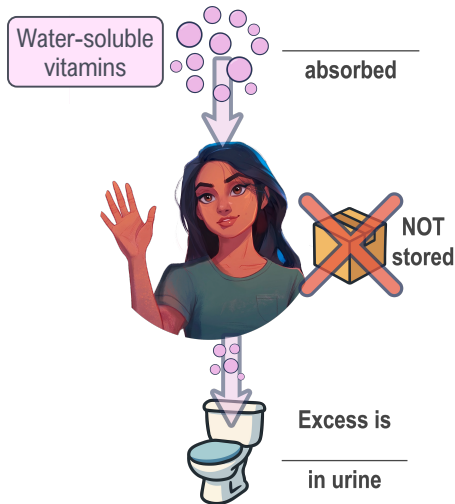


TOPIC: WATER-SOLUBLE VITAMINS

Water-Soluble Vitamins

◆ Water-soluble vitamins dissolve in _____ & therefore are *easily* absorbed by the body & *excreted*.



_____ -Soluble Vitamins

- **B Vitamins:**
 - Vitamin B₁ (Thiamin)
 - Vitamin B₆ (Pyridoxine)
 - Vitamin B₂ (Riboflavin)
 - Vitamin B₇ (Biotin)
 - Vitamin B₃ (Niacin)
 - Vitamin B₉ (Folate or Folic Acid)
 - Vitamin B₅ (Pantothenic Acid)
 - Vitamin B₁₂ (Cobalamin)
- **Vitamin C** (Ascorbic Acid)

EXAMPLE

Fill in the blanks in the table below to review the major differences between fat- & water-soluble vitamins.

	Fat-Soluble Vitamins (A, D, E, K)	Water-Soluble Vitamins (Bs & C)
Absorption	Requires _____ to be absorbed	Easily absorbed in the presence of water
Transport through Body	Packed in _____ & chylomicrons in lymph	Directly enters _____ stream
Storage in Body	Stored in liver, fat & muscle tissue	_____ stored in the body (excess excreted in urine).
Toxicity	Can be toxic in high doses	Low risk of toxicity

PRACTICE

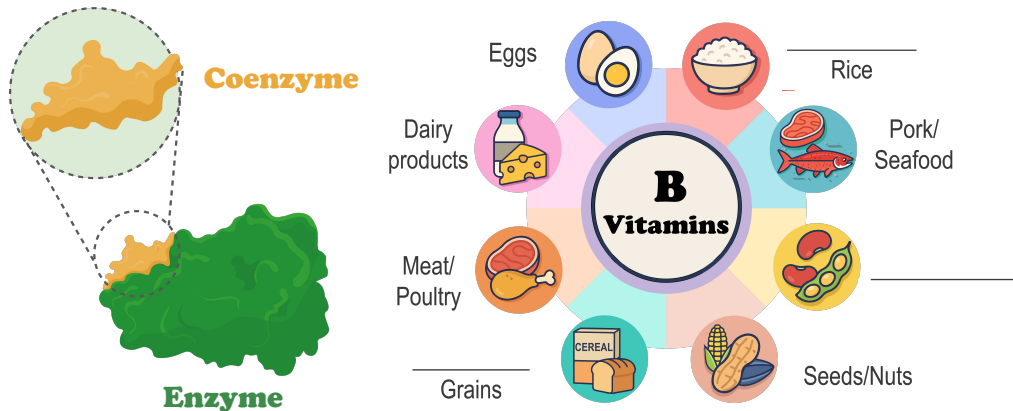
There are 4 different fat-soluble vitamins and _____ different water-soluble vitamins in total. While excess fat-soluble vitamins can be stored in the body, excess water-soluble vitamins are mostly _____.

- Nine; excreted in urine.
- Eight; excreted in urine.
- Nine; stored in the blood.
- Eight; stored in the blood.

