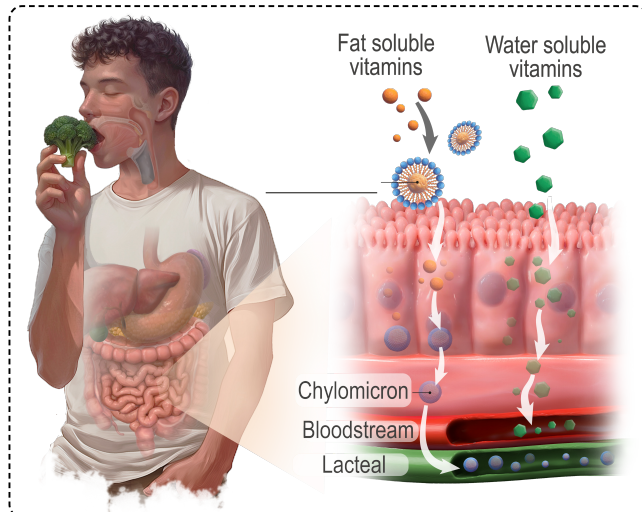


TOPIC: FAT-SOLUBLE VITAMINS

Fat-Soluble Vitamins

- ◆ Fat-soluble vitamins (A, D, E, & K) require presence of dietary _____ for absorption (via micelles/chylomicrons).



- ◆ Fat-soluble vitamins are _____ in our liver, muscles, & fatty tissue (useful if dietary intake is low).
 - Their *storage* makes them more prone to build up to the point of _____.

PRACTICE

Why are water-soluble vitamins more easily absorbed than fat-soluble vitamins?

- Water-soluble vitamins are readily absorbed directly into the bloodstream, while fat-soluble vitamins require micelles & chylomicrons to be absorbed.
- Fat-soluble vitamins cannot be stored in the body. Therefore, when the body already has enough of a fat-soluble vitamin, it does not absorb any more.
- Water-soluble vitamins are smaller, so they can be absorbed more easily in the small intestine.
- All of the above.

TOPIC: FAT-SOLUBLE VITAMINS

What is Vitamin A?

- ◆ **Vitamin A:** a group of fat-soluble micronutrients including *retinoids* (from animals) & *carotenoids* (from plants).
 - **Preformed vitamin A** retinoids include _____ (the most usable), retinal, & retinoic acid.
 - **Provitamin A carotenoids** serve as yellow-red pigments in vegetables (e.g. β -carotene) & are \rightarrow *retinol* in body.
- ◆ Vitamin A plays an essential role in _____, as it's a component of light-sensitive proteins.
 - Affects gene expression & has roles in cell differentiation/growth, reproduction, skin/bone health, & immunity.

Sources of Vitamin A

Preformed Vitamin A: liver, fish, dairy, eggs, & fortified foods.

Provitamin A carotenoids: orange, yellow, & dark leafy green vegetables (e.g., carrots, sweet potatoes, spinach).



Vitamin A Deficiency (Common globally) could cause:

- ◆ Night blindness.
- ◆ Permanent cornea damage (xerophthalmia).
- ◆ Keratinization of epithelial tissue ("hardening" of skin).
- ◆ Stunted bone growth.



EXAMPLE

Fill in the blanks throughout the table below to review & compare forms of vitamin A.

Form	Common Molecules	Sources	Bioavailability	Function
Preformed Vitamin A (Retinoids)	_____, retinal, retinoic acid	Animals (e.g. liver, dairy, eggs)	Higher – ready to be used by the body	_____, immune function, growth
Provitamin A (Carotenoids)	_____-carotene, α -carotene	Plants (e.g. carrots, spinach)	Lower – must be converted to active form	May function as antioxidants

PRACTICE

Which of the following foods are a good source of *preformed* vitamin A (e.g. retinol)?

- Liver, milk, eggs.
- Carrots, spinach, sweet potatoes.
- Kale, spinach, lettuce.
- All of the above.

TOPIC: FAT-SOLUBLE VITAMINS

What is Vitamin D (Calciferol)?

- ◆ **Vitamin D:** a group of fat-soluble micronutrients, primarily vitamins D₂ (fungi) & D₃ (animals).
 - D₂ & D₃ → calcitriol, which is vital for immune function & _____ health as it regulates Ca²⁺/P absorption.
- ◆ Body synthesizes *inactive* D₃ from a *cholesterol* precursor when exposed to _____ light (activates in liver/kidney).
 - Individuals with more melanin (darker skin) need more exposure to sunlight to produce adequate vitamin D.

