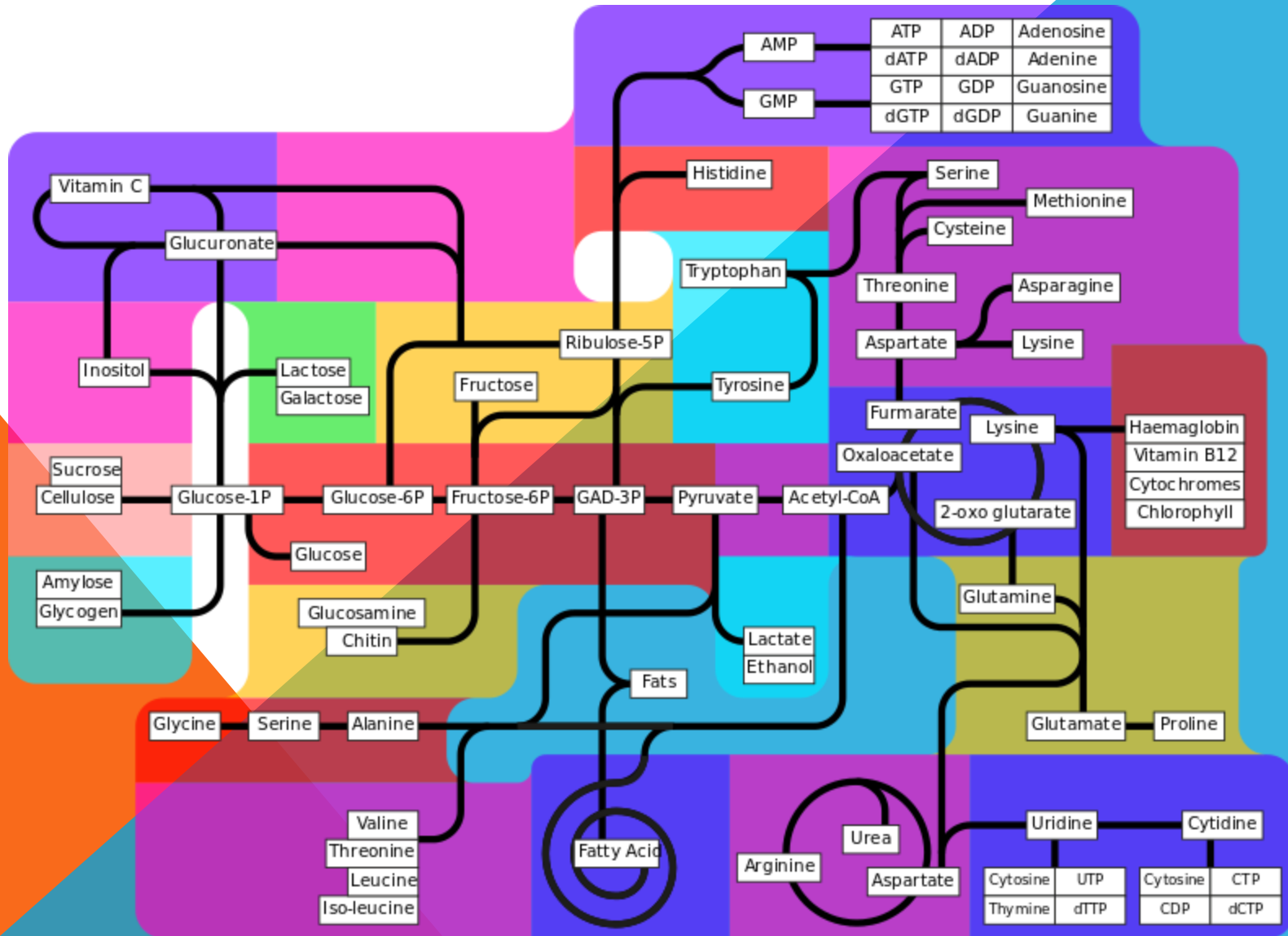


SIMPLE BASIC METABOLISM



When we eat food such as a tuna fish sandwich, the polysaccharides, lipids, and proteins are digested to smaller molecules that are absorbed into the cells of our body. As these molecules of glucose, fatty acids, and amino acids are broken down further, energy is released.

This energy is used in the cells to synthesize high—energy compounds such as adenosine triphosphate (ATP). Our cells utilize ATP energy when they do work such as contracting muscles, synthesizing large molecules, sending nerve impulses, and moving substances across cell membranes.

All the chemical reactions that take place in living cells to break down or build molecules are known as metabolism. In a metabolic pathway, reactions are linked together in a series, each catalyzed by a specific enzyme to produce an end product.

The term metabolism refers to all the chemical reactions that provide energy and the substances required for continued cell growth.

There are two types of metabolic reactions: catabolic and anabolic.

In catabolic reactions, complex molecules are broken down to simpler ones with an accompanying release of energy.

Anabolic reactions utilize energy available in the cell to build large molecules from simple ones.

Using the tuna fish sandwich for our example, we can think of the catabolic processes in metabolism as consisting of three stages, as indicated in the next slide.



