Chapter 4

ATP

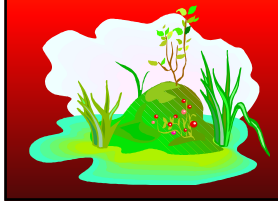
Photosynthesis

Cell Respiration

Energy of Life

All organisms need energy in order to survive

- 2 Major groups of organisms:
  - A. autotrophs– make their own food
    - Ex: plants
  - B. heterotrophs– must eat others living organisms to get their energy



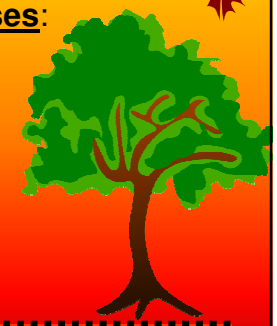
All life depends on autotrophs directly or indirectly. What does that mean?

Energy of Life

2 Major Life Processes:

a. Photosynthesis– converts energy from sunlight into chemical energy in the form of glucose

b. Cell Respiration — glucose is broken down to form ATP, CO2 + H2O



These processes keep alternating to keep carbon dioxide and oxygen in the air.

Energy of Life

- Biochemical Pathway- a series of reactions that alternate. The products of one reaction become the reactions of another reaction.

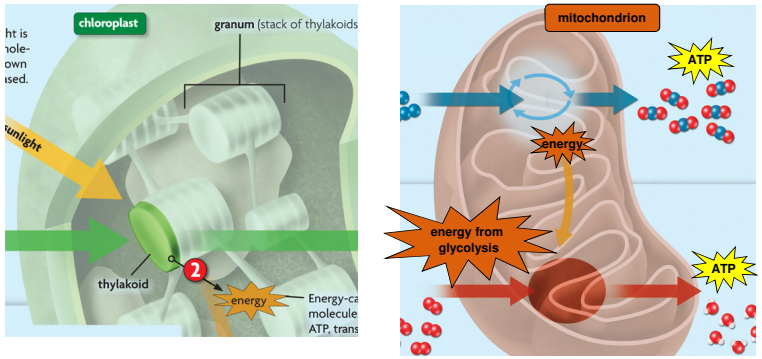
$$CO_2 + H_2O \longrightarrow C_6H_{12}O_6 + O_2$$

Reactants Products

$$C_6H_{12}O_6 + O_2 \longrightarrow CO_2 + H_2O$$

Cells need energy for Photosynthesis & Respiration

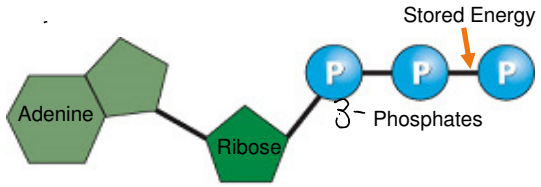
ATP is the energy molecule that is used



ATP = **a**denosine **t**ri**p**hosphate

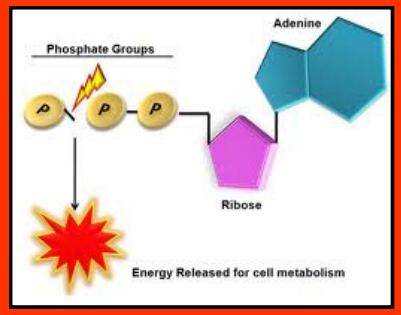
ATP has 3 parts:

a. Adenine– a base that contains nitrogen
b. Ribose– a 5-carbon sugar
c. 3 phosphate groups



ADP = **a**denosine **Dip**hosphate

- Energy is released when phosphate bond is broken to make ADP



ATP/ADP Cycle

A. Breakdown of ATP-3 steps:

- One phosphate bond is broken (always between the last 2 phosphate bonds)
- This forms ADP.
- Phosphoryation occurs when the released phosphate group (and energy) bonds with another molecule. Draw steps below.

B. Formation of ATP- reverse of breakdown:

- A phosphate group breaks away from a molecule and is added back to ADP. This requires ENERGY. Draw step below.

