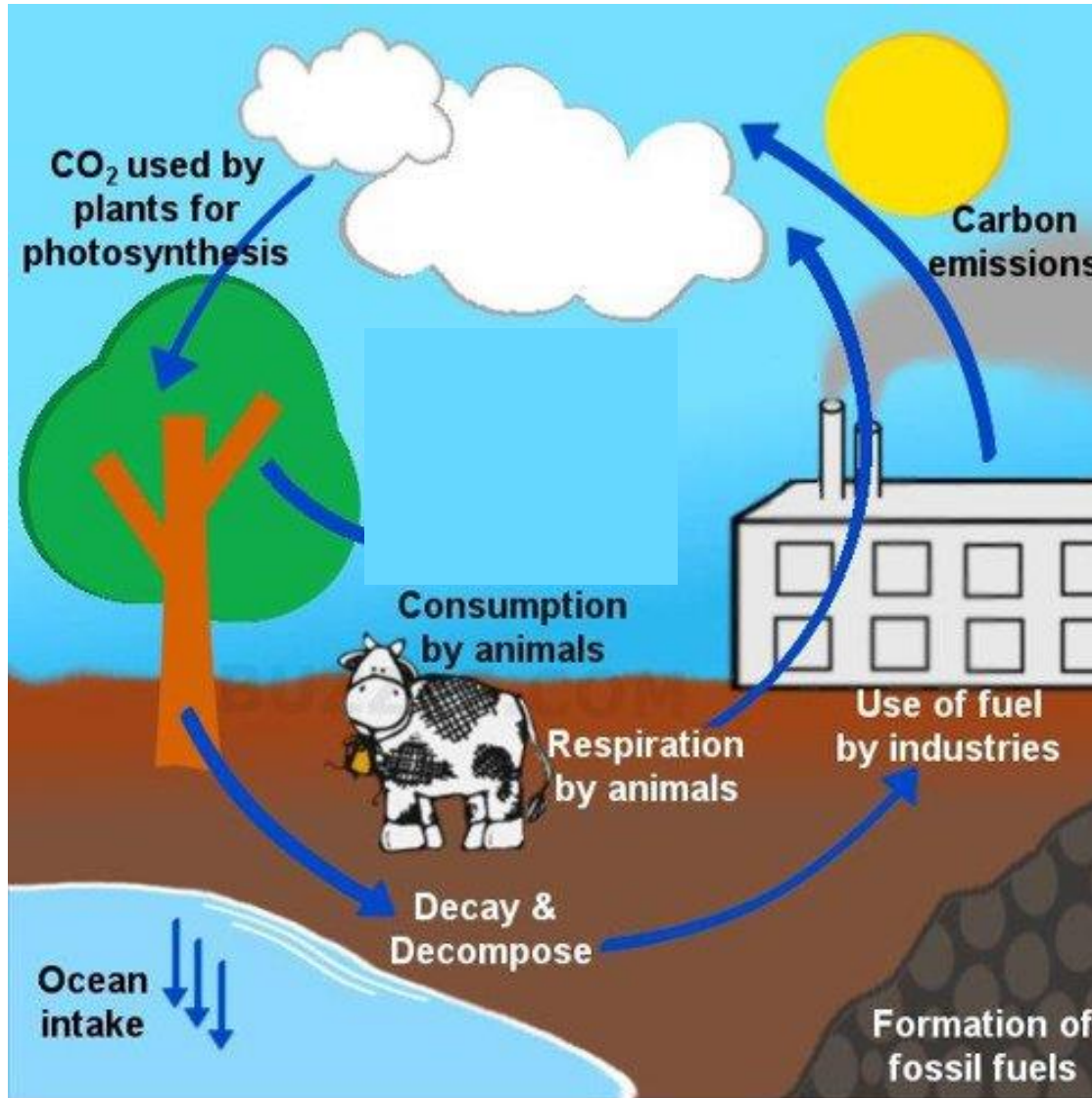


Cell Energetics

How plants make food and
everyone makes energy!

Carbon Cycle



Endosymbiotic Theory

- Endosymbiotic theory = a theory that some of the cell's organelles descended from prokaryotic cells (bacteria)
 - Bacteria was consumed by another bacteria and came to live within the cell
 - Chloroplasts and mitochondria are the organelles once thought to be free living bacteria

