Tishk International University
Faculty of Applied Science
Nutrition and Dietetics Department

Nutritional Biochemistry II/ NUT 204

TOPIC: Vitamins

2nd Grade- Spring Semester 2025-2026

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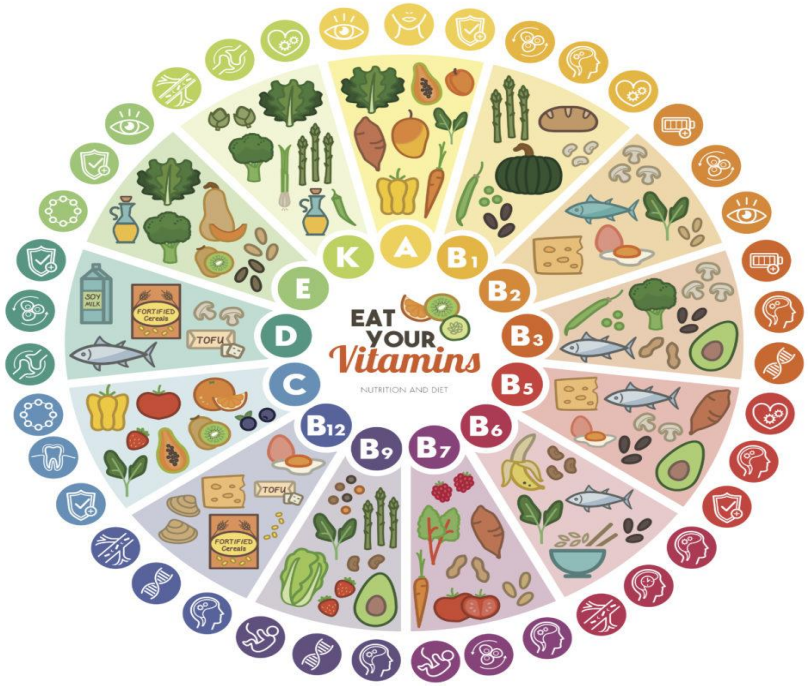
Objectives:

- ✓ Vitamins definition
- ✓ Classification
- ✓ Nutrition of Vitamins
- ✓ Metabolism
- ✓ Toxicity
- ✓ Minerals
- ✓ Trace elements

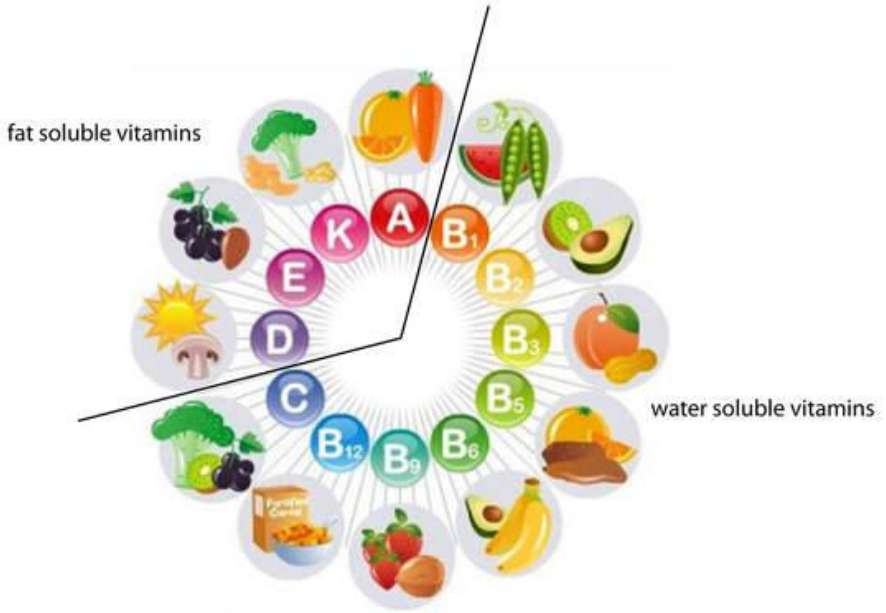
Vitamins

- Vitamins are organic compounds present in small amounts.
- Has vital role form performing body functions.
- They can't be synthesized by the body.

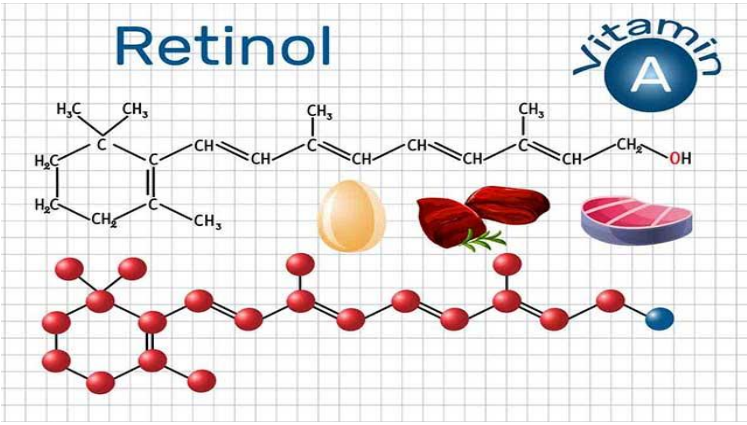


Classification

- Fat-soluble vitamins
  - Vitamin A, D, E, K.
- Water soluble vitamins.
  - Several B vitamins and vitamin C.



