EIGHTH CHAPTER: Lipids metabolism

Lipid metabolism is the synthesis and degradation of lipids in cells, involving the breakdown and storage of fats for energy and the synthesis of structural and functional lipids, such as those involved in the construction of cell membranes.

The metabolism of fatty acids and lipids includes:

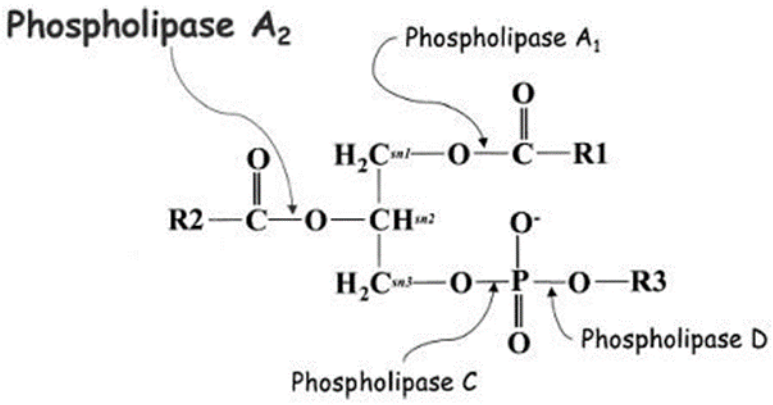
- Anabolism, which is biosynthesis or lipogenesis.
- Catabolism which is degradation or β-oxidation.

The synthesis of fatty acids is cytosolic while their degradation by β-oxidation is intramitochondrial.

I. Catabolism

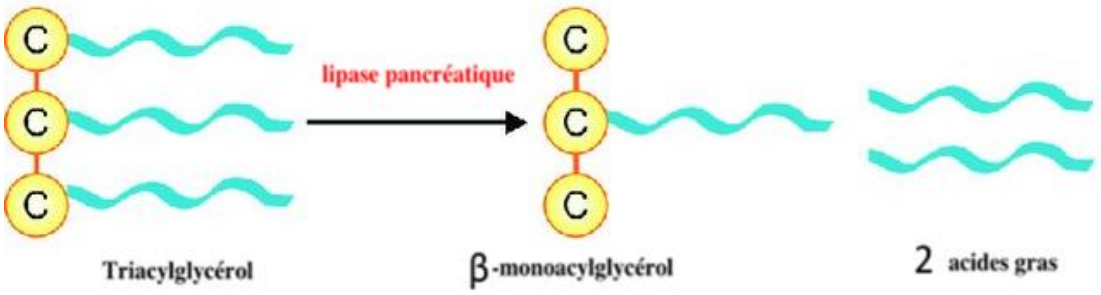
Digestion is the first step to lipid metabolism, and it is the process of breaking the triglycerides down into smaller monoglyceride units with the help of lipase and phospholipase enzymes.

Digestion of fats begin in the mouth through chemical digestion by lingual lipase. Ingested cholesterol is not broken down by the lipases and stays intact until it enters the epithelium cells of the small intestine.



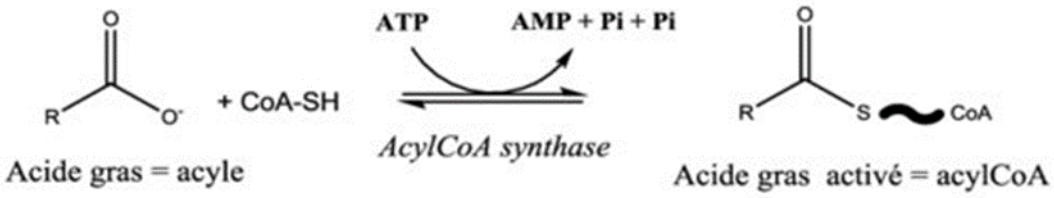
Lipids then continue to the stomach where chemical digestion continues by gastric lipase and mechanical digestion begins. The majority of lipid digestion and absorption, however, occurs once the fats reach the small intestines. Chemicals from the pancreas (pancreatic lipase family

and bile salt-dependent lipase) are secreted into the small intestines to help breakdown the triglycerides, along with further mechanical digestion, until they are individual fatty acid units able to be absorbed into the small intestine's epithelial cells. It is the pancreatic lipase that is responsible for signalling for the hydrolysis of the triglycerides into separate free fatty acids and glycerol units.



