

# Identifying the spiral pathway and justifying its name

RAGHAV WORAH

STUDENT, St. Xavier's College, AHMEDABAD

raghav.worah@gmail.com

**Abstract:** Fatty acid degradation is one of the prominent example of this spiral pathway, where the oxidation of the aliphatic compounds takes place by the action of same enzymes (the co-factors and the isoforms may vary), and result in the production of the Acetyl CoA, which is later on utilised by the TCA cycle

**Key Words:** Aliphatic Compound, Acetyl CoA, TCA cycle.

## 1. INTRODUCTION:

A Spiral pathway is a metabolic pathway, similar to the cyclic pathway. The most prominent difference between the cyclic and the spiral pathway is that the “substrate” can be lengthened or shortened by the length of its “Monomeric Unit”, each time through a spiral. The pathway is also marked by the use of same kind of enzyme (most of the time, in the pathway; like the enzyme dehydrogenase in Fatty acid Catabolism) for bio synthesis or breakdown purposes.

Spiral Pathways are used to synthesize or degrade large molecules or polymers like fatty acids, proteins, DNA or RNA.

Taking the example of Fatty Acid metabolism, that takes place in the mitochondria, where the Fatty Acid is oxidised in three successive states i.e. the  $\beta$ -oxidation of fatty acids.

**Prerequisite for the oxidation process:** For the breakdown of the fatty acid, it must be converted into fatty acyl-CoA to enter into the mitochondria and then it can be oxidized. The enzyme that brings out the esterification reaction of fatty acid to long chain fatty acyl CoA is FACS. FACS consume 2 ATP molecules

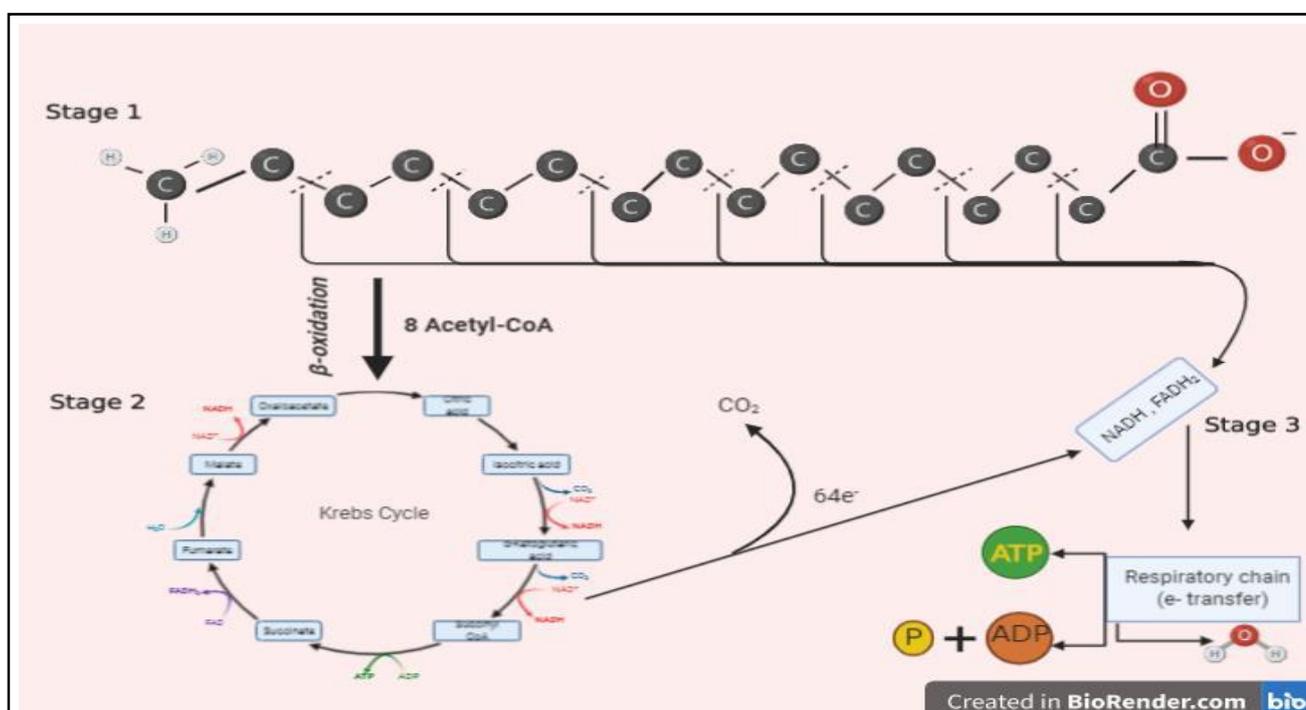
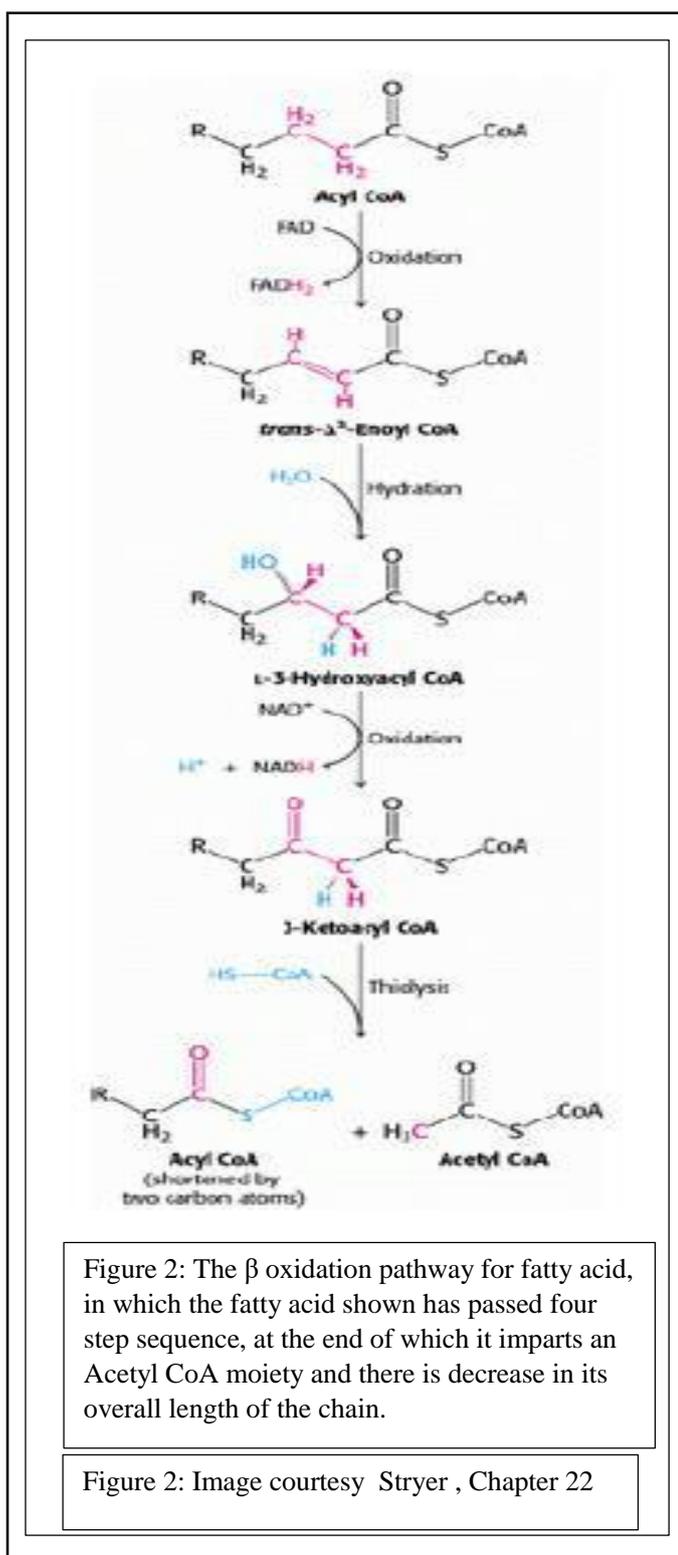