TOPIC: WATER-SOLUBLE VITAMINS

Introduction to B Vitamins

- ◆ **B Vitamins:** a group of _____ *water-soluble* micronutrients that all serve as _____ *enzymes* in the body.
 - **Coenzymes:** vitamin-derived molecules needed to _____ some enzymes.
 - We need many of the B vitamins to convert carbs, fat, & protein into usable forms of energy.
 - Many B vitamins are found in the _____ foods (deficiency in one often indicates deficiency in others).



EXAMPLE

Which of the following statements about B vitamins is true?

- They are rarely found together in the same foods.
- Most B vitamins are water-soluble, but some are fat-soluble.
- They are actually distinct vitamins, but they all form coenzymes in the body & many have similar functions.
- They all have identical functions exclusive to brain & nervous system development.

PRACTICE

Why is it difficult to isolate the symptoms of deficiency of one of the B vitamins?

- All the B vitamins have the exact same function, so deficiencies will cause the exact same symptoms.
- B vitamins are often found together in foods, so people who are deficient in one are often deficient in others.
- Humans can synthesize all the B vitamins in small amounts, so it's impossible to have a severe deficiency.
- The most common reason people have a B vitamin deficiency is due to having difficulty absorbing them in the small intestine. People with these issues usually have issues absorbing >1 B vitamin.

TOPIC: WATER-SOLUBLE VITAMINS

PRACTICE

Who is most likely to develop a deficiency in multiple B vitamins?

- a) Ed, who follows an “all-natural” diet consisting only of raw fruit & vegetables, meat, dairy, seafood, & rice.
- b) Trina, who eats a mostly well-balanced diet but sometimes snacks on candy & processed junk food.
- c) Oliver, an extremely picky eater who mostly just eats plain pasta, chicken nuggets, carrots, & soda.
- d) Devin, who is a vegan but diversifies his diet, eating plenty of nuts, seeds, whole grains, & leafy greens.

TOPIC: WATER-SOLUBLE VITAMINS

Early-Discovered B Vitamins: B₁, B₂, B₃, & B₅

Vitamin	Function	Deficiency Could Cause
Vitamin B₁ (Thiamin)	Metabolism of carbohydrates & some amino acids, transmission of nerve impulses.	Beriberi: disease that affects either cardiovascular or nervous system. Wernicke-Korsakoff syndrome.
Vitamin B₂ (Riboflavin)	Required for metabolism of carbohydrates, proteins & fats (converting nutrients to energy). Forms FAD.	Sore throat, swollen mouth/tongue, dry & cracked lips.
Vitamin B₃ (<u> </u>) [*]	Energy metabolism (forms NAD ⁺ & NADP ⁺), synthesis of fat/cholesterol. Reduces LDL & increases HDL level in blood.	Pellagra: disease causing dermatitis, dementia, diarrhea (& eventually death).
Vitamin B₅ (Pantothenic Acid) [*]	Component of Coenzyme A, which is required for fatty acid synthesis & carbs/fat/protein metabolism.	Numbness/burning in hands & feet due to nerve issues, gastrointestinal distress.

* More commonly used name

Early-Discovered B Vitamins: B₆, B₇, B₉, & B₁₂

Vitamin	Function	Deficiency Could Cause
Vitamin B₆ (Pyridoxine)	Coenzyme used in protein metabolism; required to build nonessential amino acids & hemoglobin.	Sore tongue , skin inflammation, depression, confusion, anemia.
Vitamin B₇ (<u> </u>) [*]	Important coenzyme in carbs, fat & protein metabolism. Represented as a single compound.	Hair loss, skin inflammation, lethargy.
Vitamin B₉ (Folate/Folic Acid) [*]	Comes in 2 forms – folate in natural foods, folic acid in fortified food. Vital for DNA synthesis & health during pregnancy (reduces risk of neural tube defects in the fetus).	Abnormally large red blood cells (macrocytes), eventually leads to macrocytic anemia. Neural tube defects in fetus during pregnancy.
Vitamin B₁₂ (Cobalamin)	Makes red blood cells & DNA alongside folate; only water-soluble vitamin that is stored in the body (in the liver). Found in animal products, so vegans are more likely to be deficient.	Macrocytic anemia (same as folate). NOTE: the body's ability to absorb vitamin B ₁₂ from natural foods diminishes with age.