ENERGY GENERATION OCCURS IN 3 STAGES

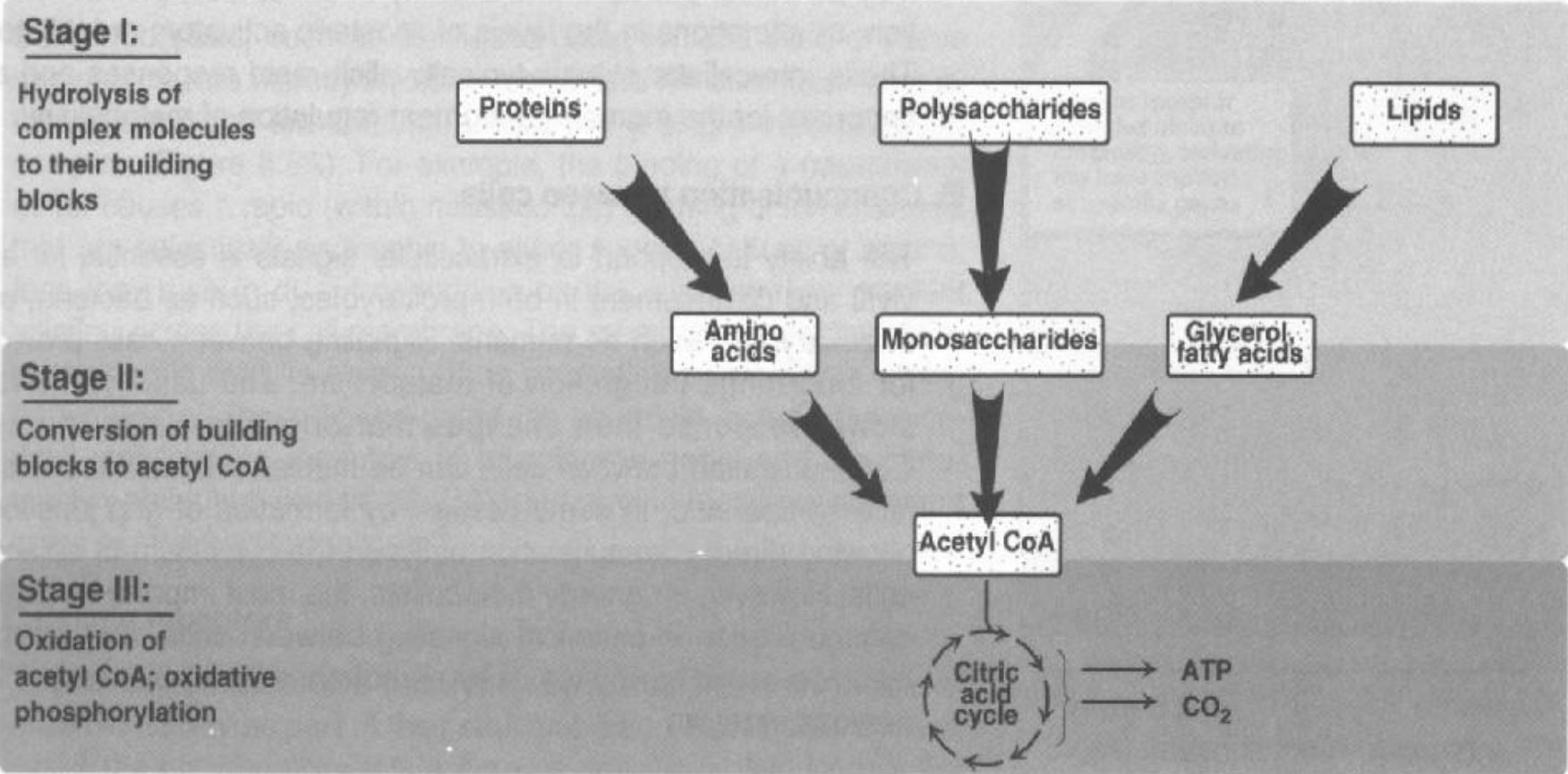


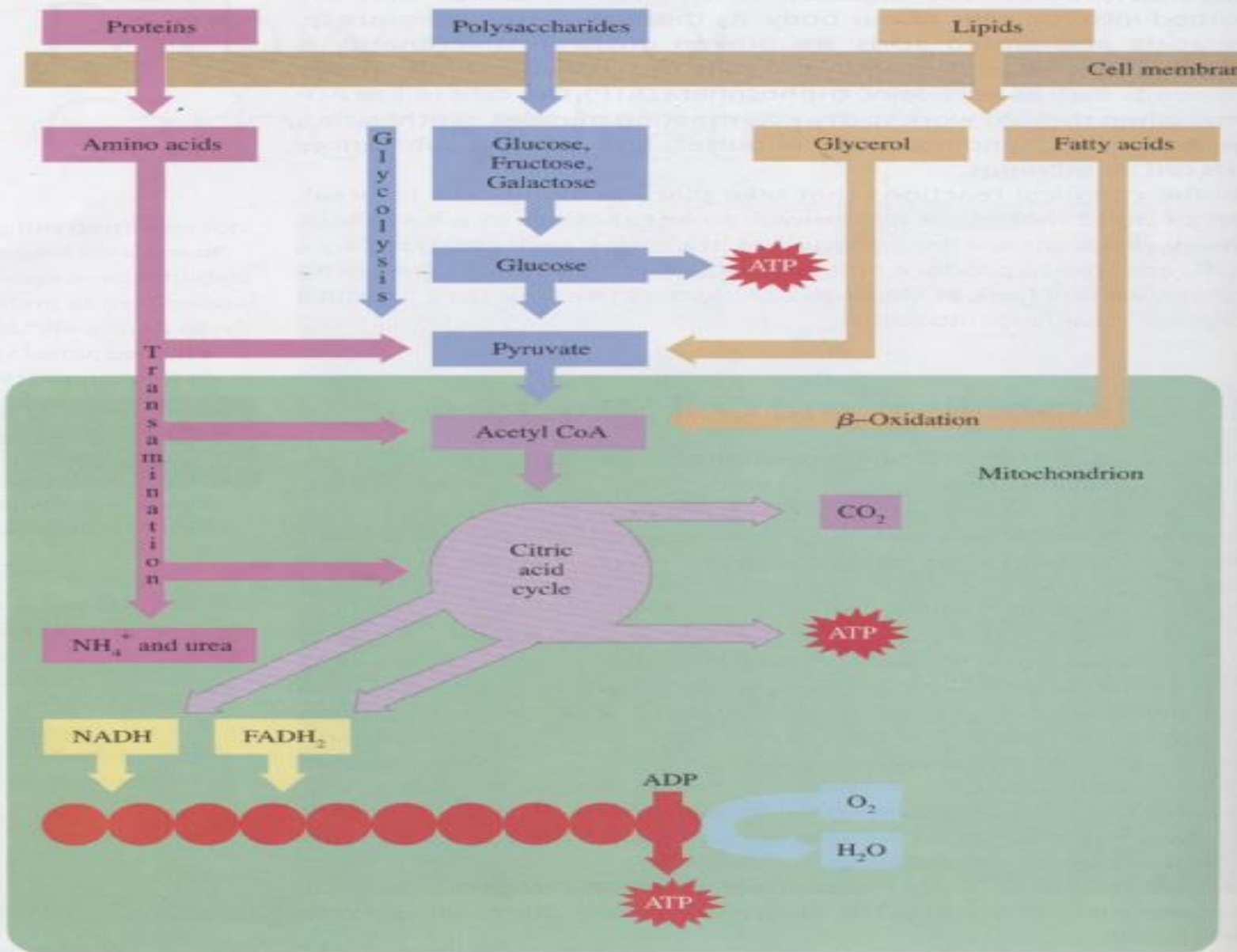
Figure 6.3
Three stages of catabolism.

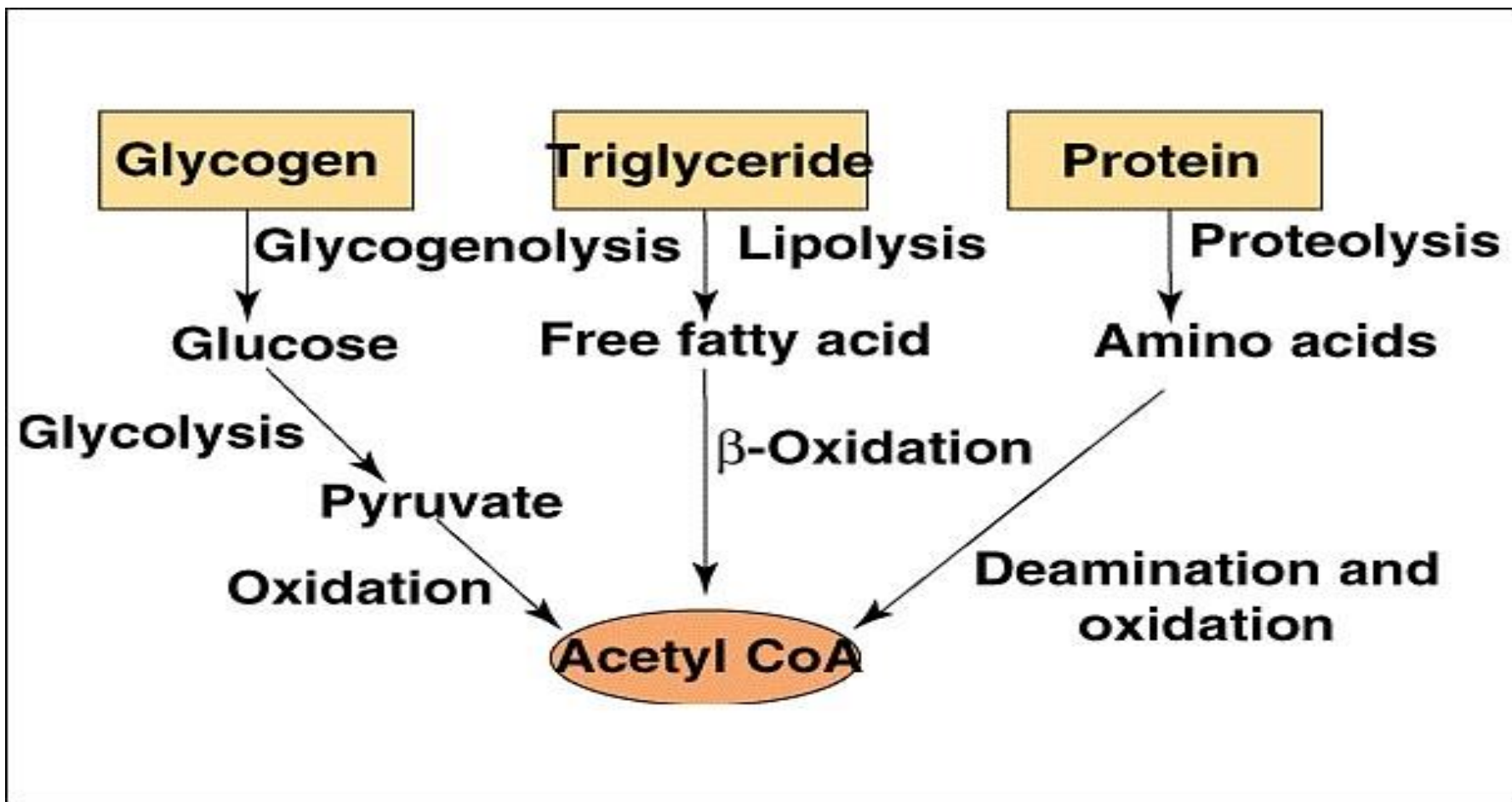
Stages of Metabolism

Stage 1
Digestion and hydrolysis

Stage 2
Degradation and some oxidation to smaller molecules

Stage 3
Oxidation to CO_2 , H_2O and energy for ATP synthesis





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Note the important role of **ACETYL CoA**

