Lipid Metabolism

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Overview of Lipid Metabolism

Introduction of Lipid

- Lipids is insoluble in polar solvent and have good solubility in non-polar solvent.
- Lipids has hydrocarbon chain and ester groups.
- Lipids classified as simple and complex lipids.
- Lipid composed by ester of fatty acid.

- The main functions of lipids
  - energy storage,
  - structural components of cell membranes,
  - as important signaling molecules.
- Oxidation of lipids produced more energy than the oxidation of carbohydrates.
- Humans have fat tissue under the skin, in the abdominal cavity, and in the mammary glands.

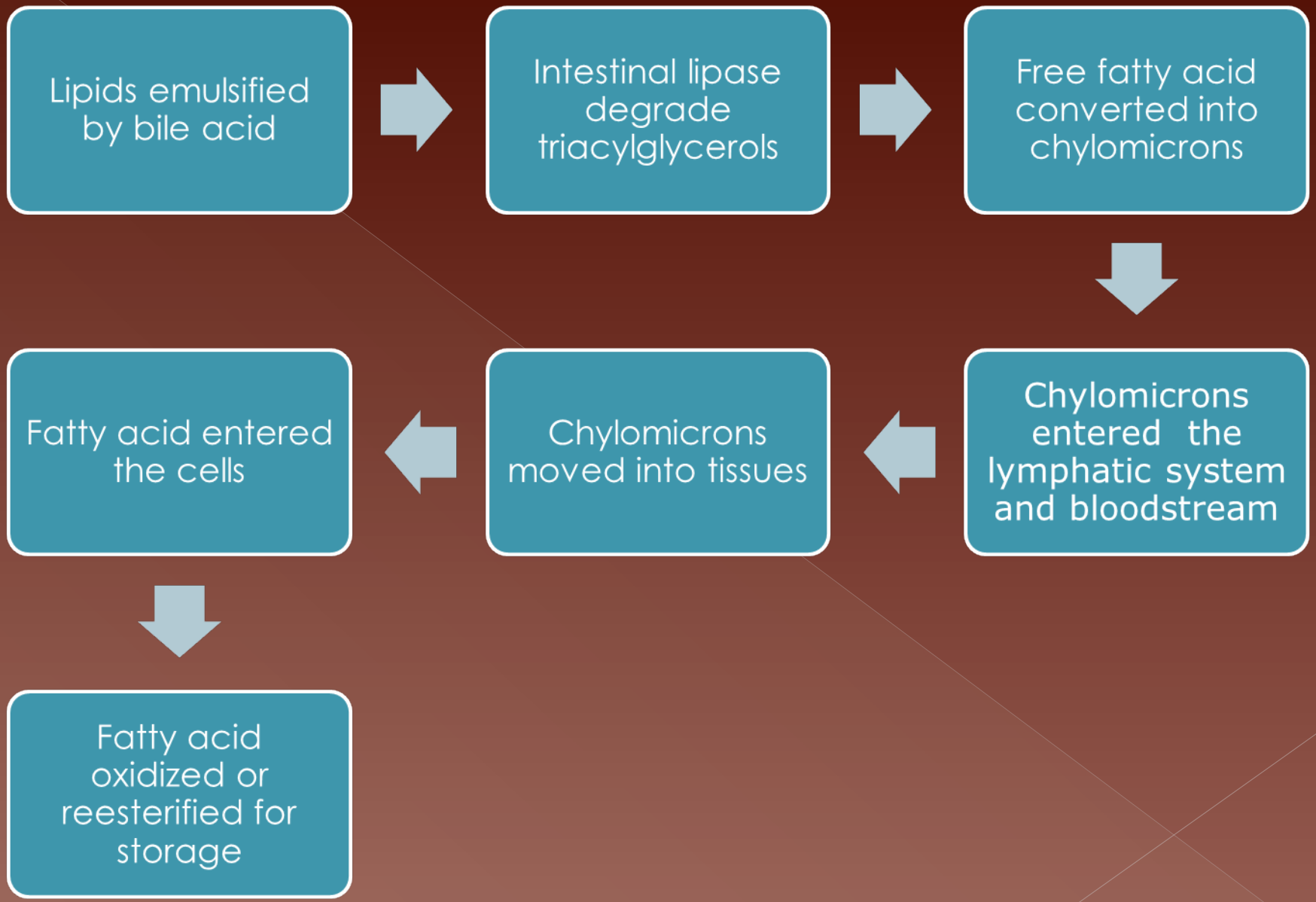
OVERVIEW OF LIPID METABOLISM

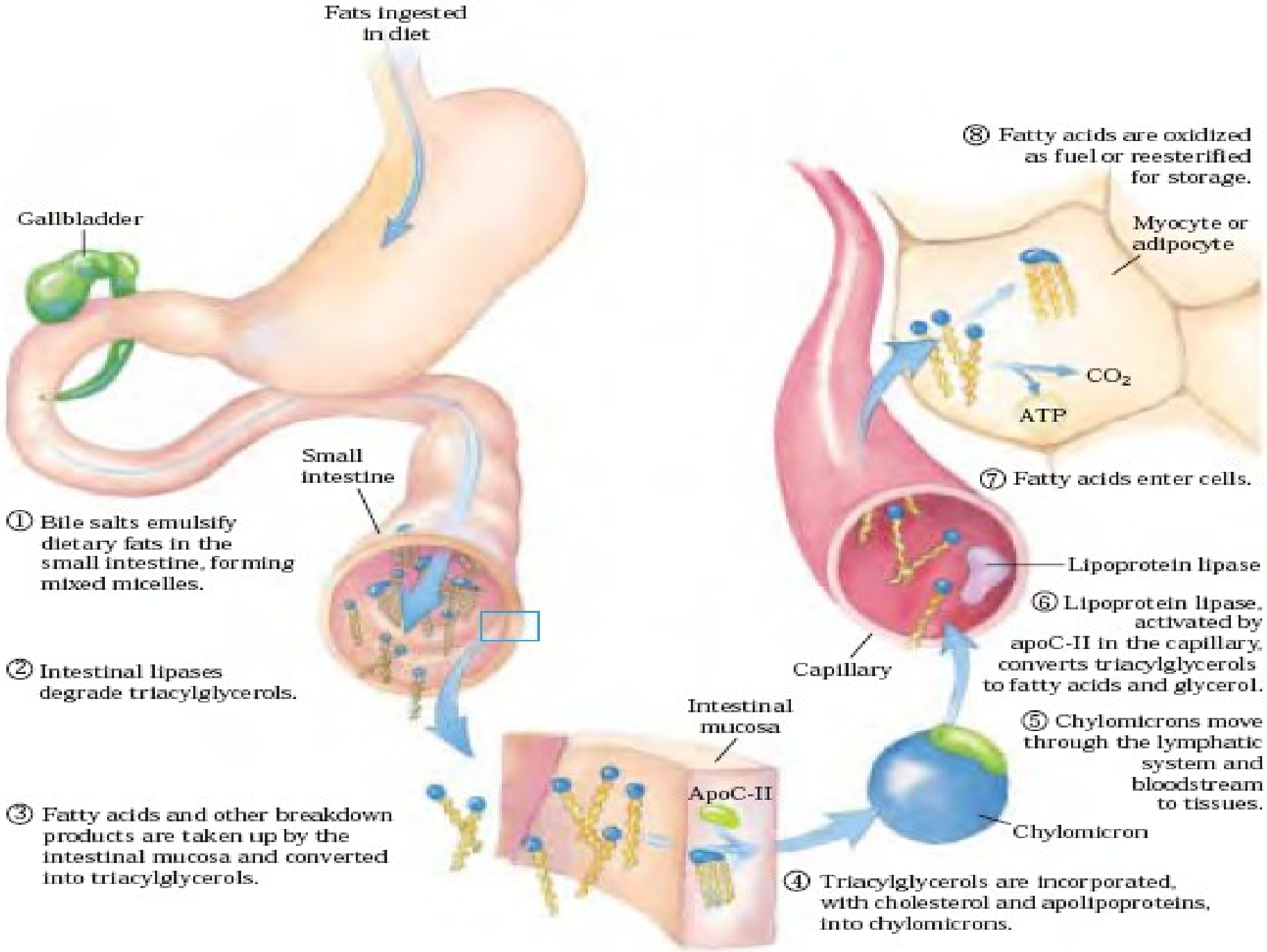
Include :

- Lipid digestion
- Lipid catabolism
- Lipid anabolism

Lipid Digestion

- Lipids cannot be digest directly.
- Lipids not easily accessible to digestive enzymes in aqueous phase.
- Dietary lipids have to emulsified first.


Lipids emulsified by bile acid
Intestinal lipase degrade triacylglycerols
Free fatty acid converted into chylomicrons
Chylomicrons entered the lymphatic system and bloodstream
Chylomicrons moved into tissues
Fatty acid entered the cells
Fatty acid oxidized or reesterified for storage


Fats ingested in diet
Gallbladder
Small intestine
① Bile salts emulsify dietary fats in the small intestine, forming mixed micelles.
② Intestinal lipases degrade triacylglycerols.
③ Fatty acids and other breakdown products are taken up by the intestinal mucosa and converted into triacylglycerols.
Intestinal mucosa
ApoC-II
④ Triacylglycerols are incorporated, with cholesterol and apolipoproteins, into chylomicrons.
⑤ Chylomicrons move through the lymphatic system and bloodstream to tissues.
Chylomicron
⑥ Lipoprotein lipase, activated by apoC-II in the capillary, converts triacylglycerols to fatty acids and glycerol.
Capillary
Lipoprotein lipase
⑦ Fatty acids enter cells.
⑧ Fatty acids are oxidized as fuel or reesterified for storage.
Myocyte or adipocyte
CO_2
ATP

