Cellular Respiration
Chapter 9

Learning Targets

- I can identify the cellular sites of and follow through the major pathways of anaerobic and aerobic respiration.
- I can compare reactants and products for each process.
- I can account for how aerobic respiration produces more ATP per monosaccharide.

Energy Review

- **Energy Storing Molecules**
  - ATP, NADPH (NAD^+), FADH (FAD^+), $FADH_2$
- **ATP** supplies most of the energy that drives metabolism in living things
- ATP *releases* energy when converted into ADP

Cellular Respiration Overview

Chapter 9-1

- **Living things get most of the energy they need from glucose.**
  - Autrotrophs make glucose using photosynthesis
  - Heterotrophs get glucose from food they eat
- **Cellular Respiration**
  - The process that releases energy by breaking down glucose and other food molecules in the presence of oxygen.

Cellular Respiration Overview

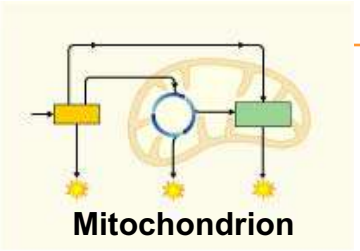
- Cellular Respiration Overall Equation

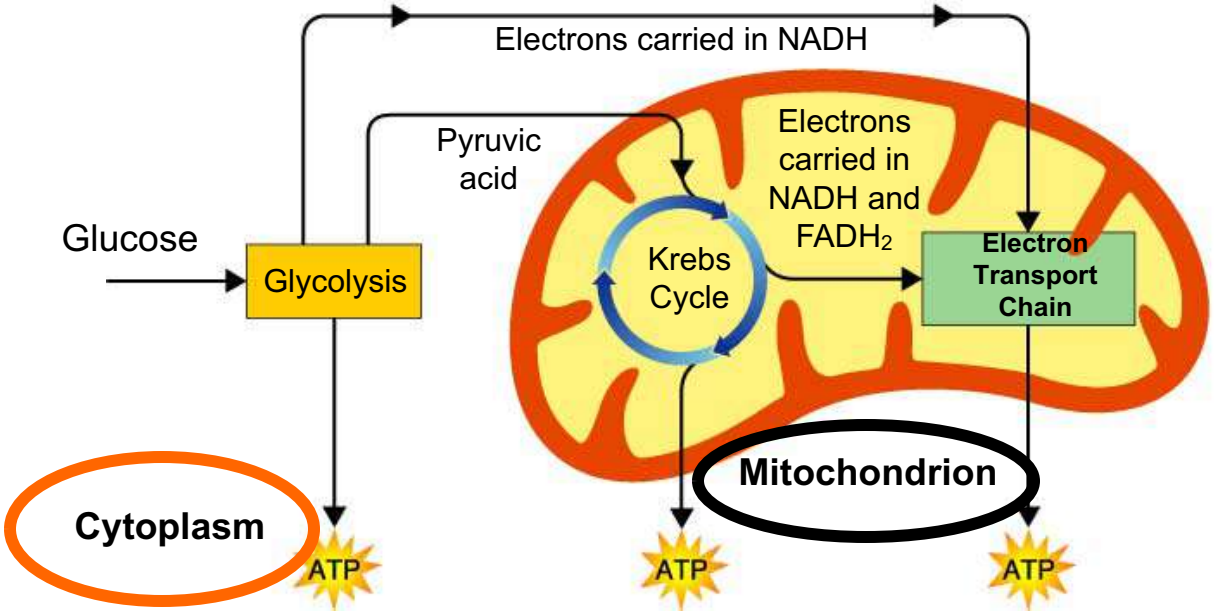
  $6O_2 + C_6H_{12}O_6 \rightarrow 6CO_2 + 6H_2O +$ Energy

- Three Stages
  - Glycolysis
  - Kreb's Cycle
  - Electron Transport Chain
- The Main form of Energy produced = ATP

