9-1 Chemical Pathways

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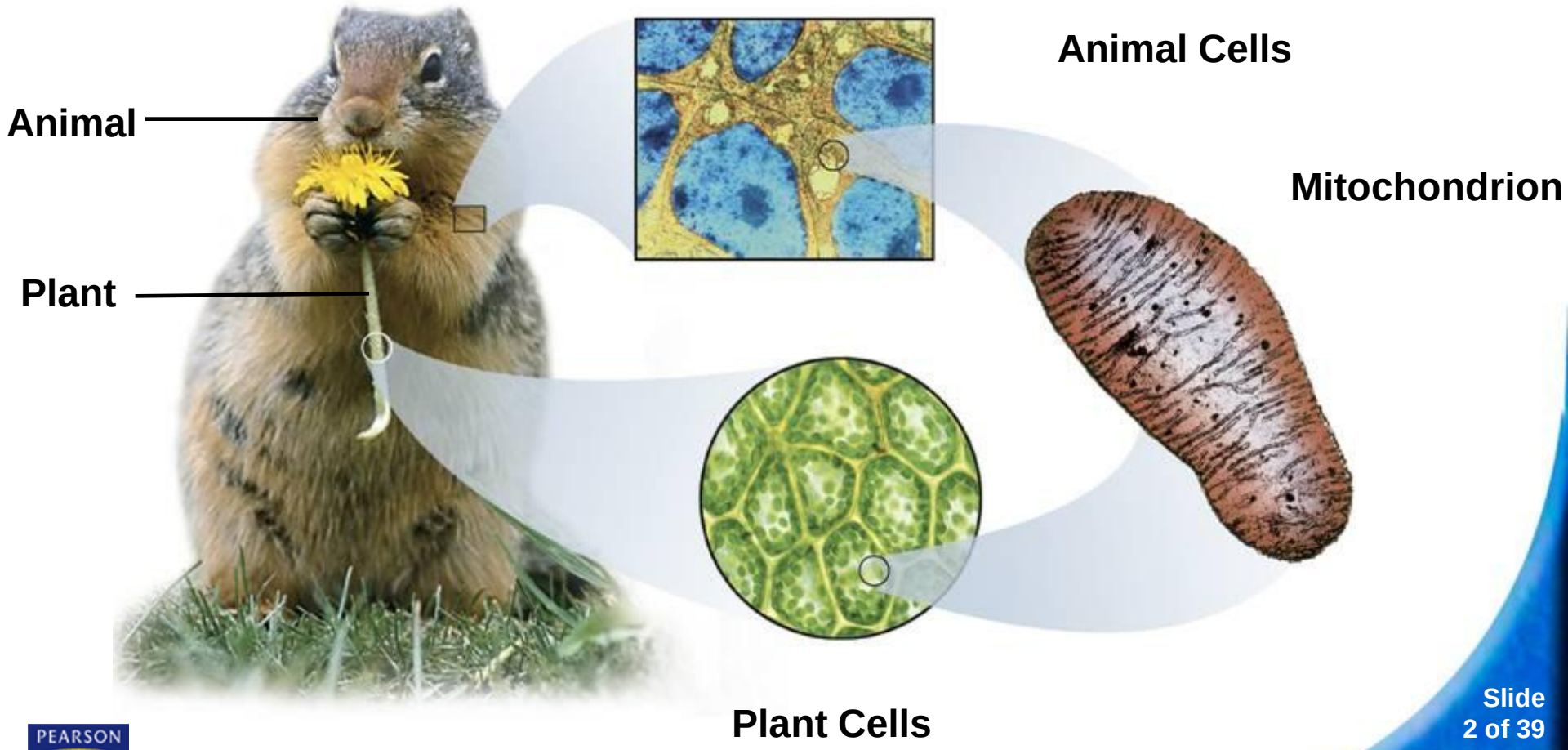
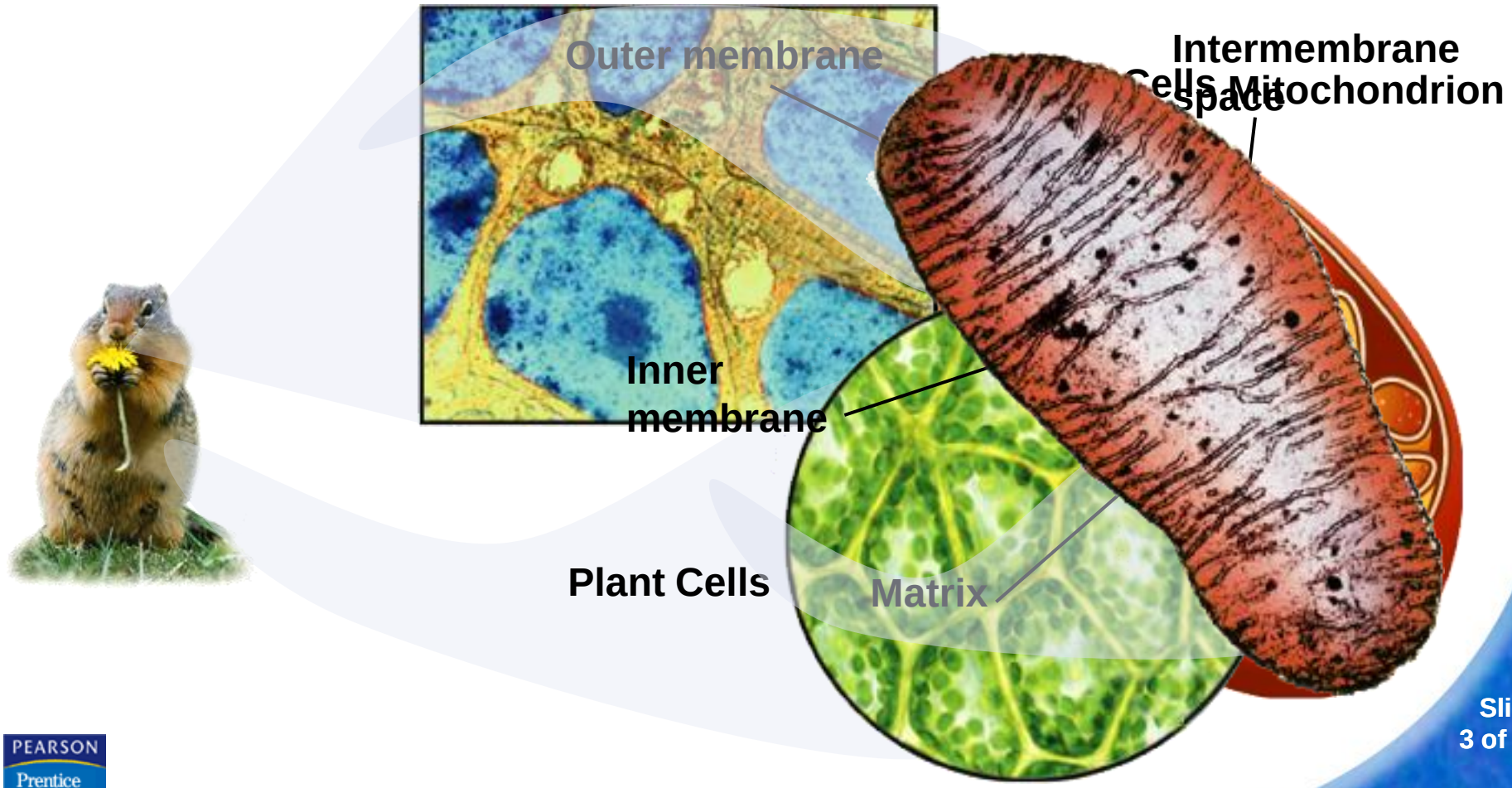
Food serves as a source of raw materials for the cells in the body and as a source of energy.



