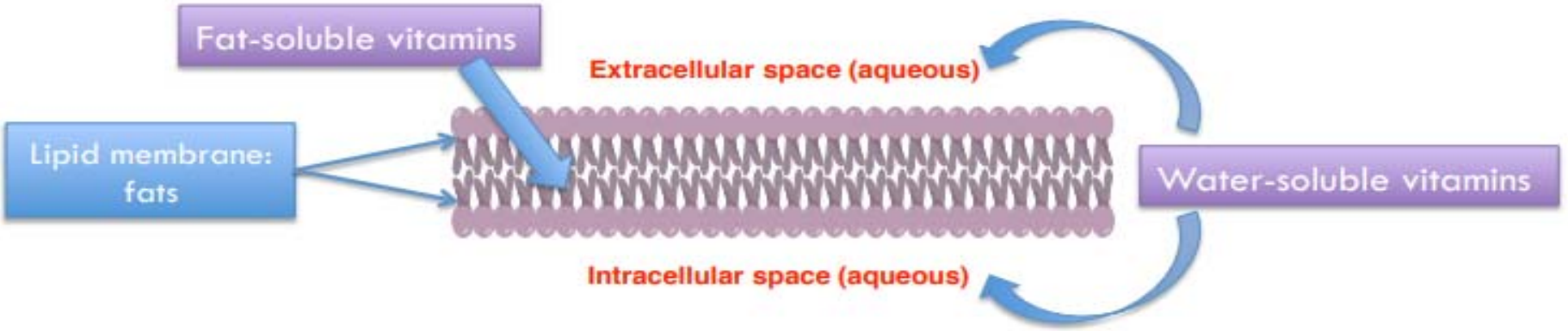
VITAMINS AND MINERALS

- **Vitamins** are organic nutrients that are essential for life. We cannot produce most vitamins ourselves. Therefore, they have to be obtained through the food we eat.
- **Minerals** are an inorganic crystalline salts. Once minerals enter the body, they remain there until excreted. They cannot be changed into anything else. Minerals cannot be destroyed by heat, air, acid, or mixing.
- Compared to other nutrients such as protein, carbohydrates and fat, vitamins and minerals are present in food in tiny quantities. This is why **vitamins and minerals are called micronutrients,** because we consume them only in small amounts.

- **A vitamin is:**
- An organic compound distinct from fats, carbohydrates and proteins.
- Natural component of foods, present in minute amounts and essential for normal physiological function.
- Cause a specific deficiency syndrome when absent or underutilized.
- Is NOT synthesized by the host in amounts required for normal physiological needs.
- **Vitamers** are different forms of a particular vitamin, e.g. vitamins K1 and K2, vitamins D2 and D3, retinol and retinal (vitamin A), etc.

Classification of Vitamins Based on Solubility

- Fat-soluble vitamins: A, D, E, K
- Water-soluble vitamins: B's and C
  - B1, thiamine; B2, riboflavin; B3, niacin; B5, pantothenic acid; B6, pyridoxine, pyridoxal, or pyridoxamine; B7, biotin; B9, folate; B12, cobalamin



Storage and Excretion

- Fat-soluble vitamins: ADEK
  - Well retained in the body and tend to be stored in fatty tissues: adipose, muscles, liver
  - Therefore, it takes time to reach a deficiency state
  - More likely to cause toxicity on over-dosage because of the slow clearance
- Water-soluble vitamins: BC
  - Excreted rapidly and not well retained
  - Need regular replacement
  - Only vitamin B12 and B9 retained and stored at significant level in the body

Functions

- Per definition, vitamins are essential to many life processes
  - Energy production by oxidation of biological molecules
  - Making biological molecules
  - Maintenance, growth, development, and/or production
  - Some vitamins participate in protection processes as antioxidants directly or indirectly: E, C, A, B2

Vitamin A (Retinol | Carotenoids)

- Vitamin A plays a central role in our vision, skin, genes, growth, and immune system.
- It is especially important during the early stages of pregnancy in supporting the developing embryo.
- There are three different forms of vitamin A are active in the body:
- **retinol, retinal, and retinoic acid.**
- These are known as retinoids. The cells of the body can convert retinol and retinal to the other active forms of vitamin A as needed.

- **Each form of vitamin A performs specific tasks.**
- **Retinol** supports reproduction and is the major transport form of the vitamin.
- **Retinal** is active in vision and is also an intermediate in the conversion of retinol to retinoic acid.
- **Retinoic acid** acts like a hormone, regulating cell differentiation, growth, and embryonic development.
- Foods derived from animals provide retinol in a form that is easily digested and absorbed.
- Foods derived from plants provide carotenoids, the body can convert carotenoids into vitamin A.

- **The primary sources of vitamin A**

- **Retinol** is found in liver, egg yolk, butter, whole milk, and cheese.
- **Carotenoids** are found in orange-flesh sweet potatoes, orange-flesh fruits (i.e., melon, mangoes, and persimmons), green leafy vegetables (i.e., spinach, broccoli), carrots, and red palm oil.

