Photosynthesis

- Chapter 8
- Photosynthesis
- Page 225

What is energy?

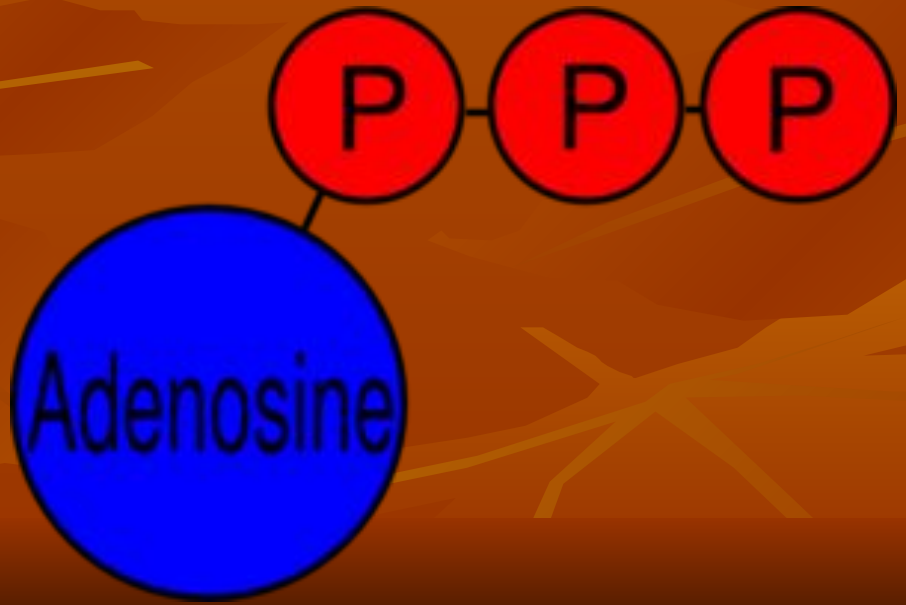
- Energy is the ability to do work

Energy

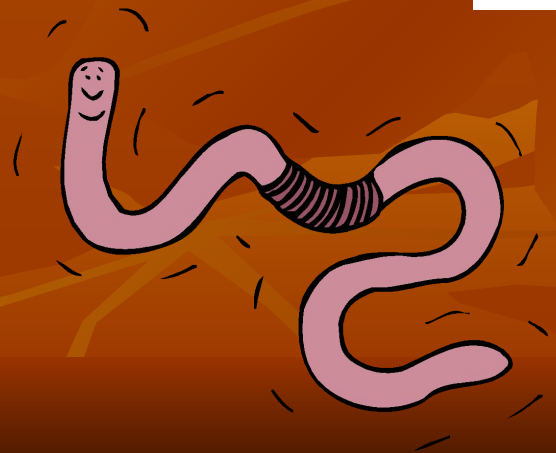
- Without the ability to **obtain** and use **energy** life would cease to **exist**
- All living things need energy
- It is in the usable form called **ATP**

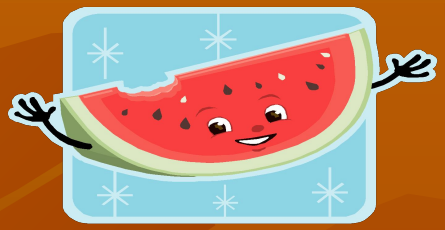
Adenosine Tri-phosphate

- Provides **energy** to living organisms
- ADP + P = ATP
- ATP can easily **release** and **store** energy by **breaking** and **reforming** the bonds between its **phosphate** groups
- Exceptionally useful as the **energy** source for all **cells**

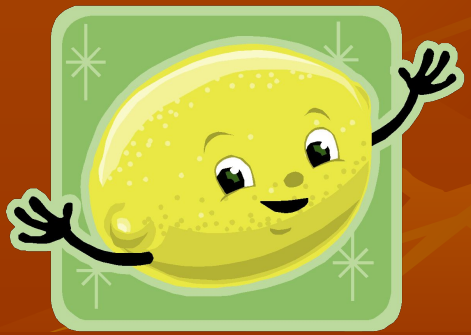


- **Heterotroph:**
  - An organism that obtain **food** by **consuming** other organisms
  - *Herbivore*
  - *Omnivore*
  - *Carnivore*
  - *Decomposer*





- **<u>Autotroph:</u>** *an organism that* ***<u>makes</u>*** *their* ***<u>own</u>*** *food*



Practice

Find chart in notes - NOT THE VENN diagram

- **Is it an autotroph or Heterotroph?**
- 1. Maple tree
- 2. Human
- 3. Wheat
- 4. Fungi (mushroom)
- 5. Amoeba (1 celled eukaryote)
- 6. Green algae
- 7. Housefly
- 8. Dandelion
- 9. Goldfish

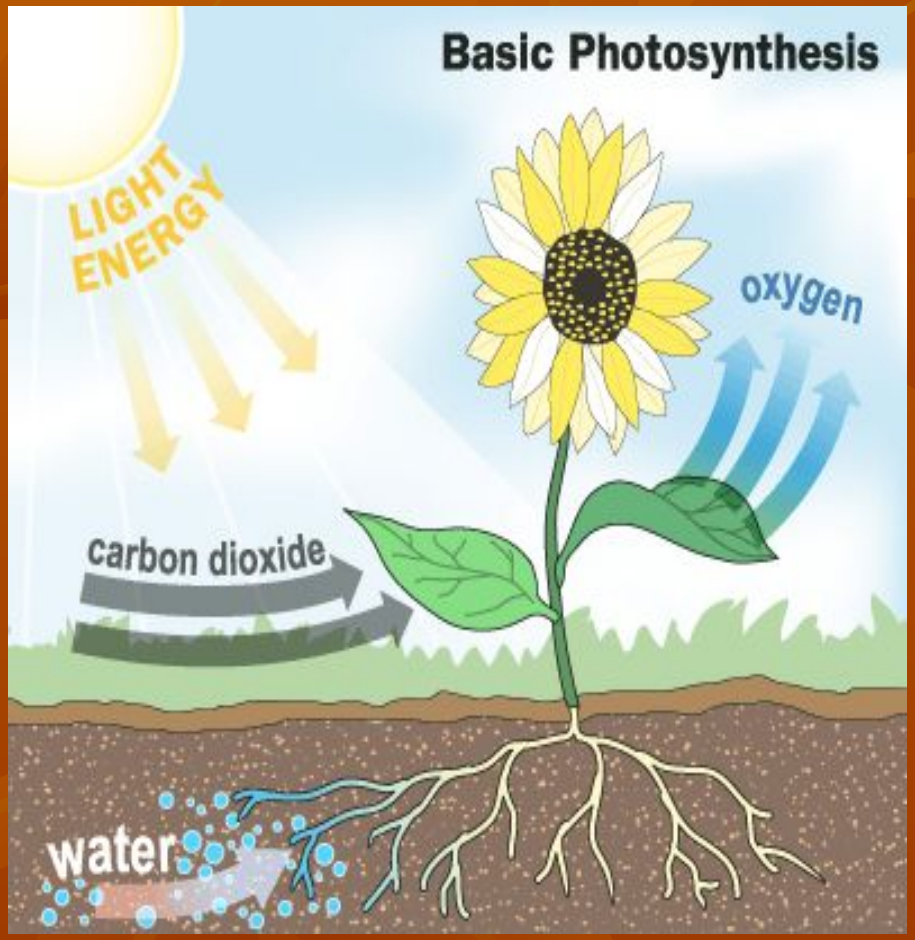
Practice: does it relate to an Autotroph or Heterotroph?

- 1.Chlorophyll
- 2. Digestion by a cow
- 3. Phagocytosis (exocytosis)
- 4. Rhizoids (like roots)
- 5. Lipase
- 6. Carbon fixation
- 7. Light dependent reactions
- 8. Maltose
- 9. CO_2 is used in plants
- 10. Ingestion by humans
- 11. Chloroplasts
- 12. Calvin cycle
- 13. Glucose production
- 14. Bile (vomit)

Find in Notes – fill in the venn diagram

Autotroph	Heterotroph
Plants	Animals
Produce their own food	Depend on others for food
Needs carbon dioxide & water & light	Needs oxygen & H2O
Produces oxygen & sugar	Produces water & CO_2
Self - feeder	Other - feeder
Go thru photosynthesis and metabolism	Go thru metabolism

Section 2 - Photosynthesis



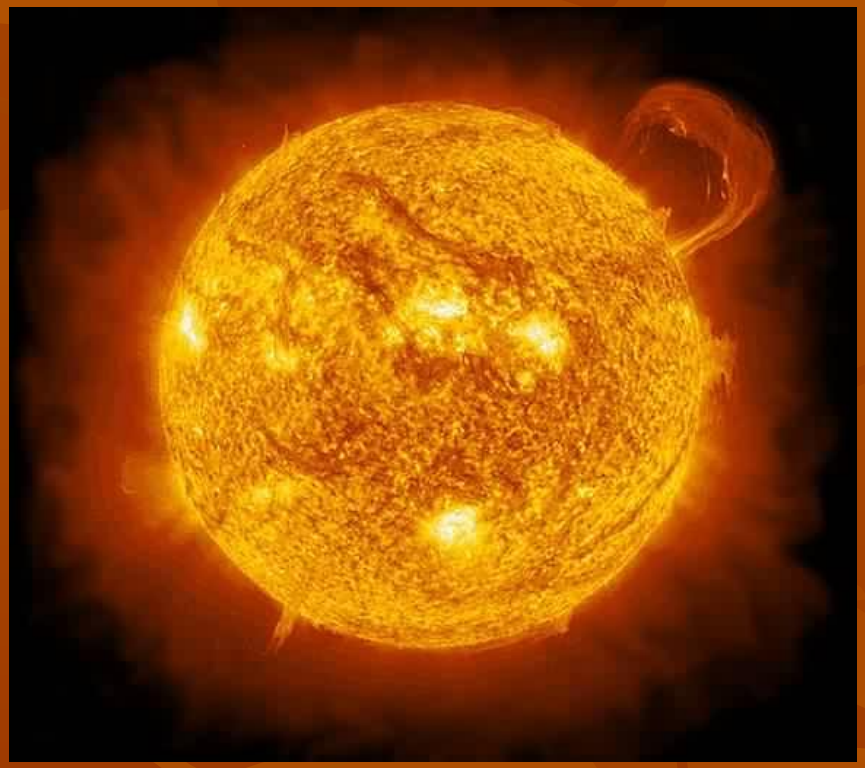
The process where autotrophs convert the energy of sunlight into chemical energy stored in the bonds of carbohydrates