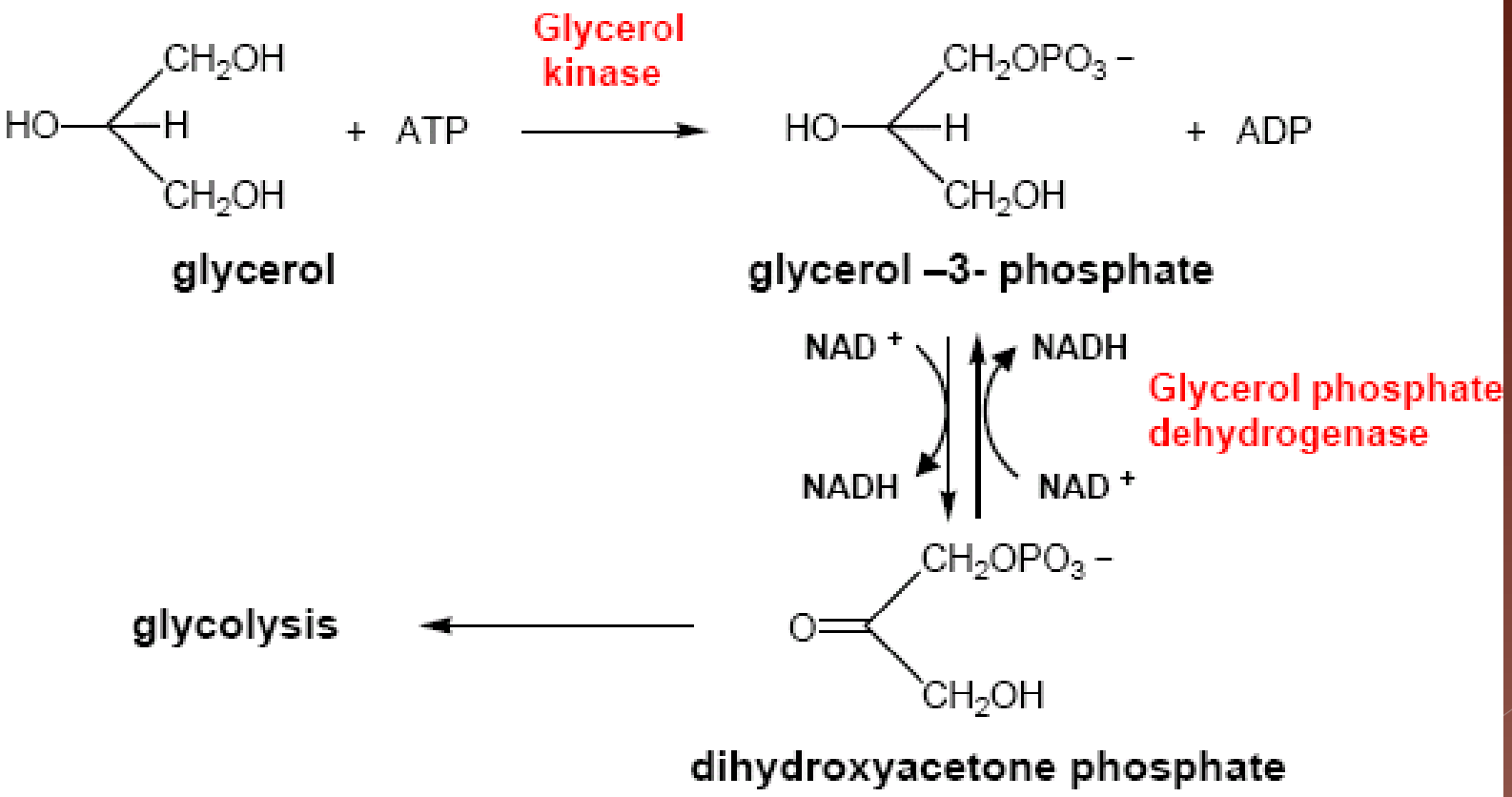
Lipid Catabolism

Catabolism of fat (lipolysis) involves two separate pathways, glycerol pathway and fatty acids pathway.

Glycerol Patyhway

Glycerol with ATP converted into glycerol-3-phosphate by glycerol kinase and release one inorganic phosphate yields ADP. Then, it is oxidized by NAD^+ into dihydroxyacetone-phosphate using glycerol-phosphate dehydrogenase. The oxidizing products entering glycolysis pathway and produced energy.