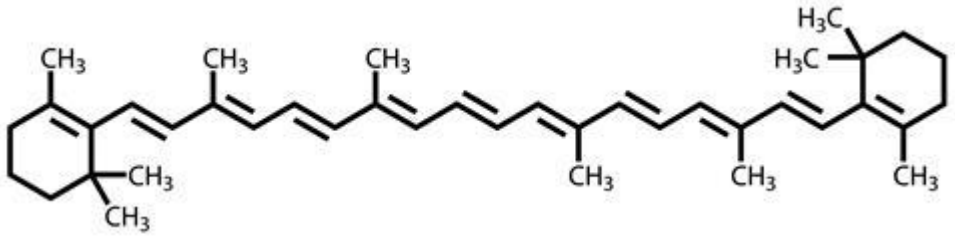
Vitamin A or Retinol.



- ✓ Retinol is a pale,yellow solid.
- ✓ Which dissolves freely in oils and fats.
- ✓ Slightly soluble in water.
- ✓ Retinol is a complex unsaturated alcohol of molecular formula **$C_{20}H_{29}OH$.**
- ✓ **In animal tissues it is stored and transported as an ester formed with a long-chain fatty acid.**

Metabolism

- ✓ Yellow pigments in vegetables are called carotenes, chemically they are related to vitamin A.
- ✓ Carotenes can be converted to retinol in the wall of the small intestine during absorption.
- ✓ Several carotenes are known, but the most important is beta-carotene, which is referred to as ‘provitamin A’.
- ✓ In the body, conversion of beta-carotene to retinol is less that yields only 50 % retinol.



- Carotenes from vegetable food are not completely absorbed and the availability is 25-50% depending on the diet and fat content in the diet.

- Based on the absorption and physiological conversion, a unit of beta carotene yields only 0.25 units of retinol in the body.

- Retinol and carotenes are highly unsaturated and get easily destroyed by oxidation especially at high temperatures.

- As retinol is not soluble in water the excess is accumulated in the liver, but excessive intake is to be avoided and may prove to be injurious.

Functions

- Retinol has a vital role in the visual process.
- Aids in maintaining the integrity of healthy epithelium especially the membrane line of eyes, mouth, GI, respiratory and genitourinary tract.
- Required for skeletal growth and tooth development.
- Facilitates other functions such as for reproductive cycle, in iron metabolism.
- Beta- carotene is a powerful antioxidant.

Deficiency

- Causes ‘Night blindness’.
- Essential for the maintenance of healthy skin and mucous membranes.
- In severe Vitamin A deficiency, epithelial changes, skin changes, degeneration of cells, with increase susceptibility to infection may occur.

Treatment and prevention of vitamin A deficiency

- For children below 6 years old; prophylactic acid of 50,000 IU is recommended.
- A daily oral dose of 10,000 IU of Vit-A is advised in case of mild to moderate deficiency cases.
- 50,000 IU vitamin A for a week for severe cases.

Recommended Dietary Allowance

- Both deficiency and surplus intake may cause severe side effects, so while it’s crucial to meet the RDA of 700–900 mcg daily for adults, don’t exceed the upper daily limit of 3,000 mcg.

Dietary sources

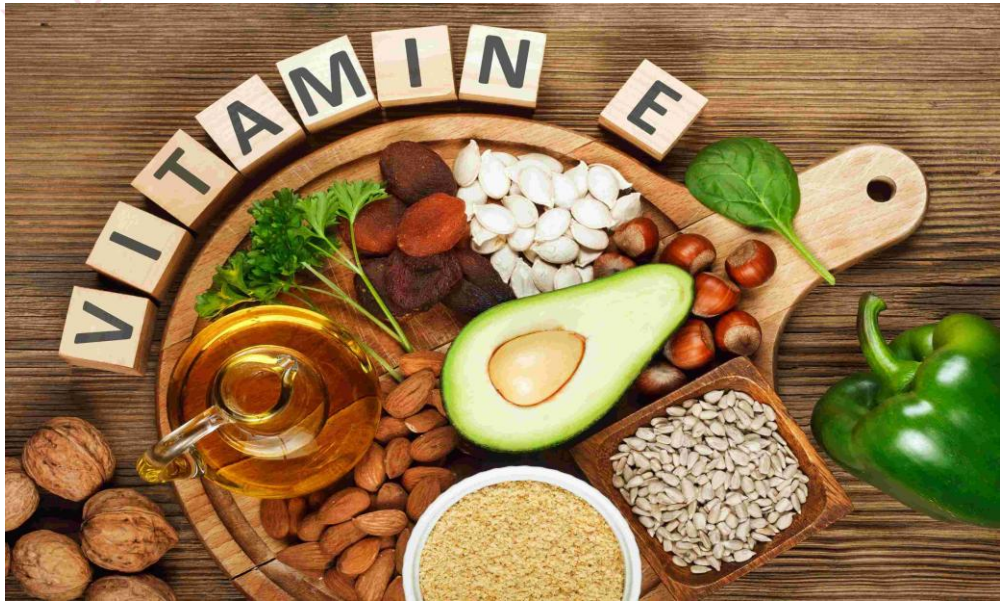
- Retinol is found in animal tissues (liver, egg yolk) and dairy products (whole milk, butter, cheese).
- Fish liver oils are the richest source.
- Carotenes are found in plant tissues such as dark green vegetables and yellow fruits.
- Vegetables are good source of carotene.

Toxicity

- Large intake of vitamin A for long periods would lead to *hypervitaminosis* with symptoms such as nausea, headache, vomiting, etc.

