Cell Respiration

January 30, 2009

Cellular Respiration

- Summary Reaction:

$$C_6H_{12}O_6 + 6O_2 \xrightarrow{\text{(enzymes)}} 6CO_2 + 6H_2O + \text{energy (ATP)}$$

2 Stages of Cellular Respiration

- Stage 1: Glucose is converted to pyruvate, producing a small amount of ATP and NADH.
- Stage 2: When oxygen is present, pyruvate and NADH are used to make a large amount of ATP.

Stage One: Breakdown of Glucose

- The primary fuel for cell respiration is glucose.
- Glucose is broken down in the cytoplasm during a process called glycolysis.
  - Glucose (a 6-carbon molecule) → 2 pyruvate (a 3-carbon molecule)

Stage Two: Production of ATP

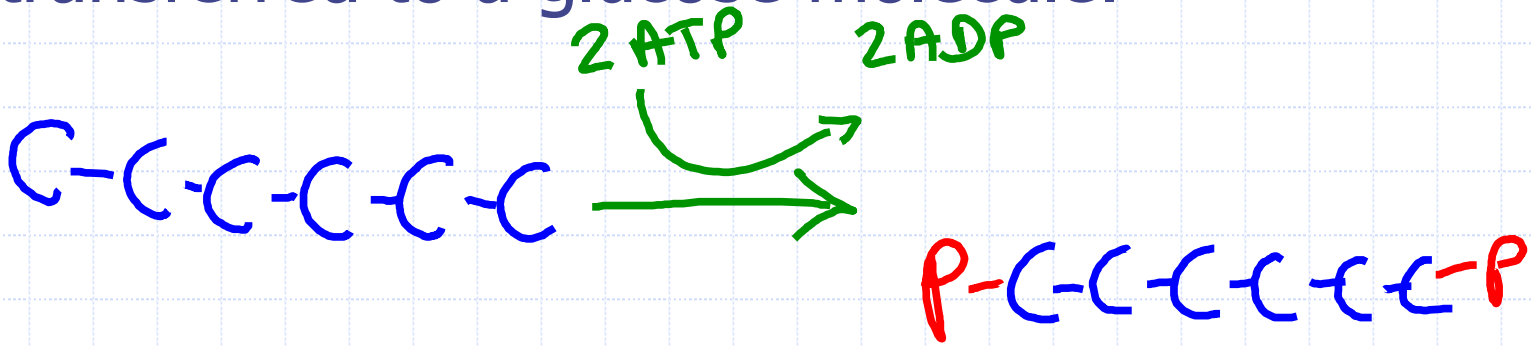
- Happens in the mitochondrion
- Pyruvate is converted to a 2-carbon molecule finally forming acetyl-CoA
- Acetyl-CoA enters a series of enzyme assisted reactions called the Krebs Cycle.

Stage One – *a closer look*

- Glycolysis – an enzyme-assisted anaerobic process where glucose is broken down in the cytoplasm.
  - *Anaerobic – without oxygen*
- Glycolysis yields a net gain of two ATP molecules.

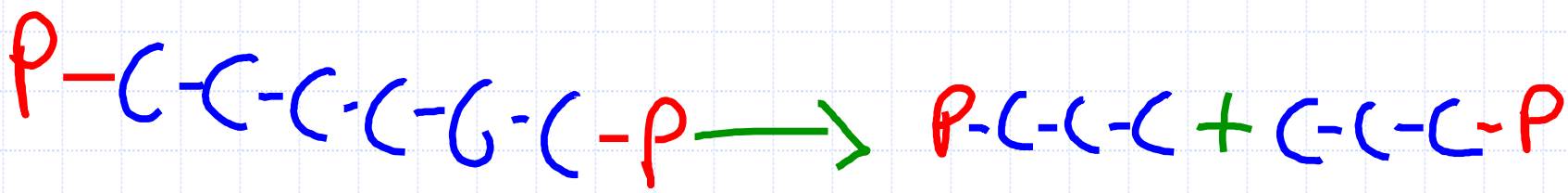
Glycolysis

Step 1 – In a series of 3 rxns, phosphate groups from 2 ATP molecules are transferred to a glucose molecule.



