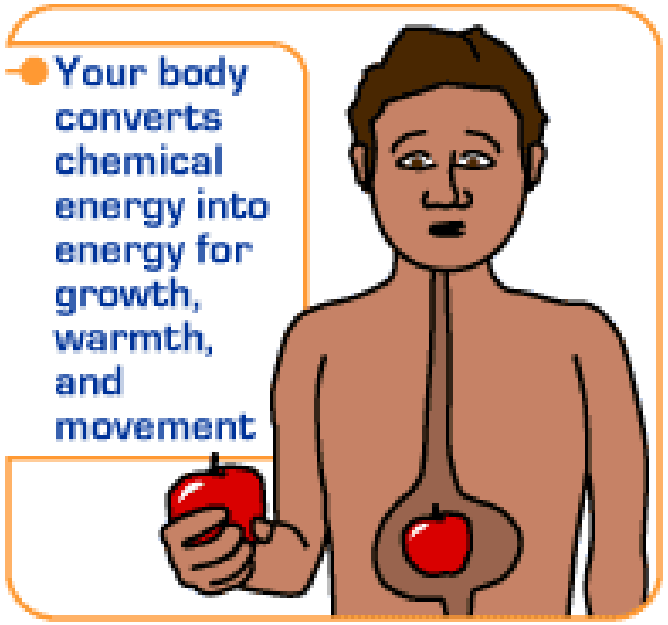
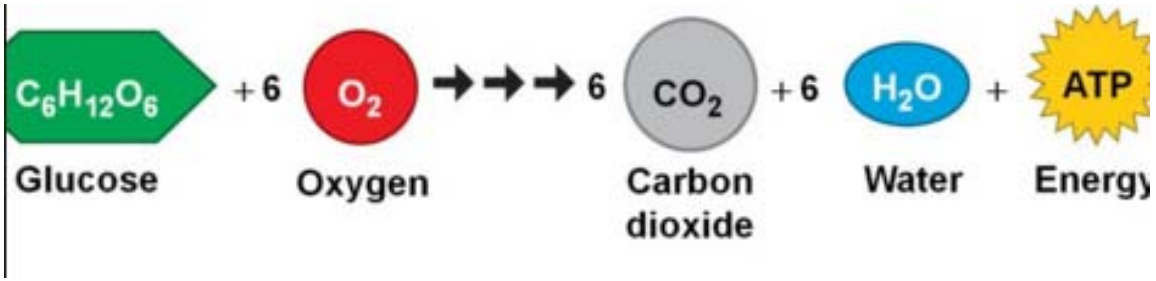
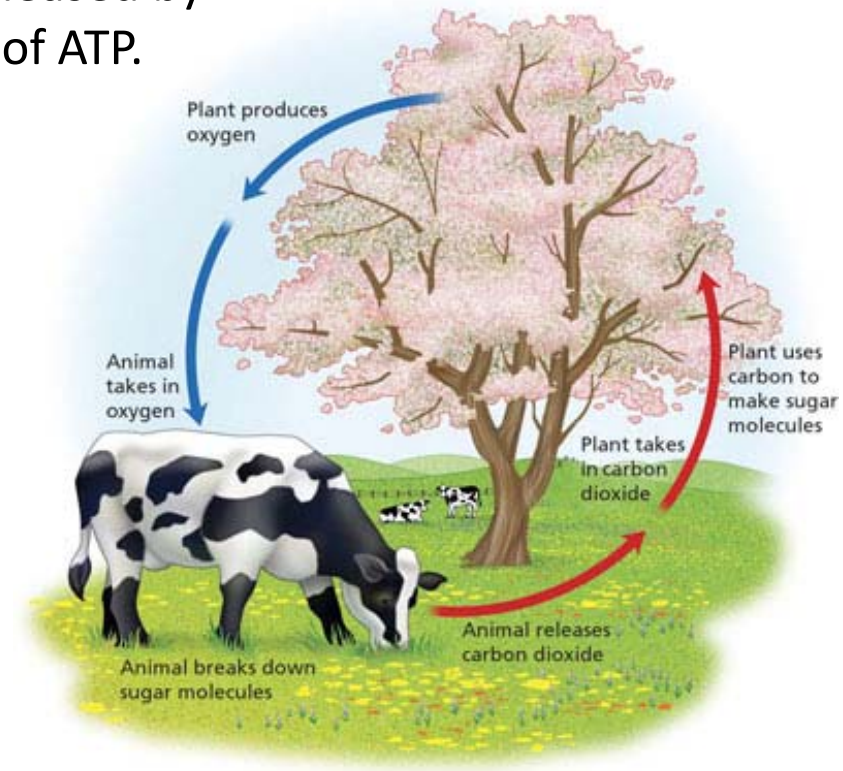
Cellular Respiration: (2 kinds—Aerobic and Anaerobic)