*** This requires enzymes-special molecules that speed up chemical reactions.

Do you know…

1. What does ATP stand for?

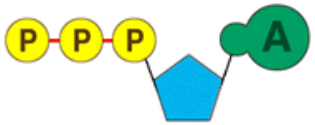
Adenosine **T**ri**P**hosphate

2. Why is energy released from ATP?

For Cell Function

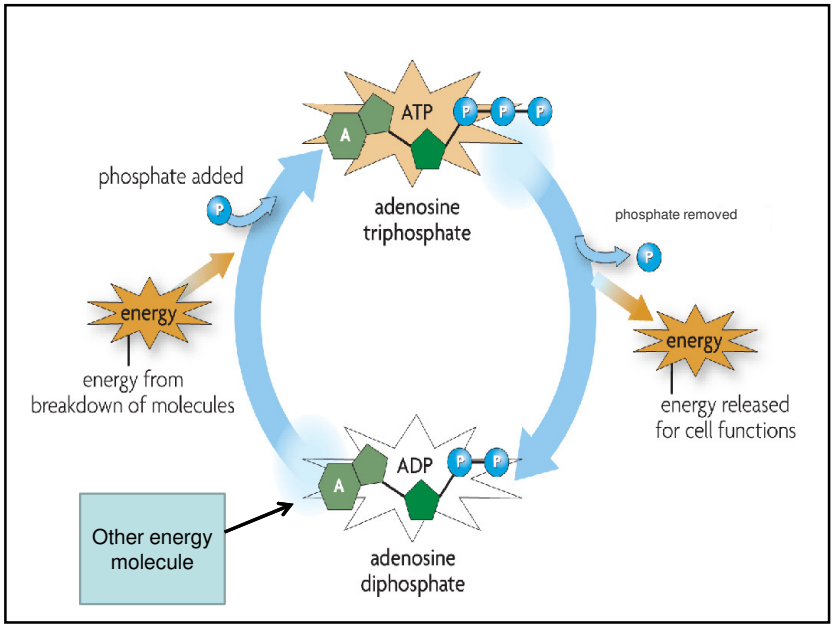
3. What has to happen to turn an ATP molecule into ADP?

It has to release a phosphate

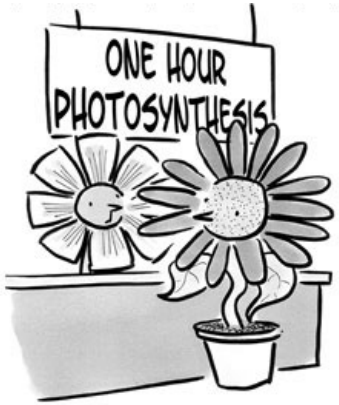


How do cells get ATP?

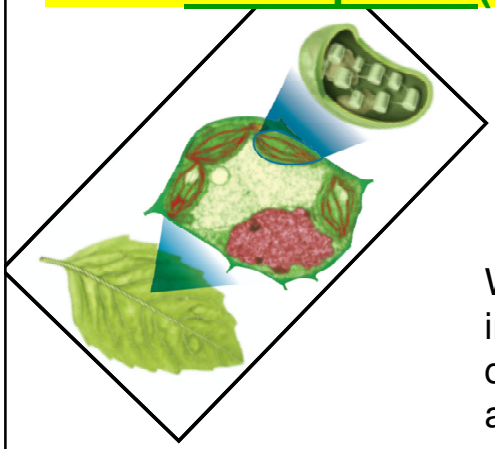
- By breaking down carbohydrates and other organic molecules from food (respiration)

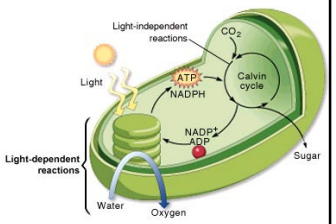


PHOTOSYNTHESIS



Photosynthesis occurs in the **Chloroplasts (organelle)**





What is found inside the chloroplast that absorbs sunlight?