The carbs, fats proteins and even the alcohol we consume are converted to **ACETYL CoA**

In stage I of metabolism, the processes of digestion break down the large macromolecules into small monomer units by hydrolysis.

For example, the polysaccharides in bread break down to monosaccharides, the lipids in the mayonnaise break down to glycerol and fatty acids, and the proteins from the tuna yield amino acids.

These digestion products diffuse into the bloodstream for transport to cells.



In stage 1, we see that the hydrolysis of complex molecules that take place in the stomach during digestion converts complex molecules such as carbohydrates, proteins and fats into their component building blocks, or monomeric units, i.e amino acids, glucose, fructose, galactose, glycerol, and fatty acids etc.



In stage 2 of metabolism, digestion products are further broken down in body cells to two- and three—carbon compounds such as pyruvate and acetyl CoA.

In stage 2 of metabolism, there is conversion of the digestion products (building blocks) to key simple intermediates such as **acetylCoA or other simple molecules.**

A small amount of energy is usually captured as ATP in the process. But the amount is small compared to that produced during the third stage of metabolism.

Stage 3 begins with the oxidation of the two-carbon acetyl CoA in the citric acid cycle, which produces several reduced coenzymes.

As long as the cells have oxygen, the hydrogen ions and electrons are transferred to the electron transport chain, where most of the energy in the cell is produced.

This energy is used to synthesize adenosine triphosphate (ATP), which provides energy for the anabolic pathways in the cell.



The citric acid cycle is the final common pathway in the oxidation of fuel molecules. In stage 3 of metabolism, citric acid is a final common catabolic intermediate in the form of acetylCoA.

AcetylCoA is oxidized to two CO₂, and 4 pairs of electrons are transferred to the coenzymes NAD⁺ and FAD to produce NADH and FADH₂.

Large amounts of energy are generated as the electrons from NADH and FADH₂ flow to oxygen in oxidative phosphorylation.



the Krebs cycle, which involves both the catabolism of carbohydrates and fatty acids and the synthesis of anabolic precursors for amino-acid synthesis (e.g. α -ketoglutarate and oxaloacetate).

In the next slide we see how amino-acids enter the Krebs cycle to complete their degradation or catabolism.

