrhaging.
- Vitamin K is also required for the biosynthesis (the production of complex molecules within living organisms or cells) of several other proteins found in the plasma, bone and kidney
- source: green leaves, spinach, soybean oil, egg yolk, liver

Minerals

MACROMINERALS

CALCIUM

• the most abundant of the minerals.
• Building and maintaining healthy bones as well as teeth.
• Controlling excitability of nerves and muscles.
• Maintaining blood cholesterol levels

Function of Calcium:

- structural unit of bones and teeth
- contraction and relaxation of muscles
- stabilizes nervous tissue
- required for blood clotting
- activates various enzymes

Excretion:

– urine and feces
– enhanced by lack of vitamin D and ingestion of large quantities of proteins (acid urine)

PHOSPHORUS

- required in many phases of
- metabolism

food sources:

- phosphoproteins
- nucleoproteins
- nucleolipids
- glycerophosphates

– inorganic phosphates (Na and Ca)

- foods rich in calcium are also richest in phosphorus (milk,cheese, eggs, beans, fish)

Phosphorus deficiency

• (hypophosphatemia)
• Not common
• May be associated with total parenteral nutrition (TPN) without sufficient phosphates;
give either sodium or potassium phosphate

SULFUR

• Most sulfur in the diet comes in from protein sources containing sulfur amino acids such as cysteine, cystine and methionine.

POTASSIUM

• Potassium is the principal cation in intracellular fluid
• **functions:**
– buffer constituent
– acid-base balance
– water balance
– membrane transport
– neuromuscular irritability
• **Food sources:** vegetables, fruit (bananas), whole grains, meat, milk
• **absorption and metabolism:**
– readily absorbed (more so than sodium)
– intracellular

– secreted by kidney (also in sweat)

CHLORIDE

• an essential anion
• closely connected with sodium in foods, body tissues and fluids and excretions
• readily absorbed along with sodium
• Excreted mainly in the kidneys
• important for osmotic balance, acid-base balance and in the formation of gastric HCl

Deficiency of chloride:

– hypochloremic alkalosis
– hypovolemia
– pernicious vomiting
– psychomotor disturbances

SODIUM

• Sodium is the principal cation in extracellular fluids
• functions include:
•osmotic equilibrium
•acid-base balance
•carbon dioxide transport
•cell membrane permeability
•muscle irritability
• **food sources:** table salt, salty foods (potato chips, pretzels, etc.), baking soda, milk
• **absorption and metabolism:**
– readily absorbed
– excreted in the urine and sweat
– aldosterone increases reabsorption in renal tubules

MAGNESIUM

• second most plentiful cation in intracellular fluids
• ~50% of total amount in bone
• ~45% in muscle and nervous tissue
• ~ 5% in extracellular fluids
• blood plasma magnesium : ~ 2 mEq/L

Functions:

a. enzyme systems

– cofactor of all enzymes involved in phosphate transfer reactions that use ATP and other nucleotide triphosphates
– phosphatases
– pyrophosphatases

b. CNS

– hypomagnesemia ---- cns irritability, disorientation, psychotic behavior, convulsions

c. neuromuscular system:

– magnesium has a direct depressant effect on skeletal muscle
– magnesium also causes a decrease in Ach release at motor end plate (used in treatment of eclamptic seizures)
• **food sources:** all green plants (chlorophyll); meats

MICROMINERALS OR TRACE MINERALS

•Microminerals are generally required in much smaller amounts and either stored by the body in very small amounts.
•They contain zero calories.

Iron

•Function:

– plays a key role in the formation of hemoglobin and myoglobin.
–Supports brain development and keeps the immune system strong.

• **Chief functions in the body:**

–Part of the protein hemoglobin, which carries oxygen in the blood
–Part of the protein myoglobin

in muscles, which makes oxygen available for muscle contraction
–Necessary for the utilization of energy as part of the cells' metabolic machinery.
• **Sources –** two forms of iron in food:
1. Heme iron – meats, poultry, fish; READILY ABSORBED
2. Nonheme iron – plants foods; LESS ABSORBED
a. Absorption enhanced by Vitamin C
b. Absorption diminished by phytates, oxalates, and tannic acid
•Significant sources
–Red meats, fish, poultry, shellfish, eggs
–Legumes, dried fruits
Iron deficiency

- is the most common nutrient deficiency worldwide

•Can occur if inadequate intake or blood loss
•Females are prone due to menstruation, lower iron intake & pregnancy
•Preschoolers also at risk due to high milk diets
• **Deficiency symptoms**
– Microcytic, hypochromic anemia (low Hgb & Hct): weakness, fatigue, headaches
– Impaired work performance and cognitive function
– Impaired immunity
– Pale skin, nailbeds, mucous membranes, and palm creases
– Concave nails
– Inability to regulate body temperature
– Pica (craving for ice, clay, paste, and other non-food substances)
• Toxicity – "iron overload"; more common in men
-Hemochromatosis – genetic defect
-Hemosiderosis – chronic ingestion of too much iron; more common in alcoholics
-Iron poisoning – acute toxicity from overdose of iron supplements; can be deadly in small children
• **Toxicity symptoms**
– GI distress
– Iron overload: infections, fatigue, joint pain, skin pigmentation, organ damage