2 Stages of Photosynthesis:

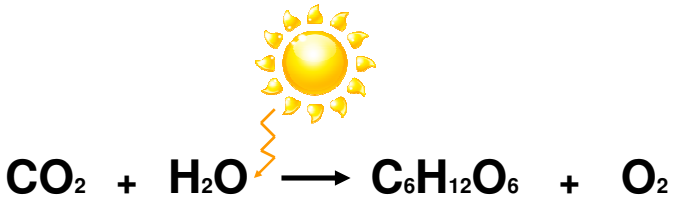
Light Reactions

light energy is turned into chemical energy (ATP)

Dark Reactions

CO_2 is used to build sugar molecules (glucose)

Photosynthesis Chemical Equation:



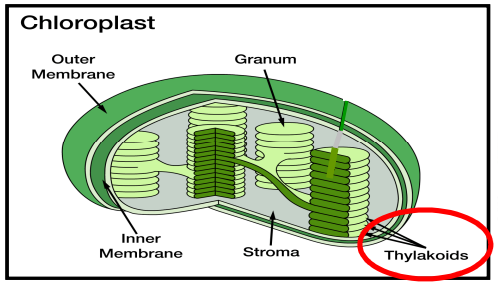
$$CO_2 + H_2O \xrightarrow{\text{light}} \underset{\text{glucose}}{C_6H_{12}O_6} + O_2$$

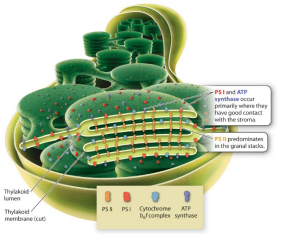
Animation

2 Stages of Photosynthesis:

Stage 1: Light Reactions (light-dependent reactions)

- Take place in the **thylakoids(stacks sac/disks)**
- A group of thylakoids is called granum.
- Found in the chloroplasts





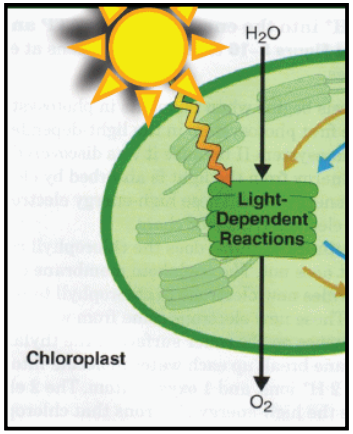
Stage 1: Light Reactions (light-dependent reactions)

What occurs in the light reaction:

1. **Chlorophyll (pigment)** in the thylakoids absorbs sunlight (Mostly red & blue light)…**green** light is *reflected*

2. Light energy breaks down H_2O molecules
   a. Hydrogen is used to make **ATP** & **NADPH**
   b. O_2 is released as waste

Light-dependent Reaction



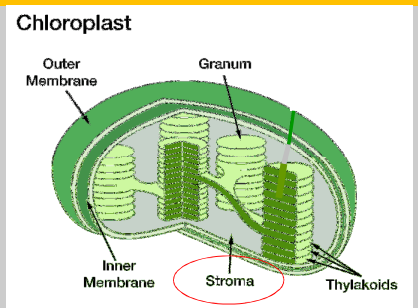
Light Reactions

"I thought plants were solar powered"

Dark Reactions

AKA: "Calvin Cycle" or light-independent reactions

- Takes place in the **stroma** of the chloroplasts
- Stroma is the fluid in the chloroplast



Dark Reactions

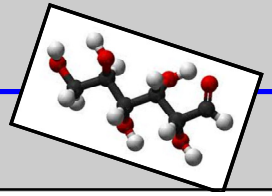
AKA: "Calvin Cycle" or light-independent reactions

What occurs in the dark reaction:

1. ATP & NADPH from light reactions provide energy to build simple sugar molecules from CO_2

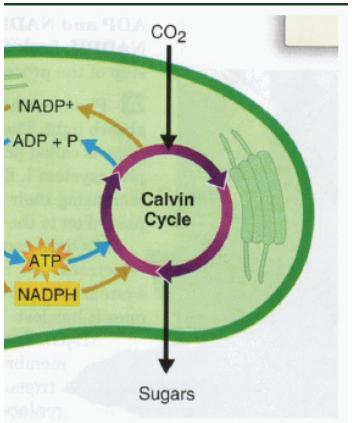
2. Glucose ($C_6H_{12}O_6$) is formed and stored in the stem of plants