Section 1 – How organisms obtain energy

- The ultimate source of energy for all living this is the …

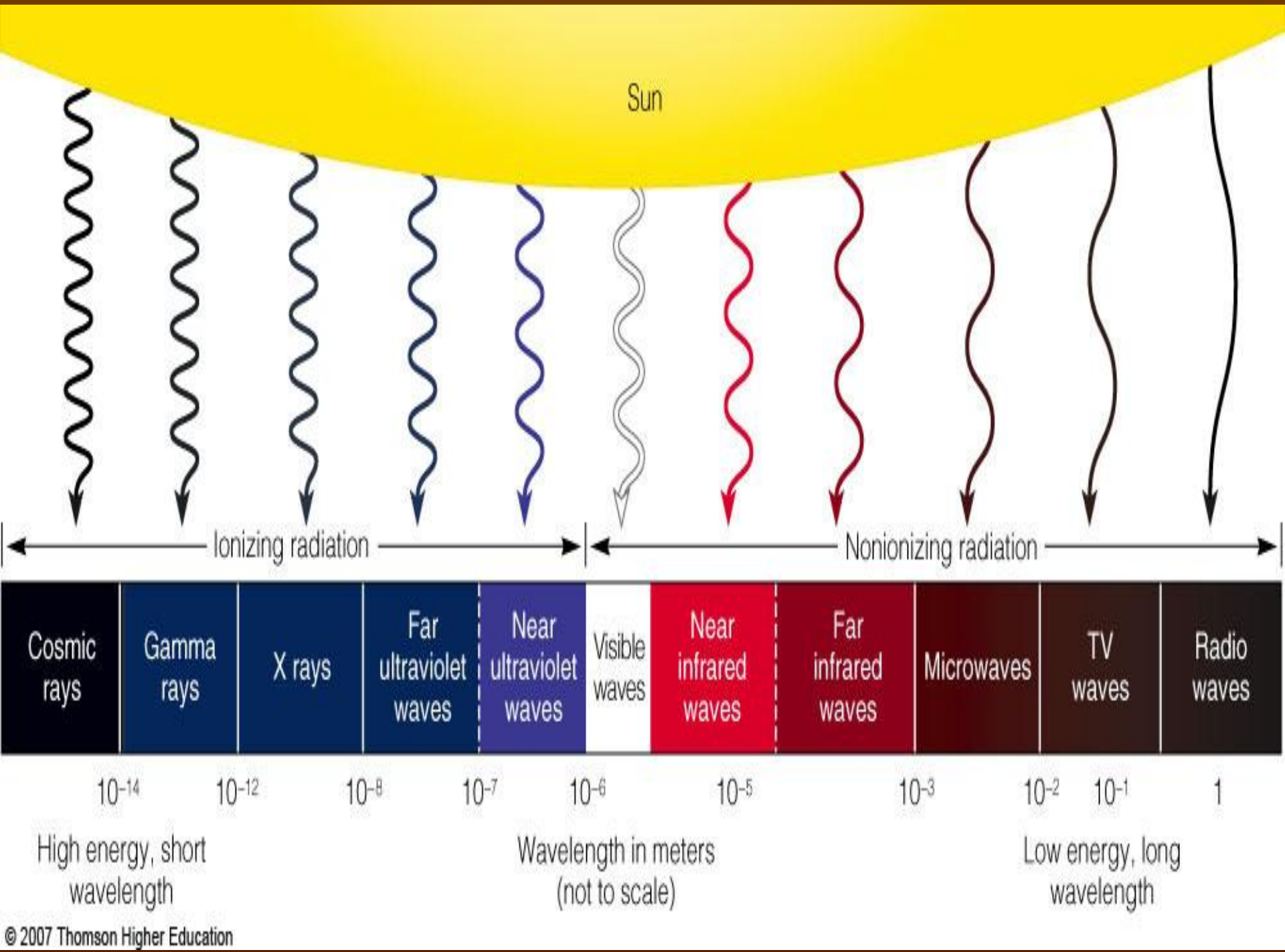
SUN

- This energy can be captured to make organic compounds



LIGHT

- Energy from the sun travels to Earth in the form of light
- We see "white" light - a mixture of all wavelengths
- Make up the Visible light spectrum (AKA the rainbow)
  - the visible light we see
  - ROY G BIV



PIGMENTS

- A light absorbing colored molecule.
- Some light wavelengths will be absorbed and others will be reflected

- **Chlorophyll**
- the primary pigment
- Types a, b
- ***Absorbed*** light: red, orange, blue, purple
- ***Reflected*** light: green light
- **Color SEEN**= Green

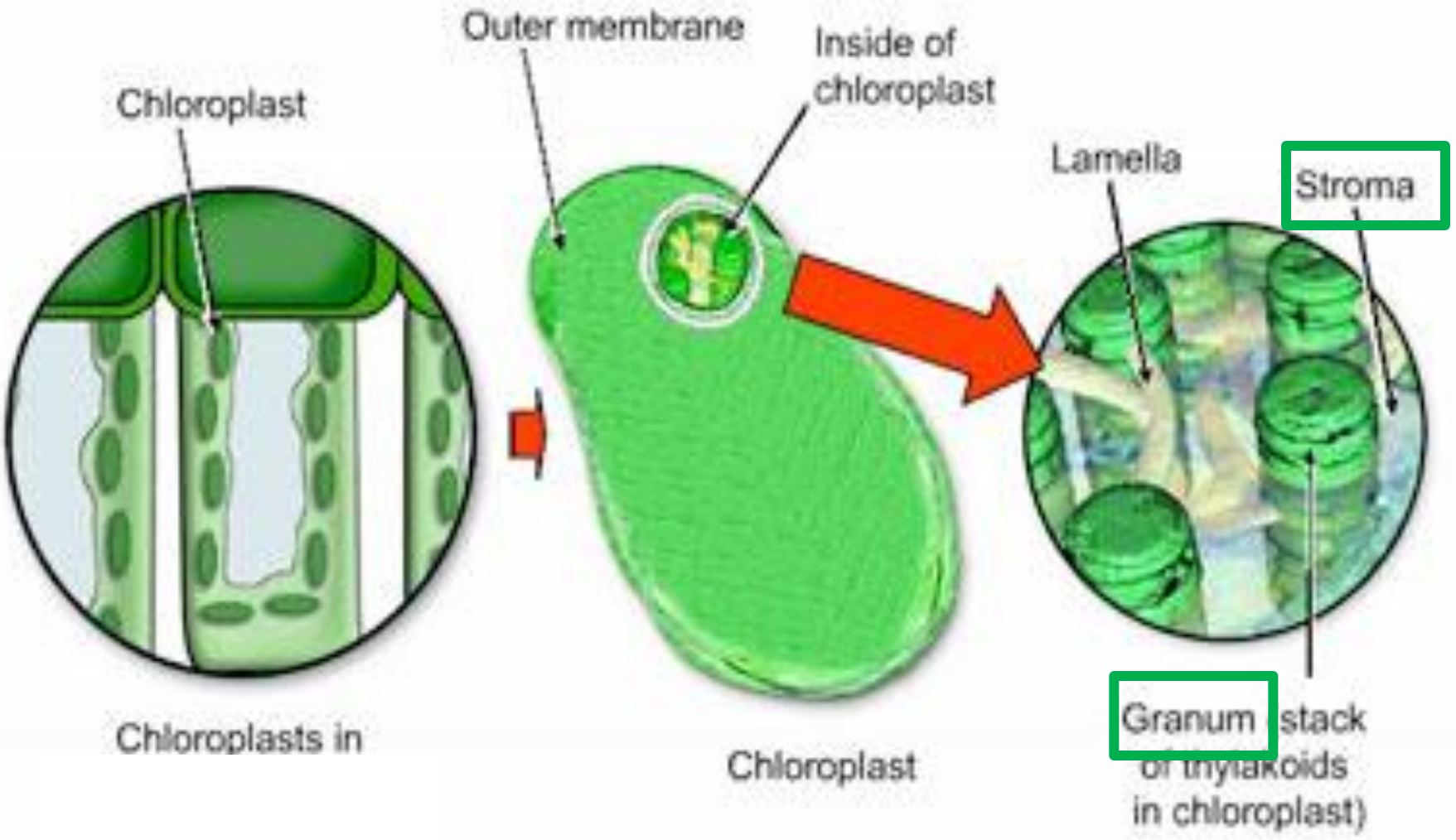
- **SECONDARY PIGMENT**
  - Carotene
  - **Absorbed light**= green, blue, purple
  - **Reflected light**= Red, Orange, Yellow
  - Give the body Vitamin A and beta carotene

Fall leaves Color – why?