Vitamin E

- ✓ A term used for tocopherols.
- ✓ It is light yellow oil $C_{29}H_{50}O_{2.}$
- ✓ In nature four tocopherols and four tocotrienols occur.
- ✓ Several types of synthetic Vitamin E are available.



Function

- ✓ Regulation of immune response.
- ✓ Protects from various diseases.
- ✓ Prevents oxidation of beta carotene, vitamin A and vitamin C.
- ✓ The vitamin derivative is found to be necessary for coenzyme Q synthesis.
- ✓ Used in food industry as antioxidants and permitted food derivatives.

Dietary sources

- Most of the cereal germ oils like wheat germ oil, corn oil and cottonseed oil, are good sources.

Deficiency

- Observed in subjects with either fat malabsorption or subjects on total parenteral nutrition or in premature infants fed on formula feeds.

Recommended Dietary Allowance

- The Recommended Dietary Allowance (RDA) for vitamin E for males and females ages 14 years and older is 15 mg daily (or 22 international units, IU),including women who are pregnant.

- Lactating women need slightly more at 19 mg (28 IU) daily.

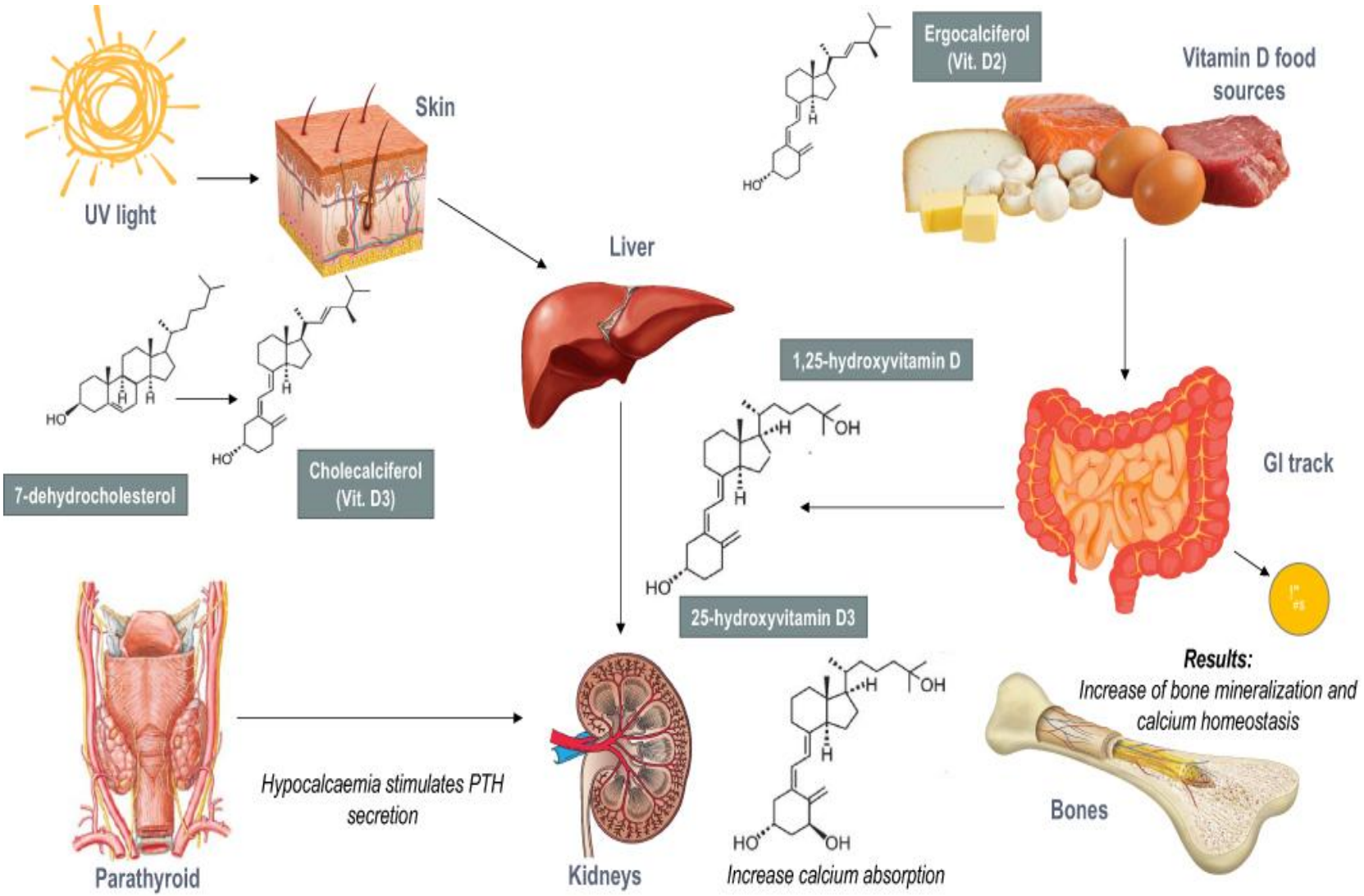
Toxicity and therapeutic doses

- ✓ Excessive ingestion of vitamin E for long periods should be avoided as some sources have reported;

- ✓ Adverse effects like impaired blood coagulation, reduction in thyroid hormones and elevation of lipids.