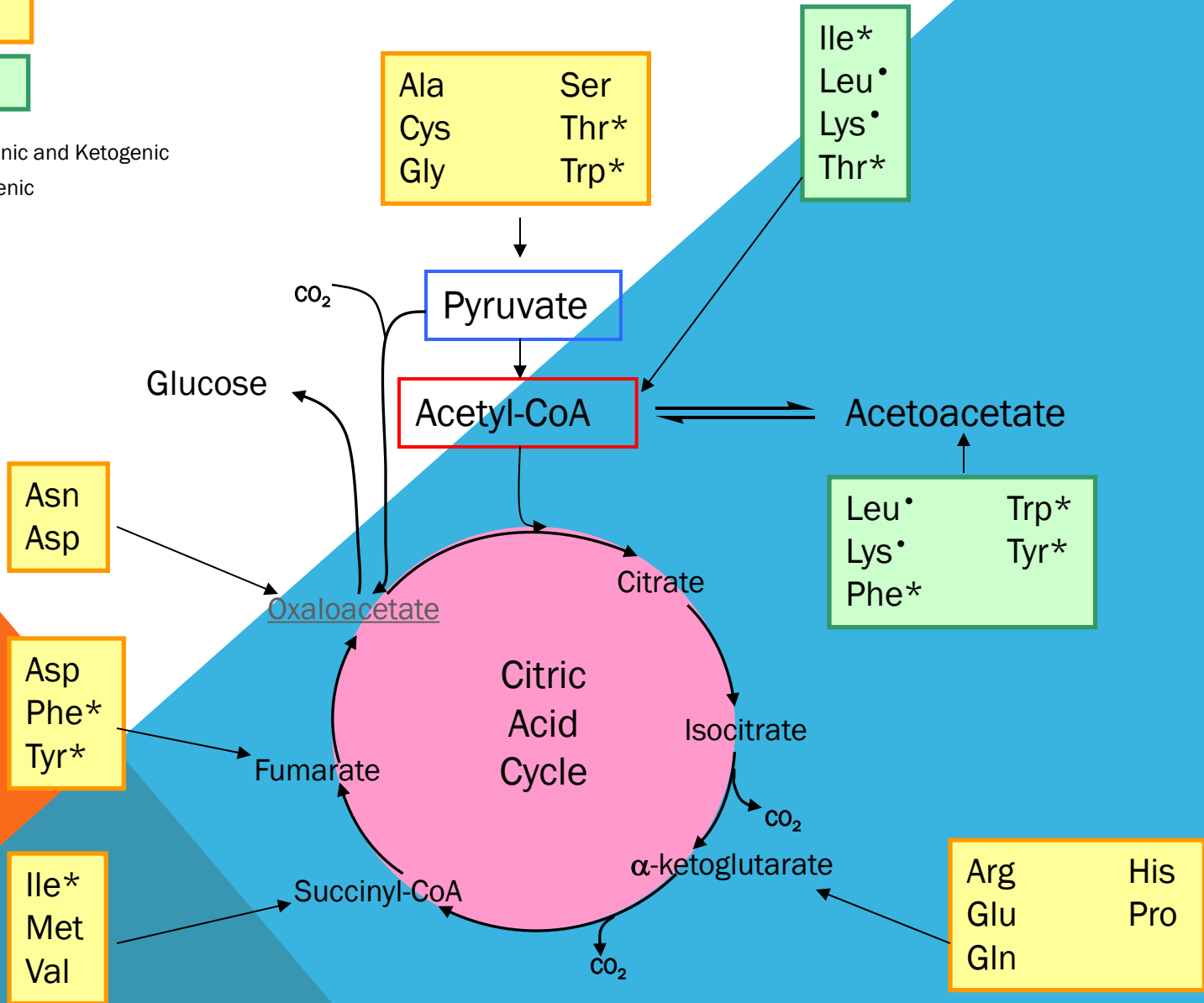


Glucogenic

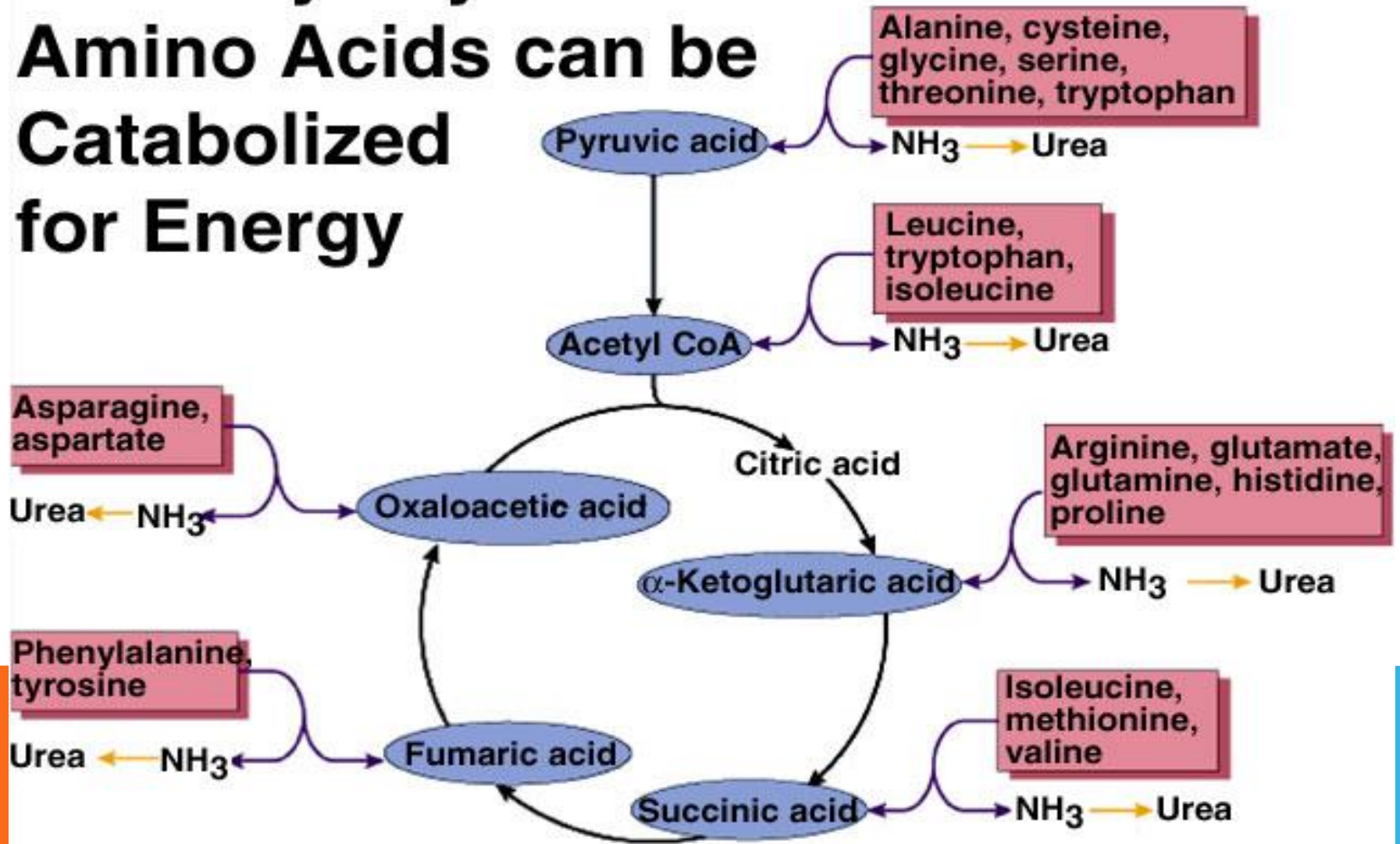
Ketogenic

* Both Glucogenic and Ketogenic

• Purely Ketogenic



Pathways by which Amino Acids can be Catabolized for Energy