- Most of the time, the intense **green** color of chlorophyll **overwhelms** the accessory pigments so that you do not **notice** them
- "True colors are seen"

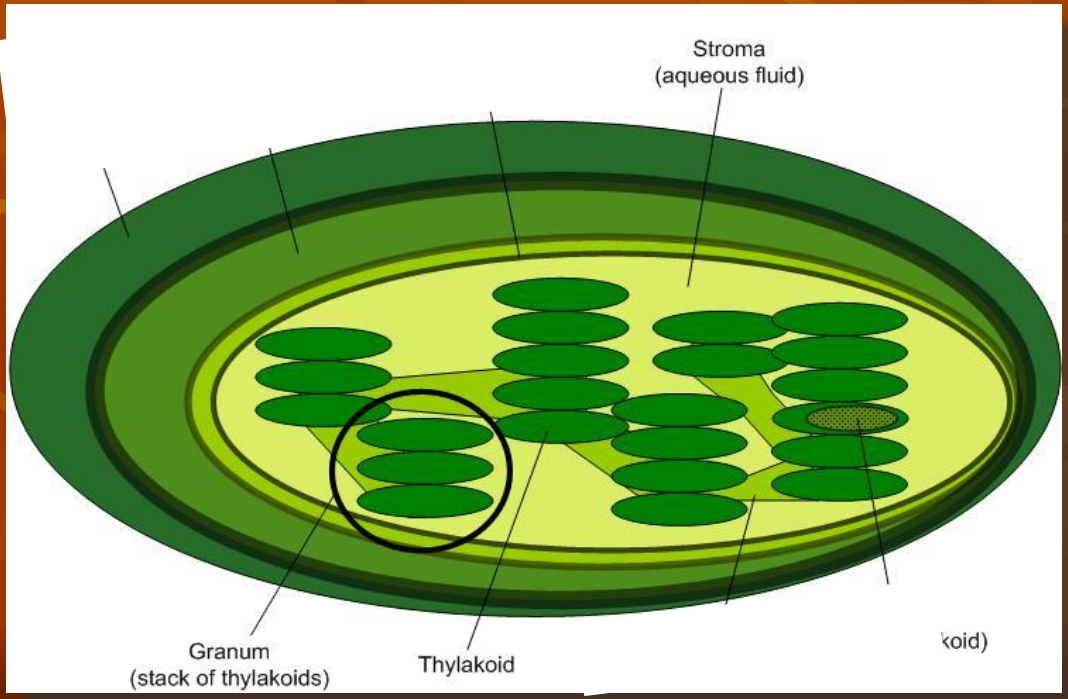
Where does is all begin?

Structure of a Chloroplast

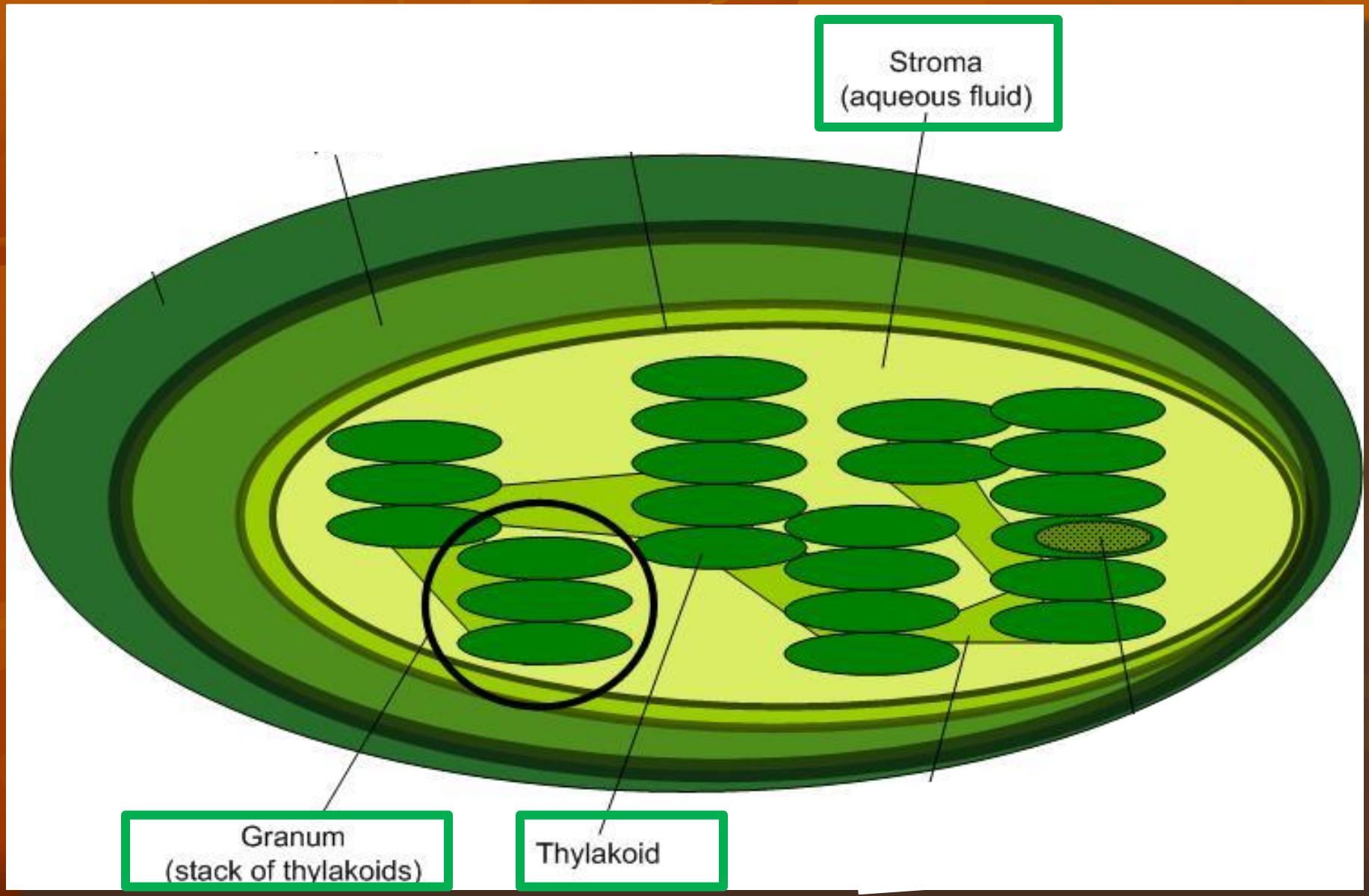


Organelle = CHLOROPLAST

- Chloroplast
  - **THYLAKOID**= a sac-like photosynthetic membrane
  - **GRANA**= thylakoids arranged in stacks
  - **STROMA**=the fluid portion outside of they thylakoid



Chloroplast In which stage does each occur?

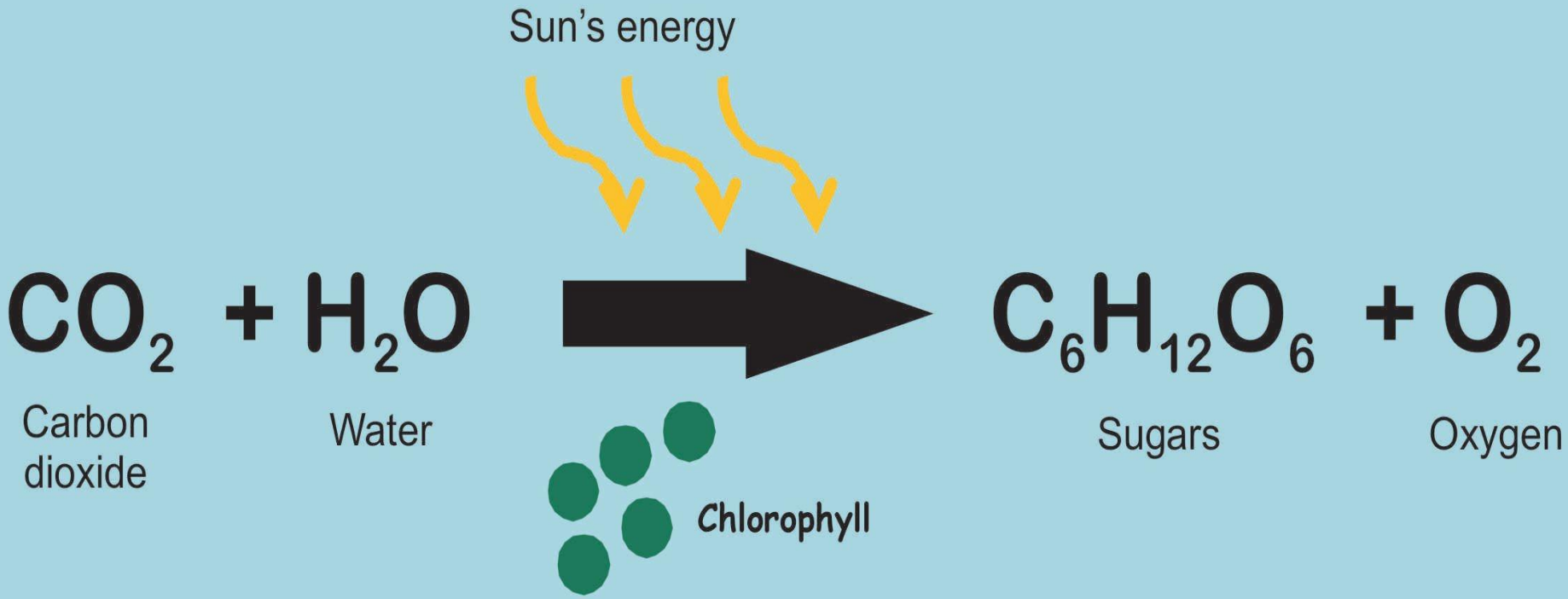


Chlorophyll is Important

- Because it absorbs energy from the sun
- Transfers this energy to electrons
- These electrons give it to high energy carrier molecules that will power photosynthesis