Figure 9–2

Cellular Respiration: An Overview

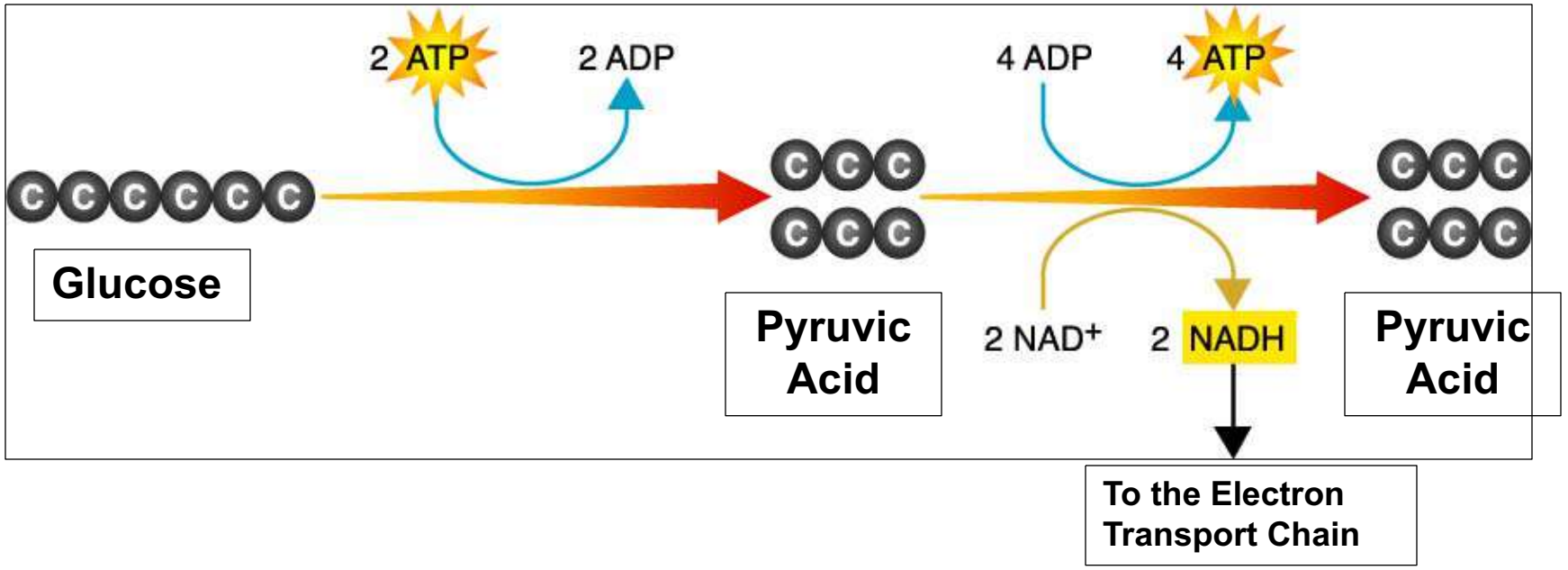




Glycolysis (Anaerobic)