   **** It is a high energy sugar

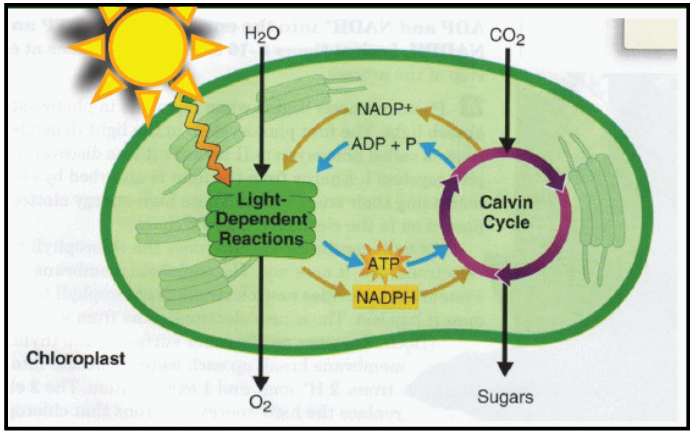


Animation

Light-independent Reaction



Photosynthesis Process



Animation

Do you Know???

1. Where in the chloroplast do light independent reactions occur?

In the Stroma

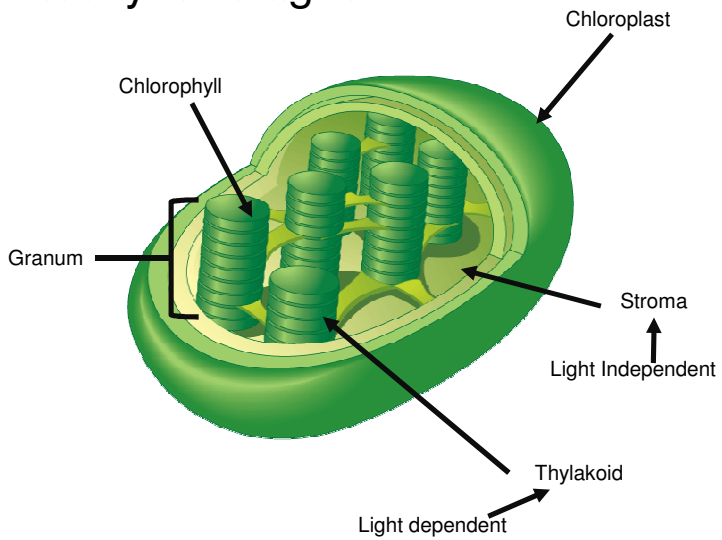
2. Where are the ATP and NADPH coming from?

From the light dependent

3. Why are these reactions called a cycle?

They happen over and over

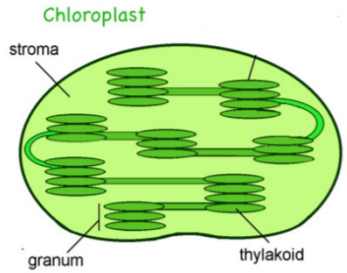
Label your diagram



Make A Chloroplast

Label the following parts of a chloroplast:

