

Image

17/11/2021/089
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BCU 2of! Beta oxidation of fatty acids.

Assignment:
Describe the three stages of beta oxidation in fatty acids.

Answers:
Beta oxidation is the pathway for metabolism of fatty acids. It begins from beta carbon third carbon and takes place in the mitochondria.

The three stages of beta oxidation are:

- Beta oxidation.
- Activation of fatty acids.
- Transport of fatty acyl-CoA into mitochondria.

Activation of Fatty acids:
- Long chain fatty acids; They are activated by ATP and co-enzyme A (acyl-CoA synthetase) to form fatty acyl-CoA. While short chain fatty acids are activated in mitochondria.

E.g.:

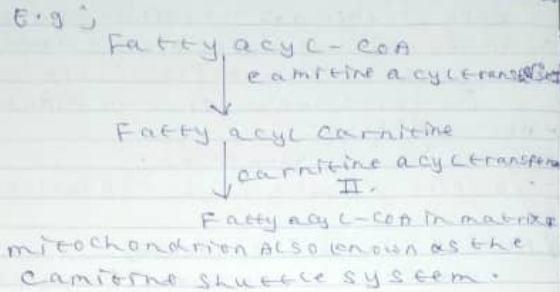
palmitic acid $\xrightarrow[\text{Co-enzyme A}]{\text{ATP}}$ palmitoyl-CoA $\xrightarrow{\text{AMP+PP}}$

ATP is converted to AMP & Pyrophosphate (PP), which is cleared by pyrophosphatase into two inorganic phosphates (2 Pi). Therefore high energy phosphate bonds are called the equivalent of two molecules of ATP used for fatty acid activation.

Activation of fatty acid takes place on the outer membrane of mitochondria.

Transport of fatty acyl-CoA into mitochondria:
Fatty acyl-CoA from the outer membrane react with carnitine in the outer mitochondrial membrane forming acyl carnitine. The enzyme used is carnitine acyltransferase (CAT I).

Fatty acyl carnitine passes to the inner membrane where it reforms to fatty acyl-CoA which enters the matrix. The enzyme used is carnitine acyltransferase II (Carnitine acyltransferase II).



Beta oxidation of fatty acids:
Beta oxidation or degradation consists of four sequential stages. Therefore, each stage is repeated until all carbons of fatty acyl-CoA are converted to acetyl-CoA.

- For even-chain fatty acids;
• FAD accepts hydrogens from a fatty acyl-CoA in the first step & a double bond is produced between the α - and β -carbon to form an α,β -unsaturated acyl-CoA.

FADH₂ produced interacts with electron transport chain generating ATP.
Enzyme used: α,β -unsaturated acyl-CoA dehydrogenase.
2. β -hydroxyacyl-CoA is oxidized by NAD⁺ to β -ketoacyl-CoA.

NADH produced interacts with electron transport chain to generate ATP.
Enzyme used: β -hydroxyacyl-CoA dehydrogenase.

- For odd chain fatty acids:

Beta oxidation of odd-chain fatty acids produces acetyl CoA and propionyl CoA.

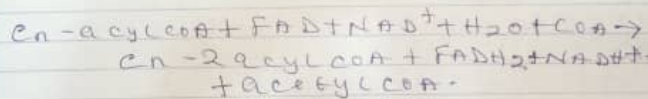
As these fatty acids repeat the four steps of beta oxidation producing acetyl CoA until the case of cleavage when the three remaining carbons are released as propionyl-CoA which can be converted to glucose.

- For unsaturated fatty acids:

Beta oxidation of unsaturated fatty acids requires enzymes in addition to the four that catalyze the repetitive steps of beta-oxidation. The reaction pathways differ depending on whether the double bond is at an even or odd-numbered carbon position.

So, the beta-oxidation occurs until a double bond of the unsaturated fatty acid is near the carboxyl end of the acyl chain.

- Overall reaction of beta-oxidation



17/11/2021

Memuduaghan Frances
Biol 201: Beta oxidation of fatty acids.

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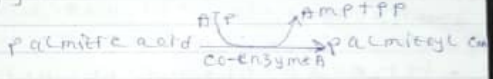
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Activation of Fatty acids;

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ATP is converted to AMP & pyrophosphate (PPi), which is cleared by pyrophosphatase to two inorganic phosphate (2 Pi). Therefore the high energy phosphate bonds are cleared, go the equivalent of two molecules of ATP is used for fatty acid activation.

Activation of fatty acid takes place on the outer membrane of mitochondria.

Transport of fatty acyl-CoA into mitochondria;

Fatty acyl-CoA from the outer membrane react with carnitine in the outer mitochondrial membrane forming Co-fatty acyl carnitine. The enzyme used is carnitine acyltransferase (CAT II).