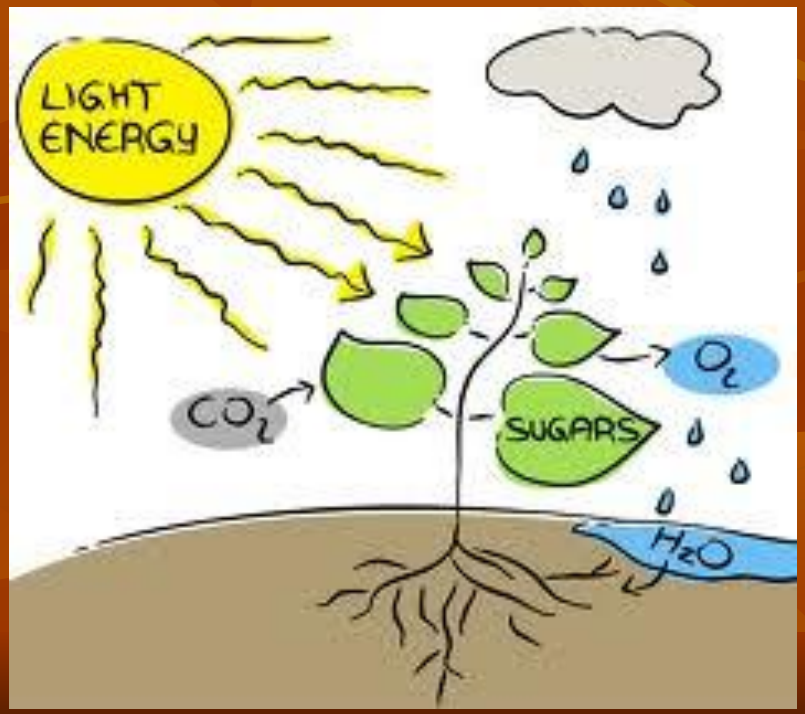
- **Electron Carrier Molecule**: a compound that can accept a pair of **high energy electrons** and transfer them along with most of their **energy**
  - Example: NADPH/ATP

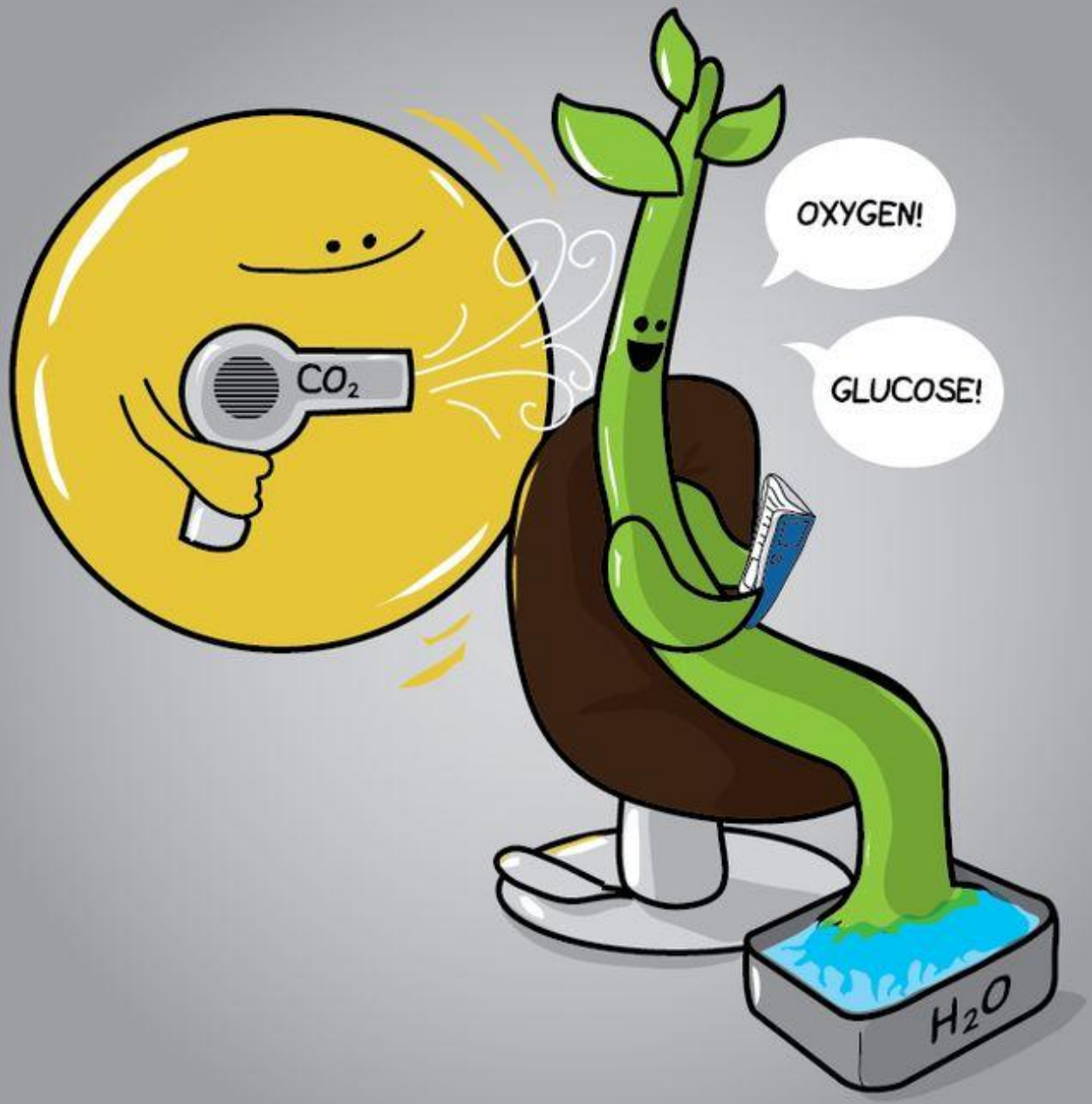
THE EQUATION *of Photosynthesis*



THE EQUATION *of Photosynthesis*

- **Reactants**
  - Carbon dioxide
  - Light energy
  - Water
- **Products**
  - Oxygen
  - Sugars (glucose)