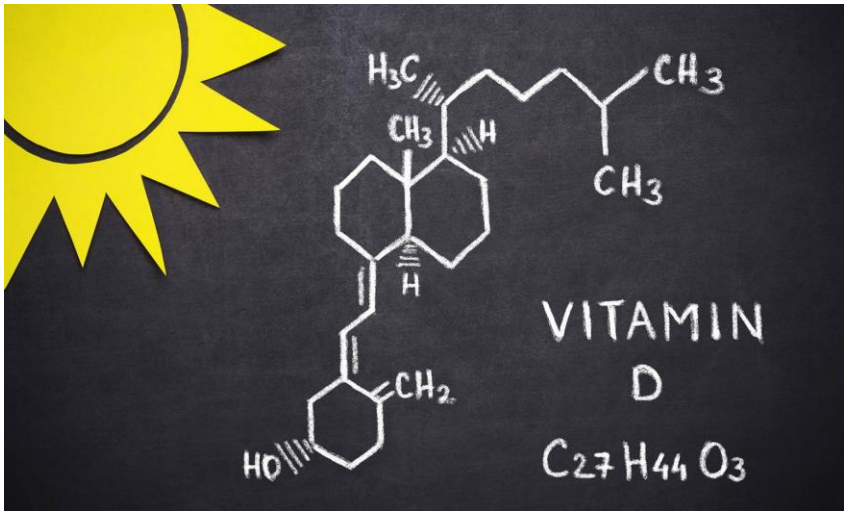
Vitamin D

- Cholecalciferol (D3) is the naturally occurring form on animal cells.
- Dietary vitamin D2 is ergocalciferol- the major source being fish , and some fortified margarines.
- Vitamin D is white crystalline solid, freely soluble in oils and fats.
- Vitamin D is stored in the liver.


UV light
Skin
7-dehydrocholesterol
Cholecalciferol (Vit. D3)
Liver
Ergocalciferol (Vit. D2)
Vitamin D food sources
1,25-hydroxyvitamin D
GI track
25-hydroxyvitamin D3
Results:
Increase of bone mineralization and calcium homeostasis
Bones
Parathyroid
Hypocalcaemia stimulates PTH secretion
Kidneys
Increase calcium absorption

Metabolism

- In the food dietary vitamin D is absorbed along with fats from jejunum and ileum.
- It is transported in the chylomicrons through the lymph circulation.
- Vitamin D produced in the skin enters the blood and circulates and attachd to specific globulin.
- Cholecalciferol is hydroxylated first in the liver to *25-hydroxyl cholecalciferol (25-OH-D3)* and then in the kidney to *1,25 dihydroxy cholecalciferol (1-25-OH-D3).*
- With the help of specific binding proteins, these metabolites are transported in circulation.



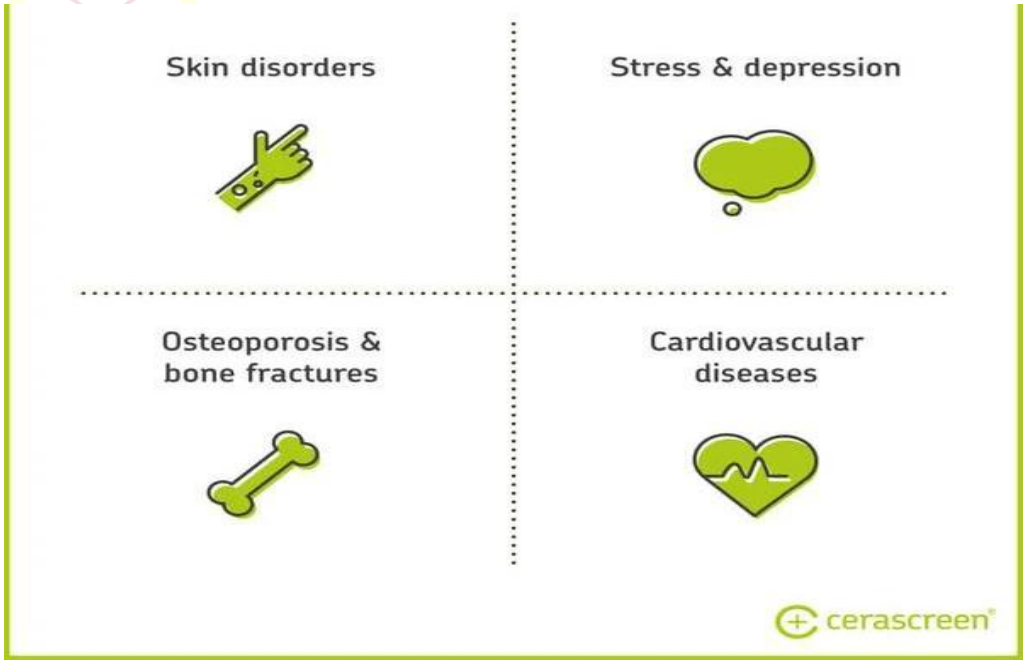
Function

- Necessary for absorption of calcium and phosphorus by the body.

- The minerals (Ca and P) are needed for formation of bones and teeth.

Deficiency

- Inadequate absorption of calcium and phosphorus.
- Decreased synthesis or dietary deficiency causes rickets in children and ostemalacia in adults.
- Low serum calcium also causes tetany.



Recommended Dietary Allowance

- Adequate vitamin D can be synthesized in the body.
- Therapeutic supplementation is necessary (10mcg) in case of deficiency due to metabolic or genetic reasons.

Table. Current recommended dietary allowances for vitamin D.

