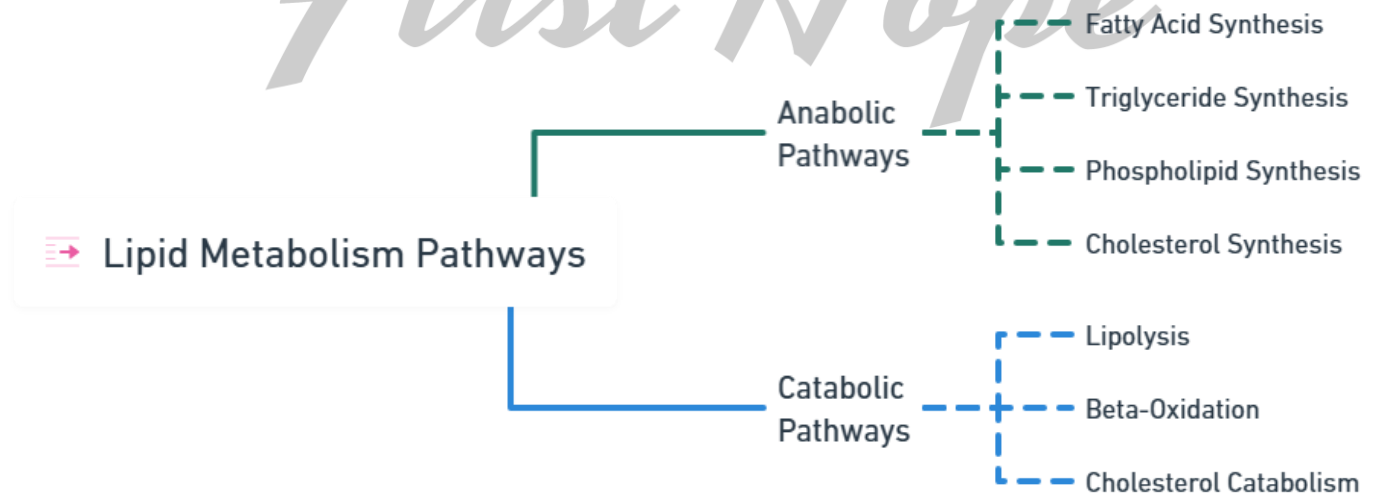


Lipid metabolism

Lipid Metabolism

- Lipid metabolism involves the synthesis, transport, and breakdown of lipids in the body.
- Lipids are diverse organic compounds, including:**
 - Fatty acids
 - Triglycerides
 - Phospholipids
 - Cholesterol
- These molecules play critical roles in:**
 - Cellular structure
 - Energy storage
 - Signaling
- Lipid metabolism is categorized into:**
 - Anabolic pathways (lipid synthesis)
 - Catabolic pathways (lipid breakdown)



Anabolic Pathways

A. Fatty Acid Synthesis:

- **Process:** Fatty acids are synthesized from acetyl-CoA, which is mainly derived from glucose metabolism.
- **Location:** Occurs in the cytosol of cells, especially in the liver and adipose tissue.
- **Key Enzymes:** Acetyl-CoA carboxylase and fatty acid synthase.

B. Triglyceride Synthesis:

- **Function:** Triglycerides are the primary form of energy storage in adipose tissue.
- **Process:** Synthesized from glycerol-3-phosphate and fatty acids through esterification.
- **Location:** Takes place in the endoplasmic reticulum of cells.

C. Phospholipid Synthesis:

- **Function:** Phospholipids are essential components of cell membranes.
- **Process:** Synthesized from glycerol-3-phosphate, fatty acids, and a polar head group (e.g., choline, ethanolamine, serine).
- **Location:** Occurs in the endoplasmic reticulum.

D. Cholesterol Synthesis:

- **Function:** Cholesterol is vital for cell membranes and is a precursor for steroid hormones and bile acids.
- **Process:** Synthesized from acetyl-CoA in a complex, multi-step process.
- **Location:** Primarily occurs in the liver.
- **Key Enzymes:** HMG-CoA reductase and squalene synthase.