- Cellular respiration is the process by which the energy of **glucose** is **released** in the cell to be used for life processes (**movement, breathing, blood circulation**, etc…)



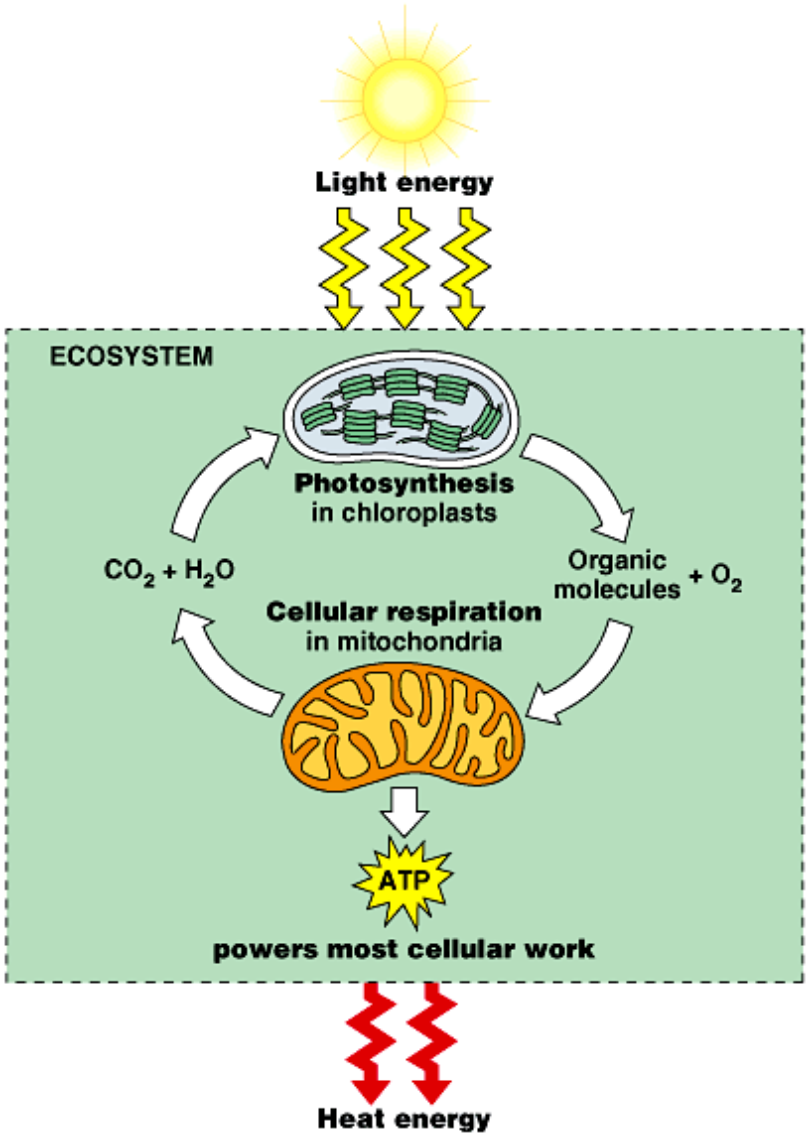


- Cells require a **constant source of energy** for life processes but keep only a **small amount** of **ATP** on hand. Cells can regenerate ATP as needed by using the **energy stored in foods** like glucose.
- The energy stored in glucose by photosynthesis is released by **cellular respiration** and repackaged into the energy of ATP.

