

18/MHS07/048  
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Pharmacology  
BCH 204

### Assignment

Describe the three stages of beta oxidation

### Answers

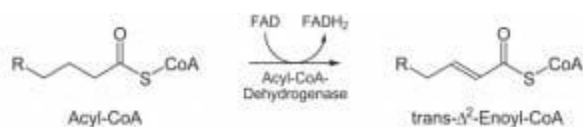
Beta oxidation takes place in four steps: dehydrogenation, hydration, oxidation and thiolysis. Each step is catalyzed by a distinct enzyme.

Briefly, each cycle of this process begins with an acyl-CoA chain and ends with one acetyl-CoA, one FADH<sub>2</sub>, one NADH and water, and the acyl-CoA chain becomes two carbons shorter. The total energy yield per cycle is 17 ATP molecules (see below for details on the breakdown). This cycle is repeated until two acetyl-CoA molecules are formed as opposed to one acyl-CoA and one acetyl-CoA. The four steps of beta oxidation are described below.

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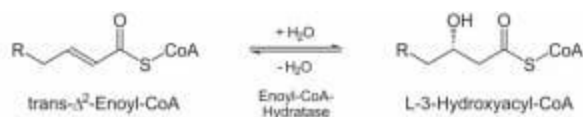
### Dehydrogenation

In the first step, acyl-CoA is oxidized by the enzyme acyl CoA dehydrogenase. A double bond is formed between the second and third carbons (C2 and C3) of the acyl-CoA chain entering the beta oxidation cycle; the end product of this reaction is trans- $\Delta^2$ -enoyl-CoA (trans-delta 2-enoyl CoA). This step uses FAD and produces FADH<sub>2</sub>, which will enter the citric acid cycle and form ATP to be used as energy. (Notice in the following figure that the carbon count starts on the right side: the rightmost carbon below the oxygen atom is C1, then C2 on the left forming a double bond with C3, and so on.)



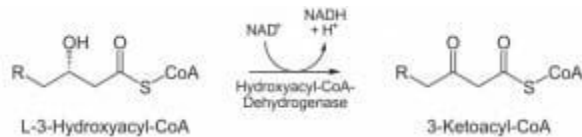
## Hydration

In the second step, the double bond between C2 and C3 of trans- $\Delta^2$ -enoyl-CoA is hydrated, forming the end product L- $\beta$ -hydroxyacyl CoA, which has a [hydroxyl group](#) (OH) in C2, in place of the double bond. This reaction is catalyzed by another enzyme: enoyl CoA hydratase. This step requires water.



## Oxidation

In the third step, the hydroxyl group in C2 of L- $\beta$ -hydroxyacyl CoA is oxidized by NAD<sup>+</sup> in a reaction that is catalyzed by 3-hydroxyacyl-CoA dehydrogenase. The end products are  $\beta$ -ketoacyl CoA and NADH + H<sup>+</sup>. NADH will enter the citric acid cycle and produce ATP that will be used as energy.



## Thiolysis

Finally, in the fourth step,  $\beta$ -ketoacyl CoA is cleaved by a thiol group (SH) of another CoA molecule (CoA-SH). The enzyme that catalyzes this reaction is  $\beta$ -ketothiolase. The cleavage takes place between C2 and C3; therefore, the end products are an acetyl-CoA molecule with the original two first carbons (C1 and C2), and an acyl-CoA chain two carbons shorter than the original acyl-CoA chain that entered the beta oxidation cycle.