- **Bioavailability of vitamin A**
- The bioavailability of vitamin A derived from animal sources is high – about 70–90% of the vitamin A ingested is absorbed by the body.
- Carotenoids from plant sources are absorbed at much lower rates – between 9% and 22% – and the proportion absorbed decreases as more carotenoids are consumed.
- Dietary fat enhances the absorption of vitamin A. Absorption of β-carotene is influenced by the food matrix.
- Diarrhea or parasite infections of the gut are associated with vitamin A malabsorption

- **Risks related to inadequate or excess intake of vitamin A**
- **About 90% of vitamin A is stored in the liver.**
- **Vegetarians can meet their vitamin A requirements with sufficient intakes of deeply colored fruits and vegetables, with fortified foods, or both.**
- **Vitamin A deficiency is a major problem . Vitamin A plays a role in mobilizing iron from liver stores, so vitamin A deficiency may also compromise iron status.**
- **Excessive intakes of pre-formed vitamin A can result in high levels of the vitamin in the liver – a condition known as hypervitaminosis A.**
- **No such risk has been observed with high β-carotene intakes.**

Vitamin D (Calciferol)

- With the help of sunlight, vitamin D is synthesized by the body from a precursor derived from cholesterol.
- Vitamin D is therefore not an essential micronutrient, given the right season and enough time in the sun.
- The active from of vitamin D is actually a hormone that targets organs – most notably the intestines, kidneys, and bones.
- In the intestine, vitamin D is involved in the absorption of calcium and phosphorus.
- In the bone, it assists in the absorption of calcium and phosphorus, helping bones grow denser and stronger as they absorb and deposit these minerals.

The primary sources of vitamin D

- Sunlight – exposure to ultraviolet B (UVB) rays is necessary for the body to synthesize vitamin D from the precursor in the skin.
- There are a few foods that are natural sources of vitamin D. These sources are oily fish, egg yolk, veal, beef, and mushrooms.

- **Bioavailability of vitamin D**
- the food matrix has little effect on absorption. Bioavailability also varies among individuals and depends on the level of circulating vitamin-D-binding protein.

- **Risks related to inadequate or excess intake of vitamin D**
- **NOT exposure to sunlight is the primary risk factor for poor vitamin D status.**
- **The use of sunscreen, higher levels of melanin in skin (i.e., dark skin), skin coverings (clothes, veils), and time of day are factors that decrease exposure to UVB rays.**
- **People living in latitudes above or below 40 degrees from the equator will be unable to form vitamin D from the skin precursor during the winter months.**
- **Breast milk is a poor source of vitamin D. Children who are exclusively breastfed and have no or little sun exposure require vitamin D supplements to meet their vitamin D requirements.**

- One of the main roles of vitamin D is to facilitate the absorption of calcium and phosphorus.
- Consequently, a vitamin D deficiency creates a calcium deficiency, with significant consequences to bone health.
- Among children and adolescents, it may cause rickets and adversely affect peak bone mass.
- In adults, vitamin D deficiency increases the risk of osteomalacia and osteoporosis.

Vitamin B1 (Thiamin)

- Thiamin is a sulfur-containing vitamin that participates in energy metabolism, converting carbohydrates, lipids and proteins into energy.
- Thiamin also plays a key role in nerve and muscle activity.
- **The primary sources of vitamin B1**
- Offal (liver, kidneys, heart), fish, meat (pork), whole grain cereals, leafy green vegetables.
- eggplant, fruits , legumes (beans and lentils), nuts, soymilk, brewer's yeast.

- **Risks related to inadequate or excess intake of vitamin B1**
- **Clinical vitamin B1 deficiency is called beriberi, a condition which still occurs in South-East Asia.**
- **In beriberi, there is damage to the nervous system characterized by muscle weakness in the arms and legs, or damage to the cardiovascular system which is characterized by dilated blood vessels, causing the heart to work harder and the kidneys to retain salt and water, resulting in edema.**
- **No adverse effects have been associated with excessive thiamin intakes.**

Vitamin C (Ascorbic Acid)

- Vitamin C parts company with the B-vitamins in its mode of action. It acts as an antioxidant or as a cofactor, helping a specific enzyme perform its job.
- High levels of vitamin C are found in pituitary and adrenal glands, eyes, white blood cells, and the brain.
- Vitamin C has multiple roles - in the synthesis of collagen, absorption of iron, free radical scavenging, and defense against infections and inflammation.