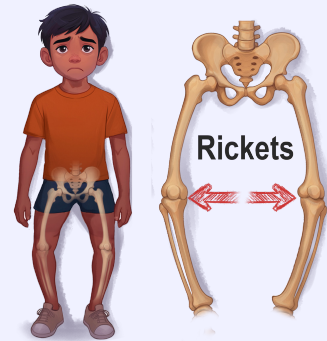
Sources of Vitamin D

- ◆ Exposure to sunlight drives Vitamin D₃ synthesis.
- ◆ Fatty fish (e.g. sardines, salmon, tuna, swordfish).
- ◆ Egg yolks, butter.
- ◆ Fortified foods (e.g. milk, yogurt, cereal, juice).
- ◆ Mushrooms (e.g. portobello, white button, shiitake).



Vitamin D Deficiency (Common) could cause:

- ◆ Rickets - causes soft/weak bones in children, leading to skeletal deformities & frequent bone fractures.
- ◆ Osteomalacia – adult equivalent of rickets – muscle & bone weakness.
- ◆ Osteoporosis – Bone weakness.



PRACTICE

Which of the following is NOT a function of vitamin D?

- a) Stimulates absorption of calcium & phosphorus.
- b) Helps build new bone tissue.
- c) Helps maintain bones, keeping them strong & healthy.
- d) Acting as an antioxidant.

PRACTICE

Who is most likely at risk of a vitamin D deficiency?

- a) A 19th century sailor who does not consume much fruit or vegetables on a long voyage at sea.
- b) Brittany, a vegetarian who lives in a sunny beachside town & spends significant time in the sun.
- c) Dave, a vegan who lives in a city that receives very little sunlight.
- d) Maya, who lives in the same city as Dave but eats fish, dairy products, & eggs.

TOPIC: FAT-SOLUBLE VITAMINS

What is Vitamin E?

- ◆ **Vitamin E:** a group of 8 fat-soluble, _____ *oxidant* micronutrients, mainly α -tocopherol.
 - Its role as a powerful *antioxidant* _____ cell membranes from *free radicals*.
 - Prevents oxidation of “bad” LDL cholesterol, _____ plaque buildup in arteries.
- ◆ Also acts as an *anticoagulant*, which _____ dangerous & unnecessary blood clots.

Sources of Vitamin E

Vegetable oils (e.g. wheat germ, sunflower).

Nuts & seeds.

Green leafy vegetables, avocados.

Fortified cereals.



Vitamin E Deficiency (Very Rare) could cause:

- ◆ Cell membrane vulnerability to free radicals.
- ◆ Nerve damage, muscle weakness.
- ◆ Red blood cell rupture (erythrocyte hemolysis) in babies born prematurely (before vitamin E transfer from mother)



PRACTICE

Which of the following processes requires vitamin E?

- a) Preventing dangerous & unnecessary blood clots.
- b) Preventing the oxidation of LDL cholesterol, reducing plaque buildup in arteries.
- c) Stabilizing free radicals by donating electrons.
- d) All of the above.

TOPIC: FAT-SOLUBLE VITAMINS

What is Vitamin K?

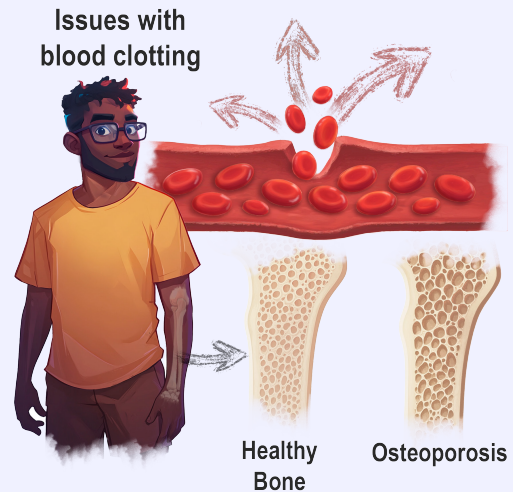
- ◆ **Vitamin K:** a group of fat-soluble micronutrients vital for blood clotting (*coagulation*), mainly vitamins K₁ & K₂.
 - K₁ (phylloquinone) is found in plants/diet, while K₂ (menaquinone) is found in animals & made by gut bacteria.
 - Vitamin K can interact with anticoagulant medications (e.g. warfarin).
 - Also enables osteocalcin (a bone protein) to bind calcium (Ca²⁺), helping strengthen bones.

Sources of Vitamin K

- ◆ **K₁** (Phylloquinone): green leafy vegetables (e.g. kale, spinach, broccoli, brussels sprouts, cabbage).
Vegetable oils & margarine.
- ◆ **K₂** (Menaquinone): meats (e.g. chicken thighs/liver), egg yolks, hard cheeses (e.g. gouda, swiss), fermented foods (e.g. yogurt).



