**NTD 206 ASSIGNMENT: GLYCOLYSIS, KREBBS CYCLE AND ELECTRON TRANSPORT CHAIN**

**HUMAN BIOCHEMISTRY AND NUTRITION**

**SCHOLASTICA IGHAGBON**

**18/MHS04/002**

**QUESTION ONE: DESCRIBE THE GLYCOLYTIC PATHWAY**

The glycolytic pathway is one of the body's important metabolic pathways. It involves a sequence of enzymatic reactions that break down glucose (glycolysis) into pyruvate, creating the energy sources adenosine triphosphate (ATP) and nicotinamide adenine dinucleotide (NADH).

Glycolysis, which translates to "splitting sugars", is the process of releasing energy within sugars. In glycolysis, a six-carbon sugar known as [glucose](https://www.thoughtco.com/pathway-most-atp-per-glucose-molecule-608200) is split into two molecules of a three-carbon sugar called pyruvate. This multistep process yields two ATP molecules containing [free energy](https://www.thoughtco.com/definition-of-free-energy-605148), two pyruvate molecules, two high energy, electron-carrying molecules of NADH, and two molecules of water.

Glycolysis can occur with or without oxygen. In the presence of oxygen, glycolysis is the first stage of [cellular respiration](https://www.thoughtco.com/cellular-respiration-process-373396). In the absence of oxygen, glycolysis allows [cells](https://www.thoughtco.com/types-of-cells-in-the-body-373388) to make small amounts of ATP through a process of fermentation.

Glycolysis takes place in the cytosol of the cell's [cytoplasm](https://www.thoughtco.com/cytoplasm-defined-373301). A net of two ATP molecules are produced through glycolysis (two are used during the process and four are produced.) Learn more about the 10 steps of glycolysis below.

## **Step 1**

The enzyme **hexokinase**phosphorylates or adds a phosphate group to glucose in a cell's [cytoplasm](https://www.thoughtco.com/cytoplasm-defined-373301). In the process, a phosphate group from ATP is transferred to glucose producing [glucose 6-phosphate](https://www.thoughtco.com/cellular-respiration-quiz-p2-4095507) or G6P. One molecule of ATP is consumed during this phase.

## **Step 2**

The enzyme **phosphoglucomutase**isomerizes G6P into its [isomer](https://www.thoughtco.com/definition-of-isomer-604539) fructose 6-phosphate or F6P. Isomers have the same [molecular formula](https://www.thoughtco.com/molecular-formula-definition-606378) as each other but different atomic arrangements.

## **Step 3**

The kinase **phosphofructokinase** uses another ATP molecule to transfer a phosphate group to F6P in order to form fructose 1,6-bisphosphate or FBP. Two ATP molecules have been used so far.

## **Step 4**

The enzyme **aldolase** splits fructose 1,6-bisphosphate into a ketone and an aldehyde molecule. These sugars, dihydroxyacetone phosphate (DHAP) and glyceraldehyde 3-phosphate (GAP), are isomers of each other.

## **Step 5**

The enzyme **triose-phosphateisomerase** rapidly converts DHAP into GAP (these isomers can inter-convert). GAP is the substrate needed for the next step of glycolysis.

## **Step 6**

The enzyme **glyceraldehyde 3-phosphatedehydrogenase** (GAPDH) serves two functions in this reaction. First, it dehydrogenates GAP by transferring one of its hydrogen (H⁺) molecules to the [oxidizing agent](https://www.thoughtco.com/definition-of-oxidizing-agent-605459) nicotinamide adenine dinucleotide (NAD⁺) to form NADH + H⁺.

Next, GAPDH adds a phosphate from the cytosol to the oxidized GAP to form 1,3-bisphosphoglycerate (BPG). Both molecules of GAP produced in the previous step undergo this process of dehydrogenation and phosphorylation.

## **Step 7**

The enzyme **phosphoglycerokinase** transfers a phosphate from BPG to a molecule of ADP to form ATP. This happens to each molecule of BPG. This reaction yields two 3-phosphoglycerate (3 PGA) molecules and two ATP molecules.

## **Step 8**

The enzyme **phosphoglyceromutase** relocates the P of the two 3 PGA molecules from the third to the second carbon to form two 2-phosphoglycerate (2 PGA) molecules.

## **Step 9**

The enzyme **enolase** removes a molecule of [water](https://www.thoughtco.com/why-is-water-a-polar-molecule-609416) from 2-phosphoglycerate to form phosphoenolpyruvate (PEP). This happens for each molecule of 2 PGA from Step 8.

## **Step 10**

The enzyme **pyruvatekinase** transfers a P from PEP to ADP to form pyruvate and ATP. This happens for each molecule of PEP. This reaction yields two molecules of pyruvate and two ATP molecules.

**QUESTION 2: COMPUTE THE STOICHIOMETRY OF COENZYME REDUCTION AND ATP FORMATION IN THE AEROBIC OXIDATION OF GLUCOSE VIA GLYCOLYSIS, THE PRIVATE DEHYDROGENASE COMPLEX REACTION, THE CITRIC ACID CYCLE, AND THE OXIDATIVE PHOSPHORYLATION USING 1 NADH = 3 ATP AND 1 FADH2 = 2 ATP**

REACTION ENERGY FORMED NO OF ATP

Glucose glucose 6-phosphate -1 ATP -1

Fructose 6-phosphate fructose 1,6-bisphosphate -1 ATP -1

2 Glyceraldehyde 3-phosphate

2 1,3-bisphosphoglycerate 2 NADH 6

2 1,3-Bisphosphoglycerate 2 3-phosphoglycerate 2 ATP 2

2 Phosphoenolpyruvate 2 pyruvate 2 ATP 2

2 Pyruvate 2 acetyl-CoA 2 NADH 6

2 Isocitrate 2 a-ketoglutarate 2 NADH 6

2 α-Ketoglutarate 2 succinyl-CoA 2 NADH 6

2 Succinyl-CoA 2 succinate 2 ATP (or 2 GTP) 2

2 Succinate 2 fumarate 2 FADH2 4

2 Malate 2 oxaloacetate 2 NADH 6 Total 38