Welcome to the module for the subject of zoology from the program Bachelors of Science, third year, myself, Dr. K. K. Therisa, assistant professor Dhempe College of Arts and Science and the paper is ZOC 106 from Biochemistry and Metabolic processes.

The unit - Amino acid metabolism and the module name are Fate of skeleton of glucogenic and ketogenic amino acids.

The outline of the module. First, we will talk about the glucogenic and ketogenic amino acids followed by Degradation of glucogenic and ketogenic amino acids and a fate of skeleton of amino acids.

The learning outcome students will be able to differentiate between glucogenic and ketogenic amino acids. They will be able to understand degradation of the glucogenic and ketogenic amino acids with the fate of skeleton of these amino acids. Amino acids are catabolized to intermediates for carbohydrate and lipid biosynthesis.

In the previous three modules we have seen how amino acid catabolism leads to the formation of urea cycle, formation of urea and the C skeleton left behind which enters into the citric acid cycle.

A portion of this carbon skeleton of every amino acid is easily convertible either to the carbohydrate, fat, or maybe both fat and carbohydrate, so they are also being known as glucogenic and ketogenic amino acids. The standard amino acids usually get degraded it into one of the seven intermediates. That is, it maybe gets degraded into a pyruvate or some maybe into alpha ketoglutarate, some into a succinyl CoA few into a fumarate, oxaloacetate, acetyl Co A and acetoacetate molecule. Thus, the excess of amino acids are catabolized to amphibolic intermediates and based on their catabolic pathways, the amino acids are grouped into glucogenic amino acids and ketogenic amino acids. glucogenic are those whose carbon skeletons are degraded to pyruvate, Alpha Ketoglutarate, succinyl CoA, Fumarate or oxaloacetate and are therefore known as a glucose precursor. And therefore, the term glucogenic amino acids. Whereas the ketogenic amino acids are the ones who may be involved in the ketone body formation, such as the leucine and lysine, are known to be ketogenic. As for example leucine carbon skeleton is converted to acetyl Co A and acetoacetate whereas that of lysine is converted into acetoacetate and carbon dioxide. The amino acids are being classified into the glucogenic and ketogenic, and we know that there are 20 important commonly known amino acids and all of them have been distributed either as glucogenic amino acids or they may be a ketogenic amino acid or some who are both glucogenic and ketogenic amino acid. For example the glucogenic amino acids are alanine, arginine, asparagine, aspartate, cysteine, glutamine, glutamate, glycine, methionine, histidine, proline, serine, threonine, and valine. These are known to be glucogenic amino acids. The ketogenic ones are the leucine and the lysine. And five, four of the amino acids are both, that is, the isoleucine, phenylalanine, tryptophan, and tyrosine to be considered as the glucogenic and ketogenic. At the same time, even the lysine also being considered to be sometimes glucogenic, and ketogenic.

The fate of skeleton. See skeleton means the carbon skeleton. Once amino group is removed from amino acid, what is left behind is the carbon skeleton. So, the fate of this carbon skeleton of glucogenic and ketogenic amino acids are very important.

As we have already discussed, the amino group of the amino acid cannot be stored. Therefore, it is either used or it is excreted out in the form of a urea, but the skeleton, the carbon skeleton what is left behind after removal of amino group are being used for further energy production processes, maybe by entering into a citric acid cycle. Therefore, nearly all of the amino acids yield on breakdown either and intermediate of the citric acid cycle. This may be a pyruvate or acetyl Co A.
5 amino acids that is, the leucine, lysine, phenylalanine, tryptophan and tyrosine are exception to this since they give rise to acetoacetate acid.
However, this compound also forms the acetyl Co A. A carbon skeleton of all of the amino acids is ultimately oxidized via the citric acid cycle. The 10 amino acids get degraded into the acetyl CoA, so the fate of these ten amino acids that is the alanine, cysteine, glycine, serine, and tryptophan is that it gets degraded into the acetyl Co A via pyruvate whereas the remaining five that is the leucine, lysine, phenylalanine, tryptophan, and tyrosine are converted into the acetyl Co A. Or maybe acetoacetyl CoA and which is then cleaved to form acetylcholine.

Whereas the five of the amino acids are converted into alpha ketoglutarate. That means the C skeleton of the five amino acids. That is the arginine, histidine, proline, glutamate, glutamine is to form alpha Ketoglutarate that enters into the citric acid cycle. 4 amino acids converted into succinyl CoA. The carbon skeleton of methionine, isoleucine, threonine, and Valine are degraded by pathways that produces succinyl coA. This also will enter into the citric acid cycle. 3 branched chain amino acids. That is the leucine, isoleucine, and valine. These are the branched chain amino acids gets degraded in the extrahepatic tissues. So, these are known to be oxidized as fuels, primarily in the tissues like muscle, Adipose, kidney, brain etc.

Two of the amino acids, especially the asparagine and aspartate, are known to get degraded to oxaloacetate. The carbon skeleton of this amino acid ultimately enters the citric acid cycle via oxaloacetate. Asparagine is hydrolyzed by the enzyme asparaginase to form ammonium and a aspartate group, and the aspartate then undergoes transamination reaction with alpha ketoglutarate to yield a glutamate and a oxaloacetate.

So here we have a chart that depicts the degradation and the fate of skeleton of glucogenic and ketogenic amino acids. If you look at this, this is the central cycle that is the citric acid cycle. And we have important molecules like the pyruvate, acetyl Co A, acetoacetate, alpha Ketoglutarate Succinyl CoA, fumarate, oxaloacetate. That is being formed as an intermediate from the degradation of the various amino acids. For example isoleucine, leucine and lysine with threonine are known to be degraded directly into the acetyl Co A and this acetyl CoA along with the oxaloacetate will enter into the citric acid cycle.

The leucine, lysine, phenylalanine, tryptophan, and tyrosine form the acetoacetate. Whereas the arginine, glutamate, glutamine, histidine and proline gets transformed or get degraded into alpha keto glutarate which

enters into the citric acid cycle, the isoleucine methionine valine can be also degraded into succinyl CoA which enters these cycle.

Besides the aspartate, final alanine and tyrosine known to get degraded into a fumarate. Entering into this cycle. Asparagine and Aspartate forms the oxaloacetate, which combines with the acetyl CoA and again completes the cycle. Alanine cysteine glycine serine threonine and tryptophan forms the pyruvate. And what we get to see at the end is these carbon skeletons of all these amino acids.

Once the amino group has been removed from it enters one or the other way into the citric acid cycle. Therefore, we can conclude that the 20 different protein amino acids, after losing their nitrogen atoms are degraded through dehydrogenation, decarboxylation and other reactions to yield portions of their carbon skeleton to form 5 central metabolites, and this enters into the citric acid cycle.

Here they are completely oxidized to carbon dioxide and water molecule. And during the electron transfer ATP that is, the adenosine triphosphate is generated by oxidative phosphorylation and in this way the amino acids contribute to the total energy supply of the Organism.

These are the references used to prepare this module.

Thank you.