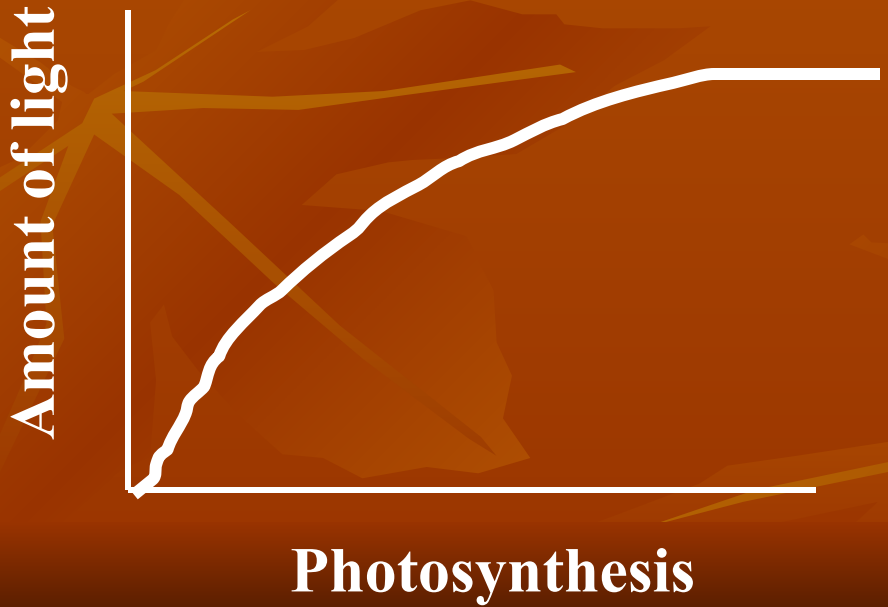


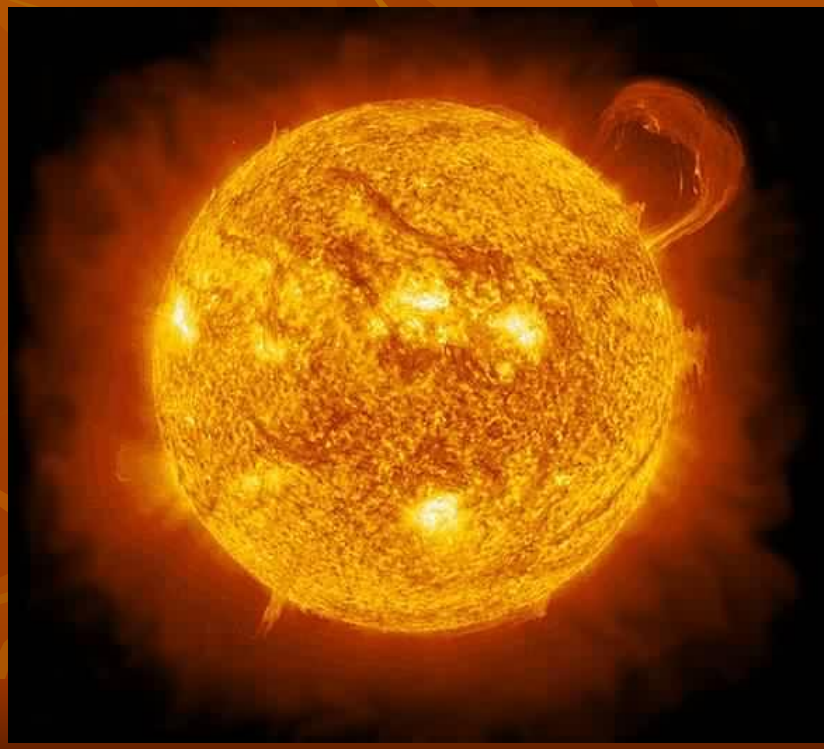


A plant at the Spa ☺

Factors that affect Photosynthesis

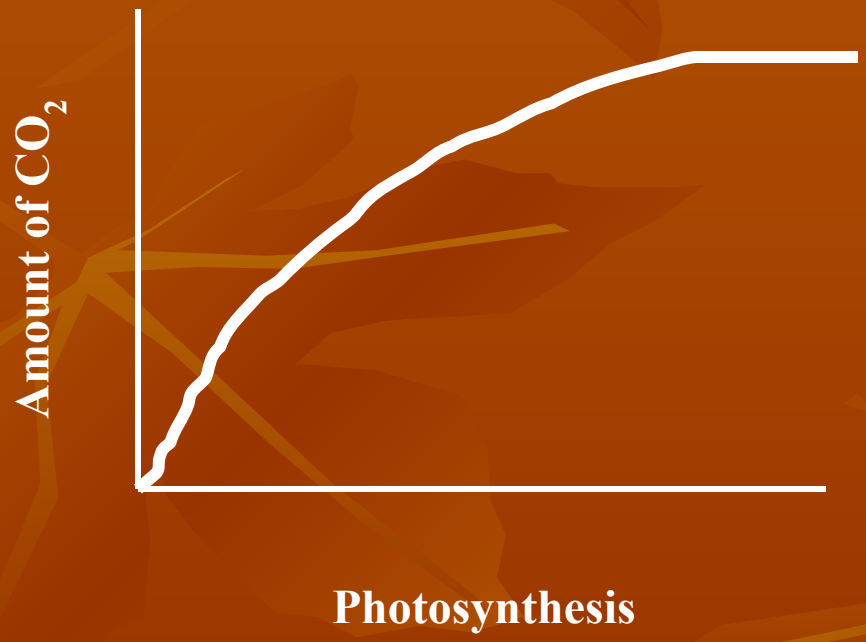
- **Sunlight**
  - As **light** energy increases the rate of photosynthesis will also increases the plant reaches its **maximum** level (when the pigments are used)





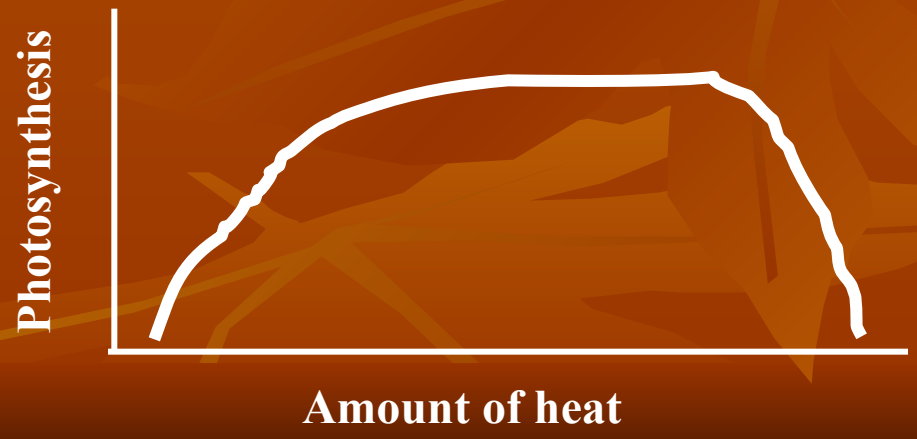
Factors that affect Photosynthesis

- **Carbon Dioxide**
  - Once a certain amount of **CO2** is present, photosynthesis cannot proceed any further



Factors that affect Photosynthesis

- **Temperature**
  - Plants operate at a certain **temperature** range (68-77 F)
  - Thus increased temperature and photosynthesis **will not** work correctly
  - Decreased temperature and photosynthesis will **not work** correctly



Factors that affect Photosynthesis

- Water
- Water is one of the **reactants**
- A shortage of water can **slow** photosynthesis or even **damage** the plant
- Some plants have **adapted** to overcome water loss (cacti, conifers)

Plants that have alternative cycles

- **C4 Plants**
  - Photosynthesis continues to work BUT in
    - Low CO2 levels
    - High temperatures
    - Intense light
  - Example: sugarcane, corn, sorghum

Plants that have alternative cycles

- **CAM PLANTS**
  - Photosynthesis continues despite Hot dry climate
  - CO_2 enters only at night = This helps minimize water loss
  - Example: cacti, pineapple, ice plant

Find the space in notes

Leaf foldable

- Draw a plant or leaf onto your paper
- Using the arrows draw the same onto your page in the correct direction

Phases *of Photosynthesis*

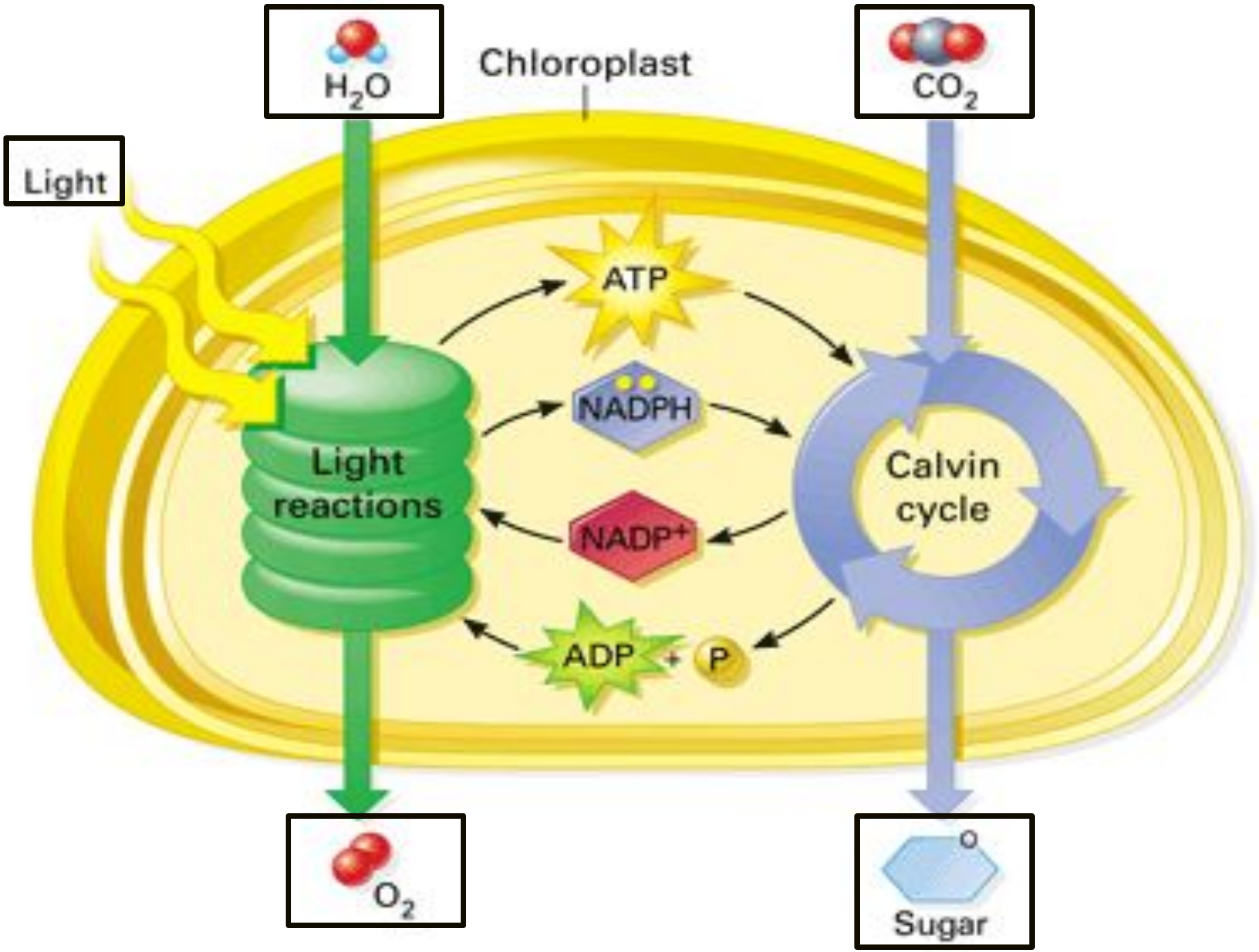
- #1=Light Dependent Reaction
- #2 Light Independent Reaction

