Cellular Respiration - Chapter 7 - Lesson 1 - Importance of Cellular Respiration

Remember:

- Photosynthesis occurs in plants and creates glucose and oxygen from CO_2 and H_2O

- We consume glucose in the form of carbohydrates and we breathe in oxygen from the air

- Our circulatory system carries glucose and oxygen to our cells

- All plant and animal cells use a molecule called adenosine triphosphate (ATP) for energy

Chemical Reaction for Cellular Respiration

- Cellular respiration is the opposite reaction from photosynthesis

Photosynthesis: $CO_2 + H_2O$ + solar energy → glucose ($C_6H_{12}O_6$) + O_2

Cellular Resp: glucose ($C_6H_{12}O_6$) + O_2 → $CO_2 + H_2O$ + energy (ATP)

- it occurs in all plant and animal cells

- Just like in photosynthsis, there are many steps to get from the reactants to the products

Role of ATP in the Cell- Read pgs 205-206

- It is ATP that cells use to provide energy for a variety of the cells functions

- Active transport is the use of ATP to move substances across the cell membrane

- The **sodium-potassium pump** is a very important type of active transport that is necessary to our nerve and muscle functioning

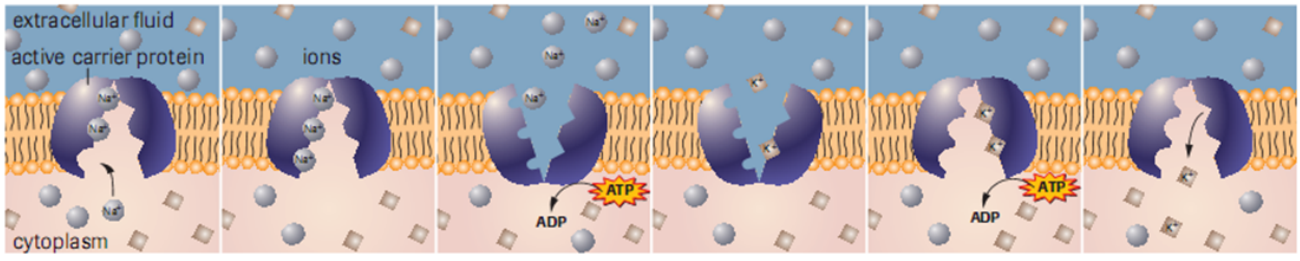

Figure 3
The energy of ATP is used to actively transport three sodium ions out of a cell for every two potassium ions that are transported into the cell.

Remember: our muscle cells use ATP to help the muscle fibers contract and relax

Glucose and ATP- Read pgs 207-208
- Our cells use glucose to make ATP in a series of steps called cellular respiration

- Read the money analogy for the relationship between glucose and ATP on pg 207.

Two types of Cellular Respiration- Read pgs 208 - 209
- There are two types of cellular respiration

1. Aerobic cellular respiration -

- Takes place in the presence of **oxygen**

- Mostly take place in the **mitochondria** of the cell (except glycolysis)

- Involves 4 stages

Stage 1 - Glycolysis
Stage 2 - Pyruvate oxidation
Stage 3 - The Krebs Cycle
Stage 4 - The electron transport chain and chemiosmosis

This equation summarizes aerobic respiration:

$$C_6H_{12}O_6 + 6\,O_2 + 36\,ADP + 36\,P_i \rightarrow 6\,CO_2 + 6\,H_2O + 36\,ATP$$

glucose + oxygen + ADP + inorganic phosphate → carbon dioxide + water + ATP

2. Anaerobic cellular respiration
- Takes place in the absence of **oxygen**

- All steps occur in the **cytoplasm** of the cell

- Takes place in two stages
Stage 1: **Glycolysis** Stage 2: **Fermentation**

- Two types of anaerobic cellular respiration which have different end products
  - **Alcohol** fermentation

  - **Lactic acid** fermentation

The equations below summarize the two types of anaerobic cellular respiration that occur in eukaryotes:

$$C_6H_{12}O_6 + 2\,ADP + 2\,P_i \rightarrow 2\,C_2H_5OH + 2\,CO_2 + 2\,ATP$$

glucose + ADP + inorganic phosphate → ethanol + carbon dioxide + ATP

$$C_6H_{12}O_6 + 2\,ADP + 2\,P_i \rightarrow 2\,C_3H_6O_3 + 2\,ATP$$

glucose + ADP + inorganic phosphate → lactic acid + ATP

Glycolysis - Read pgs 210 - 212

- The first step in both types of cellular respiration is a process called **glycolysis**

- Glycolysis occurs in the **cytoplasm** of the cell

- Glycolysis is Greek for "**sugar splitting**"

- At the end of glycolysis, glucose has been converted into 2, three-carbon sugars called **pyruvate**

- Glycolysis **uses** 2 ATP molecules to provide energy for the reaction to take place