Glycerol Metabolism

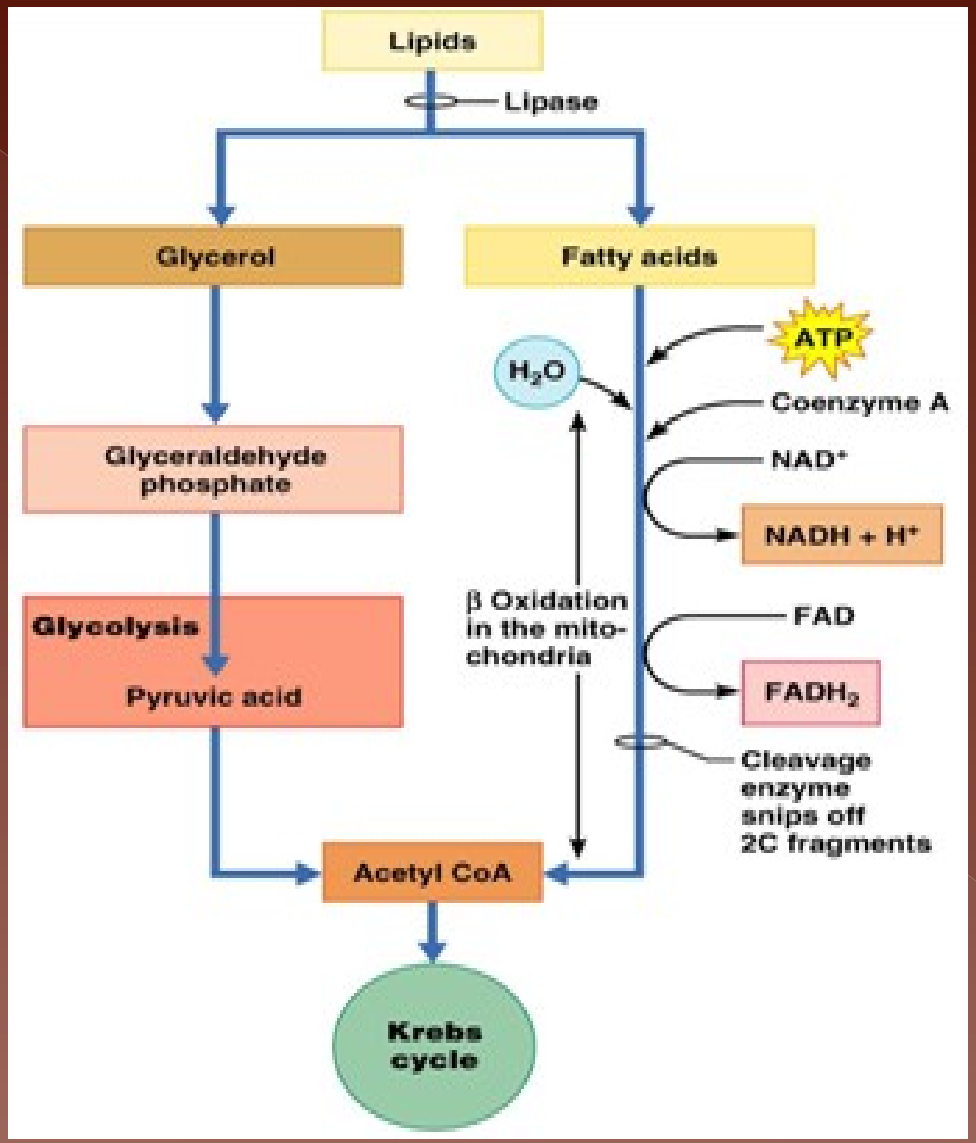


Fatty Acid Pathway

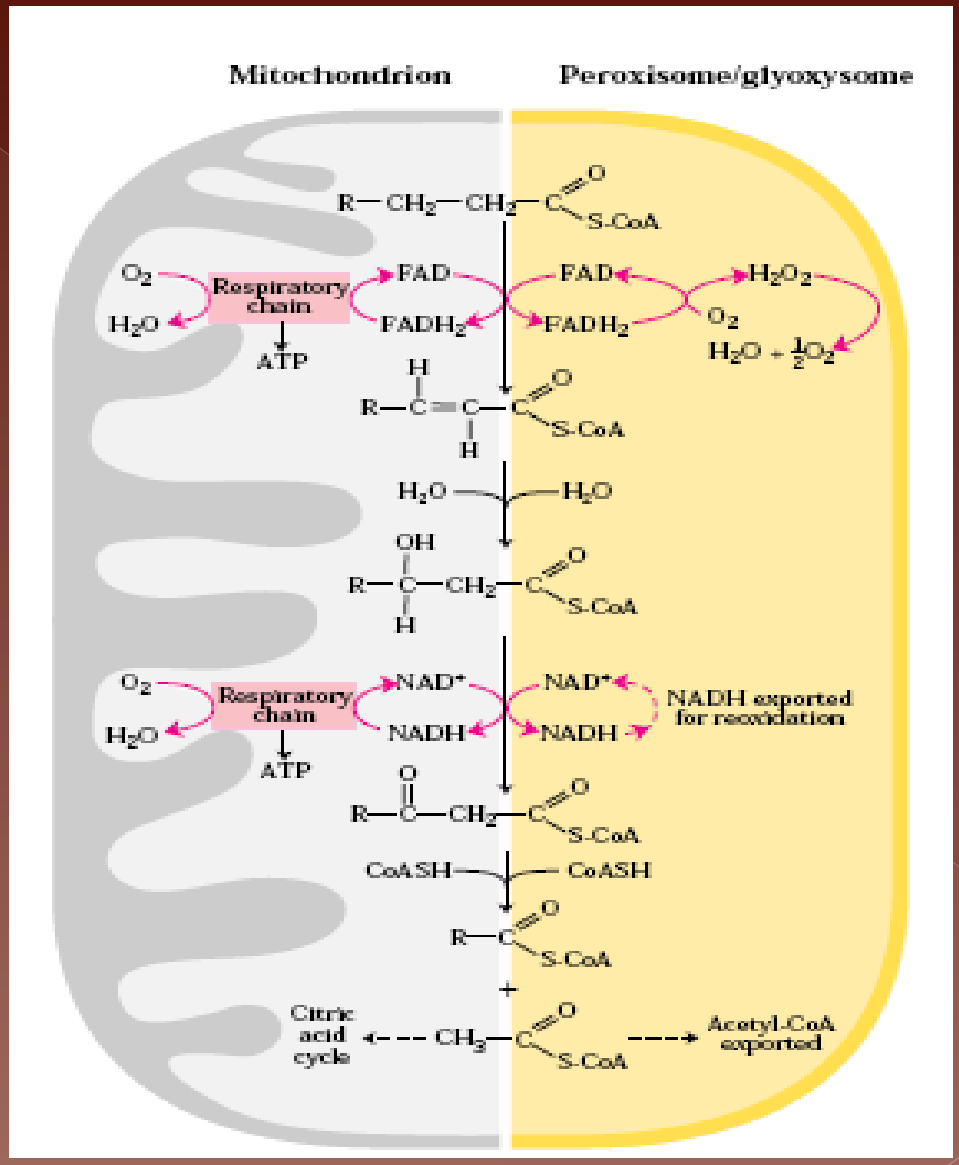
Fatty acid catabolism through beta oxidation (the broken down process of Acyl-CoA molecules into Acetyl-CoA) occurred in mitochondria and/or in peroxisomes. Beta oxditation will produced :

- Two-carbon acetic acid fragments, which are converted to acetyl-CoA and enter the Krebs cycle
- Reduced coenzymes, which are entered the electron transport chain
- An acetyl-CoA is then used in the Krebs Cycle to make one ATP , 3 $NADH^{+}$, H^{+} and 1 $FADH_2$. If a fatty acid has 18 carbon units, then 9 acetyl CoA units would be made.

