

# Tutorial 29: Lipid Metabolism and Fatty Acid Oxidation

## Goals:

- ✓ Be able to give an overview to describe what is happening in fatty acid oxidation, and be able to use a copy of the fatty acid spiral to answer questions about the reactions involved.
- ✓ Be able to calculate ATP yields from catabolism of different fatty acids.

# Fatty Acid Oxidation

- **Overview of the Fatty Acid Spiral:** A fatty acid is activated as a fatty acyl-CoA that can enter the fatty acid spiral for oxidation. It takes 2 ATP for this activation. Two carbons at a time are cleaved from the fatty acyl-CoA as acetyl-CoA. This cleavage continues until the entire fatty acid has been converted into acetyl-CoA. The fatty acid spiral occurs in the mitochondrial matrix.
- **Details of the Fatty Acid Spiral:**
  - In step 1, two hydrogen are removed to create a double bond between the alpha and beta carbon. FAD acts as the oxidizing agent.
  - In step 2, the double bond is hydrated to form a secondary alcohol.
  - In step 3, the secondary alcohol is oxidized to a ketone. NAD<sup>+</sup> is the oxidizing agent.
  - In step 4, two carbons break off as acetyl-CoA, leaving a fatty acyl-CoA that is 2 carbons shorter.
  - Steps 1-4 continue until all of the carbons have been converted into acetyl-CoA.
  - NOTE: For fatty acids with odd numbers, the final turn in the spiral yields acetyl-CoA and propionyl-CoA (a 3 carbon molecule). Propionyl-CoA is converted into succinyl-CoA and enters the Krebs Cycle.
  - NOTE 2: Unsaturated fatty acids involve an additional step to isomerize the cis bond into the trans geometry seen in the Fatty Acid Spiral.
- **Net Result from Fatty Acid Spiral:**

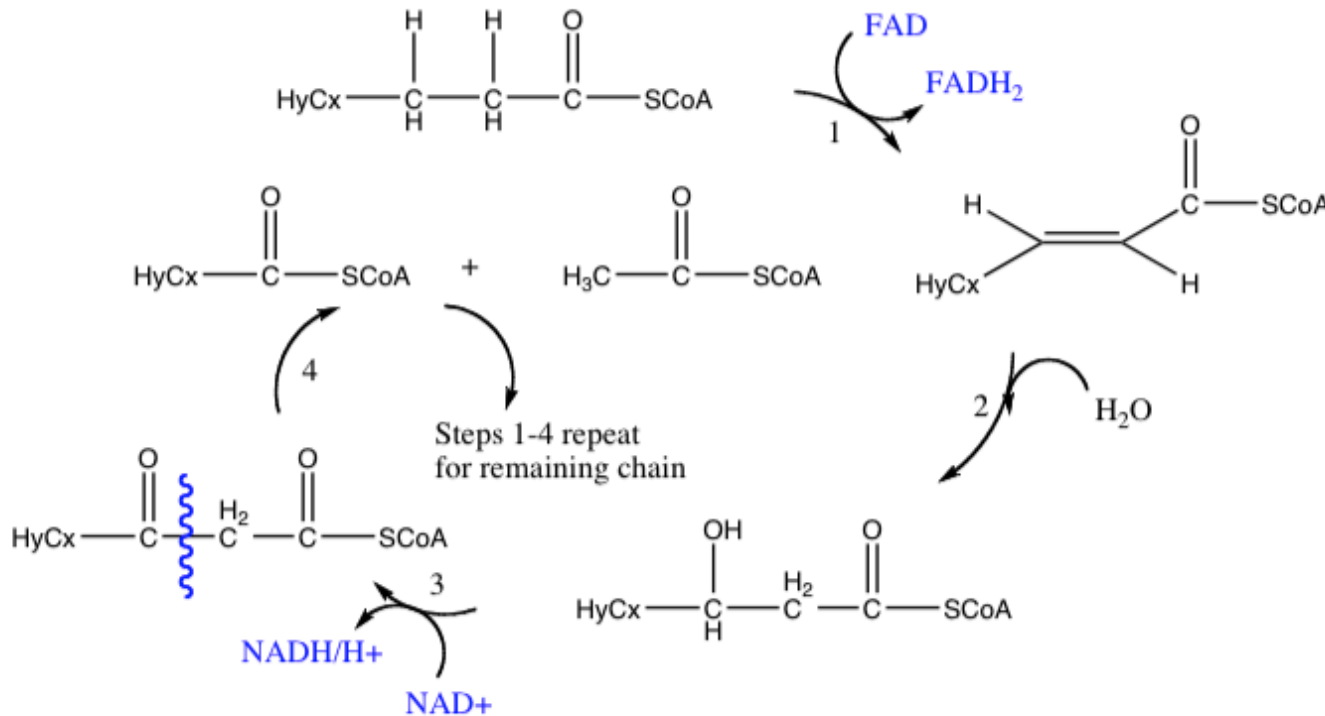
-2 ATP to activate

+1 FADH<sub>2</sub> per turn which results in 2 ATP in ETC/Ox Phos per turn

+1 NADH/H<sup>+</sup> per turn which results in 3 ATP in ETC/Ox Phos per turn

**Total ATP = (5 ATP x # turns) -2 ATP**

# Fatty Acid Oxidation Continued



<u>Step</u>	<u>Enzyme</u>
1	Acyl-CoA dehydrogenase
2	Enoyl-CoA hydratase
3	beta-hydroxyacyl-CoA dehydrogenase
4	Acyl-CoA acetyltransferase