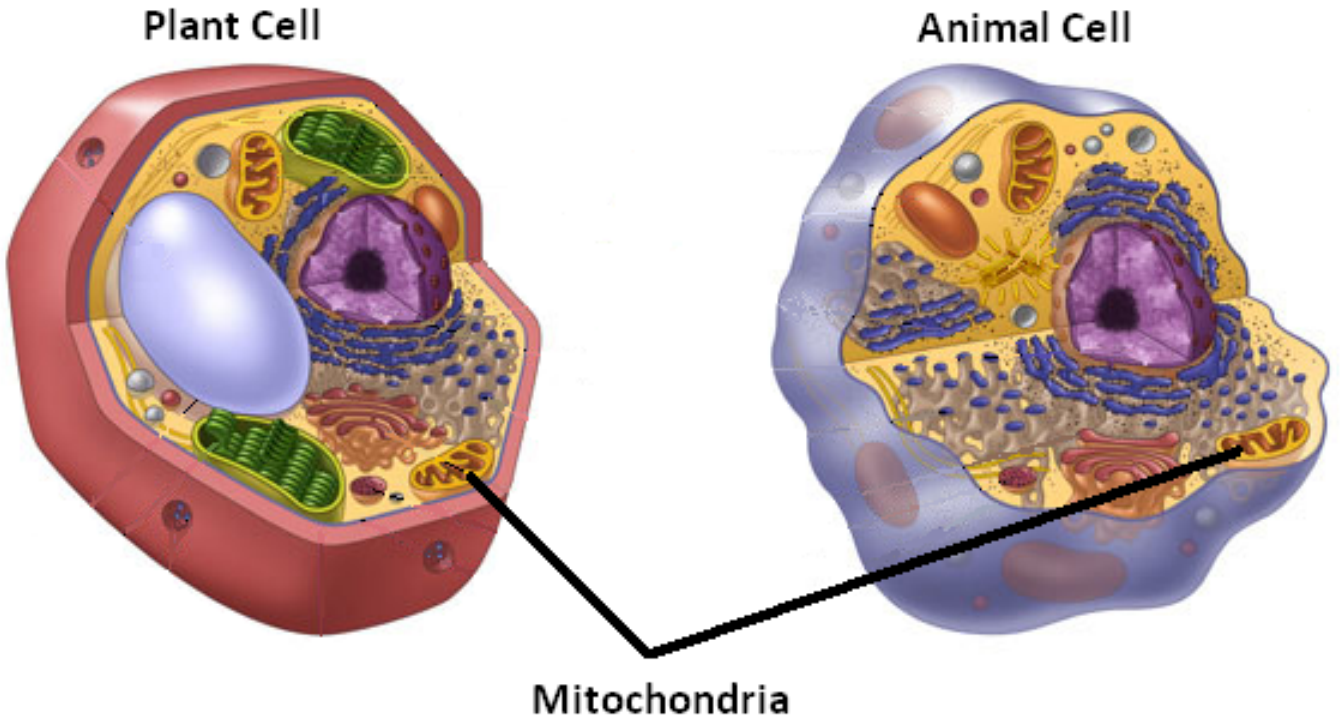


Snail Gizmo

https://www.explorelearning.com/index.cfm?method=cResource.dspView&ResourceID=641


Light energy
ECOSYSTEM
Photosynthesis
in chloroplasts
$CO_2 + H_2O$
Organic
molecules
$+ O_2$
Cellular respiration
in mitochondria
ATP
powers most cellular work
Heat energy

- Respiration occurs in **ALL cells** and can take place either **with or without oxygen** present.



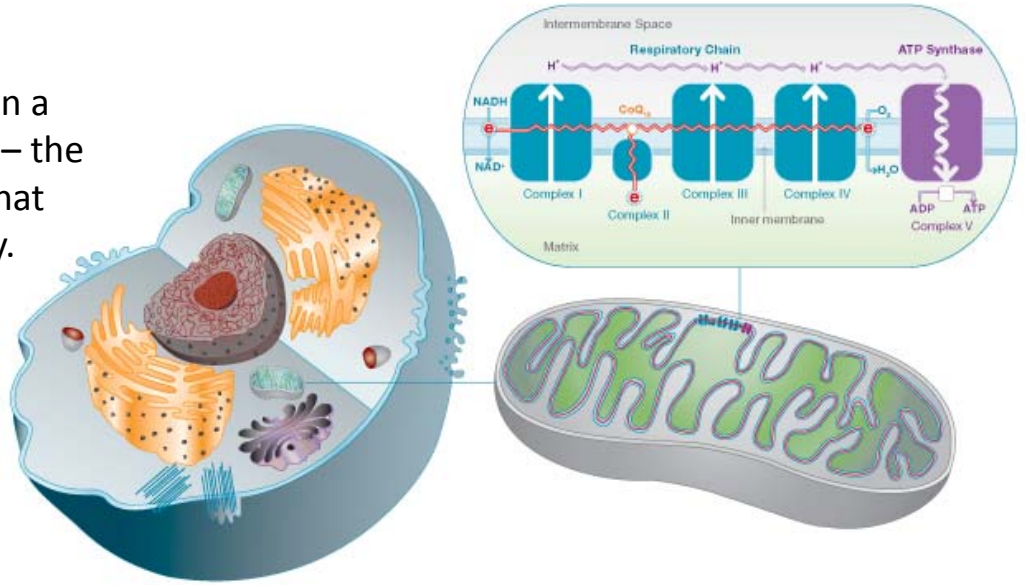
Aerobic Respiration: requires oxygen

- Occurs in the **mitochondria** of the cell
- Total of **36 ATP** molecules produced
- General formula for aerobic respiration:

