FAT METABOLISM

Fat oxidation :—

Fat in the natural system are hydrolysed to glycerol and fatty acids the enzyme lipase before oxidation

Fats + H_2O $\xrightarrow{\text{Lipase}}$ Glycerol + Fatty acids.

Glycerol reacts with ATP to form glycerol phosphate which is oxidized to glyceraldehyde 3-phosphate. Glycogen or glucose and fructose may be synthesized from this by the reversal of glycolytic process. ernatively, it is converted to pyruvate and then oxidized by TCA cycle.

Oxidation of fatty acid is a sequential process for which the following two pathways have been suggested.

β - OXIDATION :- The principles of β-oxidation were discovered by F knoop. Although this process was discovered and illucidated in animal systems, the enzymes involved in the process have been discovered in plants also.

In the first step of oxidation, fatty acids are activated their conversion to thioesters with the help of coenzyme A. The gy for this process is derived from ATP. The enzyme thiokinase catalyses thes reaction.

$$RCH_2CH_2COOH + COASH \xrightarrow[\text{Thiokinase, } Mg^{++}]{ATP \rightarrow AMP + PPi} RCH_2CH_2\overset{O}{\overset{\|}{C}}-SCoA$$

The second rkⁿ- is a dehydrogenation, removing two hydrogen atoms from α and β carbon atoms of the fatty acids. This rkⁿ- catalysed by FAD containing enzymes, acyl CoA dehydrogenases.

$$RCH_2CH_2\overset{O}{\overset{\|}{C}}\cdot SCoA \underset{FADH_2}{\overset{\text{Dehydrogenase}}{\underset{FAD}{\rightleftharpoons}}} R\overset{H}{\overset{|}{C}}=\overset{H}{\overset{|}{C}}\cdot\overset{O}{\overset{\|}{C}}\cdot SCoA$$

Three types of dehydrogenases have been identified from liver tissu They differ according to their specificity to the substrate.

First prefers to act on long chain fatty acids (C_{14}, C_{16}, C_{18}), while other two act on medium or short chains. Next step the oxidation involves addition of water by the enzyme enoy hydrase and yields a hydroxy acyl CoA.

$$R-\overset{H}{\overset{|}{C}}=\overset{H}{\overset{|}{C}}\cdot\overset{O}{\overset{\|}{C}}\cdot SCoA \underset{}{\overset{\text{Hydrase}}{\rightleftharpoons}} R\,\overset{OH}{\overset{|}{C}}H-CH_2-\overset{O}{\overset{\|}{C}}\cdot SCoA$$

β hydroxy group of this compound is dehydrogenated to ke... group by the enzyme hydroxy acyl dehydrogenase. The hydrog... is by NAD^+.

$$RCH(OH)\cdot CH_2\cdot C(=O)\cdot SCoA + NAD^+ \xrightleftharpoons{\text{Dehydrogenase}} RC(=O)\cdot CH_2\cdot C(=O)\cdot SCoA + NADH + H^+$$

Thus NADH is reoxidised through the electron short chain and produces 3 molecules of ATP.

Final step in the oxidation is thiolytic cleavage to the ketoacyl by CoA.

$$RC(=O)\cdot CH_2\cdot C(=O)\cdot SCoA + COASH \longrightarrow RCSCoA + CH_3C(=O)\cdot SCoA$$

Thus reaction is catalyzed by ketothilase. The product here is a fatty acid with two carbon atoms short. It may enter the entire process of oxidation at step 2 and further dissociation may occurs. Thus, it is a of cleaving fatty acids into frag... ments of 2c compounds in steps.

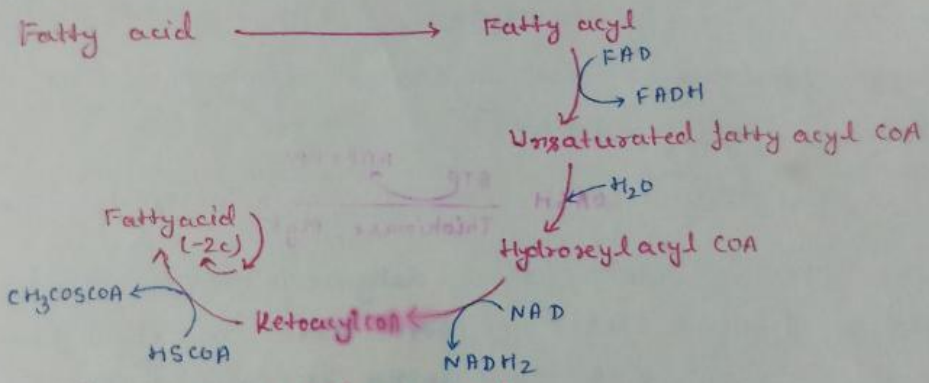

fig:- β oxidation spiral

The end product of β-oxidation of fatty acid is acetyl CoA. Fatty acids with odd number of carbon atoms produce acetyl CoA & propionyl CoA. The acetyl CoA is either oxidized for the production of ATP or is converted into carbohydrate. The propionyl CoA is converted to malonic semialdehyde in both ~~pal~~ plants and animals. Malonic semialdehyde may converted to alanine by transamination with glutamic acid in animals, plants, however, it appears that this compound is oxidized to CO_2 and H_2O.

β-oxidation of fats is a good source of energy production. In each of β-oxidation 5 ATP molecules are produced. One

ATP is used in reaction In this way 35-1 = 34 ATP molecules can be produced in 7 turns of palmitic acid oxidation Besides this, 8 acyl CoA produced from palmitic acid will produce 12×8 = 96 ATP molecules. Thus will give a total of as much as 130 (96+34) ATP per palmitic acid molecule.

ALPHA (α) - OXIDATION :- An alternative mechanism of fatty acid oxidation was proposed by P.K. Stumpf. It is also a stepwise decarboxylation of fatty acids. In the first step, fatty acid is decarboxylated and reduced to an aldehyde one carbon shorter than the original fatty acid. It is catalysed by a peroxidase

$$RCH_2CH_2CH_2COOH \xrightarrow[\text{Fatty acid Peroxidase}]{+H_2O} RCH_2CH_2CHO + CO_2 + H_2O + O_2$$

This aldehyde is then oxidized to the acid form by dehydrogenase

$$R.CH_2CH_2.CHO \xrightarrow[\text{Aldehyde Dehydrogenase}]{NAD \rightarrow NADH + H^+} RCH_2CH_2COOH$$

This new acid may become substrate for fatty acid peroxidase and take another turn in the α-oxidation spiral. This kind of α-oxidation has been observed in the peanut cotyledons. In leaf tissues and brain microsomal preparations, a different type of α-oxidation occurs, in which decarboxylation takes place after oxidation of the fatty acids.

The biological significance of α-oxidation is not known. It may provide, however, fatty acids with odd number of carbon atoms. Further, the aldehydes produced during this process may be reduced so as to yield long chain alcohols.