Lipid Catabolism Pathway



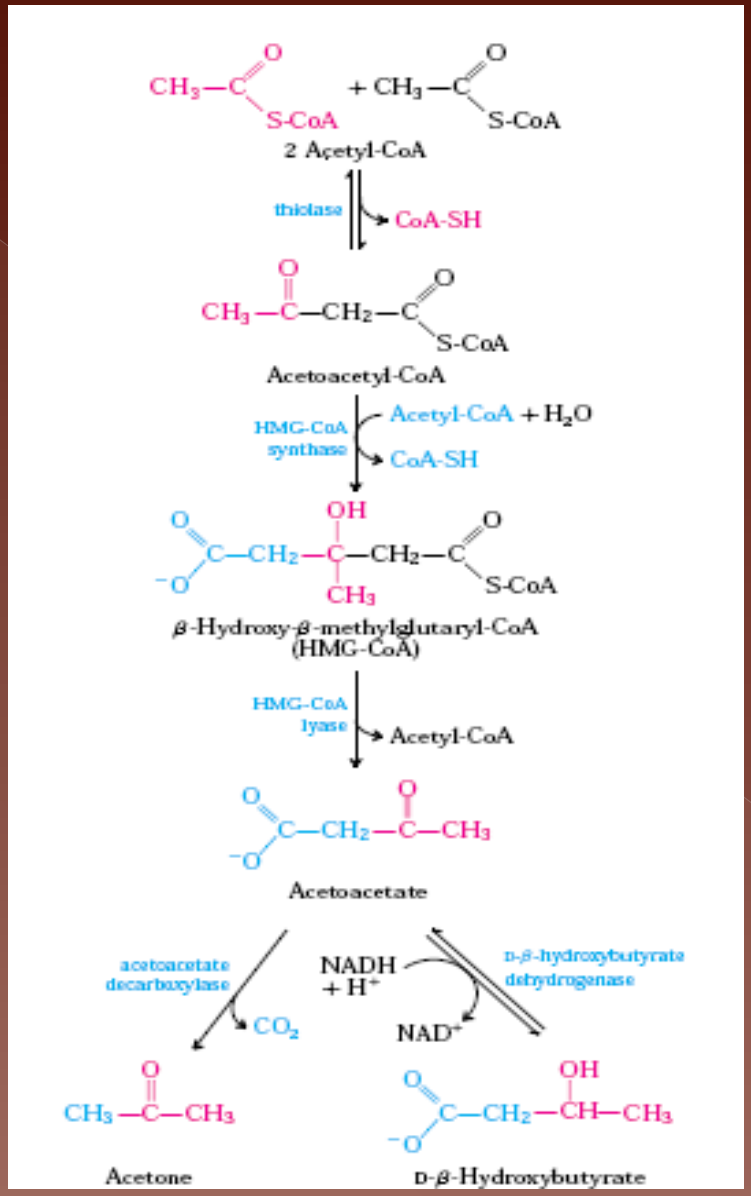
β-oxidation Pathway



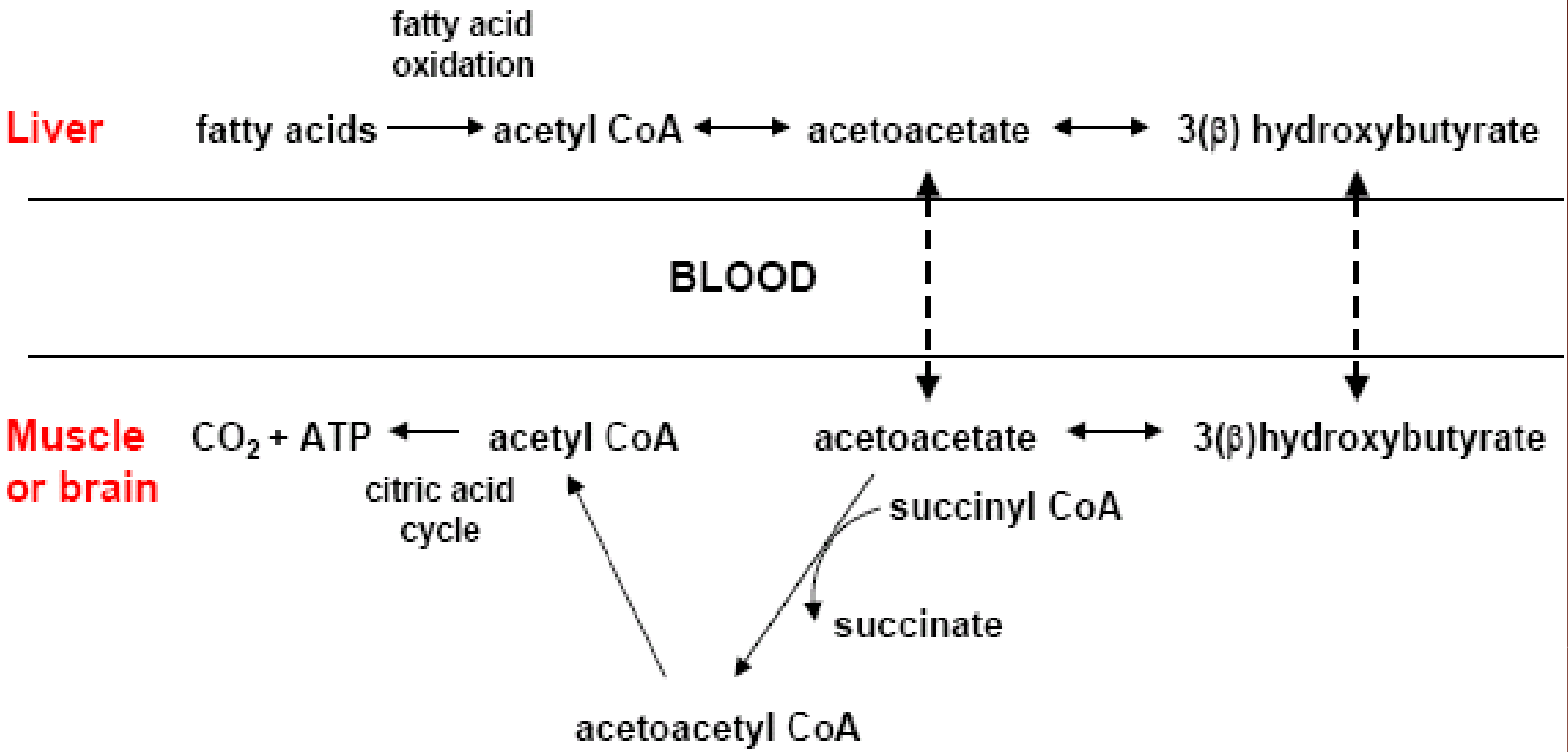
- *Ketone Body Formation*

  Low glucose levels in the blood causing ketogenesis. When it happened , oxaloacetate is depleted in liver because it is used for gluconeogenesis to get energy. This block the entries of acetyl-CoA into Krebs cycle. Acetyl-CoA converted in liver mitochondria to ketone bodies, acetoacetate, acetone and β-hydroxybutyrate.