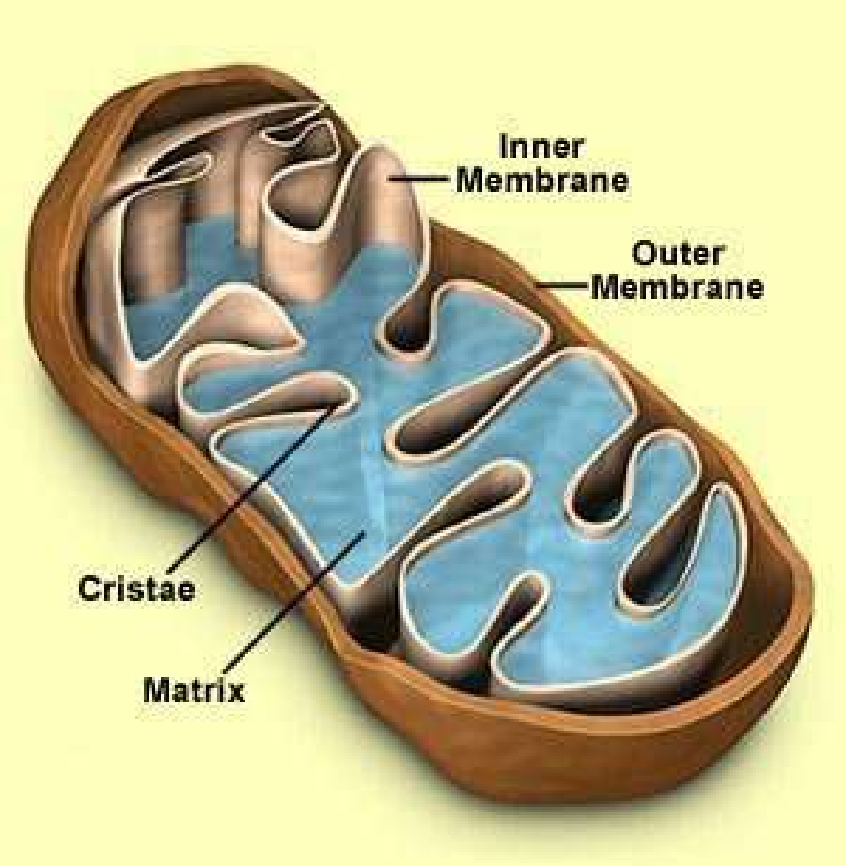
- Glyco = Glucoselysis = Breakdown
- Occurs in the cytoplasm of the cell
- Molecules of GLUCOSE are broken down into 2 molecules of Pyruvic Acid.
- Cell must use (invest) 2 ATP
- Produces Energy Carrier Molecules
  - 4 ATP
  - 2 NADH

Glycolysis


2 ATP
2 ADP
4 ADP
4 ATP
Glucose
Pyruvic Acid
Pyruvic Acid
2 NAD+
2 NADH
To the Electron Transport Chain

The "Mighty" Mitochondria

- The mitochondria is the organelle where the final stages of cellular respiration occurs.
  - Kreb's Cycle
  - Electron Transport Chain
- Cells that use a lot of energy have high numbers of mitochondria.
  - Example: Muscle cells in the heart!!



Kreb's Cycle

Chapter 9-2

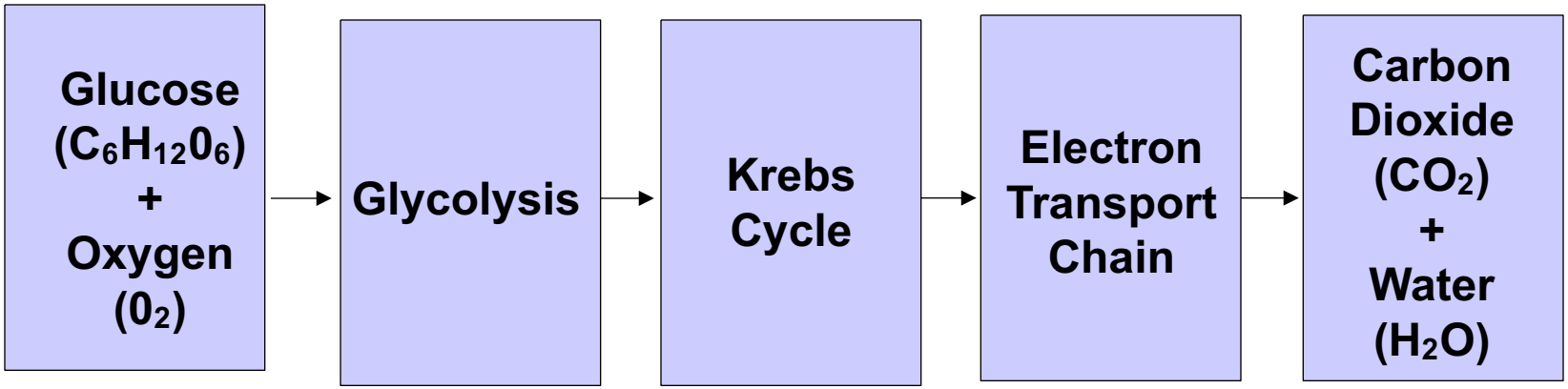
- Aerobic Process = Only if oxygen is present!!
- Occurs in the MATRIX of the mitochondria
- Pyruvic Acid from Glycolysis enters to form
  - 1 ATP
  - 3 NADH
  - 1 $FADH_2$
  - CO_2 *(which is released when we exhale!!)*
- AKA….Citric Acid Cycle