Figure 1: The oxidation of the fatty acid schematically

## 2. The working of the actual pathway:



**Step 1:** The first enzyme required is the acyl CoA dehydrogenase, which is specific to chain length. This enzymes catalyse the formation of the double bond between the  $\alpha$  and  $\beta$  carbons on acyl CoA molecule.

The process involves the release of two electrons and 1 molecule of FAD which accounts for 1.5 ATP molecule (produced in ETC)

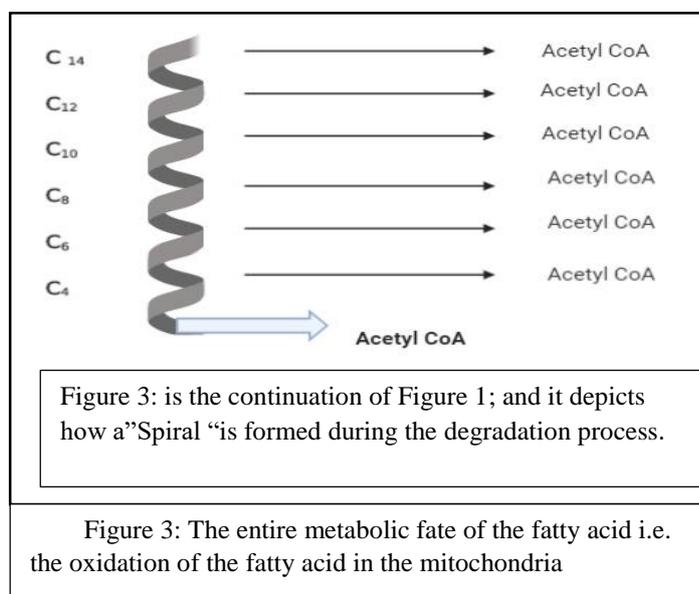
**Step 2:** The enzyme enoyl CoA hydratase performs the hydration step of the double bond between the  $\alpha$  and  $\beta$  carbon, and this results in the addition of the hydroxyl group to the  $\beta$  carbon and a  $H^+$  to the  $\alpha$  carbon.

**Step 3:** It is by the help of enzyme acyl CoA dehydrogenase (specifically known as  $\beta$ - hydroxyl acyl CoA dehydrogenase), removes two electrons and protons from the hydroxyl group of the  $\beta$  carbon.

This results in the production of NADH molecule, which would account for 2.5 ATP molecules from ETC.

**Step 4:** The cleavage of the  $\alpha$  and  $\beta$  carbon takes by CoASH (acyl CoA acetyltransferase, commonly known as thiolase)

The reaction results in the production of one molecule of CoA and fatty acyl CoA that is two carbon shorter. The entire process repeats till the fatty acid chain has completely been converted into acetyl CoA.



## 3. Inference:

The above pathway described indicates that the fatty acid (it can be any other metabolite also; like a protein or DNA or RNA) is degraded by the length of its monomeric unit and the entire process makes use of the 3 most common enzyme i.e. the dehydrogenase, hydrolase and thiolase, followed by other enzymes ; if needed ; in the upcoming metabolic pathway.

The repeated use of same enzymes and the decrease in length in the next successive steps by its monomeric unit and the product at each step enters the same step and undergoes reactions as in the previous step, justifying the “SPIRAL” nature of the pathway.

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