**17.2 Oxidation of Fatty Acids**

* Mitochondrial oxidation of fatty acids takes place in three stages (**Fig. 17-7)**.





Stage 1 : A long-chain fatty acid is oxidized to yield acetyl residues in the form of acetyl-CoA, starting from the carboxyl end. This process is called ** oxidation**. For example, the 16-carbon palmitic acid undergoes seven passes, in each pass losing two carbons as acetyl-CoA. At the end of seven cycles, the last four carbons of palmitate give two acetyl-CoA. The overall result is the conversion of the 16-carbon chain of palmitate to 8 acetyl-CoA and production of 7 FADH2 and 7 NADH.

Stage 2 : The acetyl groups are oxidized to CO2 via the citric acid cycle.

Stage 3 : Electrons derived from the oxidations of stage 1 and 2 pass to O2 via the mitochondrial respiration chain, providing the energy for ATP synthesis by oxidative phosphorylation.

* The energy released by fatty acid oxidation is thus conserved as ATP.

**The  Oxidation of Saturated Fatty Acids Has Four Basic Steps**

1. Dehydration of fatty acyl-CoA by **acyl-CoA dehydrogenase (Fig. 17-8a)**
2. Water is added to the double bond by **enoyl-CoA hydratase (Fig. 17-8a)**
3. Dehydration of -hydroxyacyl-CoA by ****-hydroxyacyl-CoA dehydrogenase (Fig. 17-8a)**
4. Production of acetyl-CoA by **acyl-CoA acetyltransferase (thiolase) (Fig. 17-8a)**







**The Four -Oxidation Steps Are Repeated to Yield Acetyl-CoA and ATP**

* Seven passes through the -oxidation sequence are required to oxidize one molecule of palmitoyl-CoA to eight molecules of acetyl-CoA **(Fig. 17-8b)**.

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**FIGURE 17-8 (b)** Six more passes through the *β*-oxidation pathway yield seven more moleculesof acetyl-CoA, the seventh arising from the last two carbon atoms of the 16- carbon chain. Eight molecules of acetyl-CoA are formed in all. The acetyl-CoA may be oxidized in the citric acid cycle, donating more electrons to the respiratory chain.

* The overall equation is

Palmitoyl-CoA + 7 FAD + 7 NAD+ + 7 H2O + 7 CoA

8 Acetyl-CoA + 7 FADH2 + 7 NADH + 7 H+

**Acetyl-CoA Can Be Further Oxidized in the Citric Acid Cycle**

* 1 Acetyl-CoA produces 3 NADH, 1 FADH2 and 1 GTP (or ATP).
* 8 Acetyl-CoA produce 24 NADH, 8 FADH2 and 8 GTP (or ATP).
* 1 Palmitoyl-CoA produces 31 NADH, 15 FADH2 and 8 GTP (or ATP).
* 31 NADH produce 77.5 ATP and 15 FADH2 produce 22.5 ATP. Total ATP is 108.
* Remember, 1 ATP was used at activation of fatty acid.
* Because the activation of palmitate to palmitoyl- CoA breaks both phosphoanhydride bonds in ATP, the energetic cost of activating a fatty acid is equivalent to two ATP, and the net gain per molecule of palmitate is 106 ATP.