Both plant and animal cells carry out the final stages of cellular respiration in the mitochondria.



Chemical Energy and Food

One gram of $C_6H_{12}O_6$) when burned in the presence of oxygen, releases 3811 calories of heat energy.

A **calorie** is the amount of energy needed to raise the temperature of 1 gram of water 1 degree Celsius.

Cells don't “burn” glucose. They gradually release the energy with a pathway called **glycolysis**.

-releases a small amount of energy.

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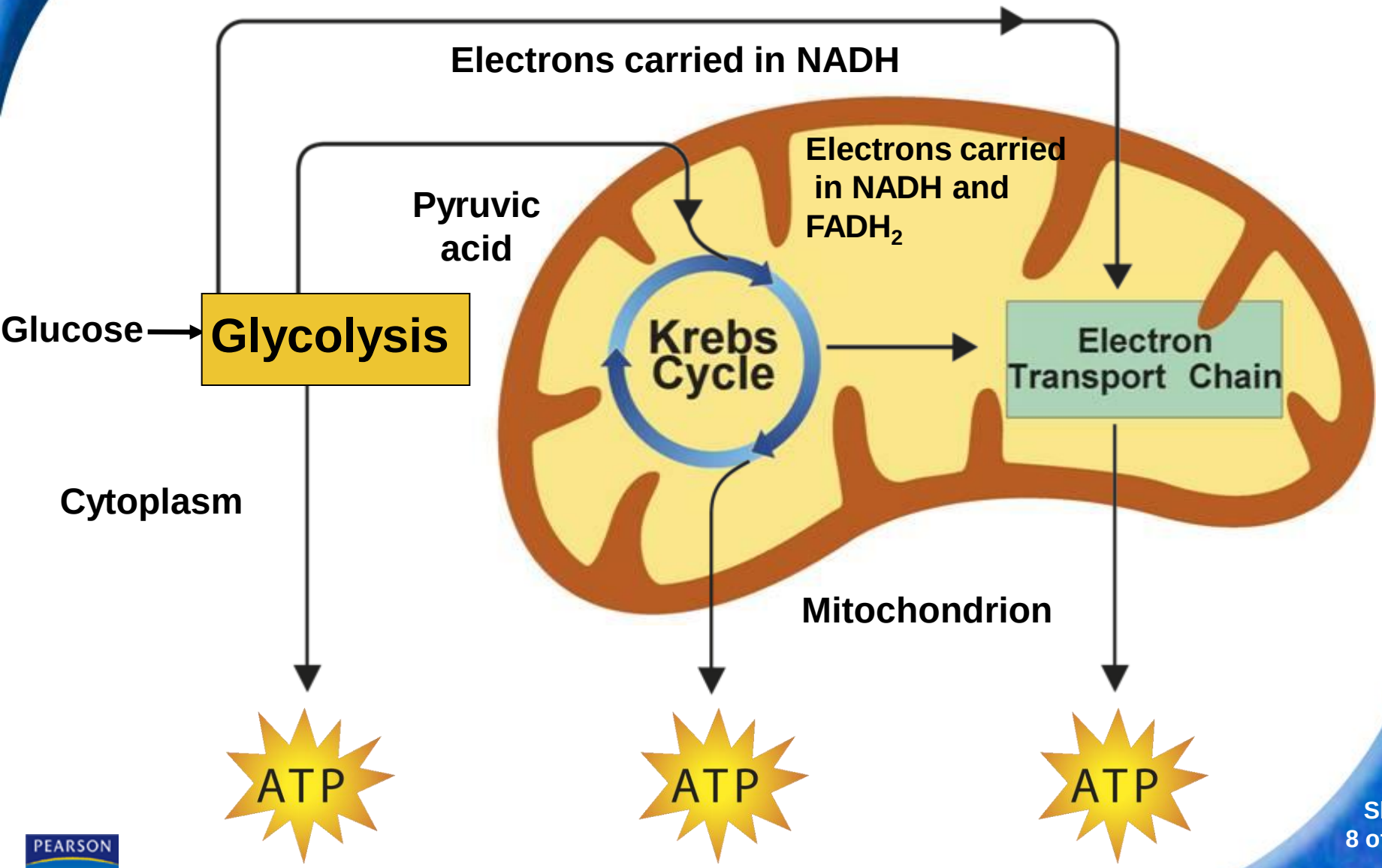
Overview of Cellular Respiration