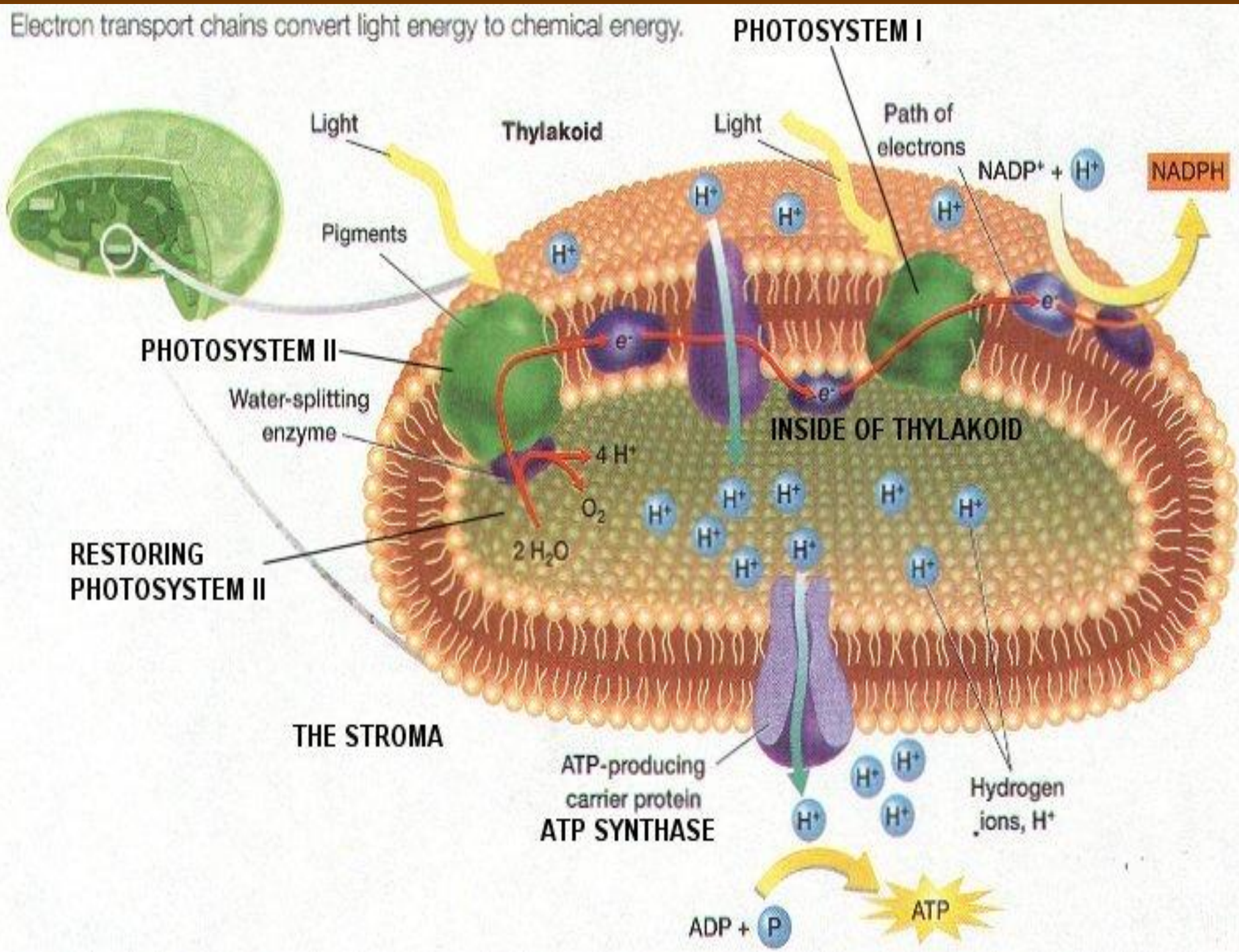
Phase #1=Light Dependent Reactions

- They require
  - Sunlight, water, chlorophyll
- Use energy from sunlight to produce ATP
- Occurs in the thylakoid of the chloroplast
- Water is required as a source of electrons
- Produces= Oxygen

Phase #2= Light Independent Reactions

- Plant absorbs CO_2 from the atmosphere and completes photosynthesis by producing carbohydrates
- ATP and NADPH from Phase 1 are used to produce glucose
- No light is needed
- Occurs in the stroma on the outside of the thylakoid


H_2O
Chloroplast
CO_2
Light
ATP
NADPH
Light reactions
Calvin cycle
$NADP^+$
ADP
+
P
O_2
Sugar


Electron transport chains convert light energy to chemical energy.
PHOTOSYSTEM I
Light
Thylakoid
Light
Path of electrons
NADP+ + H+
NADPH
Pigments
PHOTOSYSTEM II
Water-splitting enzyme
4 H+
O2
2 H2O
INSIDE OF THYLAKOID
RESTORING PHOTOSYSTEM II
THE STROMA
ATP-producing carrier protein
ATP SYNTHASE
Hydrogen ions, H+
ADP + P
ATP

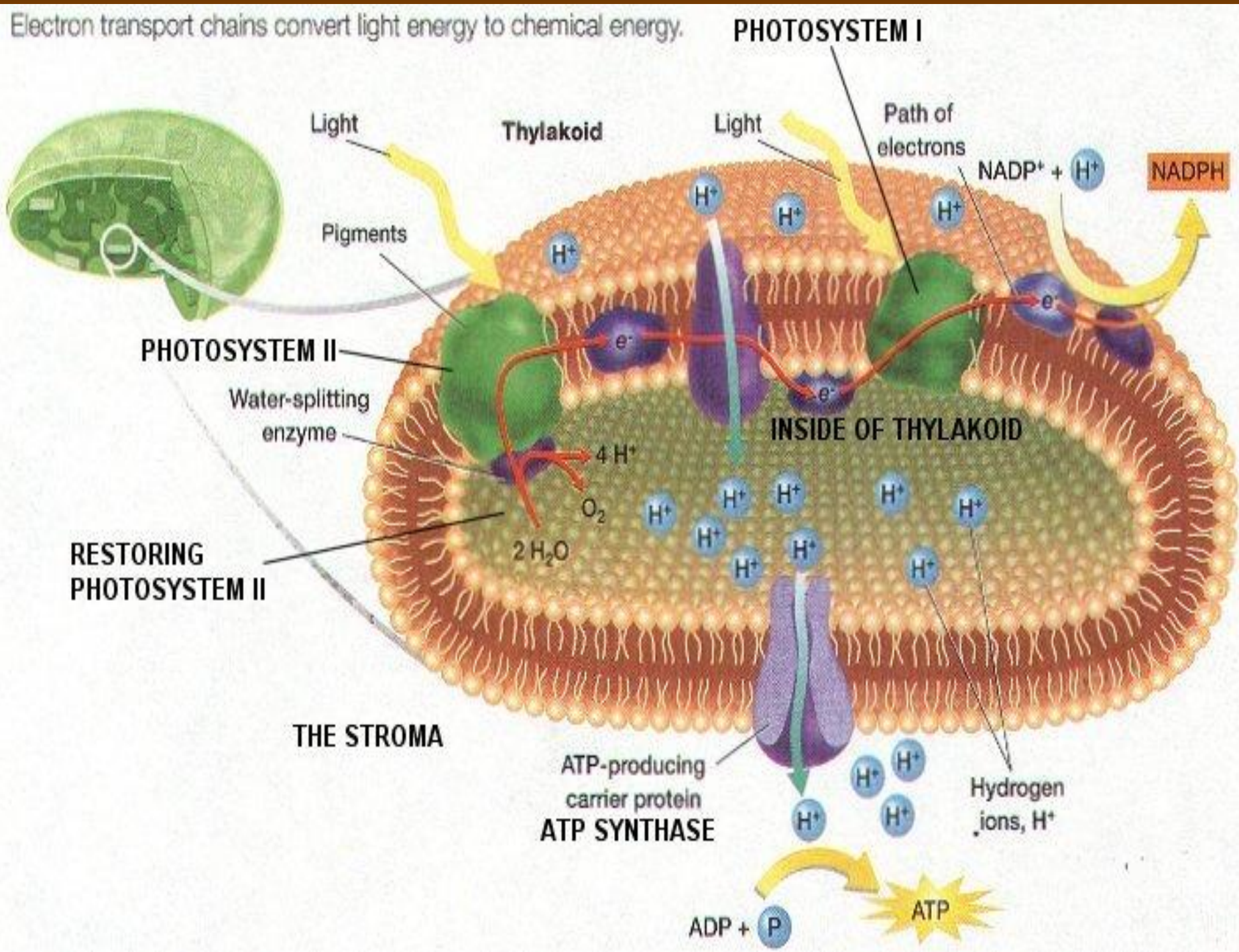
Light reaction steps

The **chlorophyll** in the thylakoid receives energy from the sun

- **Light** energy is absorbed by the **excited** electrons
- Excited **electrons** cause even more to become **excited**
- This excitement and jumping causes water to be broken down
- Water is split into O, (AKA oxygen) and H, H (AKA excited electrons)
- **Oxygen** is given off as a gas

Part 2 of Phase 1 = Electron Transport Chain

- The excited **electrons** accumulate in the **thylakoid**
- A protein embedded in the **thylakoid** membrane acts like a **pump**
- This pump will bring the excited electrons in and out of the **thylakoid membrane**
- As a result, **ATP** and **NADPH** are created
- These are **energy carrier** molecules that help power the Light Independent reactions


Electron transport chains convert light energy to chemical energy.
PHOTOSYSTEM I
Light
Thylakoid
Light
Path of electrons
NADP+ + H+
NADPH
Pigments
PHOTOSYSTEM II
Water-splitting enzyme
4 H+
O2
2 H2O
INSIDE OF THYLAKOID
RESTORING PHOTOSYSTEM II
THE STROMA
ATP-producing carrier protein
ATP SYNTHASE
Hydrogen ions, H+
ADP + P
ATP

Summing up Light Reactions

- Chlorophyll absorbs light energy
- Water is split
- H^+ accumulates in the thylakoid membrane
- Oxygen is released
- H^+ builds up a gradient that provides energy to create ATP and NADPH