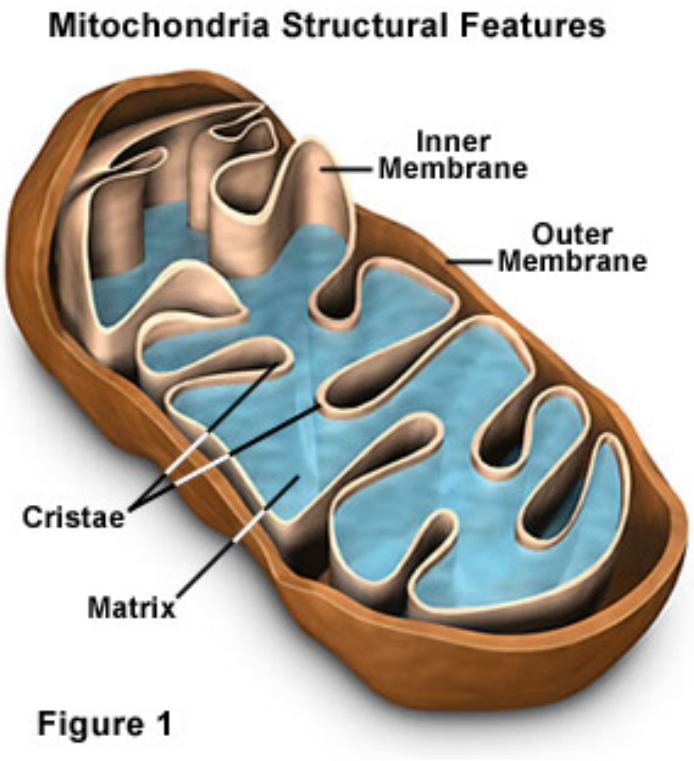
$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6\,CO_2 + 6H_2O + \mathbf{36\ ATP}$$

glucose + oxygen ⟶ carbon dioxide + water + energy

Human cells contain a specialized structure – the mitochondrion – that generates energy.