- **Catabolism of fatty acids**

However, the main steps of fatty acids catabolism occur in the mitochondria. Long chain fatty acids (more than 14 carbon) need to be converted to fatty acyl-CoA in order to pass across the mitochondria membrane. Fatty acid catabolism begins in the cytoplasm of cells as acyl-CoA synthetase uses the energy from cleavage of an ATP to catalyze the addition of coenzyme A to the fatty acid.



The resulting acyl-CoA cross the mitochondria membrane and enter the process of beta oxidation. The main products of the beta oxidation pathway are acetyl-CoA (which is used in the citric acid cycle to produce energy), NADH and FADH. The process of beta oxidation requires the following enzymes: acyl-CoA dehydrogenase, enoyl-CoA hydratase, 3-hydroxyacyl-CoA dehydrogenase, and 3-ketoacyl-CoA thiolase.

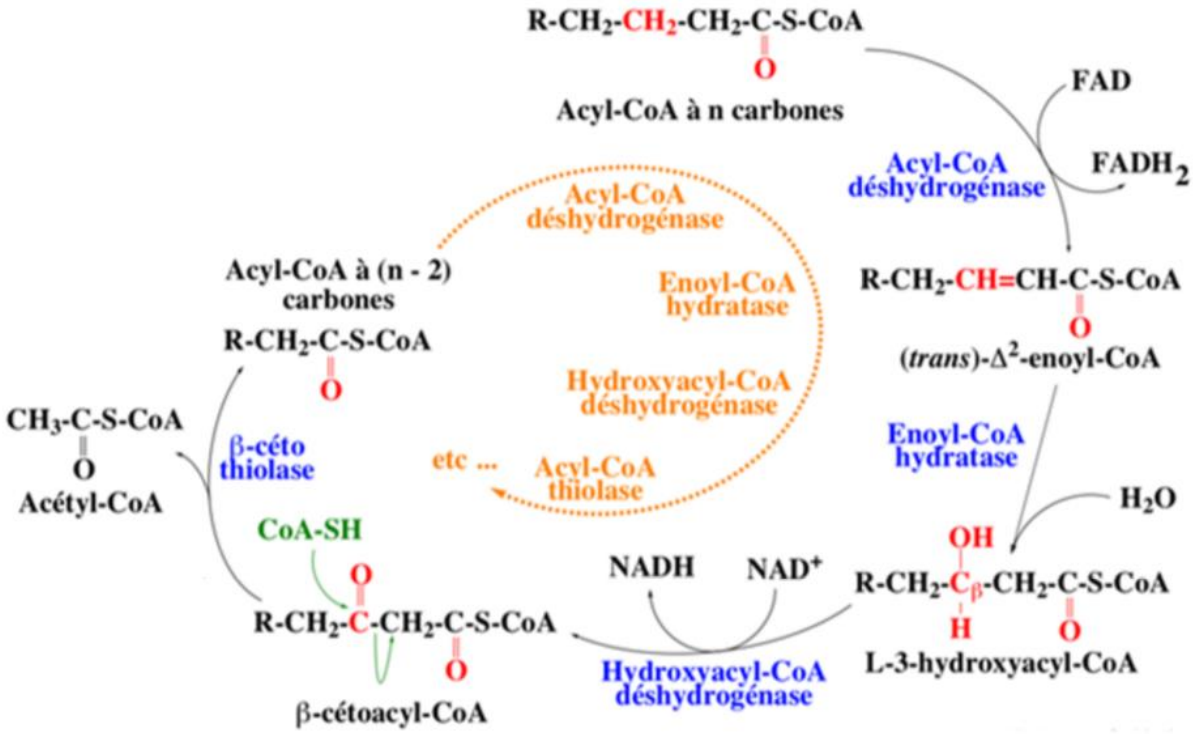


Fig 1. β-oxidation of saturated FA.

- **The overall net of the β-oxidation of saturated fatty acids**

The metabolic balance for one round is as follows:

n-carbon Acyl-CoA + FAD+ + NAD+ + CoA-SH + H2O => (n-2) carbon Acyl-CoA + FADH2 + NADH, H+ + acetyl-CoA.

The energy balance of one round is 5 ATP [1 FADH2 (2 ATP) and 1 NADH, H+ (3ATP)].

The cycle repeats n times, each time releasing an acetyl CoA and an acyl CoA shortened by 2 carbons until the carbon chain is exhausted.