Vitamin K Deficiency (Rare) could cause:



PRACTICE

Vitamin ____ acts as an antioxidant, neutralizing free radicals & preventing them from damaging cell membranes.
Vitamin ____ is vital in the blood clotting process & helps strengthen bones.

- a) K; E.
- b) E; K.
- c) E; D.
- d) A; K.

PRACTICE

People taking anticoagulants should carefully monitor their _____ intake, because it could decrease the effectiveness of the medication.

- a) Vitamin A.
- b) Vitamin D.
- c) Vitamin E.
- d) Vitamin K.

TOPIC: FAT-SOLUBLE VITAMINS

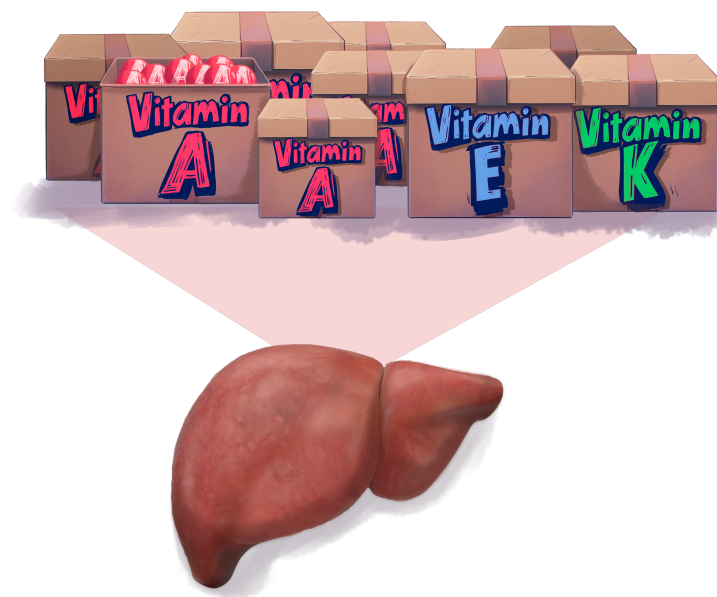
PRACTICE

If your doctor has directed you to take vitamin K supplements, why might it be a bad idea to also take vitamin E supplements?

- a) Vitamin E is an antioxidant that could inhibit vitamin K by donating an electron to it.
- b) Vitamin E is an anticoagulant, so it could inhibit the blood coagulation function of vitamin K.
- c) Vitamin K is an anticoagulant, so it could inhibit the blood coagulation function of vitamin E.
- d) None of the above.

Storage of Fat-Soluble Vitamins

- ◆ Since _____-soluble vitamins are *stored* in the body, you can survive for weeks without consuming them.
 - However, they are still essential in our diet in the long run.
 - Most vitamin A is stored in the _____ along with some vitamin E & K; vitamin D is stored in fat & muscle.
- ◆ Recall: fat-soluble vitamins can build up to the point of _____ (particularly vitamins A & D).



PRACTICE

Generally, it is hard to consume toxic quantities of vitamins without supplements. But eating which of the following organs is most likely to result in hypervitaminosis A (toxic levels of vitamin A)?

- a) Cow brains.
- b) Carnivore liver.
- c) Chicken hearts.
- d) Pork kidneys.

TOPIC: FAT-SOLUBLE VITAMINS

EXAMPLE

Fill in all the blanks throughout the table below to review the fat-soluble vitamins.

Vitamin	Function(s)	Food Sources	Deficiency Symptoms
Vitamin A	_____, immune function, growth	Orange/yellow fruits & veg, eggs, dairy, liver	Night blindness, stunted bone growth, “hardening” of skin
Vitamin D	Ca ²⁺ /P balance, _____ health	Fatty _____, dairy, exposure to sunlight	Rickets, _____porosis
Vitamin E	Antioxidant, anticoagulant, prevents plaques	Vegetable oils, nuts/seeds, avocados	Cell _____ vulnerability to free radical damage
Vitamin K	Blood _____, bone health	Leafy green vegetables, meat, egg yolks	Issues with _____ clotting, osteoporosis

PRACTICE

Alisha is starting a diet that severely limits her intake of fat-soluble vitamins. Which of the following is most likely to happen?

- a) She will start getting symptoms of fat-soluble vitamin deficiencies within a few days of starting the diet.
- b) She won't get symptoms of fat-soluble vitamin deficiencies until at least a few weeks after starting the diet.
- c) She will never have any fat-soluble vitamin deficiencies, as her body can produce & store enough.
- d) None of the above.