Electron Transport Chain

Chapter 9-2

- Energy carrier molecules produced during Glycolysis and the Kreb's Cycle enter the ETC
  - NADH
  - $FADH_2$
- Occurs in the folds of the Inner Membrane of the Mitochondria (Cristae)
- The electrons are passed down a chain of proteins until they reach the final electron acceptor…..oxygen!
  - So this step is aerobic (requires oxygen)
- The ETC produces 32 ATP and H_2O

Cellular Respiration Flowchart



What happens if

NO OXYGEN

is available??

The Kreb's Cycle and Electron Transport Chain can't function!!

These are anaerobic conditions!!

Fermentation

Chapter 9-1

- The cell can use Fermentation instead!!
- Occurs in the Cytoplasm
  - Just like glycolysis!!
- Fermentation
  - A series of reactions that convert NADH (from glycolysis) back into NAD allowing glycolysis to keep producing a small amount of ATP

2 Types of Fermentation

- Alcoholic Fermentation
  - Yeasts use this process to form ethyl alcohol and carbon dioxide as waste products.
    - This causes bread dough to rise
    - This is how some alcoholic beverages are made

Pyruvic Acid + NADH $\rightarrow$ alcohol + CO_2 + NAD+

Lactic Acid Fermentation

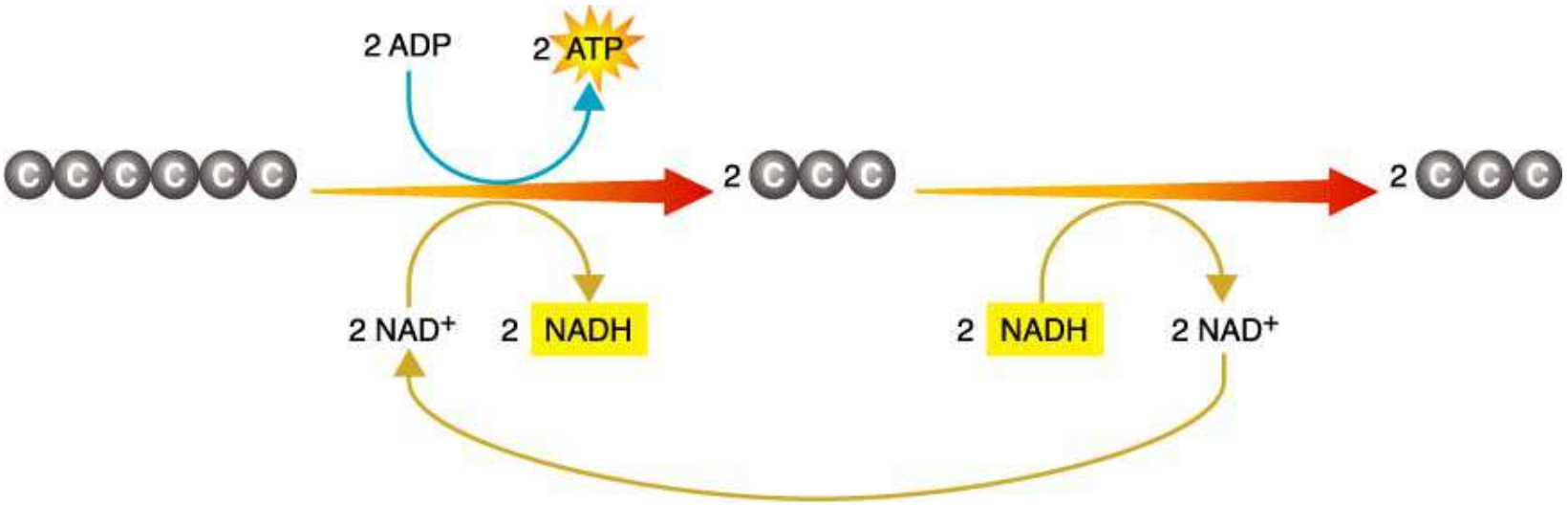
- Occurs in bacteria (unicellular organisms)
  - This is how cheese, yogurt, and pickles are made.
- Occurs in muscles during rapid exercise
  - When your body runs out of oxygen your muscle cells must produce some ATP using fermentation and glycolysis
  - Lactic Acid build-up causes muscle soreness or burning after intense activity.