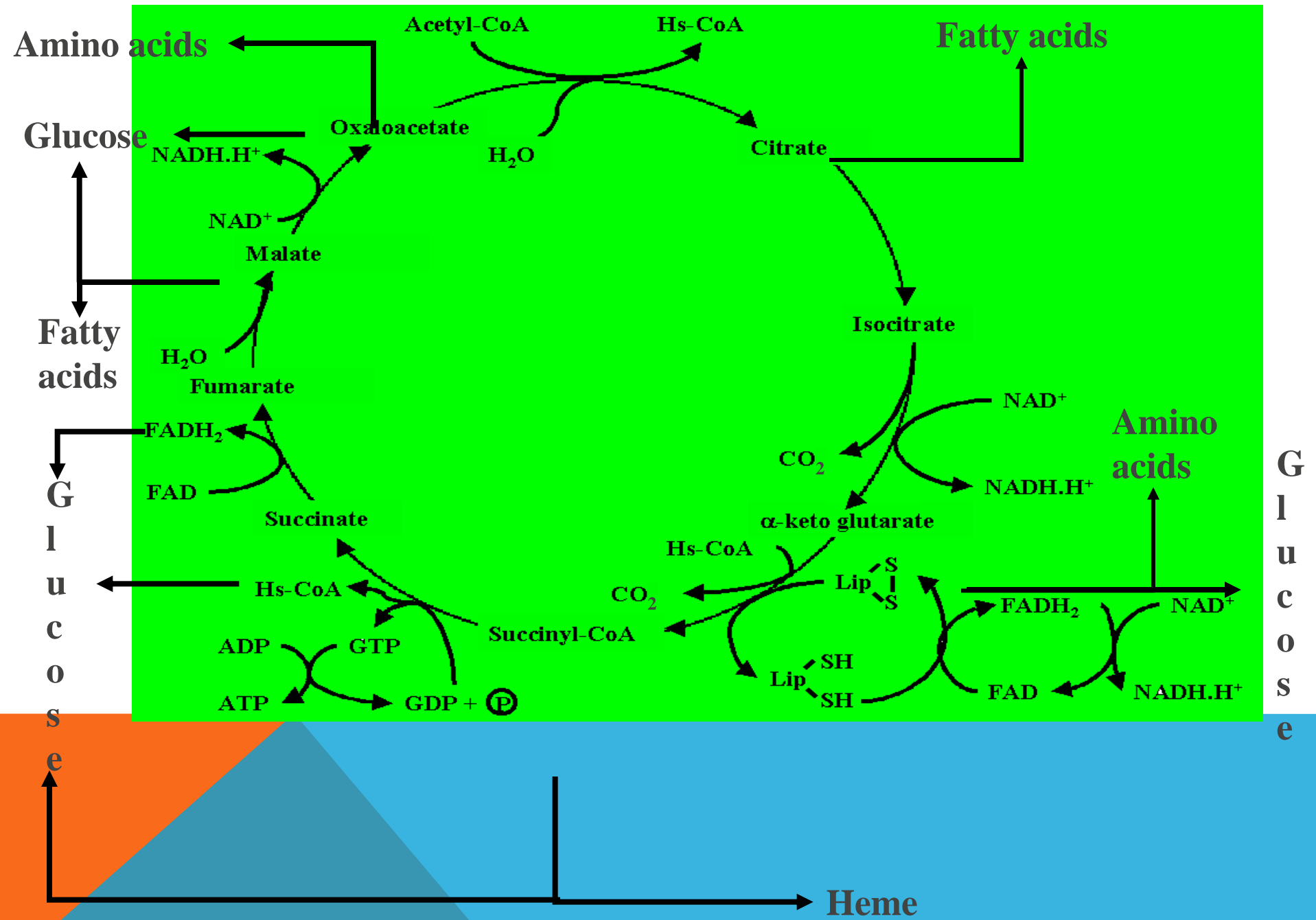
We have shown in several slides above how the Krebs Cycle is involved in **catabolism** or degradation of lipids amino acids and carbohydrates.

BUT

The Krebs Cycle is also a source of biosynthetic precursors also.