Life stage	Recommended dietary allowance per day	Tolerable upper intake level per day
0–6 months	400 IU*	1000 IU
6–12 months	400 IU*	1500 IU
1–3 years	600 IU	2500 IU
4–8 years	600 IU	3000 IU
9–70 years	600 IU	4000 IU
Pregnant or lactating	600 IU	4000 IU
> 70 years	800 IU	4000 IU

*The listed RDA values for infants from 0 to 12 months are actually adequate intake values, based on lack of sufficient evidence to generate RDA values.

Dietary sources

Toxicity

- Leads to hypocalcemia.
- Intake should not exceed a total of 400 IU daily.
- Toxicity symptoms may include, nausea, vomiting and diarrhea.

Vitamin K

- Vitamin comprises of compounds derived from menadione.
- Exists in two forms in nature:

Vitamin K1 phylloquinone

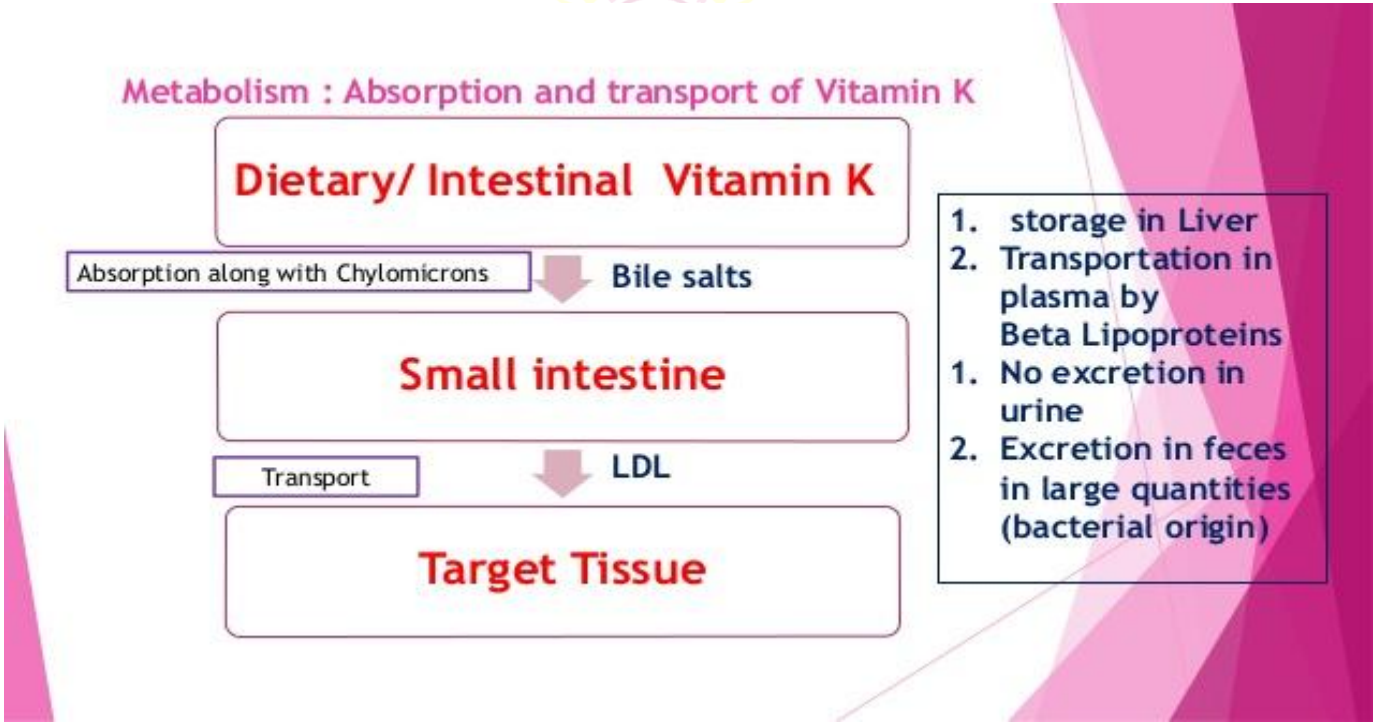
K2- menaquinone.

K1 is present in various green leafy vegetables.

K2 in GI of human and some animals.

Metabolism

- Vitamin K is absorbed along with fats in the upper small intestine and is transported to liver in the chylomicrons.



Function

- Formation of a number of coagulation factors like prothrombin factor.
- Has role on bone mineral density/bone health.

Deficiency

Deficiency leads to an increase in the prothrombin time and thus increase risk of hemorrhage.