If oxygen is present, glycolysis is followed by the Krebs cycle and the electron transport chain.

Glycolysis, the Krebs cycle, and the electron transport chain make up a process called **cellular respiration**.

Cellular respiration is the process that releases energy by breaking down glucose and other food molecules in the presence of oxygen.



The equation for cellular respiration is:

$$6O_2 + C_6H_{12}O_6 \rightarrow 6CO_2 + 6H_2O + \text{Energy}$$

oxygen + glucose → carbon dioxide + water + energy

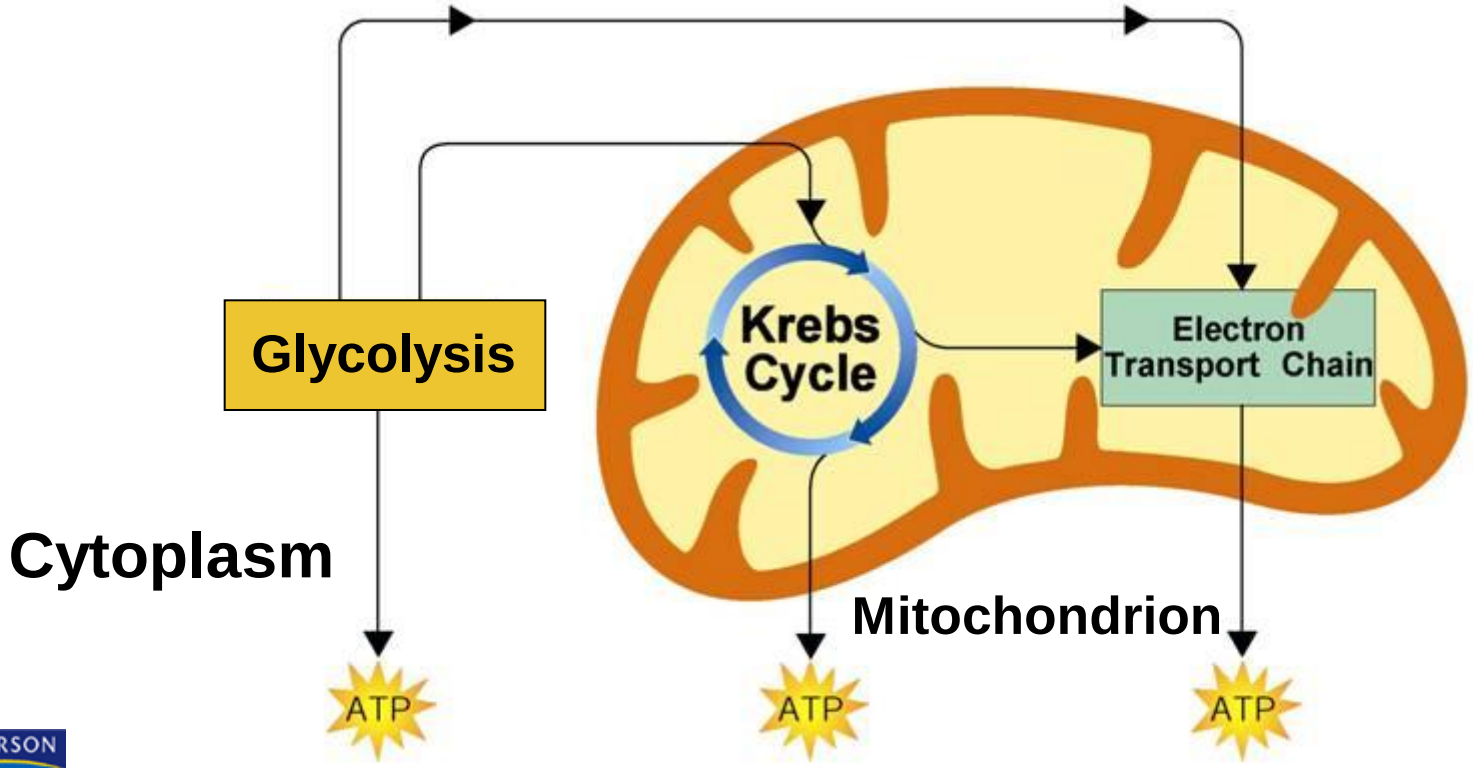
Each of the three stages of cellular respiration captures some of the chemical energy available in food molecules and uses it to produce ATP.