- Thylakoid
- Chlorophyll
- Granum
- Stroma
- Light-Reaction
- Dark-Reaction

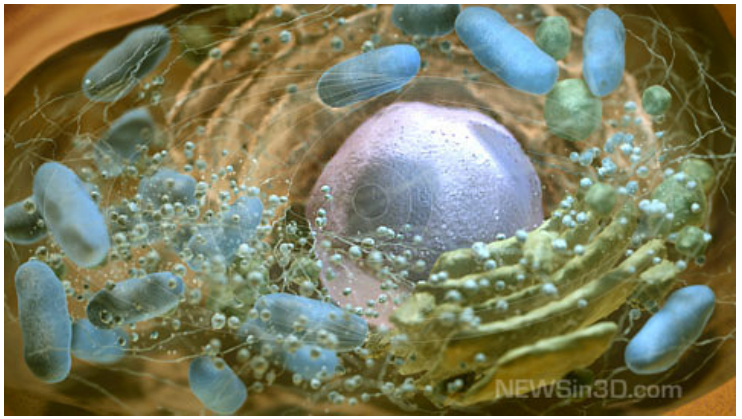


Photosynthesis: Compare and Contrast

Characteristics: **Types of Reactions:**

	Light Reaction	Dark Reaction (Calvin Cycle)
Light (Is it needed?)	Yes	No
Location (Where does it take place?)	Thylakoids	Stroma
Sources (What is needed?)	Light and H_2O	ATP, NADPH, & CO_2
Products (What is made?)	ATP, NADPH, & O_2	$C_6H_{12}O_6$
Role of ATP (What is energy used for?)	To start Dark Reaction	To make glucose

CELL RESPIRATION



Respiration Video

Cellular Respiration

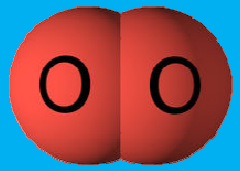
- Occurs in ALL types of cells (autotrophs and heterotrophs) because all organism need ATP to survive.
- The reason cell respiration occurs is to produce ATP. The waste products will be available for autotrophs to use in photosynthesis.

$$C_6H_{12}O_6 + O_2 \longrightarrow CO_2 + H_2O + ATP$$

2 Types of Respiration:

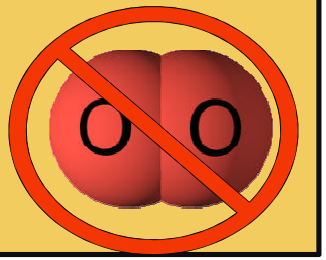
Aerobic

Requires OXYGEN

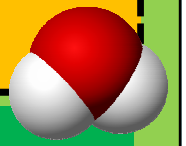


Anaerobic

DOES NOT require oxygen



Cellular Respiration

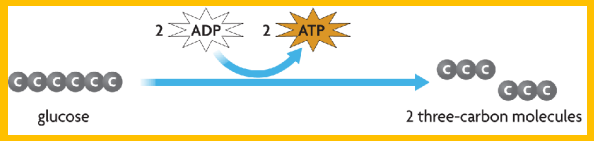


- Aerobic Respiration occurs in the **Mitochondria** of both animals & plants

Before Respiration…

GLYCOLYSIS

Breaks down glucose molecules from food to make **ATP** and **pyruvate molecules**



Occurs outside the mitochondria in the cytoplasm

2 Stages of Cell Respiration:
(take place inside the mitochondria)

Krebs Cycle
(AKA: Citric Acid Cycle)

Reactants:

- ***2 Pyruvate*: (3-carbon molecule from glycolysis after breaking down one molecule of glucose**

Products:

- ***1 ATP* per pyruvate molecule (total of 2 ATP after two cycles)**
- **Other energy molecules – *NADH + FADH2* (both containing high energy electrons that will be used in ETC)**
- ***CO_2* (waste)**

Electron Transport Chain
(occurs in inner membrane)

Reactants:

- **Electrons** from NADH & $FADH_2$
- **Oxygen (O_2)**

Products:

