What is a Vitamin?

- Organic compound (made mainly of carbon, hydrogen, and oxygen)
- Essential nutrients (must be consumed in the diet, not made by body)

Vitamins and Metabolism

Vitamins and minerals
- Are required for proper metabolism
- Do not directly provide energy
- Are necessary for obtaining energy from the macronutrients
- Often function as coenzymes

Coenzymes: Complex organic molecules that work with enzymes to facilitate the enzyme’s activity.
**B Vitamins and Metabolism**

**Act as coenzymes**
- In reactions that
  1) Release energy from food
  2) Regulate metabolism
- In cell multiplication
  1) Red blood cells
  2) Cells of the GI lining

**B Vitamins**
- Thiamin (B₁)
- Riboflavin (B₂)
- Niacin (B₃)
- Biotin
- Pantothenic Acids
  - B₆
  - Folate
- B₁₂
Catabolism of Fatty Acid

16-C fatty acid → CoA → Uses energy (ATP) → CoA

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Pantothenic Acid → Niacin → Riboflavin (Biotin) → Electron Transport Chain → Makes ATP

Catabolism of Amino Acids

Amino acids → Pyruvate → Carbon dioxide → Acetyl CoA → CoA

CoA → Electron Transport Chain (makes ATP)

All B Vitamins are involved in the TCA cycle!

- Thiamin (B₁)
- Riboflavin (B₂)
- Niacin (B₃)
- Biotin
- Pantothenic Acids
- B₆
- Folate
- B₁₂
B vitamins and the Electron Transport Chain

Niacin
Riboflavin

Metabolic Pathways Involving B Vitamins

Foods with B vitamins

• In general, B vitamins are found in a wide range of foods
• B vitamins are more likely found in foods of animal origins (B₁₂), protein-rich foods, whole-grain foods, fortified foods
• Many B vitamins are found in lots of different food

Keeping B Vitamins in Foods

• Easily destroyed by UV rays (sun), heat, exposure to oxygen
  - Implications for cooking and storage
• Water soluble
  - They leach out of foods when washed and cooked in water
To minimize vitamin losses, wrap cut fruits and vegetables or store them in airtight containers.

Is more always better?

No! More is better up to a point and then is harmful.

B Vitamin Toxicity

Some B vitamins are toxic if too much is consumed:
- Niacin: Flush, Liver damage, Impaired glucose regulation
- B₆: Nerve degeneration, skin lesions
- Folate: Masks B₁₂ deficiency

B Vitamin Deficiency Diseases

With general B deficiencies, can see:
glossitis - smooth, glossy tongue due to atrophy of the tissue
B Vitamin Deficiencies Diseases

Niacin: *Pellagra* - Diarrhea, dermatitis, dementia, death

Thiamin: *Beriberi* - Muscle wasting and nerve damage, sometime edema

Riboflavin: *Ariboflavinosis* - Sore throat, swollen mucous membranes

Folate
- Involved in DNA synthesis, amino acid metabolism
- Helps prevent heart disease and cancer
- Critical for cell division of very early embryos
- Critical for formation of neural tube in developing fetus

Folate Deficiency
- Failure to replace tissues that turnover frequently (GI tract, red blood cells)
  - Anemia: not enough red blood cells present or properly functioning
  - GI tract deterioration
- Spinal bifida: Improper development of spinal chord in fetus

Vitamin B$_{12}$
- Part of coenzymes for blood formation
- Required for nerve functioning
- Required for homocysteine breakdown
- Deficiency results in anemia, low energy, fatigue, shortness of breath, and can lead to pernicious anemia
- Deficiencies seen in vegetarians, older people with GI system complications
Manganese

• Mineral (not a vitamin)

• Coenzyme involved in energy metabolism

In-Class Activity

Work with a partner to design a meal that is high in B vitamins

- Meal should include protein, carbohydrates, and vegetables