Ketogenesis Pathway



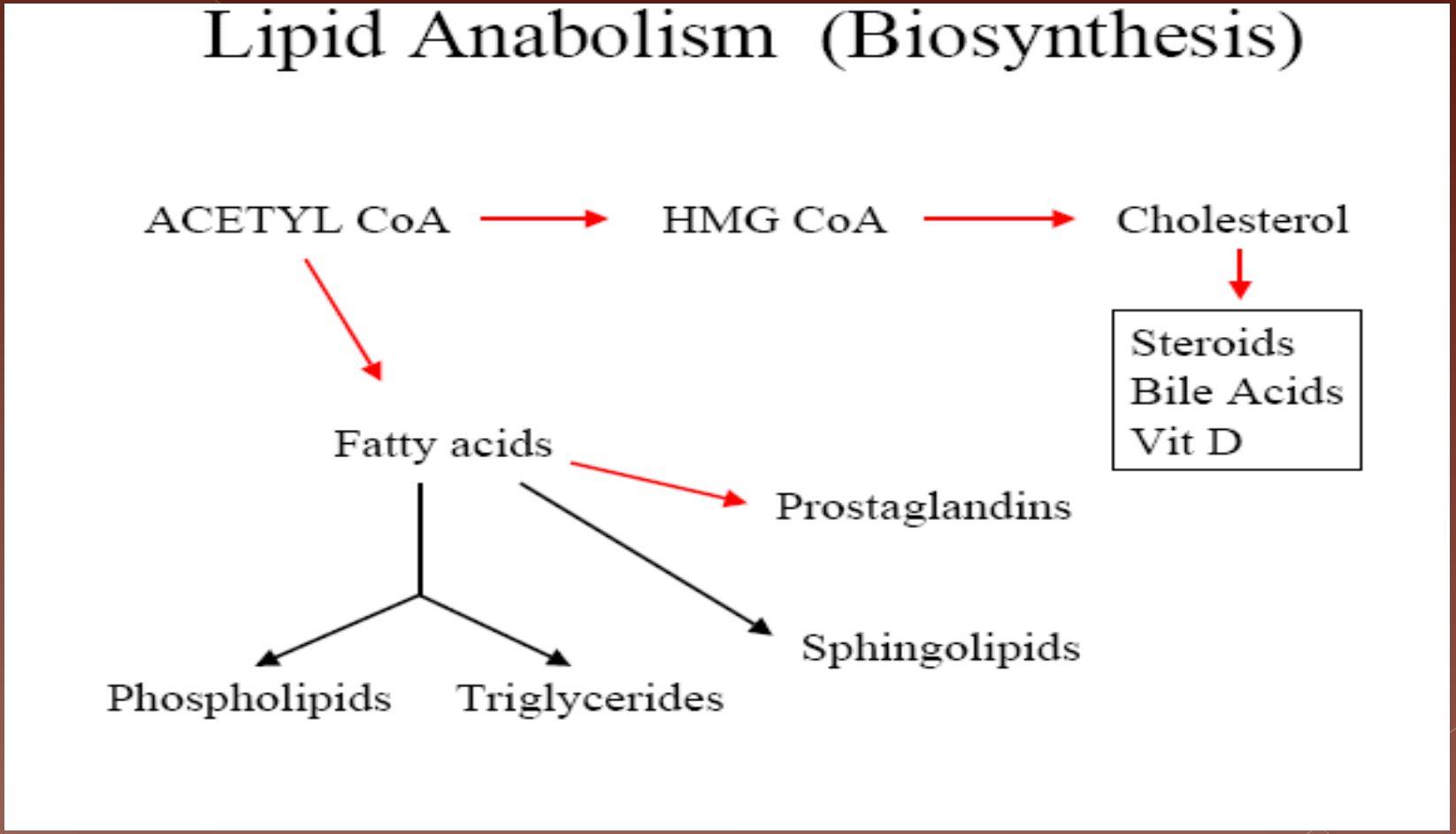
Fate of Ketone Bodies

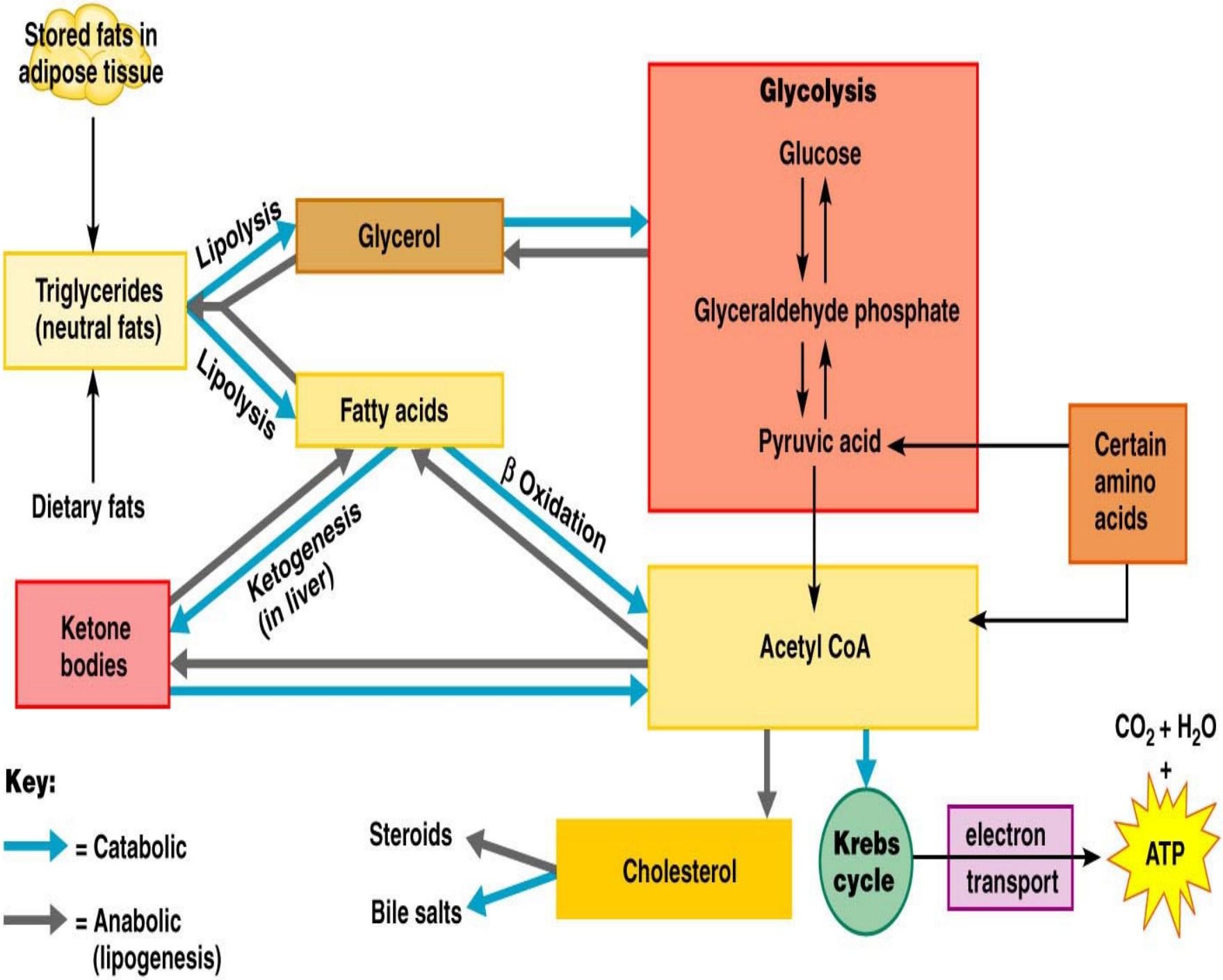


Lipid Anabolism

Lipid anabolism (lipogenesis) is synthesis of lipids on liver cells from amino acids which are converted to acetyl-CoA and from glucose into glyceraldehyde 3-phosphate. Both of acetyl-CoA and glyceraldehyde 3-phosphate converted into triglycerides.

Lipid Anabolism Diagram




Stored fats in adipose tissue
Triglycerides (neutral fats)
Dietary fats
Lipolysis
Lipolysis
Glycerol
Fatty acids
Glycolysis
Glucose
Glyceraldehyde phosphate
Pyruvic acid
Certain amino acids
β Oxidation
Ketogenesis (in liver)
Ketone bodies
Acetyl CoA
Key:
= Catabolic
= Anabolic (lipogenesis)
Steroids
Bile salts
Cholesterol
Krebs cycle
electron transport
$CO_2 + H_2O$ + ATP

Conclusion

Lipid metabolism is closely connected to the metabolism of carbohydrates to produce energy.

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