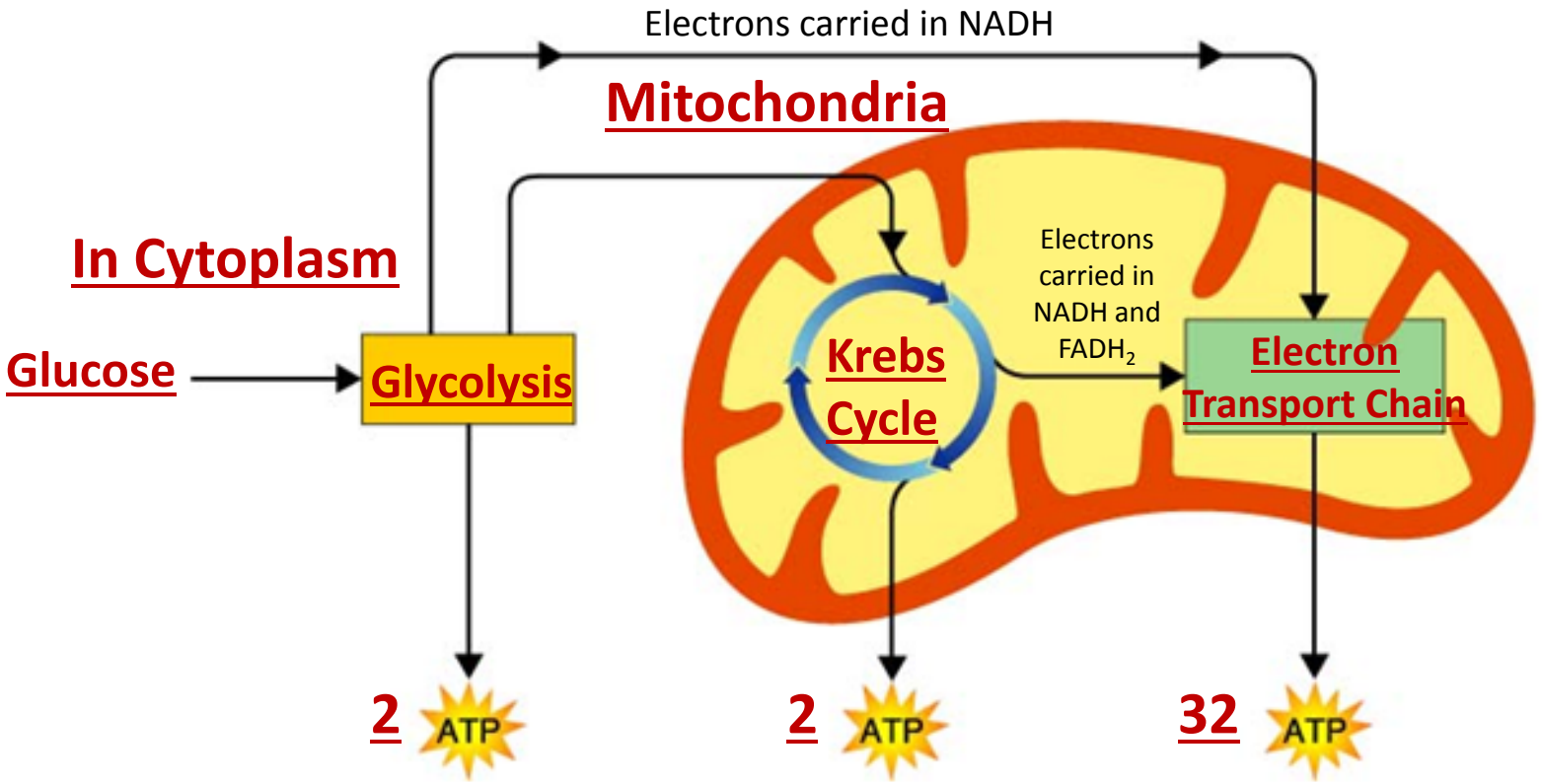


Aerobic Cellular Respiration Occurs in the Mitochondria



- **Cristae-** folding of the inner membrane
- **Matrix-** “cytosol”… similar to cytoplasm

- Diagram

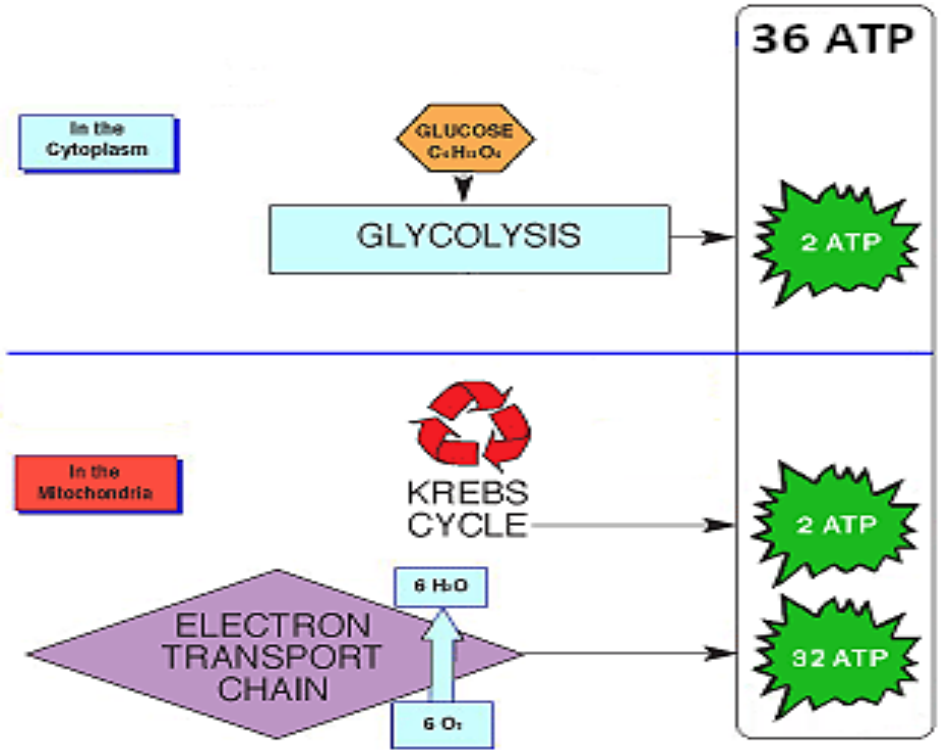

Electrons carried in NADH
Mitochondria
In Cytoplasm
Glucose
Glycolysis
Krebs Cycle
Electrons carried in NADH and $FADH_2$
Electron Transport Chain
2 ATP
2 ATP
32 ATP