Zinc
• **Functions:**
– Is an antioxidant which assists in the healing of wounds, assists in the production of sperm, maximizes your cell's sensitivity to insulin and maximizes your metabolism.
–Can protect you from various skin conditions.
–Support the production of thyroid hormones and various types of white blood cells**.**
• **Chief functions in the body:**
– Part of many enzymes, esp. enzymes for transfer of carbon dioxide
– Associated with the hormone insulin
– Involved in making genetic material and proteins
– Important to wound healing, taste perception, reproduction (the making of sperm), vision (transports and activates Vit. A) & immune function
• **Significant sources**
–Protein-containing foods
–Red meats, shellfish
–Whole grains
• **Deficiency symptoms**
–In children, growth retardation and delayed sexual maturation

–Impaired immune function
–Hair loss
–Eye and skin lesions
–Loss of appetite and abnormal taste
–Depressed immune function and poor wound healing
–Night blindness
• Toxicity – not likely, unless supplement abuse
• Toxicity symptoms
–Loss of appetite, impaired immunity, low HDL, copper and iron deficiencies
• Functions:
–Essential for good thyroid health and assists in the production of thyroxine and triiodothyronine.
–It also helps your body maintain a normal metabolic rate.
–Supports the development of healthy hair, nails, skin and teeth.
–Supports the development of a strong immune system in fetuses.

Iodine
• Chief functions in the body:
–A component of two thyroid hormones that help to regulate growth, development, and metabolic rate.
• Significant sources
–Iodized salt, seafood, bread, dairy products, plants grown in iodine-rich soil and animals fed those plants (content of iodine in soils affects food content)
• Deficiency disease
-Simple goiter-enlarged thyroid; affects
200 million people worldwide
-Creatinism- severe mental and physical retardation in infants
• Deficiency symptoms
–Underactive thyroid gland, goiter
• Toxicity symptoms
–Underactive thyroid gland, elevated TSH, goiter (also causes enlarged thyroid gland)
• Functions:
–Powerful antioxidant that protects your body in a variety of ways.
–Helps your body produce antibodies.
–Also prevents certain types of Cancer.

Selenium
• Chief functions in the body
–Defends against oxidation
–Regulates thyroid hormone
• Significant sources
–Seafood, meat
–Whole grains, vegetables (depending on soil content)
• Deficiency symptoms
–Predisposition to heart disease (cardiomyopathy) characterized by cardiac tissue becoming fibrous (Keshan disease)
• Toxicity symptoms
-Highly toxic, esp. supplement abuse.
–Loss and brittleness of hair and nails
–Skin rash, fatigue, irritability, and nervous system disorders
–Garlic breath odor
–Functions:
•Powerful antioxidant which protects the body and also supports the production of various substances including collagen, elastin, hemoglobin, melanin and myelin.
•Also reduces your risk of developing arthritis and lung cancer.

Copper

• Chief functions in the body

–Component of enzymes involved in the absorption and use of iron in the formation of hemoglobin

–Part of several enzymes necessary for collagen, healing wounds, maintaining nerve fiber's myelin sheath

• Significant sources

–Seafood

–Nuts, whole grains, seeds, legumes

• Deficiency symptoms (rare)

–Anemia, bone abnormalities

• Toxicity symptoms

-only in supplement abuse & abnormal storage in Wilson's disease

-Liver damage

• Functions:

–To activate and work with the enzymes including glycosyltransferases and xylosyltransferase and a number of enzymes that utilize several key nutrients.

–Supports metabolism.

Manganese

• Chief functions in the body

–Cofactor for several enzymes

–Component of bones and glands

• Significant sources

–Nuts, whole grains, leafy vegetables, tea

• Deficiency symptoms

–Rare; requirements are low

• Toxicity symptoms

–Nervous system disorders

–Has occurred in miners inhaling large quantities of dust causes brain damage

• Functions:

–Helps to regulate blood glucose, cholesterol and insulin making it a very useful nutrient for people with diabetes.

–Also helps your body metabolize the macronutrients and nucleic acids.

–Boosts the immune system and keeps the arteries soft and supple.

Chromium

• Chief functions in the body

–Enhances insulin action

–CHO & lipid metabolism

• Significant sources

–Meats (especially liver)

–Whole grains, brewer's yeast

• Deficiency symptoms

–Diabetes-like condition; mimics symptoms of diabetes, especially in elderly.

• Functions:

–It activates the enzymes aldehyde oxidase, sulfate oxidase and xanthine oxidase as part of the coenzyme protein.

–It also helps the body breakdown sulfur containing amino acids, form uric acid and digest the macronutrients and certain Macrominerals.

Molybdenum

• helps the body utilize iron, detoxifies the liver, increases alertness, supports balanced blood glucose levels, promotes proper sexual function in men, promotes good dental health, prevents anemia and supports proper growth.

• **Significant sources**
–Chilli beans
–Green peas
–Lima beans
–Oats
–Small white beans
• **Deficiency symptoms**
–Anemia, dental cavities, dizziness, headaches, night blindness, impaired sexual function, mental disturbances, nausea, rapid heartbeats and vomiting.
• **Functions:**
–Part of vitamin B12 and so performs the same functions in the body. These functions include helping the body to absorb vitamin B9 and assisting in the production of the genetic information carriers DNA and RNA.
–Also helps the body produce melatonin, myelin, red blood cells, and serotonin.

Cobalt
• **Significant sources**
–Green leafy vegetables
–Muscle meat
–Organ meats
• **Deficiency symptoms**
–Dementia, depression, diarrhea, fatigue, heart disease, menstrual problems in women, nerve damage, pernicious anemia and Weakness.

Selenium

- Selenium is a trace mineral.
- The body only needs it in small amounts.
- It helps the body to make special proteins, called antioxidant enzymes, that prevent cell damage.

Dietary sources include seafood and meat.