Light Independent Reactions

- Does not need to be in the **light** to occur
- Occurs in the **stroma** of the chloroplast
- Called **Calvin Cycle** or **Carbon dioxide fixation**
- **ATP** and **NADPH** provide the cells with large amounts of **energy** and help to power the **Calvin Cycle**
- This stage used **CO2** to produce **Glucose**

Calvin Cycle (add to notes)

- ATP and NADPH provide the cells with large amounts of energy
- This stage uses **CO2** to help produce **glucose**
- 1 CO2 molecule is added to a 5-carbon compound
- This makes a 6 carbon compound
- Then it splits into 2 three-carbon compounds
- One of these 3 carbon compounds is used to create glucose
- The other goes back in the cycle

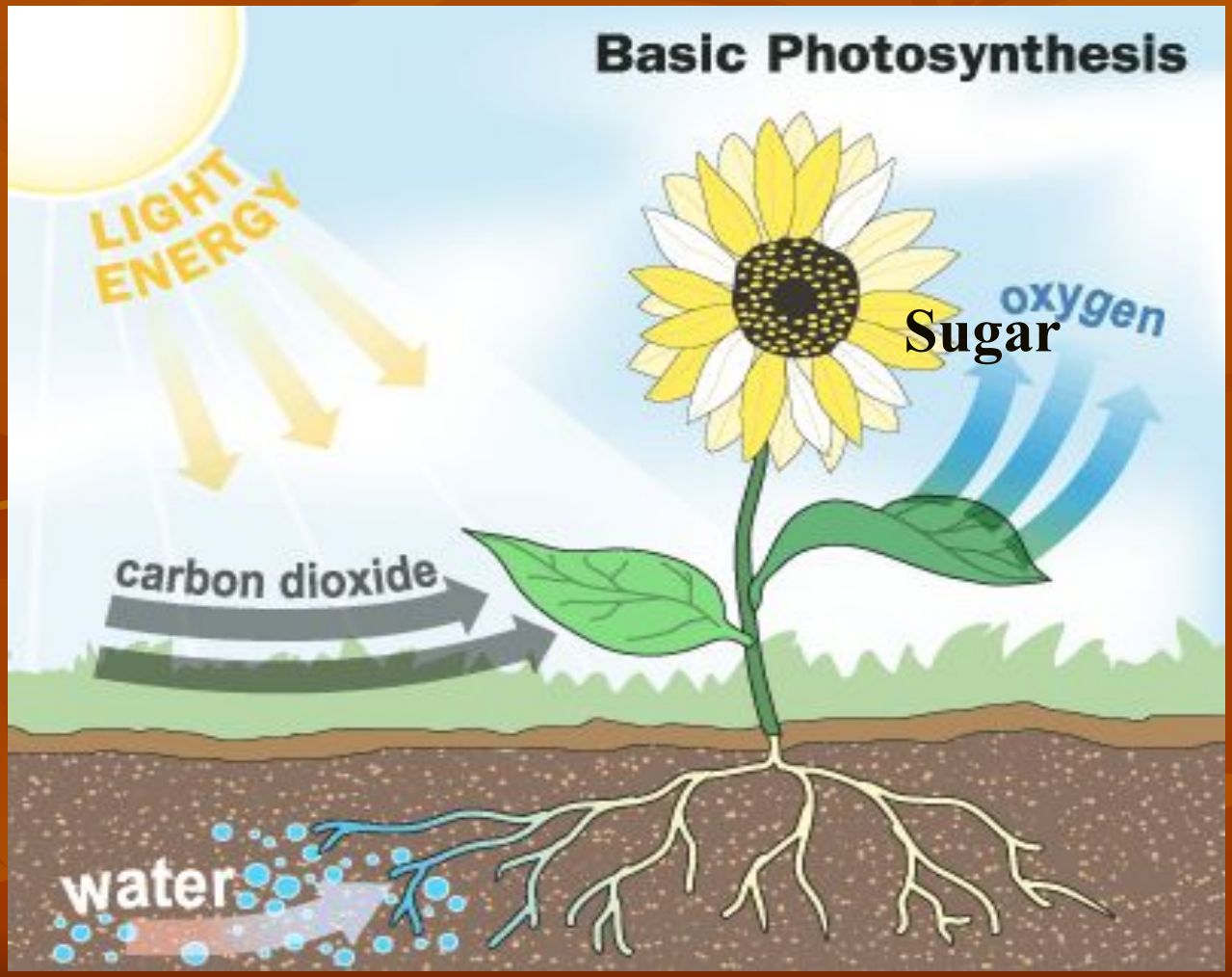
Check this out

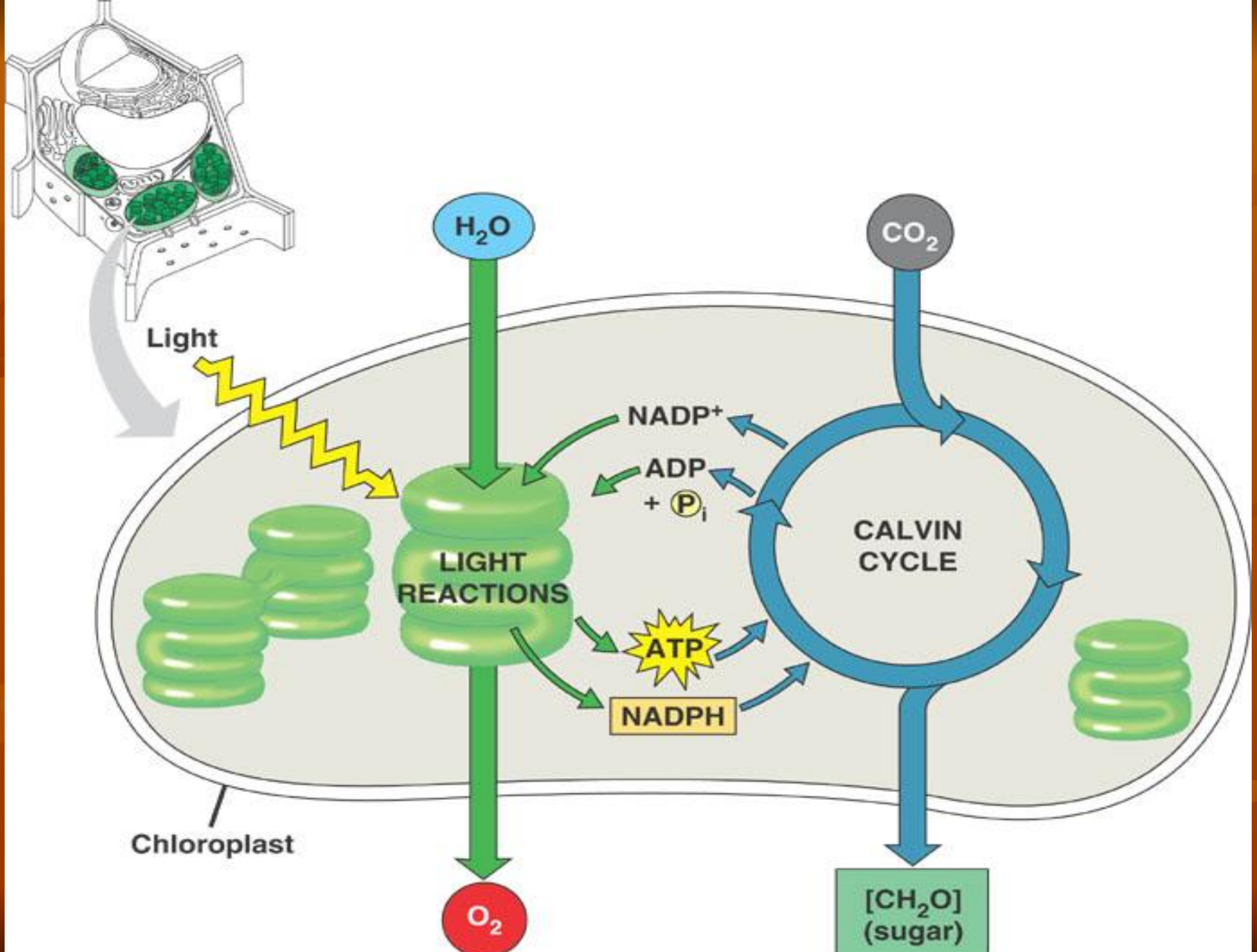
- http://faculty.nl.edu/jste/calvin_cycle.htm

- Check this site out….. It puts all of the Calvin Cycle together in an animation

The End Products of Photosynthesis are:

