- Autotrophic Process: Plants and plant-like organisms make their energy (glucose) from sunlight.
- Stored as carbohydrate in their bodies.
- $6CO_2 + 6H_2O + sunlight \square C_6H_{12}O_6 + 6O_2$



### Why is Photosynthesis important?

- Makes organic molecules (glucose) out of inorganic materials (carbon dioxide and water).
- It begins all food chains/webs. Thus all life is supported by this process.
- It also makes oxygen gas!!

### Photosynthesis-starts to ecological food webs!

The sun is the source of energy for most living things.



The zebra obtains energy by eating grass.



Plants such as grass use energy from the sun to make their own food.

The lion obtains energy by feeding on the zebra.

# **Photo-synthesis**

means 'putting together with light'
Plants use sunlight to turn water and carbon dioxide into glucose. Glucose is a kind of sugar.
Plants use glucose as food for

- energy and as a building block for growing.
- <u>Autotrophs</u> make glucose and <u>heterotrophs</u> are <u>consumers</u> of it.

How do we know that plants make carbohydrates from just carbon dioxide water and light energy?

• For example:

Jan Baptisa van Helmont (1648) planted a willow branch weighing 5 pounds into 200 pounds of soil and then after 4 years the tree weighed 169 lbs. and the soil was still nearly 200 lbs.



# Photosynthesis

#### **Carbon dioxide + water** glucose + oxygen absorbed by chlorophyll

#### 600, + 6H, 0 + energy $\rightarrow$ C, H, 0, + 60

Light energy

60,

C.H.O. As can be seen from the equation for photosynthesis, the wood, bark, and root came from water and carbon dioxide.

6 H.O

6 CO.

Plants in Action Check it!

carbon dioxide

What is the process that uses the sun's energy to make simple sugars?

**Basic Photosynthesis** 

oxygen

### Plant leaves have many types of cells!



### Plant Cells



Cells containing chloroplasts

The photograph below is an elodea leaf X 400. Individual cells are clearly visible. The tiny green structures within the cells are

chloroplasts this is where photosynthesis happens.



## Chloroplasts make the sugars!



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### Plants

Leaves are green because they contain the pigment: <u>chlorophyll</u>

Leaves have a large surface area to absorb as much <u>light</u> as possible

# Chloroplasts make the oxygen too!

Elodea photosynthesizing

### Stoma

This opening how plants exchange gases! Check it! Can you name the two important gases that go in and out of the leaves?







- Absorbing Light Energy to make chemical energy: glucose!
  - Pigments: Absorb different colors of white light (ROY G BIV)
    - Main pigment: Chlorophyll a
    - Accessory pigments: Chlorophyll b and Carotenoids
    - These pigments absorb all wavelengths (light) BUT green!

- Why do we see green?
  - Green color from white light reflected NOT absorbed
  - Chloroplast: organelle responsible for photosynthesis
    - Chlorophyll: located within Chloroplast
      - Green pigment













### <u>Chlorophyll</u>: A Light Absorbing Pigment The Solar Panel Chemical!



#### INTERACTION OF LIGHT WITH MATTER IN CHLOROPLAST; LIGHT DIVIDED INTO THREE PARTS



#### Stage 2

The captured light energy is used to produce sugars and oxygen from water and carbon dioxide.

**Carbon dioxide** 

enters the leaf

Water ( the plan roots and upward

through ope

called stom

### Photosynthesis

Sugars produced are used by the plant cells for energy.

Oxygen exits through stomata on the underside of the leaf.

Glucose provides the energy and carbon needed to make other plant materials like wax and proteins.



In plants and simple animals, waste products are removed by **diffusion**. Plants, for example, excrete  $O_2$ , a product of photosynthesis.



# EQUATION FOR PHOTOSYNTHESIS

### WATER OXYGEN $6C_{2} + 6H_{2}O + ENERGY \longrightarrow C_{12}O_{6} + 6O_{2}$ CARBON DIOXIDE GLUCOSE



### The end!

- 2 Phases
  - Light-dependent reaction
  - Light-independent reaction
- Light-dependent: converts light energy into chemical energy; produces ATP molecules to be used to fuel light-independent reaction
- Light-independent: uses ATP produced to make simple sugars.

- Light-dependent reaction (LIGHT Reaction)
  - Requires light
  - Occurs in chloroplast (in thylakoids)
  - Chlorophyll (thylakoid) traps energy from light
  - Light excites electron (e-)
    - Kicks e- out of chlorophyll to an electron transport chain
    - Electron transport chain: series of proteins in thylakoid membrane
      - Bucket brigade

- Light-dependent reaction (LIGHT Reaction)
  - Energy lost along electron transport chain
  - Lost energy used to recharge ATP from ADP
  - NADPH produced from e- transport chain
    - Stores energy until transfer to stroma
    - Plays important role in light-independent reaction
  - Total byproducts: ATP, NADP, O<sub>2</sub>

- How did we get O<sub>2</sub> as a byproduct?!
  - Photolysis: replaces lost electrons by splitting water



At each step along the transport chain, the electrons lose energy.





Chlorophyll passes energy down through the electron transport chain.



for the use in light-independent reactions

- Light-independent reaction (Dark Reaction)
  - Does not require light
  - Calvin Cycle
    - Occurs in stroma of chloroplast
    - Requires CO<sub>2</sub>
    - Uses ATP and NADPH as fuel to run
    - Makes glucose sugar from CO<sub>2</sub> and Hydrogen



• What affects photosynthesis?

• Light intensity: as light increases, rate of photosynthesis increases

Rate of Photosynthesis



Light Intensity

• What affects photosynthesis?

• Carbon Dioxide: As CO<sub>2</sub> increases, rate of photosynthesis increases

Rate of Photosynthesis



Carbon Dioxide

- What affects photosynthesis?
  - Temperature:
    - Temperature Low = Rate of photosynthesis low
    - Temperature Increases = Rate of photosynthesis increases
    - If temperature too hot, rate drops



### Check it!

1. The process that uses the sun's energy to make simple sugars is \_\_\_\_\_.

A. Cellular respiration

- B. Glycolysis
- C. Photosynthesis
- D. Photolysis

### Check it!

2. The function accomplished by the light-dependent reactions is \_\_\_\_\_

- A. Energy storage
- B. Sugar production
- C. Carbon fixation
- D. Conversion of sugar