What happens during the process of glycolysis?

Glycolysis

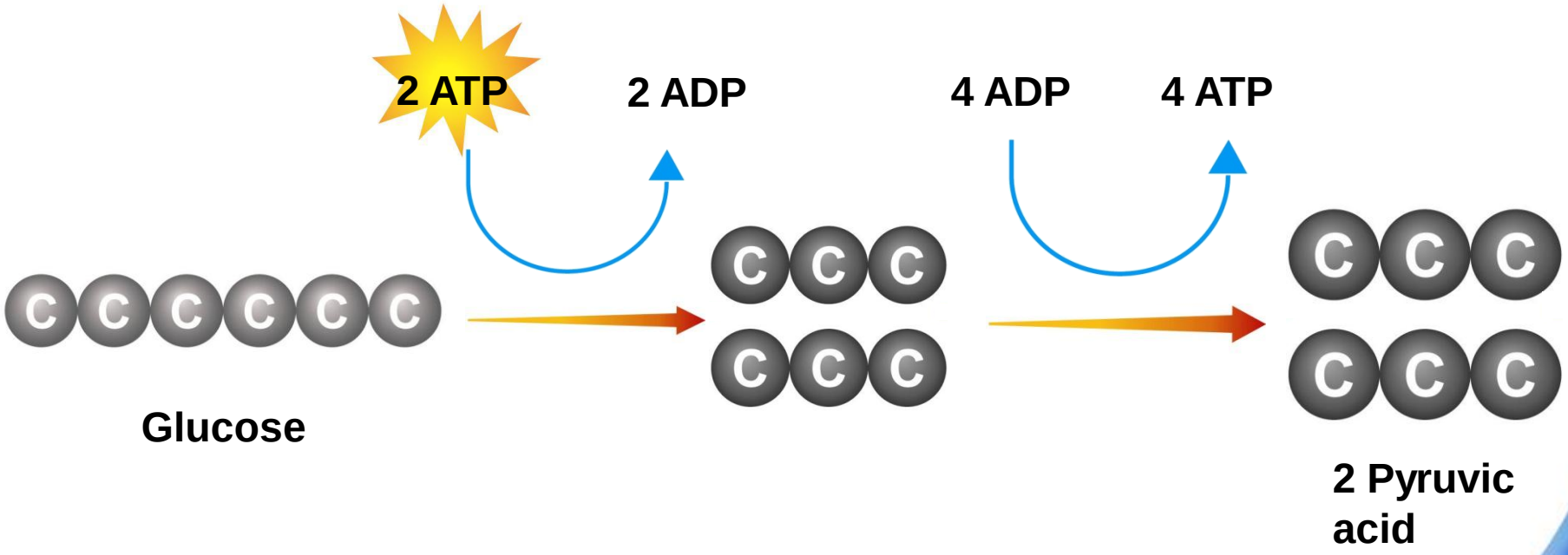
Glycolysis is the process in which one molecule of glucose is broken in half, producing two molecules of pyruvic acid, a 3-carbon compound.

Glycolysis takes place in the cytoplasm. The Krebs cycle and electron transport take place in the mitochondria.