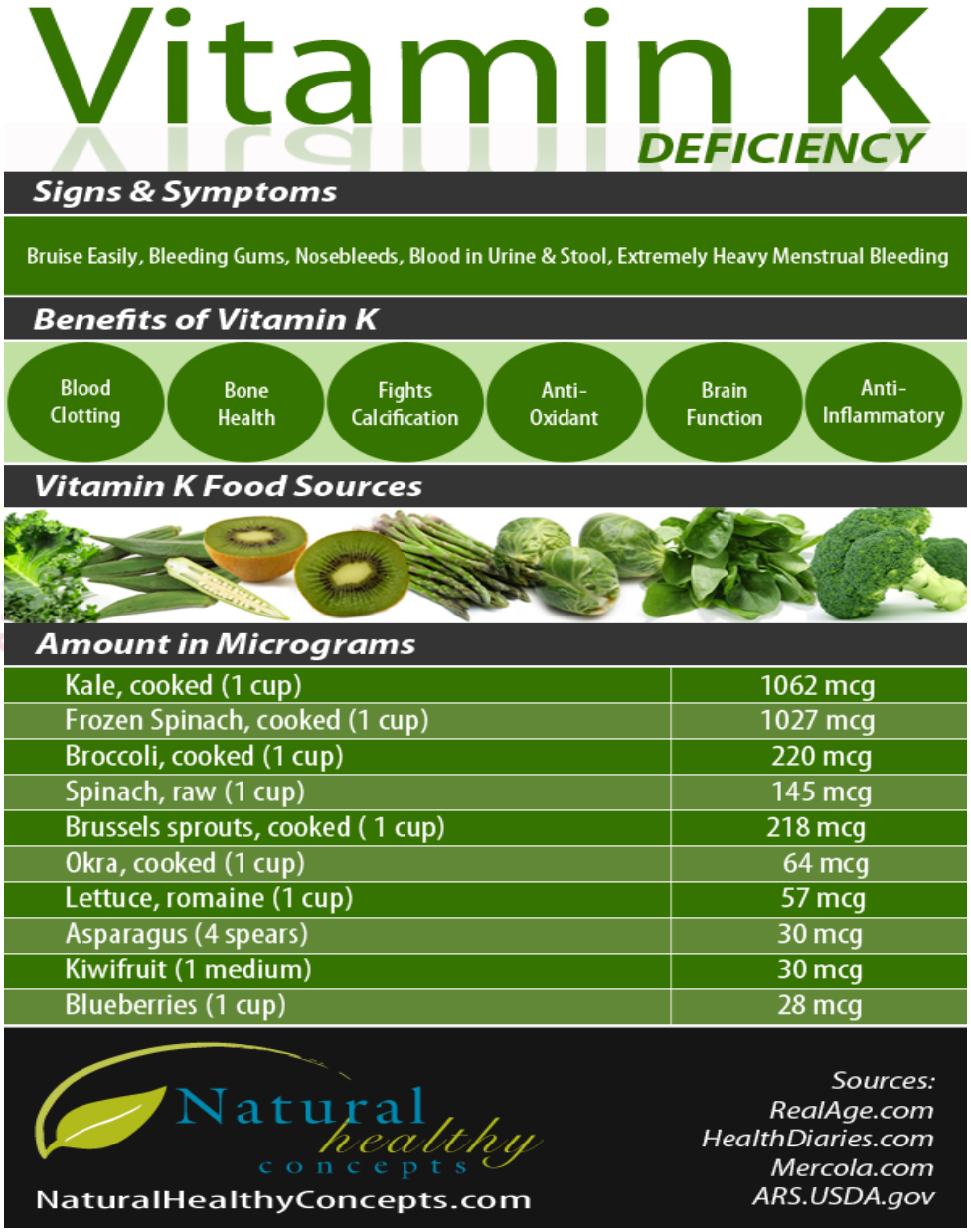
Recommended Dietary Allowance

- ‘Safe intake’ is advised for adults 1-2 µg/kg body weight/day.
- 10µg/day for infants.

- **Infant (0-1 year): 2-2.5**
- **Children (1-8): 30-55**
- **Men (19+): 120**
- **Women (19+): 90**
- **Pregnancy / lactation: 90 / 90**

Dietary sources

- Green leafy vegetables are good sources of vitamins K.
- Plant derived oils such as; Soya and Canola oils are also rich in vitamin K.



Toxicity

Oral Supplements

The normal doses of dietary vitamin K and oral supplements are generally safe. Doses as high as 10 mg K1 and 45 mg K2 (MK-4) per day have been tested in clinical trials without toxic effects .

However, the following mild side effects have been reported :

Nausea

Diarrhea

Abdominal upset

Injections

Skin reactions with itching and redness from vitamin K injections have been reported on rare occasions. They normally resolved within a few weeks. Severe reactions to injected vitamin K (anaphylaxis) are even less frequent

Synthetic Vitamin K

A synthetic vitamin K form (menadione or vitamin K3) caused high blood bilirubin in premature babies in an old study, but only at very high injected doses (over 10 mg/day).

Due to a lack of safety data, a tolerable upper limit for vitamin K has not been established.

No known toxicity has yet been associated with natural forms of vitamin K1 (phylloquinone) or vitamin K2 (menaquinone)

Water soluble vitamins

B group Vitamins;

Are important in the metabolism of carbohydrates, proteins and fats.

Vitamin	Major Dietary Sources	Some Major Functions in the Body	Possible Symptoms of Deficiency or Extreme Excess
Water-Soluble Vitamins			
Vitamin B_1 (thiamine)	Pork, legumes, peanuts, whole grains	Coenzyme used in removing CO_2 from organic compounds	Beriberi (nerve disorders, emaciation, anemia)
Vitamin B_2 (riboflavin)	Dairy products, meats, enriched grains, vegetables	Component of coenzymes FAD and FMN	Skin lesions such as cracks at corners of mouth
Niacin	Nuts, meats, grains	Component of coenzymes NAD^+ and $NADP^+$	Skin and gastrointestinal lesions, nervous disorders Flushing of face and hands, liver damage
Vitamin B_6 (pyridoxine)	Meats, vegetables, whole grains	Coenzyme used in amino acid metabolism	Irritability, convulsions, muscular twitching, anemia Unstable gait, numb feet, poor coordination
Pantothenic acid	Most foods: meats, dairy products, whole grains, etc.	Component of coenzyme A	Fatigue, numbness, tingling of hands and feet
Folic acid (folacin)	Green vegetables, oranges, nuts, legumes, whole grains (also made by colon bacteria)	Coenzyme in nucleic acid and amino acid metabolism	Anemia, gastrointestinal problems May mask deficiency of vitamin B_{12}
Vitamin B_{12}	Meats, eggs, dairy products	Coenzyme in nucleic acid metabolism; needed for maturation of red blood cells	Anemia, nervous system disorders
Biotin	Legumes, other vegetables, meats	Coenzyme in synthesis of fat, glycogen, and amino acids	Scaly skin inflammation, neuromuscular disorders
Vitamin C (ascorbic acid)	Fruits and vegetables, especially citrus fruits, broccoli, cabbage, tomatoes, green peppers	Used in collagen synthesis (e.g., for bone, cartilage, gums); antioxidant; aids in detoxification; improves iron absorption	Scurvy (degeneration of skin, teeth, blood vessels), weakness, delayed wound healing, impaired immunity Gastrointestinal upset