Summary:

3 steps: 1st **Glycolysis**

2nd **Krebs cycle**

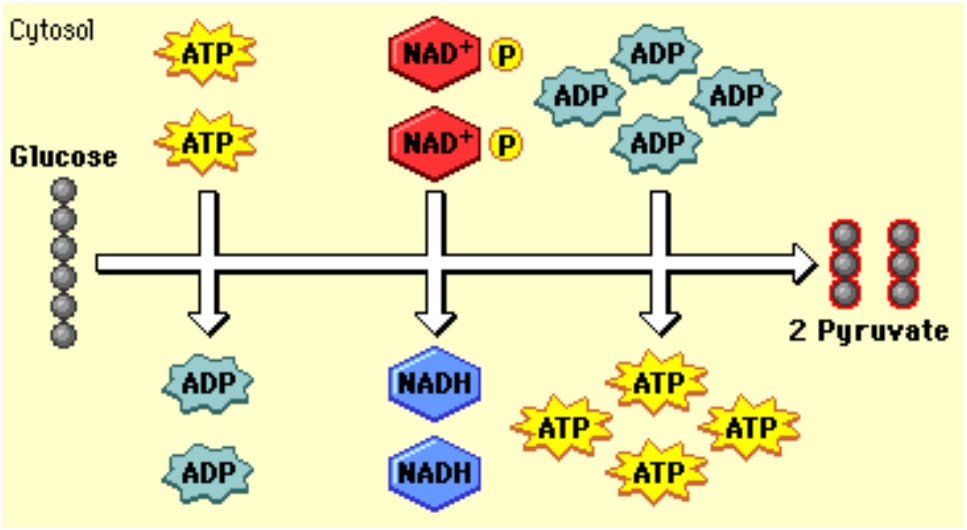
3rd **Electron Transport Chain** (ETC)



Step 1: Glycolysis

$$\mathbf{C_6H_{12}O_6} + 6O_2 \rightarrow 6CO_2 + 6H_20 + \mathbf{ATP}$$

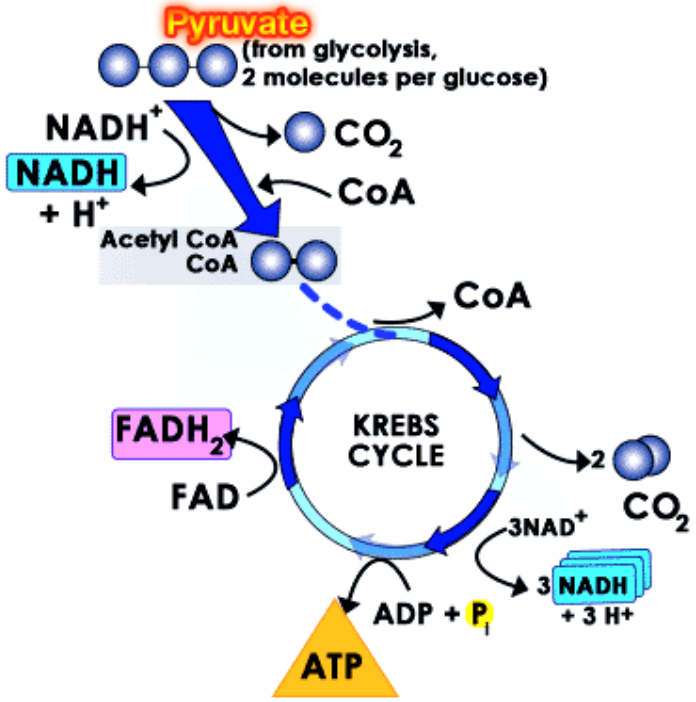
- **Glycolysis- split glucose (sugar)**
- Occurs in cytosol (cytoplasm)
- **Reactants**
  - Use 2 ATP to split glucose into pyruvate
  - Rearrange resulting compounds
- **Products**
  - 4 ATP & pyruvate
- **4 ATP-2 ATP= 2 NET ATP**



Step 2: The Krebs Cycle

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6\mathbf{CO_2} + 6H_20 + \mathbf{ATP}$$