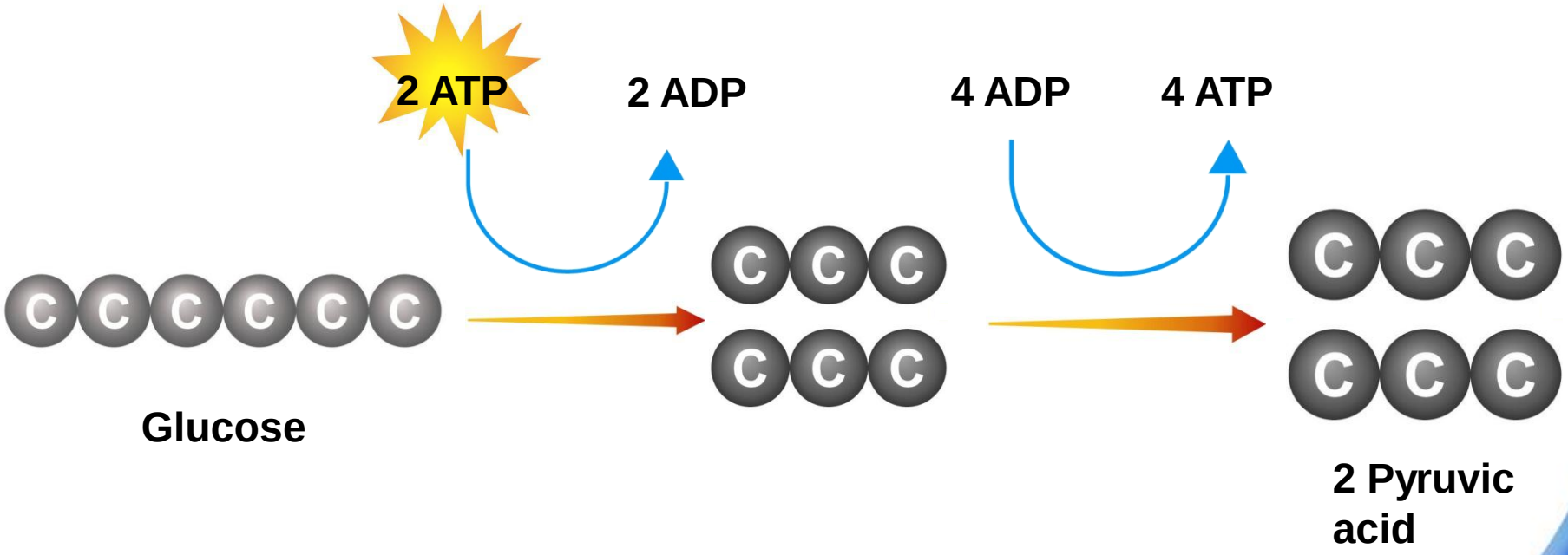


ATP Production

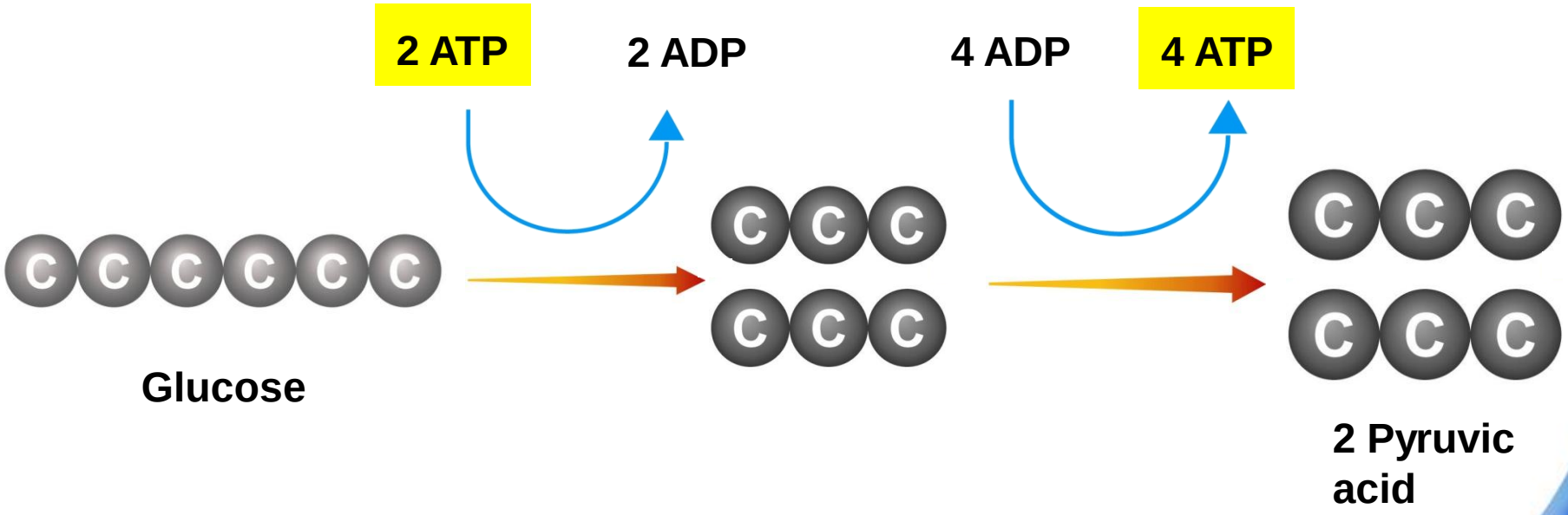
At the beginning of glycolysis, the cell uses up 2 molecules of ATP to start the reaction.



