**Unit:** metabolic pathways of Prokaryotes

**Chapter:** Glycolysis

INTRODUCTION

Something as simple as taking a breath requires energy. Therefore, it was crucial for organisms evolve a way to obtain a constant mechanism that develops continuous energy. This mechanism is called the **metabolism** and is a term that consist of many pathways that are dedicated for acquiring energy in order to maintain the life of the organism. It is a complex and highly regulated series of processes that require countless organic molecules to carry on the reactions. One of the numerous metabolic pathways is especially important for the getting energy from food. Cellular respiration is a series of chemical reactions involving glycolysis, The Citric acid Cycle, and oxidation phosphorylation (Electron transport Chain.). This Chapter will focus on the primary step for cellular respiration in nearly all organisms, Glycolysis.

**Glycolysis**

Glycolysis is a ten -step breakdown of a one single six carbon glucose molecule into two 3-carbon molecules. This is the first step to **cellular respiration**, a metabolic process responsible for creating ATP and NADH. Glycolysis is a **Catabolic** reaction, which means that no energy is used during the process but rather energy is released. The entire process is **anerobi**c and do not require the use of oxygen.

What is ATP and NADH?

For an organism to maintain homeostasis, it must use many different cellular processes. ATP or adenosine triphosphate is a currency or fuel that supplies the energy for the processes. Adenosine triphosphate is a molecule not found outside of an organism. Therefore, the body is responsible for the productions and use of ATP. **Cellular respiration** is a complicated way that prokaryotes and eukaryotes produce ATP. It is a process of multiple pathways that work to create the most efficient production of ATP. What makes ATP so valuable? ATP is an organic molecule, meaning that it is made of building blocks that are elements primarily involved in creating and maintaining life. Because of ATP’s structure, its able to successfully store, transport, and release energy throughout cells. NADH is another energy storing molecule that is used as currency for the use of cellular processes.

Glycolysis is divided into two- phases.

The first half of glycolysis is the focus of acquiring energy to further finish the pathway. It includes six steps and requires the use of 2 ATP molecules to change the structure of the six-carbon glucose molecule (C6H12O6) by adding two phosphate groups from ATP. This creates an unstable compound and thus gets split into two compounds that contain 3 carbons and a phosphate group.

The second half of glycolysis is known as the energy releasing half and this is where the two 3-carbon compounds are converted into pyruvate, a molecule that is crucial for the next step of cellular respiration, ATP, and NADH (openstax). This also composed of six steps.

Glycolysis is a controlled Process.

Glycolysis takes place in the cytoplasm of the cell membrane. The cytoplasm is the jelly substance that houses cell organelles inside the cell. It is filled with many nutrients and is the home to other cellular processes besides glycolysis. The cell’s membrane does now allow glucose to freely enter the cell, instead glucose is escorted in by proteins. These proteins are glucose transporter proteins or GLUT proteins. Glucose can also enter the cell through active transport, more specifically, **Secondary Active Transport**, a movement of ions or molecules against a high concentration gradient. This movement is powered by sodium ions moving down their concentration gradient and a protein using the energy from the sodium ions’ movement to push glucose into the cell(openstax). The process of secondary active transport is one example showing that obtaining glucose for glycolysis is highly regulated.

The Importance of Enzymes.

Glycolysis is a series of chemical reactions in the body at a cellular level. To make these chemical reactions move efficiently, enzymes are incorporated. **Enzymes** are proteins that bind to nutrients and speed up chemical reactions in the cell. There are ten enzymes involved in glycolysis that help remove phosphates, oxidize compounds, and split molecules. With the help of these special type of proteins, glycolysis produces a net of two molecules of ATP, 2 molecules of pyruvate, and 2 molecules of NADH. The first enzyme to aid is Hexokinase. The protein will add a phosphate group to glucose by using a phosphate from ATP. Next, Phosphoglucose isomerase changes glucose with the added phosphate into fructose while retaining the phosphate. The third enzyme phosphofructokinase, catalyzes the fructose molecule, adding another phosphate group to the fructose molecule, creating Fructose-1,6-biphosphate. The fourth enzyme is Aldolase which splits the fructose molecule into two 3-carbom molecules. Triphosphate isomerase is the fifth enzyme that works only when glyceraldehyde is low. It converts DHAP into glyceraldehyde(khan academy). The last four enzymes are important for building the two ATP molecules along with converting the changed carbon molecule that once was glucose into pyruvate.

**Why is Glycolysis Important?**

Glycolysis takes place in the cytoplasm of the cell. Most organisms require the use of glycolysis for the breakdown of glucose. This means that glycolysis is one of the oldest metabolic system used by organisms today. The importance of glycolysis transcends into the fact that glucose is the main source of energy for most organisms. It is also the preliminary step for cellular respiration.

Conclusion

Glycolysis is one of the many pathways that organism use to acquire energy. However, it is the only pathway that breaks down glucose into two pyruvate molecules, two ATP molecules, and two NADH molecules. It is included in cellular respiration as the first step for ATP production and one of earliest forms of acquiring energy by organisms. Glycolysis serves as a key process for survival as it is the only source of ATP from glucose. Therefore, understanding the importance of Glycolysis highlights how crucial the metabolism’s role for survival and showing relativity between Prokaryotes and Eukaryotes as both use glycolysis.

**Key Term**

Anaerobic- a process that doesn’t require the use of oxygen for energy

Catabolic- A chemical reaction that involves the breaking down of molecules in order to create energy.

Cellular respiration- A series of metabolic reactions that involves the breakdown of food into molecules (ATP) that are converted into energy for cellular processes.

Cytoplasm- Also known as the cytosol, is a gelatinous field in the cell membrane that consists of ion, cellular molecules, and organelles. Numerous cellular processes take place inside the cytoplasm like Mitosis, Glycolysis, and Protein synthesis.

Enzyme- A specific type of protein that catalyze or speed up chemical reactions in the cell.

Glycolysis – A ten step process where glucose is broken down into two 3-carbon molecules called pyruvate while also producing a net of two ATP molecules, and two NADH molecules.

Metabolism- A series of chemical reactions in an organism that provides energy for maintaining survival for an organism

References

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