- Glycolysis **makes** 4 ATP molecules and 2 high energy $NADH^+$ molecules

- glycolysis itself is an **anaerobic** process: it does not require oxygen

- The whole process of glycolysis actually occurs in 10 steps

    - Each step uses a different enzyme that helps break down the glucose molecule

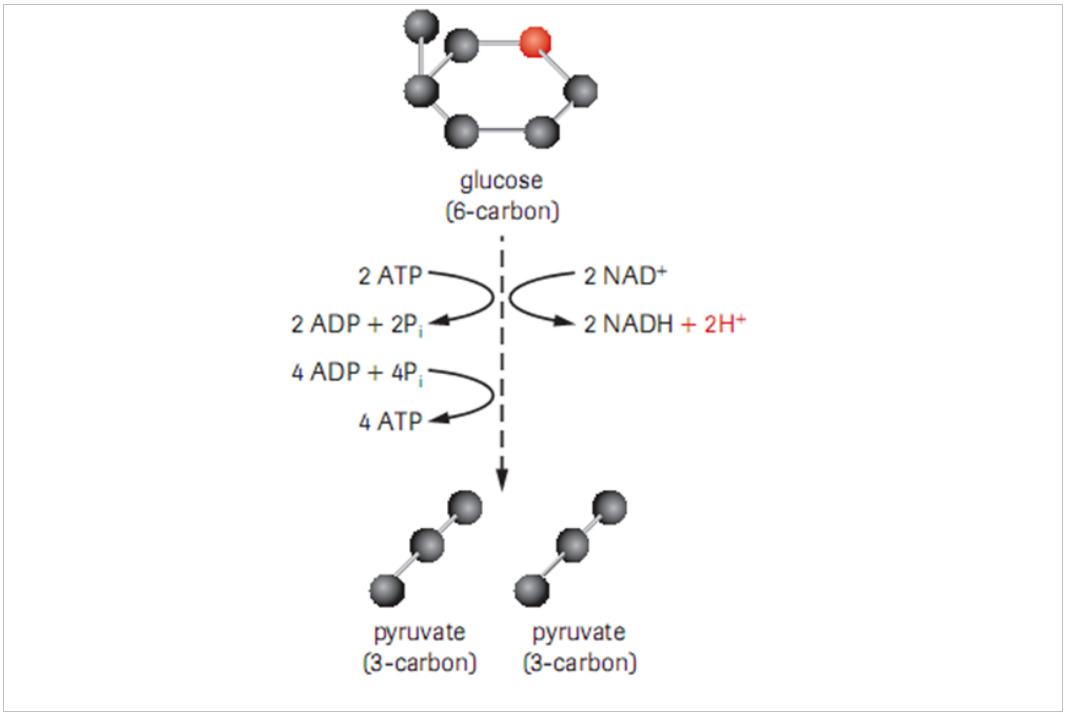

Table 1 The Reactants and Products of Glycolysis

Reactants	Products
glucose	2 pyruvate
2 NAD^+	2 NADH
2 ATP	2 ADP
4 ADP	4 ATP

The net equation for glycolysis is

$$1\ \text{glucose} + 2\ \text{ADP} + 2\ P_i + 2\ NAD^+ \rightarrow 2\ \text{pyruvate} + 2\ \text{ATP} + 2\ \text{NADH} + 2H^+$$

- The ATP produced is available for the cell to use as energy

- The NADH molecules go on to be used in other steps of cellular respiration

- There is still lots of energy still trapped in the pyruvate molecules that will be released in either aerobic or anaerobic cellular respiration

SUMMARY ***Glycolysis***

- Glycolysis occurs in the cytoplasm. It produces two 3-carbon pyruvate molecules from a 6-carbon glucose molecule. Glycolysis produces two ATP (net) and two NADH.
- The efficiency of glycolysis is only 2.2 % with most of the original energy of the glucose remaining in the pyruvate and NADH molecules.
- The net equation for glycolysis is

  $$1\ \text{glucose} + 2\ \text{ADP} + 2\ P_i + 2\ NAD^+ \rightarrow 2\ \text{pyruvate} + 2\ \text{ATP} + 2\ \text{NADH} + 2H^+$$

Assignment:

- pg 205 # 1
- pg 209 # 1-5
- pg 212 # 1-3

Lesson 1 – Review Questions

Read pages 204-212

1. What is the primary funcon of cellular respiraon?

2. How is ATP used in muscle contracon?

3. What are the characteriscs of glucose that make it well suited as an energy supply molecule within our bodies?

4. The conversion of glucose energy to ATP energy is less than 50 % efficient. In what way do birds and mammals take advantage of this inefficiency?

5. Briefly describe one cellular process that involves the use of acve transport. How is ATP involved in this process?

6. What are the four stages of aerobic respiraon?

7. Write an overall chemical equaon for glycolysis.

8. (a) What does glycolysis mean? (b) List the final products of glycolysis.

9. As a result of glycolysis, only a small poron of the energy of glucose has been converted to ATP. In what form is the rest of the usable energy found at this stage of the process?