Catabolic Pathways

A. Lipolysis:

- **Process:** Triglycerides stored in adipose tissue are broken down into glycerol and fatty acids by lipases, particularly hormone-sensitive lipase.
- **Products:** Glycerol can be converted to glucose in the liver, and fatty acids can be used for energy through beta-oxidation.

B. Beta-Oxidation:

- **Process:** Fatty acids are transported into mitochondria and broken down into acetyl-CoA units through a series of enzymatic reactions.
- **Outcome:** Acetyl-CoA enters the citric acid cycle (TCA cycle) to generate ATP, carbon dioxide, and water.

C. Cholesterol Catabolism:

- **Process:** Excess cholesterol is converted to bile acids in the liver.
- **Excretion:** Bile acids are secreted into the small intestine and excreted in feces.

Regulation and Health Implications

1. **Regulation:** Lipid metabolism is regulated by hormones such as insulin, glucagon, and adrenaline, as well as dietary factors and cellular energy status.
2. **Health Issues:** Imbalances in lipid metabolism can lead to obesity, insulin resistance, and atherosclerosis.

β -Oxidation of saturated fatty acid (Palmitic acid)

Overview:

- β -oxidation is the catabolic process by which fatty acid molecules are broken down in the mitochondria in eukaryotes (or peroxisomes in some cases) to generate acetyl-CoA, NADH, and FADH_2 .
- Palmitic acid ($\text{C}_{16:0}$) is a saturated fatty acid with 16 carbon atoms and no double bonds.

Steps of β -Oxidation:

A. Activation of Fatty Acid (Cytosol)

- **Enzyme:** Acyl-CoA synthetase (thiokinase)
- **Reaction:** Palmitic acid + CoA + ATP $\rightarrow$ Palmitoyl-CoA + AMP + PPi
- This occurs in the cytosol, and the long-chain acyl-CoA is transported into the mitochondria.

B. Transport into Mitochondria (Carnitine Shuttle)

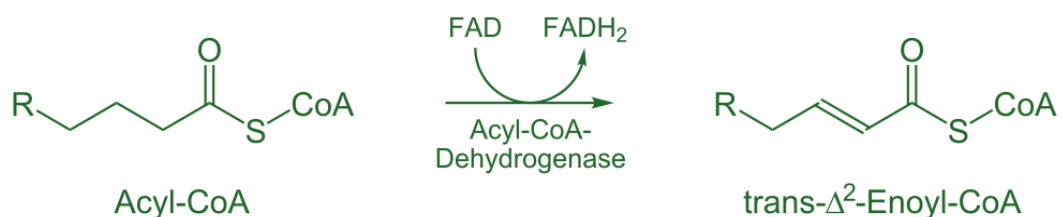
- Long-chain fatty acyl-CoA cannot directly cross the inner mitochondrial membrane.
- Carnitine shuttle system involves:
 - CPT I (Carnitine Palmitoyltransferase I): Converts Palmitoyl-CoA to Palmitoyl-Carnitine (on outer mitochondrial membrane).
 - Translocase: Transports Palmitoyl-Carnitine into the mitochondrial matrix.
 - CPT II: Converts Palmitoyl-Carnitine back to Palmitoyl-CoA in the matrix.

C. β -Oxidation Cycle (Mitochondrial Matrix)

- Each round of β -oxidation removes 2 carbon atoms from the fatty acid chain, producing:
 - 1 molecule of **acetyl-CoA**
 - 1 molecule of **FADH_2**
 - 1 molecule of **NADH**
- A single round involves 4 steps:

Step 1: Oxidation

- **Enzyme:** Acyl-CoA dehydrogenase
- **Reaction:** Palmitoyl-CoA $\rightarrow$ trans- Δ^2 -Enoyl-CoA



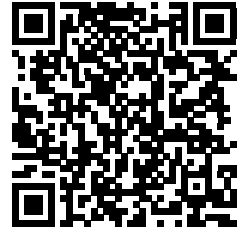


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