Welcome students.

Hi, my name is Siddhesh Menon.

Today we'll be dealing with this paper on microbial Physiology and specifically on the module Amphibolic pathway. The outline for this video presentation would be what is an amphibolic pathway? and the Amphibolic nature of the TCA or the Krebs cycle.

The students would be able to understand the concept of an Amphibolic pathway and also learn about the TCA cycle and how the intermediates of the TCA cycle are involved into this particular pathway,which is supposedly called as an Amphibolic pathway.

So what is it that is called an Amphibolic pathway? It is the one that is involved in both catabolism, and Anabolism. So the best known example for an Amphibolic pathway is the Krebs cycle or the tricarboxylic acid cycle. Now when we talk about the metabolism in case of prokaryotes as well as the eukaryotes. It usually begins with glycolysis which is the conversion of glucose, One molecule of glucose into two molecules of pyruvate, which usually takes place in the cytoplasm. And after the glycolysis, the pyruvate would be converted into acetyl coa.That goes into the mitochondria and goes through the TCA cycle.

So the TCA cycle usually, which is involved in cellular respiration, known to produce a lot amount of ATP and generate more amount of reducing powers which are required for the production of ATP through the electron transport chain is a very well known example of an Amphibolic pathway.

The reason it is called Amphibolic is because when we talk about metabolism, there are two different aspects of metabolism. One is called catabolism, the other one is called anabolism, so the catabolism would be the breakdown of your complex food material or the complex substances such as carbohydrates, fats, lipids into the simpler ones to generate energy in the form of ATP. Anabolism would be the synthesis of these kinds of molecules into the body, which would be required for different cellular components in case of prokaryotes as well as that in case of eukaryotes.

Now if you look at the TCA cycle specifically, there are various different intermediates compounds. So when we start from the first step, it is the combination of oxaloacetate together acetyl coa to form citrate and then the pathway goes on with different intermediates in between and all of these intermediates are also serving as precursors for biosynthesis purpose. So since it's a combination of both, since the TCA cycle is involved in oxidative catabolism of carbohydrate or fatty acids, amino acids as well as serving as precursors for biological synthesis of other molecules, it is being termed as an Amphibolic pathway.

So when we talk about cellular respiration, which is nothing but the production carbon dioxide as well as water molecules from the breakdown of cellular components and the food material such as the carbohydrates.It starts from glycolysis, which is the anaerobic form of respiration, and goes through the TCA cycle. Now in the TCA cycle, as I already mentioned before, there are a lot of ATP's

that are being generated by the process of catabolism, that is breakdown of the initial acetyl coa molecule combined with oxaloacetate, the citrate that is being formed gets broken down into different components through the cycle, and then we have the ATP generation, so that comprises the catabolism part.
And when the body requires fatty acids or proteins, this particular respiratory pathway would halt or stop at that particular point of time and the intermediates would serve as precursors for biological synthesis, so this part would comprise the anabolism.

So the sum of catabolism together with anabolism would be called as Amphibolic.That's how the TCA cycle is a very well known example of an Amphibolic pathway.
Will have a look at the rough diagram of the TCA cycle so if you look here there is glycolysis written on the top which ends up into pyruvate.This is in the cytoplasm,

Pyruvate through the removal of 1 carbon dioxide molecule would result in the formation of acetyl coa. The first step of the TCA cycle is the combination of acetyl coa together with oxaloacetate to form citrate, which is a 6 carbon compound and the citrate would be broken down into different intermediate molecules such as isocitrate, Alphaketoglutarate, succinate,fumarate, malate, and so on and would serve in catabolism, resulting in the release of ATP molecules and reducing power such as NADH or NADPH and FADH2, which would then go into the electron transport chain resulting in the synthesis of more ATPs.

If you look at the picture properly at different intermediate molecules, there are arrows which are indicating that those also serve as precursors in the synthesis of different biological molecules. The best known examples if you look at the picture you can see the citrate is involved in the fatty acid synthesis, Alphaketoglutarate and oxaloacetate into amino acids. You can see Succinyl Coa getting involved in the porphyrin synthesis,

So we would look at some of these examples. The Alpha Ketoglutarate, which is a 5 carbon intermediate that is formed in the TCA cycle and the oxaloacetate they both serve as precursors of amino acid synthesis, especially aspartate and glutamate.
So it's a simple transamination reaction that is taking place here where an amino group is being added to these particular intermediates,resulting in the synthesis of amino acids. So in the 1st place we saw this as involved in catabolism, but now they are being involved in anabolism process.

Through aspartate as well as glutamate, then the carbons of oxaloacetate and alphaketoglutarate are then used to build up more amino acids as well as nucleotides.

Oxaloacetate is known to be involved in gluconeogenesis, that is, synthesis of glucose, synthesis of the new sugar from a non carbohydrate source.
Succinyl coa, which is also an intermediate that is being present in the TCA cycle, is known to be involved in the synthesis of porphyrins, which are part of the heme group that exists in the electron transport chain carriers.

So if you can recollect the electron transport chain which is made up of different carrier molecules in the membrane of the mitochondria, these carriers have the presence of the porphyrin ring in the heme group, which is being contributed by the Succinyl CoA, which is an intermediate of the TCA cycle.

So let's summarize the full description. An amphibolic pathway is the one which is involved in the combination of catabolism as well as anabolism which totally comprises the metabolism of the prokaryotic as well as eukaryotic cell. The TCA cycle is the best known example of an amphibolic pathway because the intermediates of the TCA are involved in the breakdown as well as into the synthesis of different biological precursors.

These are some of the examples oxaloacetate are involved in the synthesis of amino acids, so we have already seen before Oxaloacetate would be involved in aspartate amino acid synthesis. Similarly, AlphaKetoglutarate would be involved in glutamate synthesis.
We have citrate which is involved in fatty acid synthesis. We have succinate,which is involved in the synthesis of the porphyrin ring of the heme groups, which is part of the electron carriers of the mitochondrial membrane.

Thank you.