When glycolysis is complete, 4 ATP molecules have been produced.

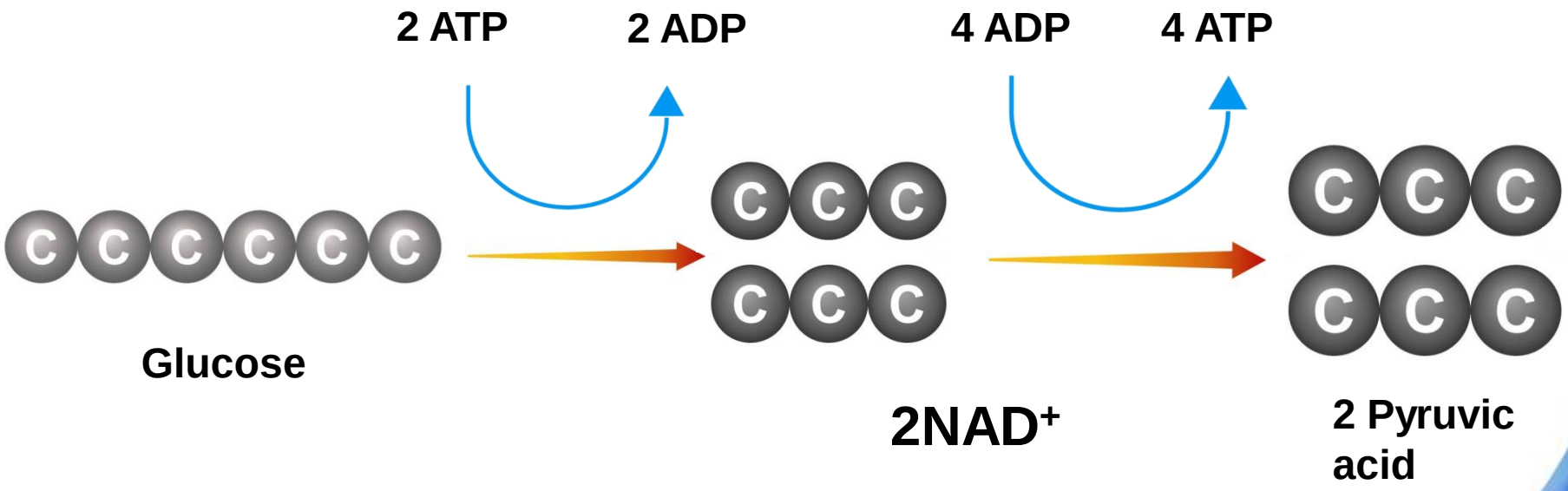


This gives the cell a net gain of 2 ATP molecules.