* More commonly used name

TOPIC: WATER-SOLUBLE VITAMINS

EXAMPLE

Appropriately match each B vitamin to its corresponding function &/or deficiency.

Vitamin B ₁ (Thiamin)		Vitamin B ₉ (Folate)	
Vitamin B ₃ (Niacin)		Vitamin B ₁₂ (Cobalamin)	

1	Very important during pregnancy to prevent neural tube defects and is vital for DNA synthesis.
2	Vital for metabolism of carbohydrates & some amino acids and deficiency causes beriberi.
3	Helps make DNA & red blood cells & is the only B vitamin that can be stored in the body. Deficiency causes macrocytic anemia.
4	Can reduce LDL & increase HDL level in blood; deficiency causes pellagra (leading to dermatitis, dementia, diarrhea).

PRACTICE

Maria is pregnant and her doctor has recommended she takes a folic acid supplement. Why?

- a) Folic acid can significantly reduce the likelihood of neural tube defects in babies.
- b) Folic acid will help Maria produce enough breast milk after giving birth.
- c) Folic acid can help strengthen Maria's bones as they take on the extra weight of her baby.
- d) All of the above.

TOPIC: WATER-SOLUBLE VITAMINS

What is Vitamin C?

- ◆ **Vitamin C (Ascorbic Acid):** a water-soluble micronutrient serving as a coenzyme & _____ oxidant.
 - Unlike most of the other vitamins, Vitamin C is a _____ compound, NOT a group.
- ◆ As a coenzyme, vitamin C is needed to synthesize/use certain _____ acids & help absorb iron.
 - Required to make _____, the most abundant protein in the body.
 - Also important for _____ system health (helps make white blood cells).

Sources of Vitamin C

Citrus fruits (e.g. oranges)

Tomatoes

Peppers

Broccoli

Sweet potatoes



Vitamin C Deficiency (Rare) could cause:

- ◆ **Deficiency: Scurvy:** causes swollen/bleeding gums, loss of teeth, skin rash, & inability to heal wounds. Used to be common among sailors.



PRACTICE

Which of the following statements is true?

- You should carefully monitor vitamin C consumption because you can easily ingest toxic quantities.
- You need to eat citrus fruits (e.g. limes, lemons, oranges) every day to avoid vitamin C deficiency.
- Vitamin C is a protein that is converted into collagen once it has been digested & absorbed.
- Eating a wide variety of fruit & vegetables will ensure you meet your daily vitamin C requirements.

PRACTICE

Vitamins _____ are both antioxidants that neutralize harmful free radicals.

- B_1 & C.
- E & C.
- B_6 & C.
- D & E.

TOPIC: WATER-SOLUBLE VITAMINS

EXAMPLE

Compare and contrast vitamin C and the B vitamins. Which of the following statements is true?

- a) Vitamin C is fat-soluble, but the B vitamins are water-soluble.
- b) Vitamin C can primarily be found in dairy, meats, & seafood, while B vitamins are found in fruit & vegetables.
- c) Vitamin C is important for vision, the B vitamins function as coenzymes & help with metabolism.
- d) Scurvy is a disease caused by vitamin C deficiency; beriberi & pellagra can be caused by B vitamin deficiency.

PRACTICE

A vitamin B₃ (niacin) deficiency may cause _____, while a vitamin B₁₂ (cobalamin) deficiency may cause _____.

- a) Pellagra; macrocytic anemia.
- b) Beriberi; macrocytic anemia.
- c) Glossitis; pellagra.
- d) Pellagra; polycythemia (high red blood cell count).

PRACTICE

Which of the following vitamins are most likely to build up to the point of toxicity with excessive intake?

- a) Vitamins A, C, E, K.
- b) Thiamin, riboflavin, niacin.
- c) Vitamins D, K, B₃ (niacin) & B₇ (biotin).
- d) Vitamins A, D, E, K.