- Oxygen
- Glucose



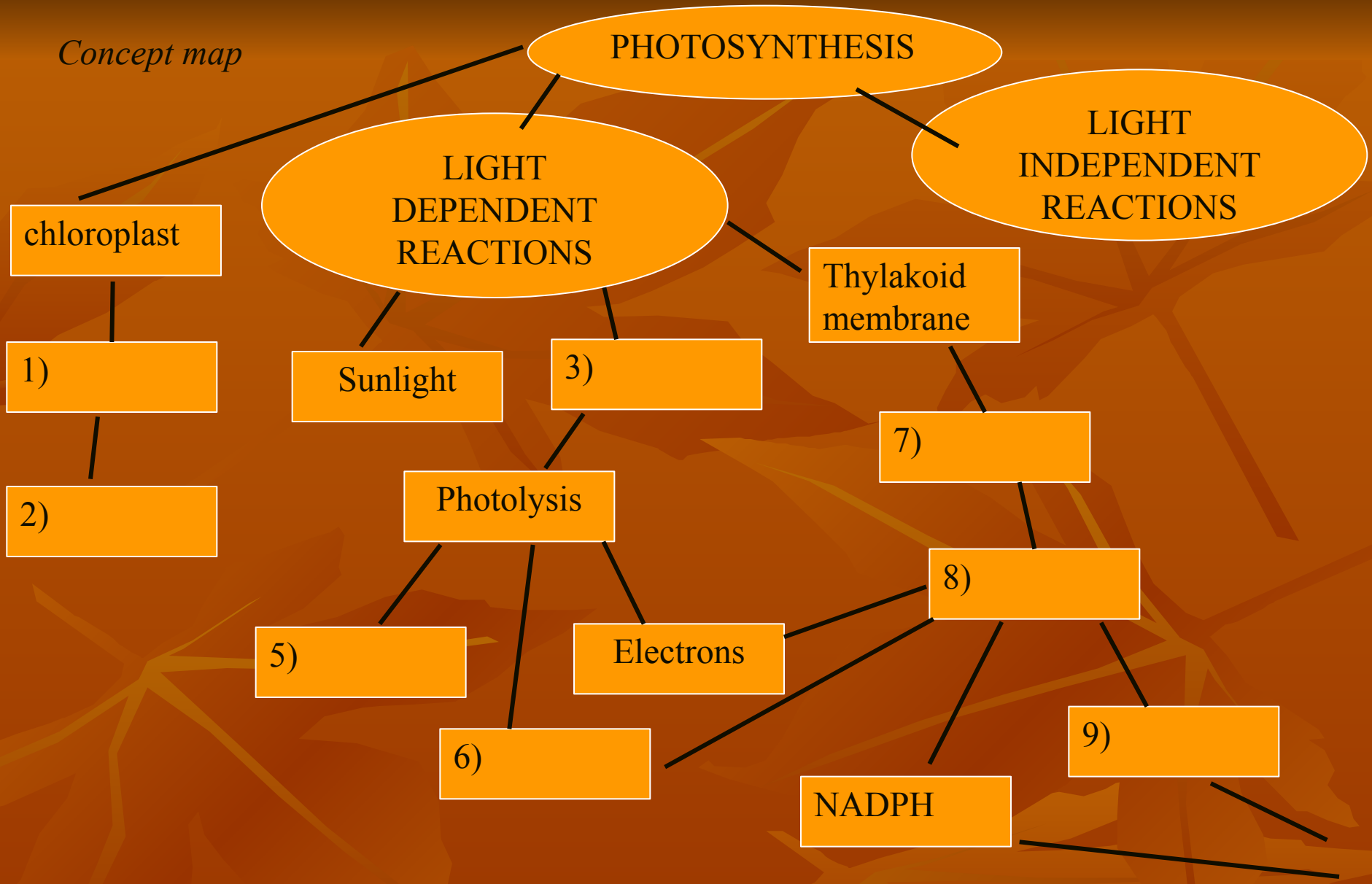

H_2O
CO_2
Light
$NADP^+$
ADP
+ P_i
LIGHT REACTIONS
CALVIN CYCLE
ATP
NADPH
Chloroplast
O_2
$[CH_2O]$ (sugar)

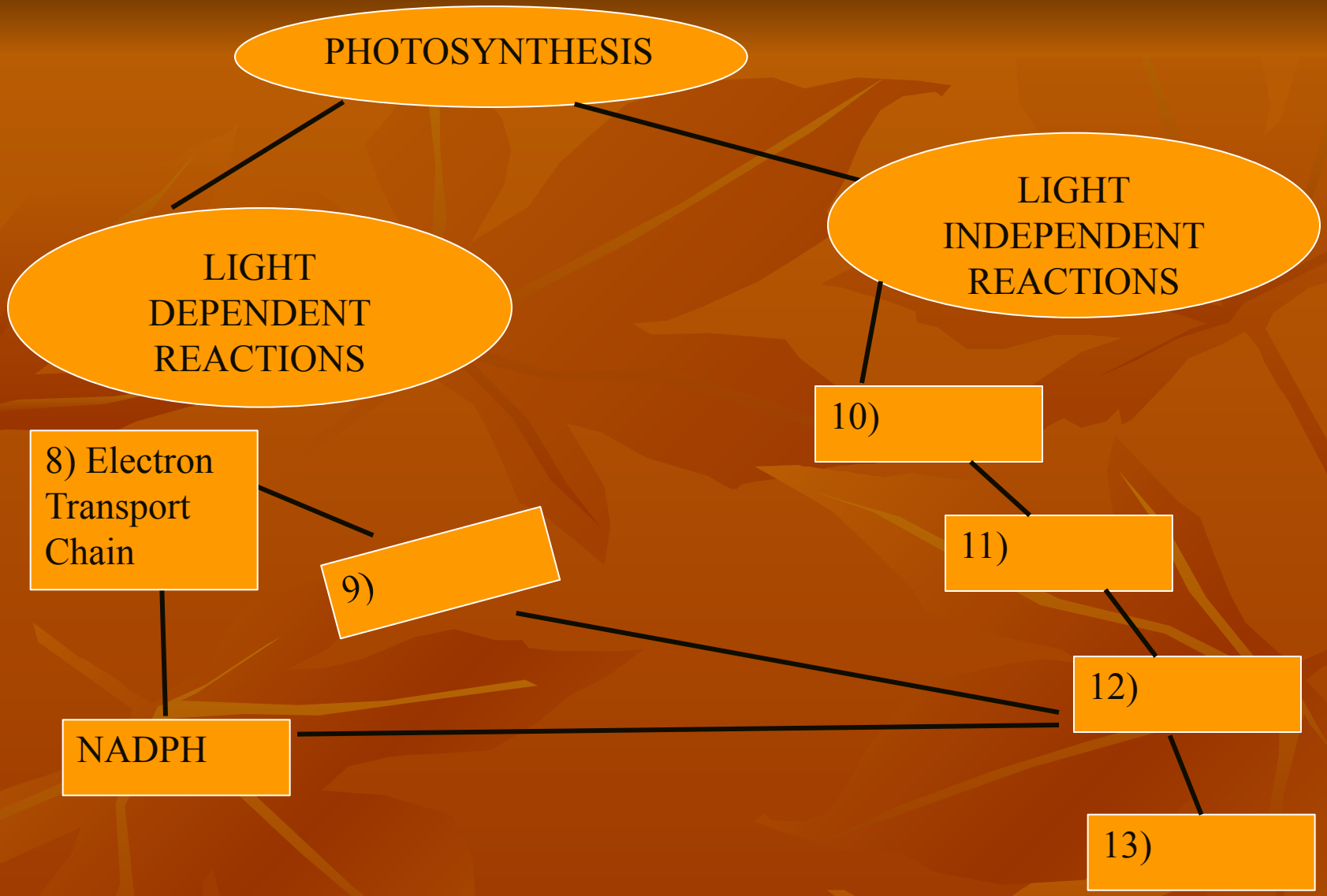
Light Dependent Reactions	Light Independent Reactions Calvin Cycle
Occurs in the thylakoid	Occurs in the stroma
Needs light	Does not need light needs CO_2
Absorbs light and converts it into chemical energy (ATP & NADPH)	Uses chemical energy (ATP & NADPH) to turn it into food
Produces O_2	Produces sugar

Questions to ponder…

- Why do plants grown in the sun have smaller leaves than those grown in the shade?
- What is the main source of the excited electrons?
- What is the source of some of the replacement electrons?
- What type of membrane protein is involved in photosynthesis?
- What is the role in photosynthesis of the following: light, water, chlorophyll, pigment, ATP, NADPH, and CO_2?
- What stage of photosynthesis would each of the limiting factors effect?

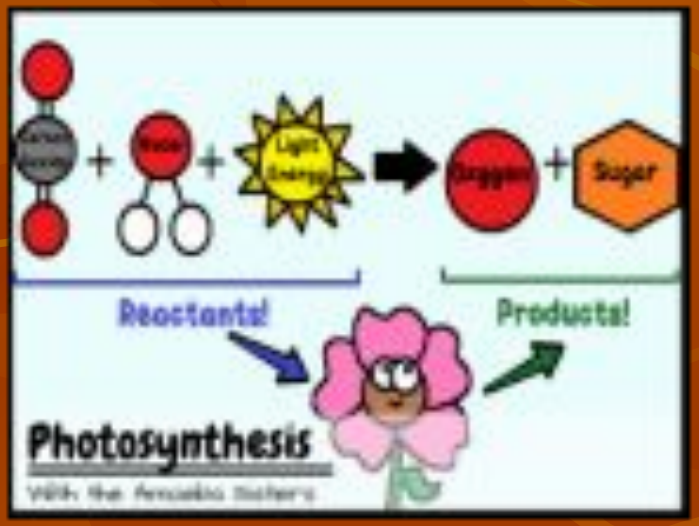
Concept map


PHOTOSYNTHESIS
LIGHT DEPENDENT REACTIONS
LIGHT INDEPENDENT REACTIONS
chloroplast
Thylakoid membrane
1)
Sunlight
3)
7)
2)
Photolysis
8)
5)
Electrons
6)
9)
NADPH


PHOTOSYNTHESIS
LIGHT DEPENDENT REACTIONS
LIGHT INDEPENDENT REACTIONS
8) Electron Transport Chain
9)
10)
11)
12)
13)
NADPH

True and False Game

- Need a piece of paper – divide into 8 pieces
- **LEFT** side *(cabinets)* – only write **FALSE** statements
- **RIGHT** side *(wall)* – only write **TRUE** statements



- GAME

  - Flip the Compare/Contrast paper over
  - Number your paper from 1 to ___
  - Pack up all of your stuff and put it under your lab table
  - Sit quietly and wait