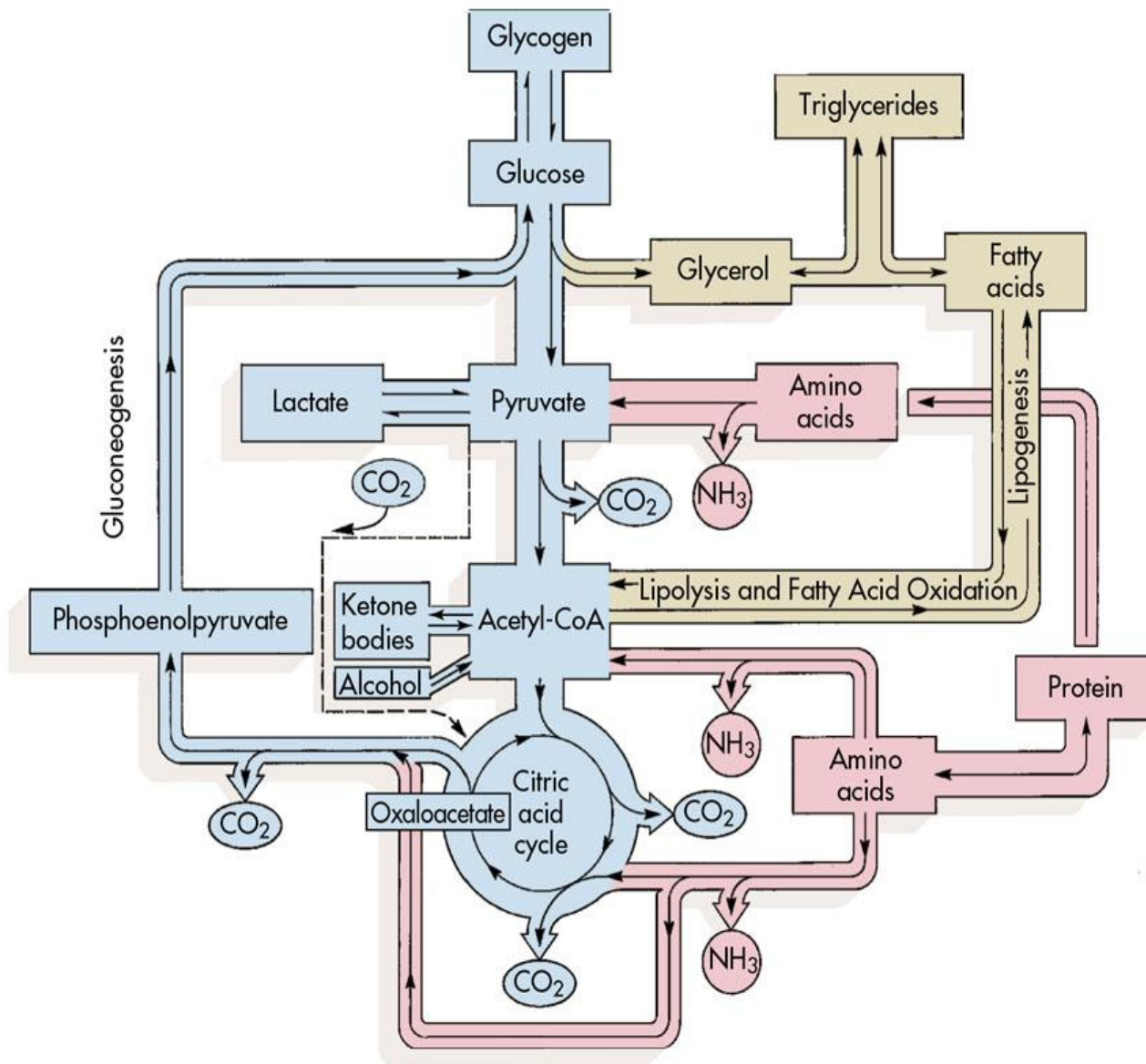
The Krebs Cycle also has an **anabolic** role, as shown in the next two slides.