- Occurs in the matrix
- **1st Reactant**: Pyruvate
- **1st Products**: CO_2, NADH, acetyl CoA
- **2nd Reactant**: Acetyl CoA begins Krebs cycle
- **2nd Products**: CO_2, NADH, (2)ATP, and $FADH_2$
- **NADH & $FADH_2$ used in last step of respiration (electron transport chain)**



Step 3: Electron Transport Chain

$$C_6H_{12}O_6 + 6\mathbf{O_2} \rightarrow 6CO_2 + 6\mathbf{H_20} + \mathbf{ATP}$$

- Occurs in the inner membrane of the mitochondria
- **Reactants:** FADH & NADH electrons
- **Electrons move down chain of electron carriers (inner membrane)**
- Enzyme at end uses electrons to convert to water
- Oxygen final electron acceptor- what makes so much energy
- **Product:** 32 ATP

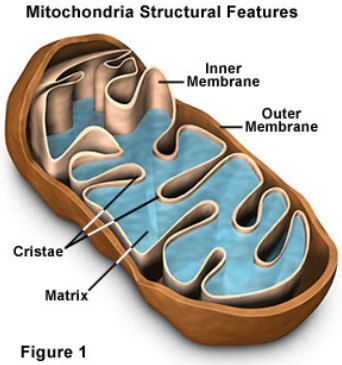
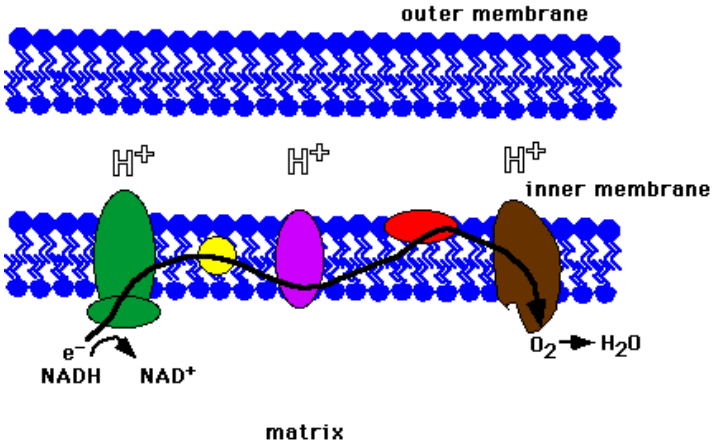


Figure 1



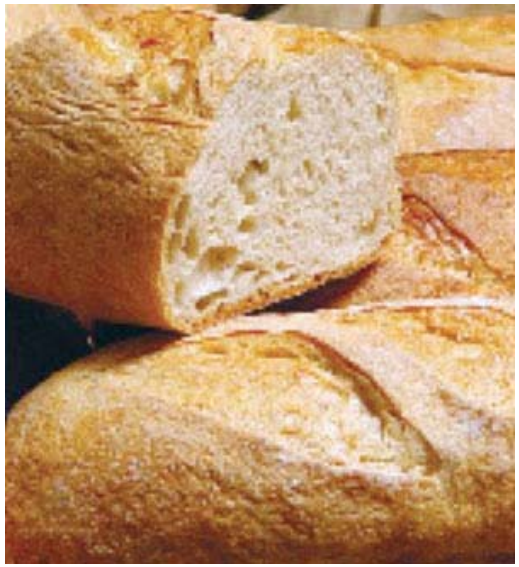
Anaerobic Respiration: occurs when **no oxygen** is available to the cell (2 kinds: Alcoholic and Lactic Acid)

- Also called **fermentation**
- **Much less ATP produced** than in aerobic respiration

- **Alcoholic** fermentation—occurs in **bacteria** and **yeast**

  Process used in the **baking** and **brewing** industry—yeast produces CO_2 **gas** during fermentation to make dough **rise** and give bread its holes