- **The primary sources of vitamin C**
- **Fruits (especially citrus fruits), cabbage-type vegetables, green leafy vegetables, lettuce, tomatoes, potatoes, and liver .**
- **Risks related to inadequate intake of vitamin C**
- **Because smoking generates free radicals, individuals who smoke have elevated requirements for vitamin C. Vitamin C deficiency can cause scurvy; signs of scurvy are bleeding gums, small hemorrhages below the skin, fatigue, loss of appetite and weight, and lowered resistance to infections.**

Minerals

- Minerals are divided into two categories: **macrominerals** and **trace minerals/trace elements**.
- **macrominerals** are required by the body in larger quantities (more than 100 mg daily) than trace elements. To meet our requirements for some macrominerals we need to consume sufficient and varied food.
- **The trace minerals** are so named because they are present in relatively small amounts in the body.

Difference between macro and micro minerals

Macrominerals

- The daily requirement of macrominerals **exceeds 100 mg**
- Calcium
- Phosphorus
- Potassium
- Sulfur
- Chloride
- Magnesium

Microminerals

- The daily requirement of microminerals (trace elements) is **less than 100 mg**
- Iron
- Zinc
- Copper
- Manganese
- Iodine
- Selenium

Calcium

- Calcium is the most abundant mineral in the body. 99% percent of the body's calcium is in the bones and teeth.
- Calcium is an integral part of bone structure, necessary to create a rigid frame to hold the body upright and for movement.
- Calcium in the bones also serves as a bank from which the body can withdraw calcium to compensate for low intakes. The remaining 1% of the body's calcium is in the body fluids, where it helps regulate blood pressure and muscle movement.
- Calcium is important at all life stages, and most especially during periods of linear growth, infancy, childhood and puberty, as well as pregnancy and lactation.

- **Calcium in the blood helps to maintain normal blood pressure. Calcium is also involved in the regulation of muscle contraction, transmission of nerve impulses, secretion of hormones and activation of some enzyme reactions.**

- **The primary sources of calcium**
- **Milk and milk products, small fish (with bones), calcium-set tofu (bean curd), and legumes, spinach, Chinese cabbage, kale, broccoli.**

Bioavailability of calcium

- Calcium absorption by the body is enhanced by the presence of vitamin D and decreased in the presence of oxalic and phytic acid in foods.
- Thus, foods with high content of calcium that are also rich in oxalic acid (e.g., spinach, sweet potatoes, and beans) or phytic acid (e.g., seeds, nuts, grains) will result in a lower absorption of calcium compared to foods with no inhibitors, such as milk and milk products.
- Diets high in sodium or phosphorus (e.g., cola beverages) also negatively affect calcium levels in the bone.

Risks related to inadequate intake of calcium

- **Because calcium is critical to muscle contraction and nerve impulses, the body tightly regulates blood calcium levels.**
- **If calcium intake is low, the body will draw on calcium in the bones. Poor chronic intake in calcium results in osteomalacia, in which bones become weak owing to lack of calcium.**
- **Insufficient calcium in bones can also result from an inadequate supply of vitamin D, which is essential for absorption of calcium and its deposition in the bones. Thus, adequate calcium and vitamin D intake is vital for bone integrity and for bone growth.**

Iron

- Iron's main role is to accept, carry and release oxygen. Most of the body's iron is found in two oxygen-carrying proteins – hemoglobin, a protein found in red blood cells, and myoglobin, which is found in the muscle cells.
- Iron also serves as a cofactor to enzymes in oxidation/reduction reactions (i.e., accepts or donates electrons). These reactions are vital to cells' energy metabolism.
- Iron requirements fluctuate throughout the life course. Iron needs increase during menstruation, pregnancy, and periods of rapid growth such as early childhood and adolescence.

The primary sources of iron

- **Red meats, fish, poultry, shellfish, eggs, legumes, grains, dried fruits.**

Bioavailability of iron

- Many factors affect the absorption of iron.
- Heme iron from animal-source foods is absorbed, on average, twice as well as inorganic iron (from plant sources).
- The absorption rates for inorganic iron are also influenced by the meal composition and the solubility of the iron form.
- Factors that enhance absorption of inorganic iron are vitamin C and animal protein.
- Factors that inhibit inorganic iron absorption include phytates (found in grains), polyphenols (found in teas and red wine), vegetable protein, and calcium (which also affects the absorption of heme iron).

Risks related to inadequate intake of iron

- A lack of dietary iron depletes iron stores in the liver, spleen and bone marrow.
- Severe depletion or exhaustion of iron stores can lead to iron deficiency anemia.
- Certain life-stages require greater iron intake and if these are not met, the risk for iron deficiency is increased. For example, pregnancy demands additional iron to support the added blood volume, growth of the fetus and blood loss during childbirth.
- Infants and young children need extra iron to support their rapid growth and brain development.
- Because breast milk is low in iron, infants exclusively fed breast milk may also be at risk for iron
- deficiency.
- Similarly, the rapid growth of adolescence also demands extra iron. Because of iron's role in energy metabolism.
- The physical signs of iron deficiency include fatigue, weakness, headaches, apathy, susceptibility

to infections, and poor resistance to cold temperatures.