	Water-Soluble Vitamins: B Vitamins and Vitamin C	Fat-Soluble Vitamins: Vitamins A, D, E, and K
Absorption	Directly into the blood.	First into the lymph, then the blood.
Transport	Travel freely.	Many require protein carriers.
Storage	Circulate freely in water-filled parts of the body.	Stored in the cells associated with fat.
Excretion	Kidneys detect and remove excess in urine.	Less readily excreted; tend to remain in fat-storage sites.
Toxicity	Possible to reach toxic levels when consumed from supplements.	Likely to reach toxic levels when consumed from supplements.
Requirements	Needed in frequent doses (perhaps 1 to 3 days).	Needed in periodic doses (perhaps weeks or even months).

NOTE: Exceptions occur, but these differences between the water-soluble and fat-soluble vitamins are valid generalizations.

Fat Soluble Vitamins vs. Water Soluble Vitamins

Minerals

Minerals are important for your body to stay healthy. Your body uses minerals for many different jobs, including:

- keeping your bones, muscles, heart, and brain working properly.
- Minerals are also important for making enzymes and hormones.
- There are two kinds of minerals:

macrominerals and *trace minerals.*

Macro-minerals and *Trace minerals*

- ✓ You need larger amounts of macro-minerals.

<u>They include;</u>

- Calcium,
- Phosphorus
- Magnesium
- Sodium
- Potassium
- Chloride
- Sulfur

- ✓ You only need small amounts of trace minerals.

<u>They include;</u>

- Iron,
- Manganese
- Copper
- Iodine
- Zinc
- Cobalt
- Fluoride
- Selenium.

Minerals

Mineral Name	Major Functions	Deficiency Effects	Toxicity Effects	Food Sources
Calcium	Makes up bone and teeth; muscle contraction/relaxation; blood pressure; clotting; nerve function	Children – stunted growth Adults – bone loss (osteoporosis)	Diarrhea, interference with absorption of other minerals	Dairy, fish with bones, tofu, greens, legumes, fortified foods
Chromium	Helps insulin move glucose (sugar) from blood into cells	Abnormal glucose metabolism	Possible muscle degeneration	Meat, whole grains, vegetable oils
Fluoride	Helps make bones and teeth stronger, helps teeth resist decay	Susceptibility to tooth decay	Fluorosis, discolored teeth, nausea, chest pain	Fluoridated water, seafood, tea
Iodine	A component of thyroid hormone – helps regulate growth, development, metabolism	Goiter, cretinism	Low thyroid activity, enlarged thyroid	Iodized salt, seafood, plants grown in iodine-rich soil
Iron	Part of hemaglobin – carries oxygen in blood, myoglobin carries oxygen in muscle	Anemia, weakness, head-aches, reduced immunity, low cold tolerance	Fatigue, infection, liver damage, colon cancer, bloody stools, fatal to kids	Red meats, fish, poultry, eggs, legumes, dried fruit
Magnesium	Mineralization of bones and teeth, helps enzymes function, muscle contraction, nerve transmission	Weakness, muscle twitches, confusion, convulsions, bizarre muscle movements	Confusion, lack of muscle coordination, death (all due to overuse of laxatives, antacids)	Nuts, legumes, whole grains, dark leafy greens, seafood, chocolate/cocoa

Phosphorus	Bones and teeth; DNA; Phospholipids (part of cell membranes)	Weakness, bone pain (Deficiency rare – usually a side effect of medication)	Low blood calcium, increased calcium excretion	All animal tissues (meat fish, poultry, eggs, milk)
Potassium	Maintains normal fluid and electrolyte balance, assists nerve impulse transmission and muscle contraction	Muscular weakness, paralysis, confusion (due to dehydration)	Muscular weakness, vomiting reflex	All whole foods, fruits, vegetables, grains, meat, milk
Selenium	Antioxidant, works with vitamin E	Keshan disease, muscle pain/degeneration, cataracts, low sperm, fragile red blood cells, heart damage	Nail and hair brittleness and loss, nerve, muscle, liver damage, nausea	Seafoods, organ meats, other meats, grains, veg depending on soil content
Sodium	Maintains normal fluid and electrolyte balance, assists nerve impulse transmission, muscle contraction	Muscle cramps, mental apathy, loss of appetite	Edema, acute hypertension, increased calcium excretion	Table salt, soy sauce, MSG, all processed foods.
Zinc	Part of insulin, helps many enzymes function, DNA repair, taste perception, immune function, wound healing, sperm	Failure to grow (kids), dermatitis, loss of taste, poor healing, sex retardation	Fever, nausea, vomiting, dizziness, uncoordinated, anemia, heart disease	Protein-containing foods, some grains and vegetables

Basic food groups

Energy foods	Carbohydrate and fat rich foods mainly contribute energy in our diet.
Body building foods	Are mainly protein rich foods.
Protective foods	Consist mainly of vitamin and mineral rich food sources.