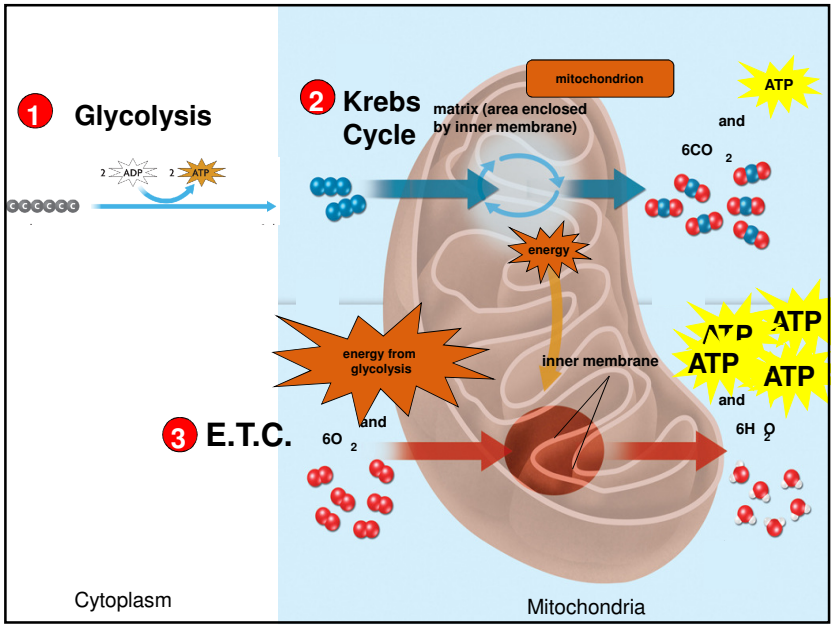
- **LOTS** of ATP ATP ATP ATP ATP
- **Water(H_2O) (waste)**

Aerobic Respiration Step-by-Step:

1. Glycolysis – glucose is split to make pyruvate molecules and a little ATP

2. Krebs (Citric Acid) Cycle – pyruvate molecules are split to make a little ATP and other energy molecules and CO_2

3. Electron Transport Chain (ETC) – electrons from energy molecules are used to power the enzymes to make LOTS of ATP and some H_2O



Review Cellular Respiration:

1. Glycolysis
   glucose → ATP & pyruvate
2. Krebs Cycle
   pyruvate → ATP, NADH, $FADH_2$ & CO_2
3. Electron Transport Chain
   NADH & $FADH_2$ → ATP & H_2O

Cell Respiration Chemical Equation:

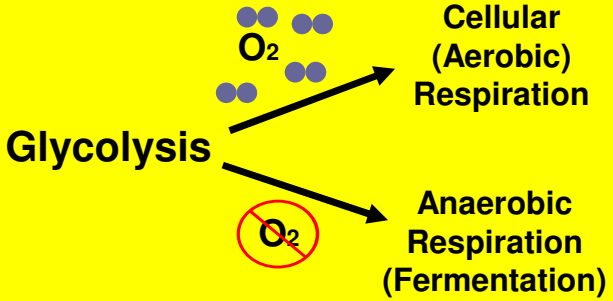
$$C_6H_{12}O_6 + O_2 \longrightarrow CO_2 + H_2O + ATP$$

glucose

Respiration Video

What if there is no Oxygen available?

Your cells will carry out **FERMENTATION** (**anaerobic**) instead of aerobic respiration



2 Types of Fermentation

Lactic Acid Fermentation

Reactants: Glucose

Products: Lactic Acid

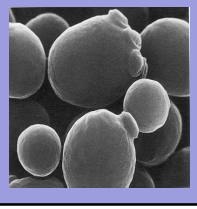
This is what causes sore muscles after heavy exercise!

Alcoholic Fermentation

Reactants: Glucose

Products: Alcohol, CO_2

Bakers & brewers use a fungus (yeast) to make bread, beer, wine, etc.



Number of ATP' Produced

- Glycolysis= 2 ATPs
- Kreb Cycle= 2 ATPs
- Electron transport chain= 34 ATPs

The most ATP is produced in the ETC

- Fermentation= 0 ATPs
- Total of ATP produced = **38 ATPS**

	Photosynthesis	**Cell Respiration**
Organelle (takes place in)	chloroplast	mitochondria
Reactants	$CO_2 + H_2O +$ Energy	$C_6H_{12}O_6$ & O_2
Products	$C_6H_{12}O_6$ & O_2	$CO_2 + H_2O +$ Energy

Do you Remember???

Using the reactants & products, make the equations for the 3 steps of Cell Respiration

Stages

- Glycolysis

  Glucose → ATP + Pyruvate
- Krebs Cycle

  Pyruvate → ATP + NADH + FADH2 + CO2
- Electron Transport Chain

  NADH + FADH2 + O2 → ATP + H2O

Reactants & Products

- Glucose
- H2O
- CO2
- ATP
- Pyruvate
- O2
- NADH
- FADH2