Pyruvic Acid + NADH $\rightarrow$ lactic acid + NAD+

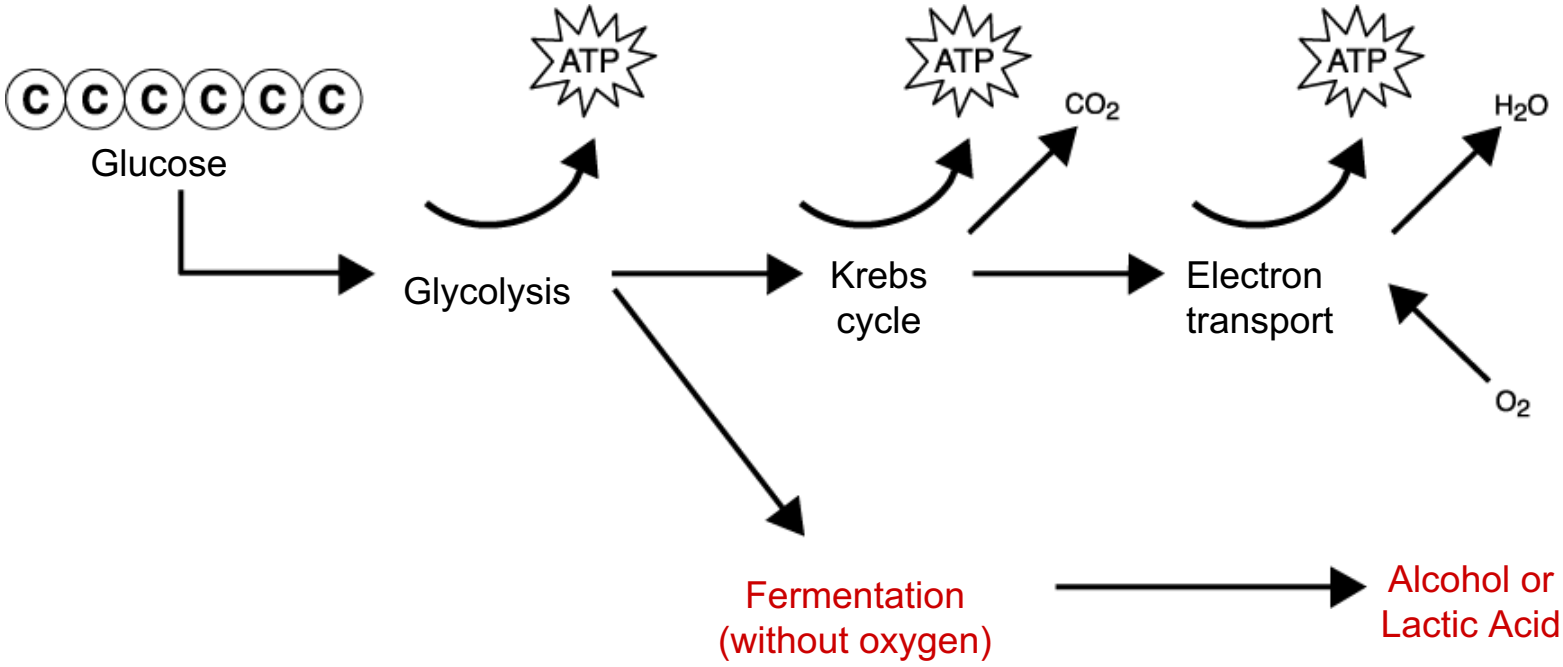
Fermentation Summary

Glycolysis: Glucose → 2 Pyruvic Acid

Fermentation: 2 Pyruvic Acid → ? or ?



Chemical Pathways



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