Drug Interactions with Vitamins and Minerals

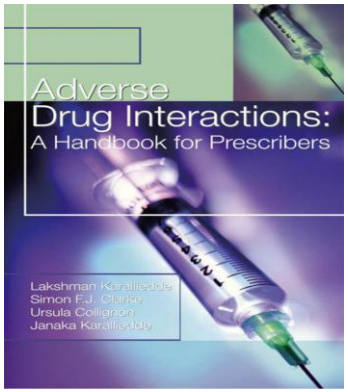
- There are many different types of drug interactions with vitamins and minerals, ranging in severity and significance.

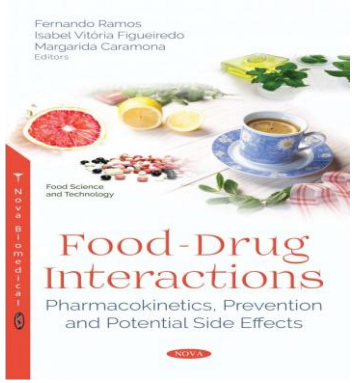
- Information about the use of vitamins, minerals, herbal products, and other nutraceuticals should be documented in patients' records for future reference.

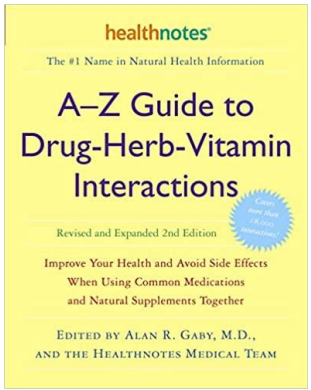
- Pharmacists should encourage software vendors and employers to provide fields in their profile systems for over-the-counter medications and supplements, since these products can impact care and cause easily avoidable drug interactions

- Vitamins and minerals serve crucial functions in almost all bodily processes and must be obtained from foods or supplements, as our bodies are unable to make them.

- 52% of adults take dietary supplements.







Supplements

- Supplement use is typically a safe and effective method of maintaining a healthy body; however, supplements have the potential to interact with prescribed medications.

- It is important to be able to identify patients who are most at risk.
- Risk factors for poor outcomes from drug interactions include;

a) use of multiple medications and/or supplements,

b) older age,

c) inadequate kidney or liver function,

d) and the use of medications with narrow therapeutic indexes.

- Be vigilant in monitoring for potential drug interactions.
- Advising patients regarding proper use.
- Educate the patient on foods and beverages to avoid when taking certain medications.
- Advising patients in disease conditions.
- Keep up-to-date on potential drug-drug and drug-food interactions of medications to counsel the patients.

Drug Interaction Classification

Major: Highly clinically significant.

Moderate: Moderately clinically significant.

Minor: Minimally clinically significant.

Unknown: No interaction information available.

Vitamins and drug interactions

Vitamin	Drug/Product
Vitamin A	Retinoids
Vitamin B6	Pyridoxine
Vitamin E	Warfarin
Vitamin K	Warfarin
Niacin	statins
Folic acid	methotrexate

Drug Interactions with Vitamins and Minerals

Vitamin/ Mineral Supplement	Affected Medication	Effect of Interaction	Management of Interaction
Vitamin A	Retinoids (isotretinoin and acitretin)	Risk of toxicity; nausea, vomiting, dizziness, blurred vision, poor muscle coordination	Avoid concomitant use
Pyridoxine (Vitamin B_6)	Levodopa	Decreased efficacy leading to parkinsonian symptoms	Recommend carbidopa/ levodopa combination
	Phenytoin	Risk of seizure	Discontinue pyridoxine or increase phenytoin dose
Vitamin E	Warfarin	Risk of bleeding	Avoid doses ≥800 IU/day of vitamin E
Vitamin K	Warfarin	Decreased efficacy; risk of thromboembolism	Maintain consistent intake of vitamin K
Niacin	HMG-CoA reductase inhibitors	Risk of myopathy or rhabdomyolysis	Avoid self-treatment with niacin
Folic acid	Methotrexate	Prevents adverse events or toxicities from methotrexate	Recommend supplementation in patients taking methotrexate for rheumatoid arthritis or psoriasis

Calcium	Fluoroquinolones and tetracyclines Levothyroxine and bisphosphonates	Decreased efficacy; risk of antibiotic failure Decreased efficacy; risk of hypothyroidism	Avoid concomitant calcium supplementation Separate doses by at least four hours
Aluminum and magnesium	Fluoroquinolones, tetracyclines, bisphosphonates, and levothyroxine	Decreased efficacy of affected medication	Separate doses by at least two hours
Iron	Fluoroquinolones, tetracyclines, digoxin, and levothyroxine Methyldopa	Decreased efficacy of affected medication Worsening of hypertension	Separate doses by at least two hours Avoid concomitant use
Potassium (including salt substitutes)	ACE inhibitors, angiotensin receptor blockers, digoxin, indomethacin, prescription potassium supplements, and potassium-sparing diuretics	Hyperkalemia	Avoid concomitant supplementation without physician supervision

ACE: angiotensin-converting enzyme.


QUESTION
ANSWER