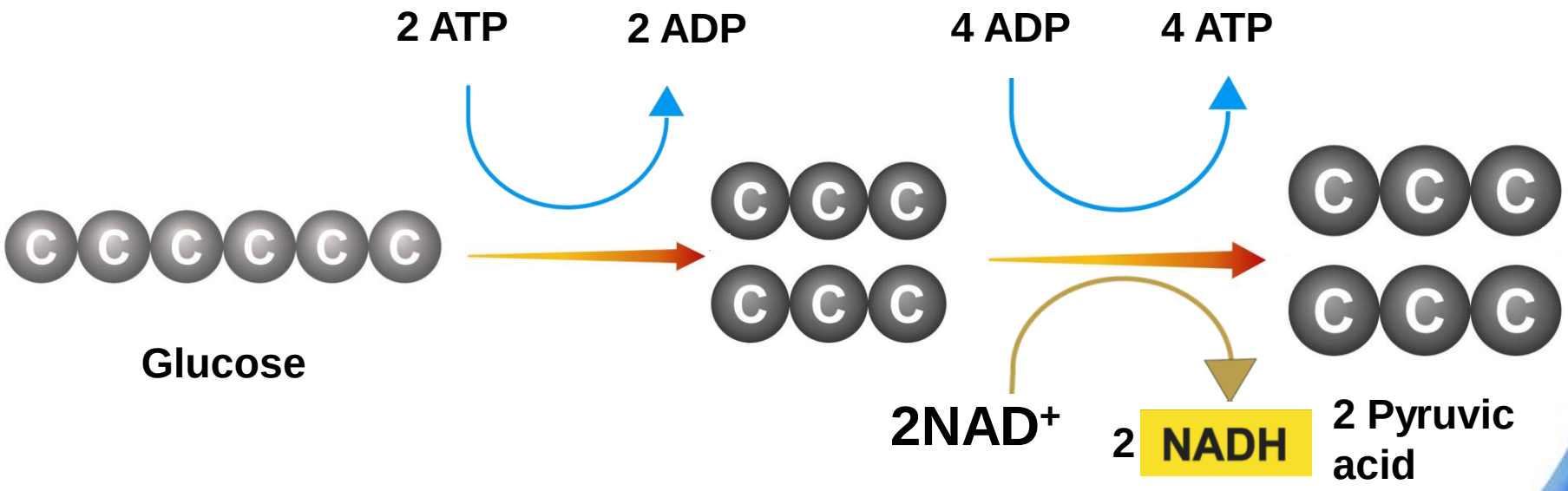


NADH Production

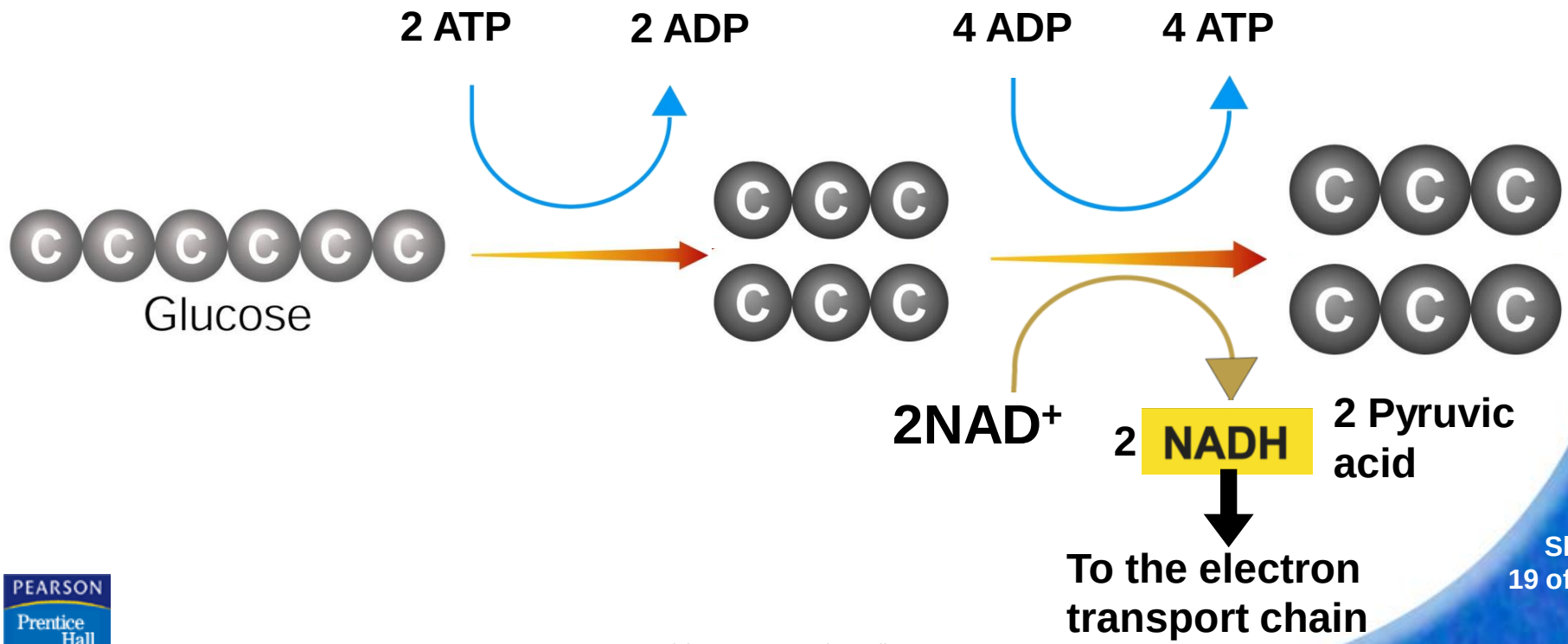
One reaction of glycolysis removes 4 high-energy electrons, passing them to an electron carrier called **NAD^+**.



Each NAD^+ accepts a pair of high-energy electrons and becomes an NADH molecule.



The NADH molecule holds the electrons until they can be transferred to other molecules.



The Advantages of Glycolysis

-so fast that cells can produce thousands of ATP molecules in a few milliseconds.

-does not require oxygen.

Fermentation

-oxygen is not present

-the combined process of this pathway and glycolysis is called fermentation.

Fermentation *releases energy from food molecules by producing ATP in the absence of oxygen.*

-cells convert NADH to NAD^+ by passing high-energy electrons back to pyruvic acid.

-converts NADH back into NAD^+, and allows glycolysis to continue producing a steady supply of ATP.

-does not require oxygen—**anaerobic**.

The two main types of fermentation are lactic acid fermentation and alcoholic fermentation.