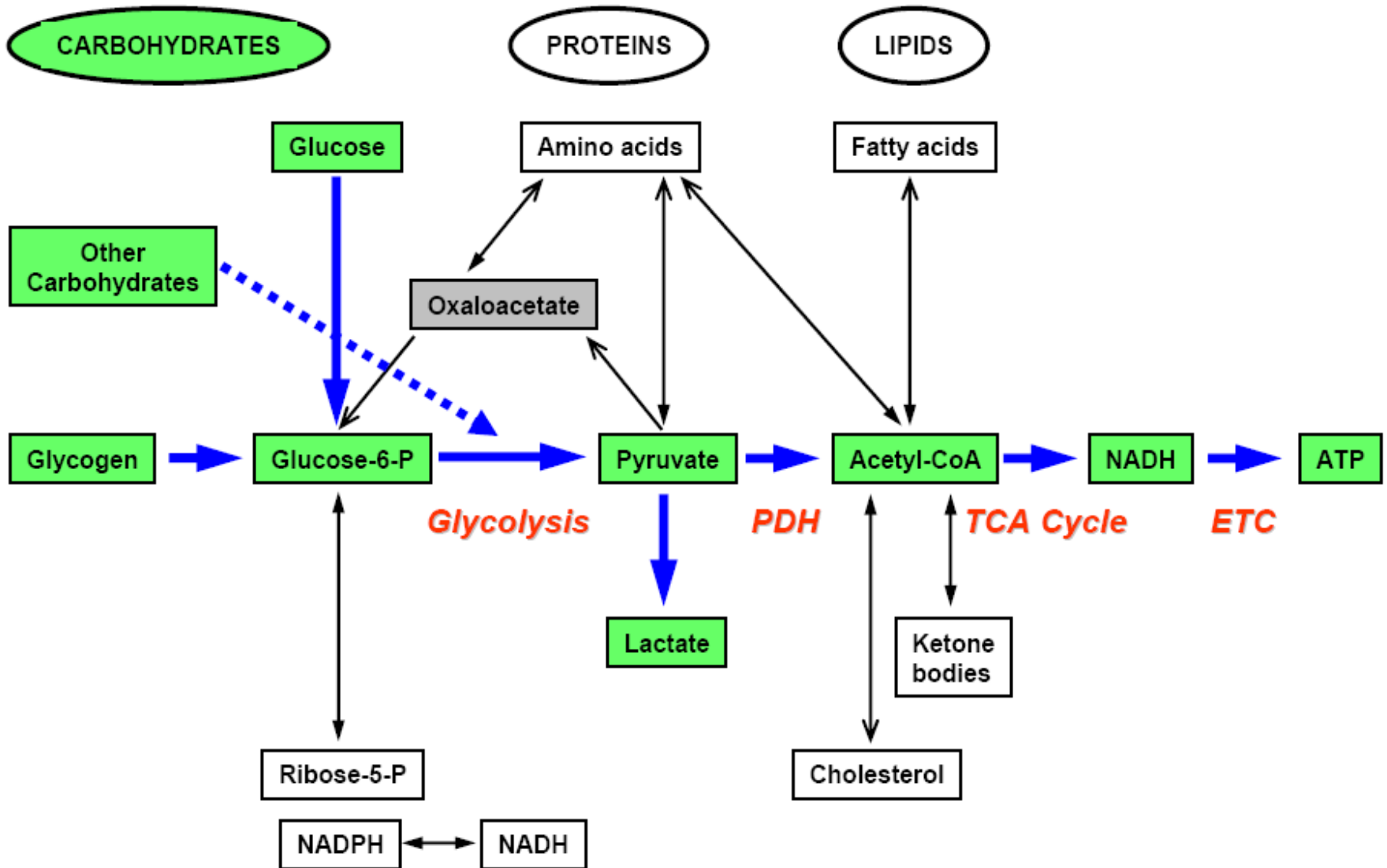


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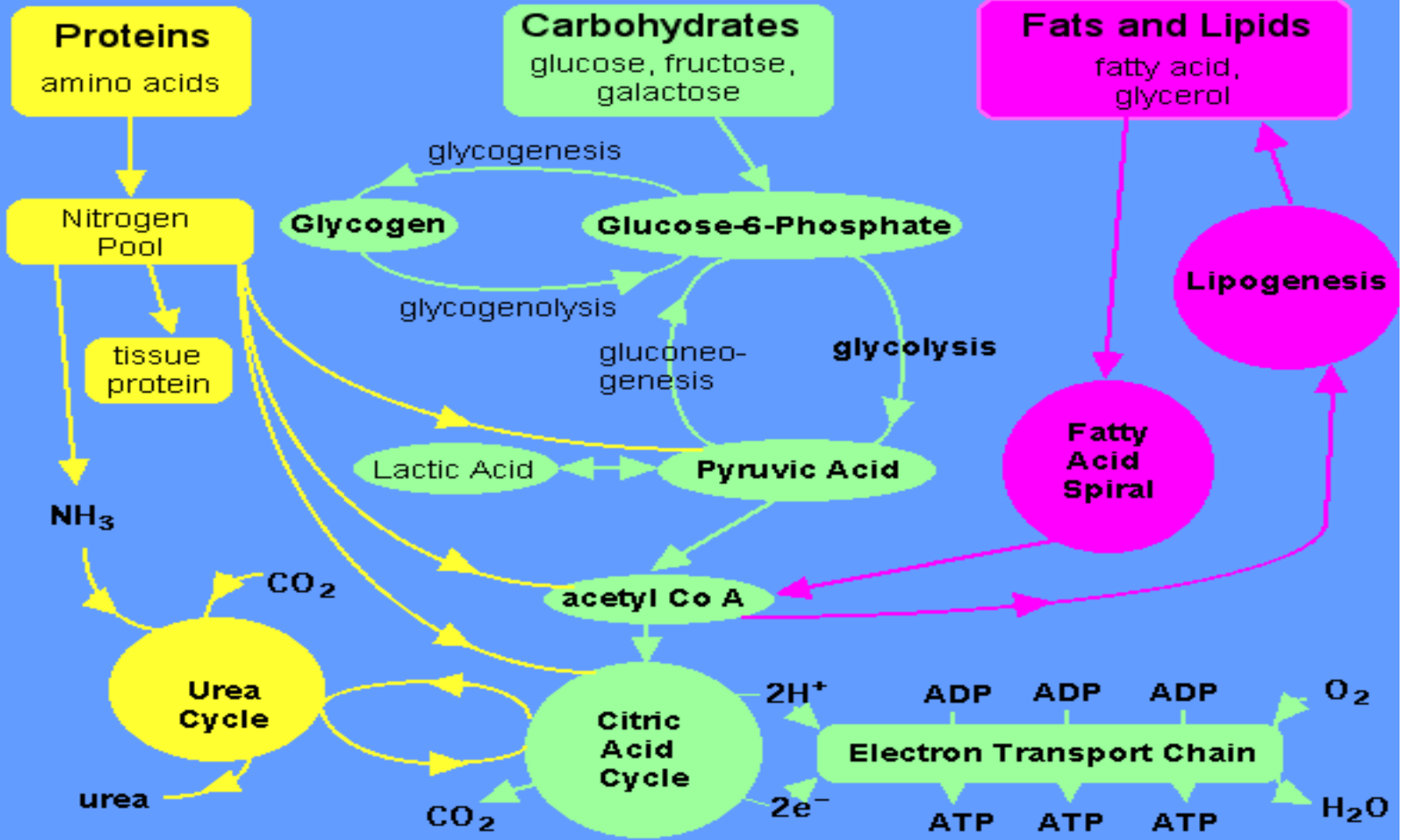
OVERVIEW OF METABOLISM



Overview of Human Metabolism



Metabolism Summary



If you look at the slides with the TCA or Krebs cycle YOU WILL NOTICE THAT

CITRATE is converted to **ISOCITRATE**

ISOCITRATE is in turn converted to **ALPHA KETO GLUTARATE**

ALPHA KETO GLUTARATE is in turn converted to **SUCCINATE**

SUCCINATE is in turn converted to **FUMARATE**

FUMARATE is in turn converted to **MALATE**

MALATE is in turn converted to **OXALOACETATE**

If you look on the packaging of many of the foods we buy today we will see one of these substances includes as a preservative

We will also see **ASPARTATE** **GLUTAMATE**

Alternatively we might see aspartate acid or glutamic acid or fumaric acid or malic acid etc

Because these substances are found in small concentrations for a fleeting time in the cells.....does the body need them in the concentrations in which they occur in our foods?