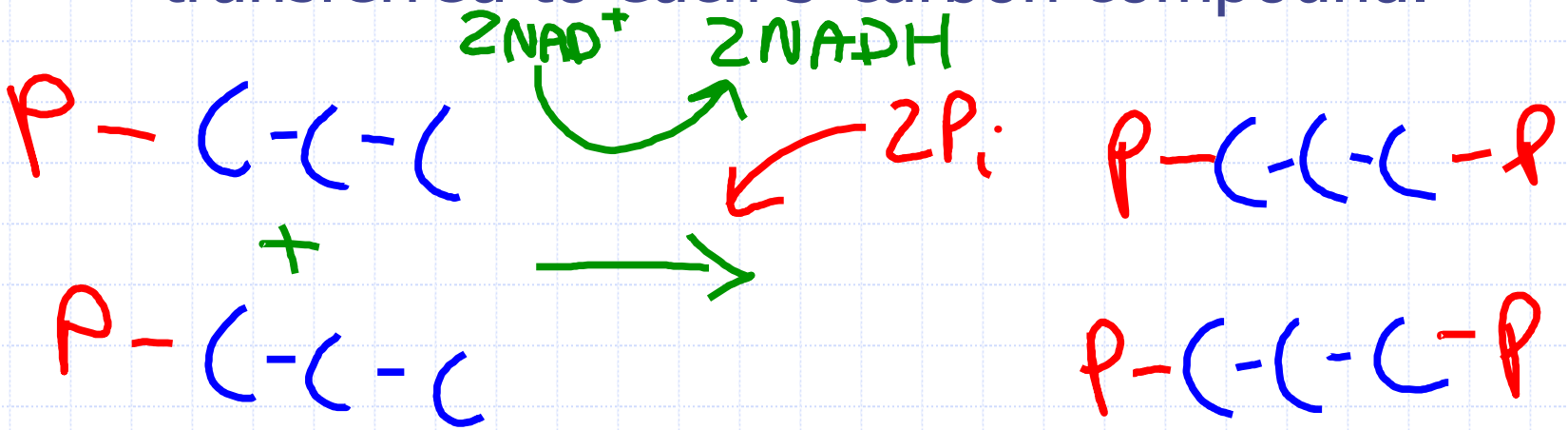
Glycolysis

Step 2 – In two rxns, the resulting 6-carbon compound is broken down to two 3-carbon compounds, each with a phosphate group.



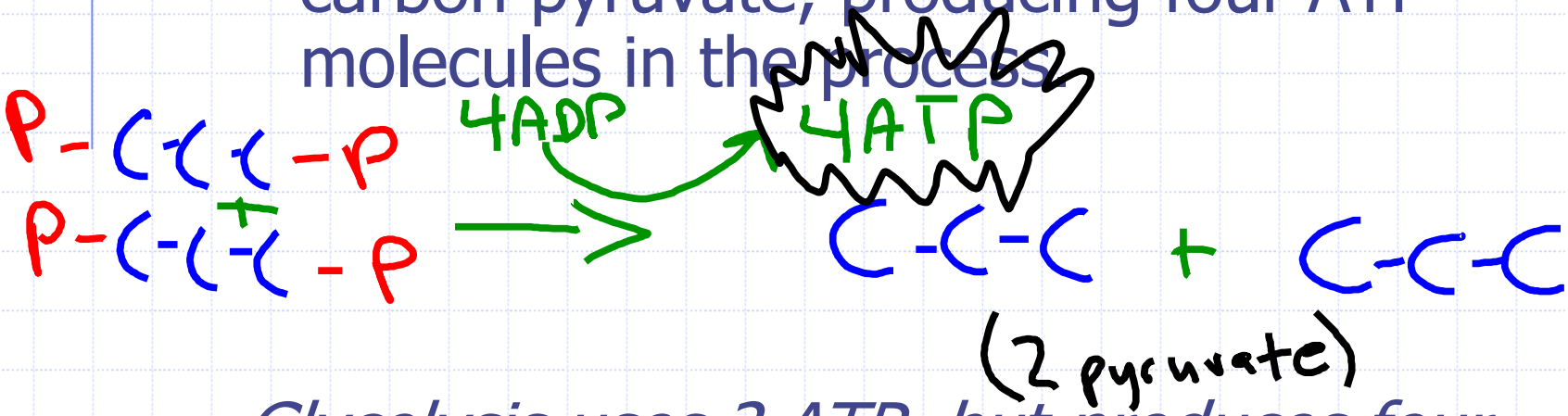
Glycolysis

Step 3 – Two NADH molecules are produced, and one more phosphate group is transferred to each 3-carbon compound.



Glycolysis

Step 4 – In a series of four rxns, each 3-carbon compound is converted to a 3-carbon pyruvate, producing four ATP molecules in the process.



Glycolysis uses 2 ATP, but produces four ATP, resulting in a net gain of 2 ATP.

Stage Two – *a closer look*

- When oxygen is present, pyruvate produced during glycolysis enters a mitochondrion and is converted to a 2-carbon compound.

Krebs Cycle

- Acetyl-CoA enters a series of enzyme-assisted reactions through the Krebs Cycle resulting in NADH and $FADH_2$ (holding energy to be used in the E.T. C.), CO_2 (waste)
  - Summary Reaction:

$$\text{Acetyl-CoA} + 3NAD^+ + FAD^+ + ADP + P_i \rightarrow$$

$$CoA\text{-}SH + 3NADH + H^+ + FADH_2 + ATP + 2CO_2$$

Electron Transport Chain

- In aerobic (with oxygen) respiration, electrons donated to NADH and $FADH_2$ pass through an electron transport chain.
- At the end of the chain e^- and H^+ combine with O_2, forming H_2O.
- ATP is then produced

ATP Molecules

- The human body uses about 1 million molecules of ATP per cell per second.
- There are more than 100 trillion cells in the human body.
- That's about 1×10^{20} or 100,000,000,000,000,000,000 ATP molecules used in your body each second!