Alcoholic Fermentation

-Primarily yeasts

-forming ethyl alcohol and carbon dioxide

The equation for alcoholic fermentation after glycolysis is:

pyruvic acid + NADH → alcohol + CO_2 + NAD^+

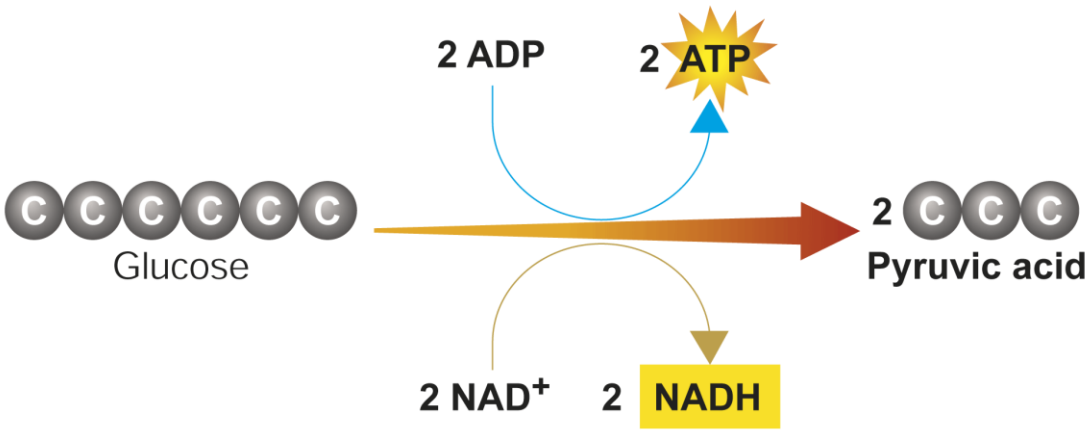
Lactic Acid Fermentation

-pyruvic acid that accumulates is converted to lactic acid.

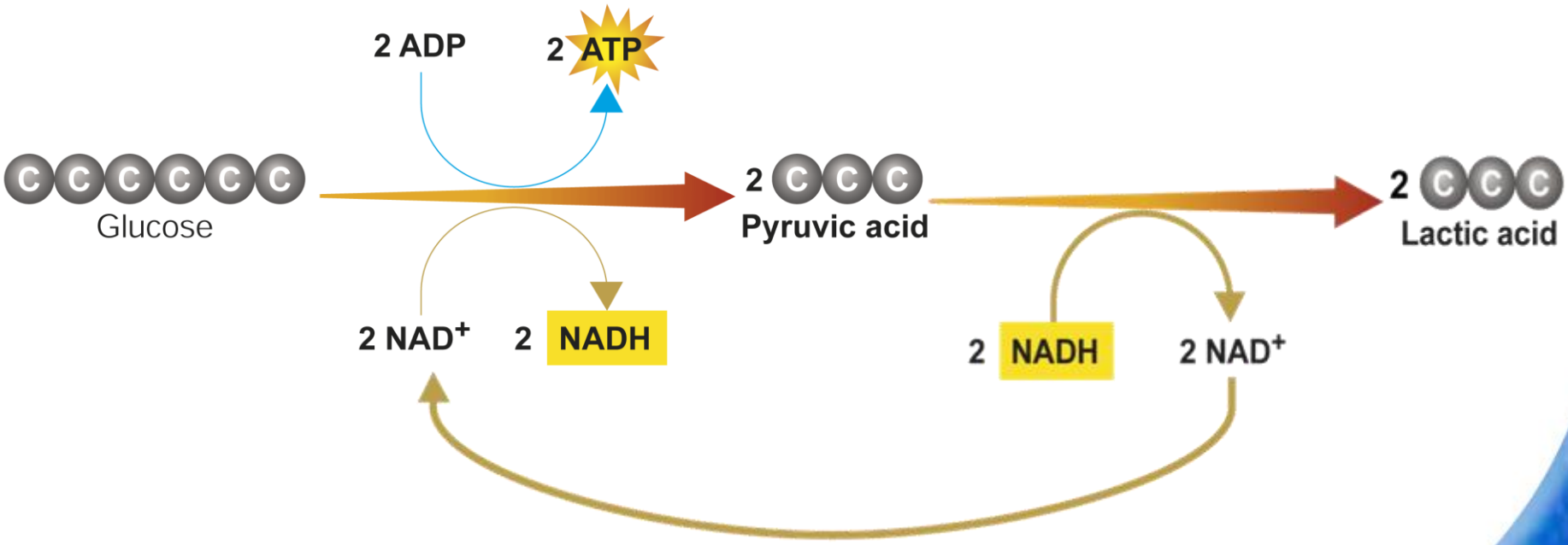
-It regenerates NAD^+ so that glycolysis can continue.

-converts glucose into lactic acid.

The first part of the equation is glycolysis.



The second part shows the conversion of pyruvic acid to lactic acid.



The NADH molecule holds the electrons until they can be transferred to other molecules.

By doing this, NAD^+ helps to pass energy from glucose to other pathways in the cell.

The equation for lactic acid fermentation after glycolysis is:

pyruvic acid + NADH → lactic acid + NAD^+

END OF SECTION