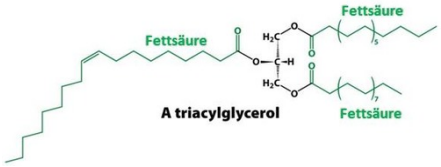
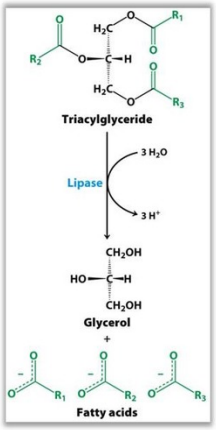
1. **Name the biological roles played by fatty acids!:** 1. energy storage / fuel
   2. components of membrane lipids
   3. mechanical and thermal insulation of organs
   4. fatty acid derivatives serve as hormones
   5. post-translational modifications
2. **What is a fatty acid?:** A carboxylic acid with a hydrocarbon chain. From about four carbons on one speaks of fatty acids, because only from that length it has amphiphilic character. With shorter chains the hydrophilic carboxylic group dominates.
3. **What is the storage from of fatty acids? Draw the structural formula!:**



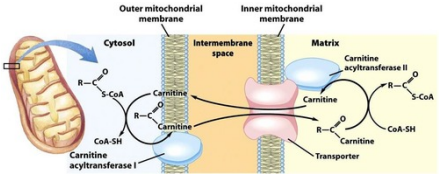
Triacylglyceroles.

4. **Where in the human body is the storage fat located?:** In the white adipose tissue, in the cytoplasm of the adipose cells. White adipose tissue is present in the subcutaneous fat layer mainly on the belly and the buttocks, but also as visceral fat in the abdominal cavity.
5. **How much storage fat does a young, healthy adult have? How long can that sustain a person (given there is enough to drink)?:** About 15% of the total body wheight, coming to about 10-12 kg on an average size man. This provides roughly enough energy to survive for 40 days (depends of course under what conditions, with or without exercise, warm or cold weather etc).
6. **Why is the caloric yield of fatty acids larger than that of carbohydrates?:** Fatty acids are in a more reduced state than carbohydrates.
7. **Where does fatty acid synthesis take place and where fatty acid degradation?:** Fatty acid synthesis occurs in the cytosol, fatty acid degradation (beta-oxidation) takes place in the mitochondrial matrix.
8. **What is lipolysis?:**



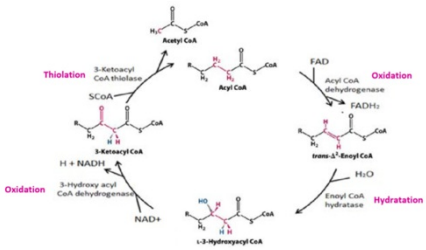
Lipolysis is the mobilisation of free fatty acids and glycerol from the storage form of fat, the triacylglycerols.

9. **What are the products of lipolysis and how are they further utilized?:** Triacylglycerols are split into free fatty acids and glycerol.
   Glycerol is then turned into dihydroxyacetone phosphate (DHAP) via glycerole kinase and glycerole phosphate dehydrogenase. DHAP can enter one of two metabolic pathways: 1. enter the second stage of glycolysis to produce pyruvate. 2. enter gluconeogenesis to produce glucose.
   Fatty acids are transported into mitochondria and enter beta-oxidation.
10. **How are fatty acids transported from the cytosol into the mitochondrial matrix? What are the steps briefly?:**



Via the carnitine-shuttle.
1. activation by thioester linkage to Coenzyme A
2. conversion of fatty acyl CoA to fatty acyl carnitine by acyl carnitine transferase I (located in outer mitochondrial membrane)
3. Antiport of fatty acyl carnitine in exchange for free carnitine by acyl carnitine translocase (transporter in inner mitochondrial membrane) into matrix
4. formation of fatty acly CoA from fatty acyl carnitine by acyl carnitine transferase II

11. **What is referred to as beta-oxidation of fatty acids? Where does it take place?**
    Draw the structure formulas of the four stages starting with a general Acyl-CoA!:



The (oxidative) degradation of fatty acids in a repetitive cycle of four steps, where each cycle results in the shortening of the hydrocarbon chain by two C-atoms.
It takes place in the mitochondrial matrix.

12. **Why is the fatty acid degradation called beta-oxidation?:** Because the methylene-group (CH2-group) at position 3 (also referred to as beta position) is oxidized to a ketogroup.
13. **What are the main products of beta-oxidation?:** Acetyl CoA, NADH and FADH2
14. **In which other cellular compartment does fatty acid degradation occur?:** The peroxisome. Particularly very long chain fatty acids are shortened in this compartment and then further degraded in the mitochondria.

15. **What are ketone bodies? When are they formed? For what purpose are they formed?:** Acetoacetate, D-3-hydroxybutyrate and acetone are keton bodies. They are formed from acetyl CoA when there is not enough oxaloacetate present for acetyl CoA to enter the TCA cycle. Acetyl-CoA can be exported from the liver to other tissues via transformation into acetoacetate and retransformation into acetyl-CoA in the new tissue to then enter the TCA cycle there.
16. **Where does fatty acid synthesis usually take place?:** In the liver and in fat tissue.
17. **When is there increased fatty acid synthesis in humans?:** During embryonal development. During lactation.
18. **Name the four enzymes of the fatty acid synthesis cycle.:** beta-ketoacyl synthase, beta-ketoacyl dehydrogenase, 3-hydroxyacyl dehydratase, enoyl reductase
19. **What is the main product of fatty acid synthesis?:** Palmitate.
20. **Which part of the stored fat can be used for gluconeogenesis?:** Triacylglycerols are converted to glycerol and free fatty acids by lipolysis. Only the glycerol backbone can enter into gluconeogenesis to produce glucose. Glycerol must first be converted to glycerol-3-phosphate by glycerol Kinase, and then be oxidised by glycerolphosphate dehydrogenase to dihydroxyacetone phosphate.
21. **Why are Triacylglycerols the most concentrated form of energy storage in our body?:** Fatty acids (the main components of TAGs) are highly reduced and for that reason have a higher energy content per weight than glycogen (which still contains many oxygens). A further reason lies in the hygroscopic nature of glycogen, which makes it retain water increasing the stored weight per unit energy further.
22. **What is an "activated carrier of chemical groups"?:** Such a carrier is a molecule that contains a functional group with a high transfer potential for biosynthetic reactions, in other words the transfer of the "activated group" X to an acceptor molecule is highly exergonic.
23. **Name three examples of activated carriers of chemical groups! Indicate which part of the carrier is the activated group.:** ATP --> phosphate
    Acetyl CoA --> acetyl group
    carboxylated biotin --> carboxyl group
    UDP-glucose --> glucose
    CDP-diacylglycerol --> phosphatidate
24. **What are the activated forms of fatty acids in fatty acid degradation and in fatty acid synthesis? What are these derivatives called, what type of chemical compounds are they?:** Fatty acid degradation: Acyl-Coenzyme A (Acyl-CoA)
    Fatty acid synthesis: Acyl-ACP (ACP = Acyl Carrier Proteine)
    They are fatty acid thioesters.