glucose ⟶ ethyl alcohol + carbon dioxide + **2 ATP**



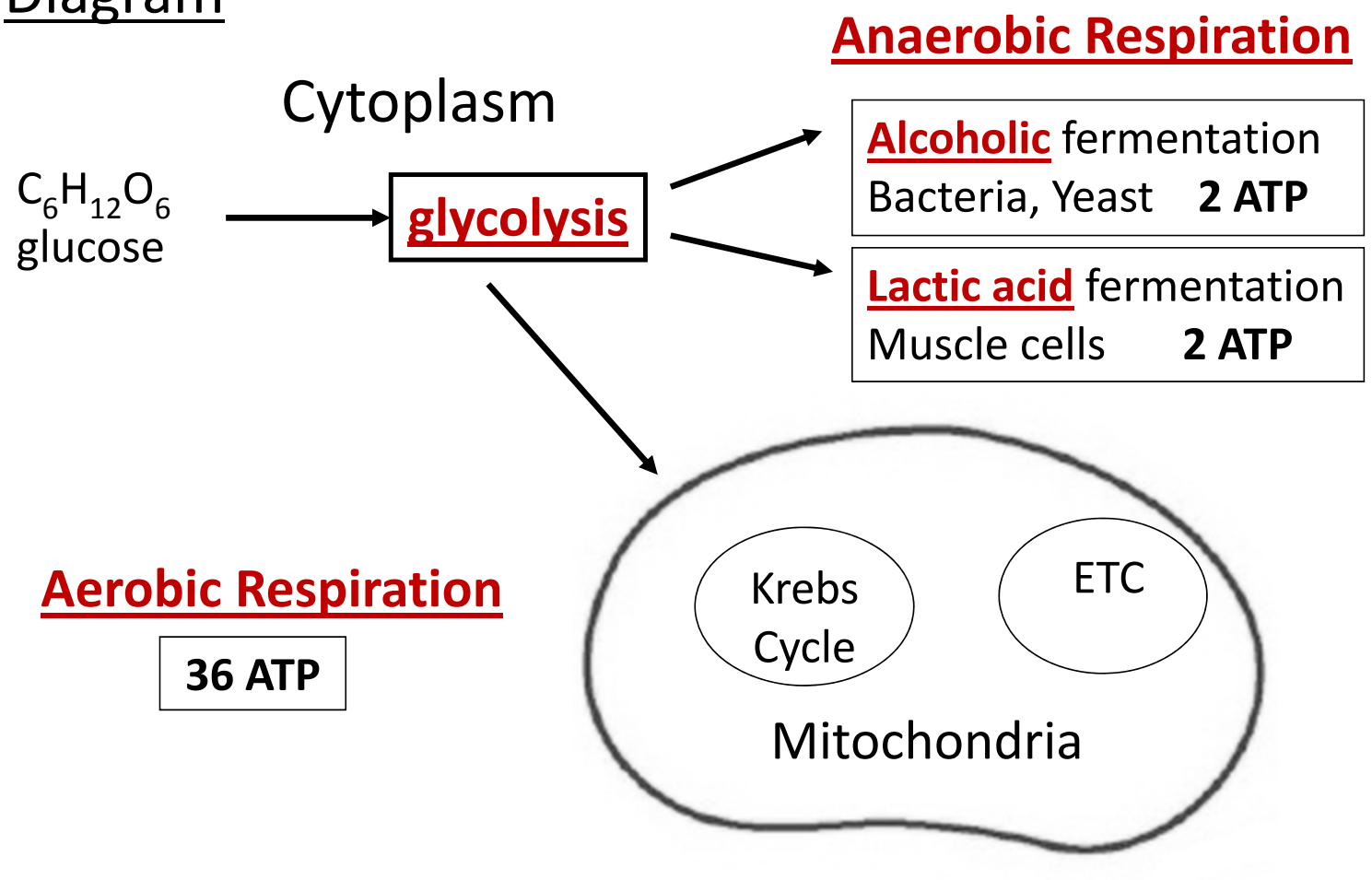
- **Lactic acid** fermentation—occurs in **muscle cells**

  Lactic acid is produced in the muscles during rapid **exercise** when the body **cannot** supply enough **oxygen** to the **tissues**—causes **burning sensation** in muscles

glucose ⟶ lactic acid + carbon dioxide + **2 ATP**

- The first step in anaerobic respiration is also **glycolysis**

Diagram



	Photosynthesis	**Cellular Respiration**
Stages	Light Reaction Dark Reaction	Glycolysis Krebs Cycle Electron Transport Chain
Energy	Light (red & blue)	Glucose, ATP
Materials Used (Reactants)	CO_2 + H_2O	$C_6H_{12}O_6$, O_2, H_20
Materials Produced (Products)	$C_6H_{12}O_{6,}$ O_2, H_20	Aerobic- ATP, H_20, CO_2 Anaerobic- ATP, H_20, CO_2, lactic acid or alcohol
Time Frame	All the time Light: day time Dark any time	All the time 24/7
Location	Chloroplasts	Mitochondria
Importance	Glucose	ATP All life processes