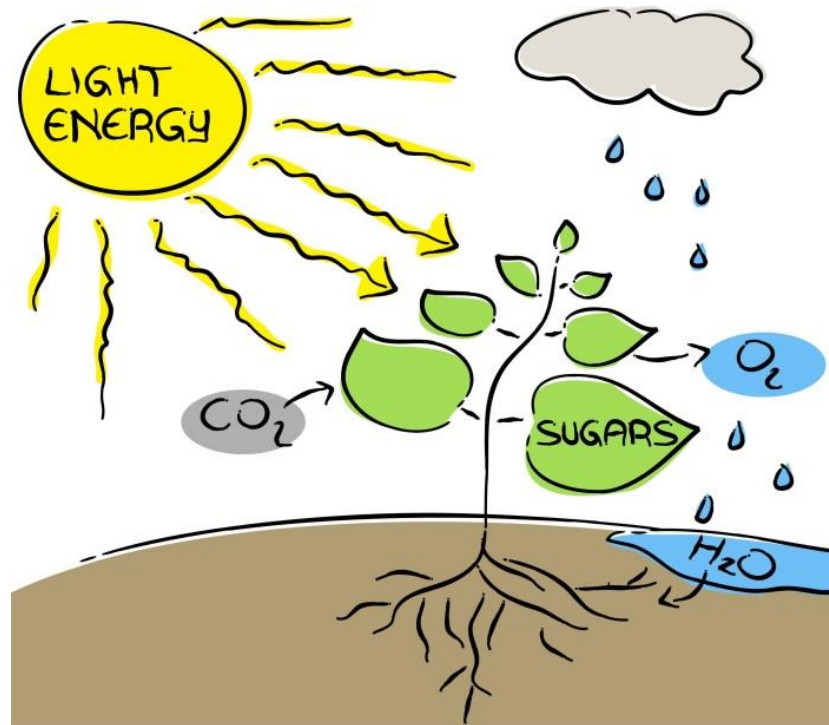
Evidence to Support This Theory

- Both organelles have DNA
- Both contains ribosomes that make proteins
- Both can multiply by itself

Photosynthesis

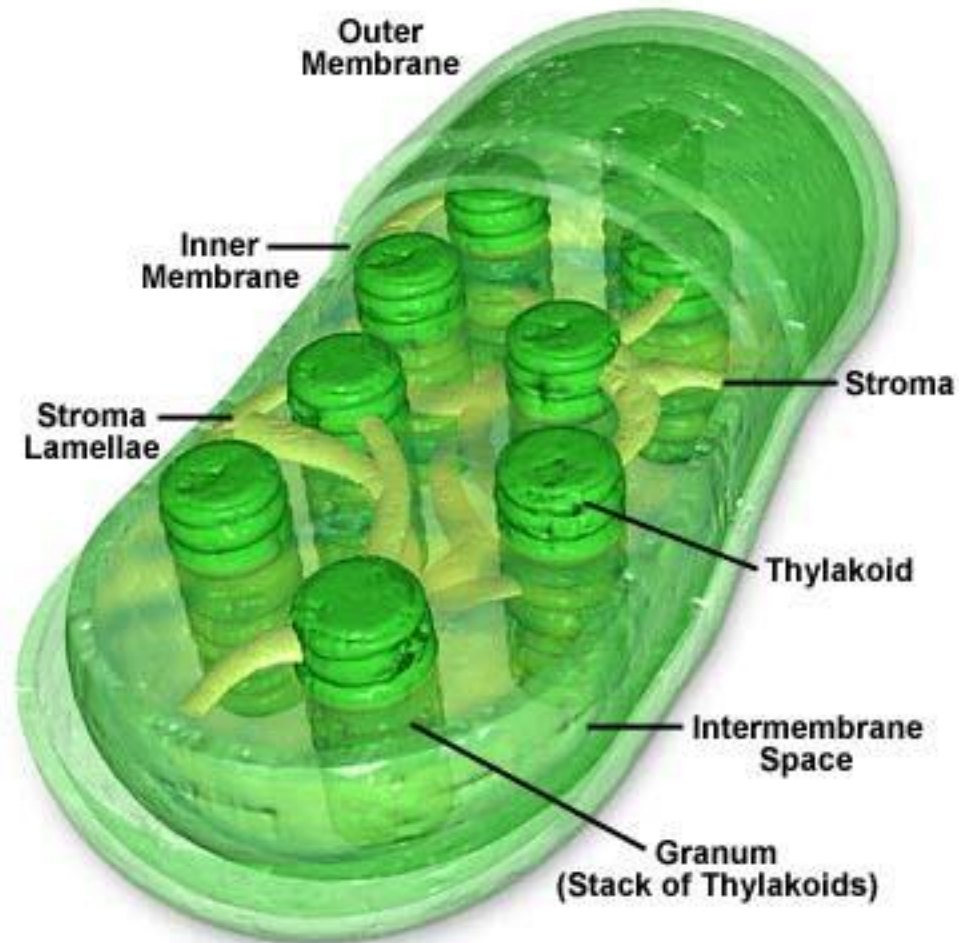
- Definition: The process by which autotrophs use light energy to convert, carbon dioxide and water into carbohydrates
- Occurs in the chloroplast
- Occurs only in plants, some protists (algae), and some bacteria

Equation



Photosynthesis

- 2 parts
- Light reaction = thylakoid (disk)
- Calvin cycle = stroma (fluid)

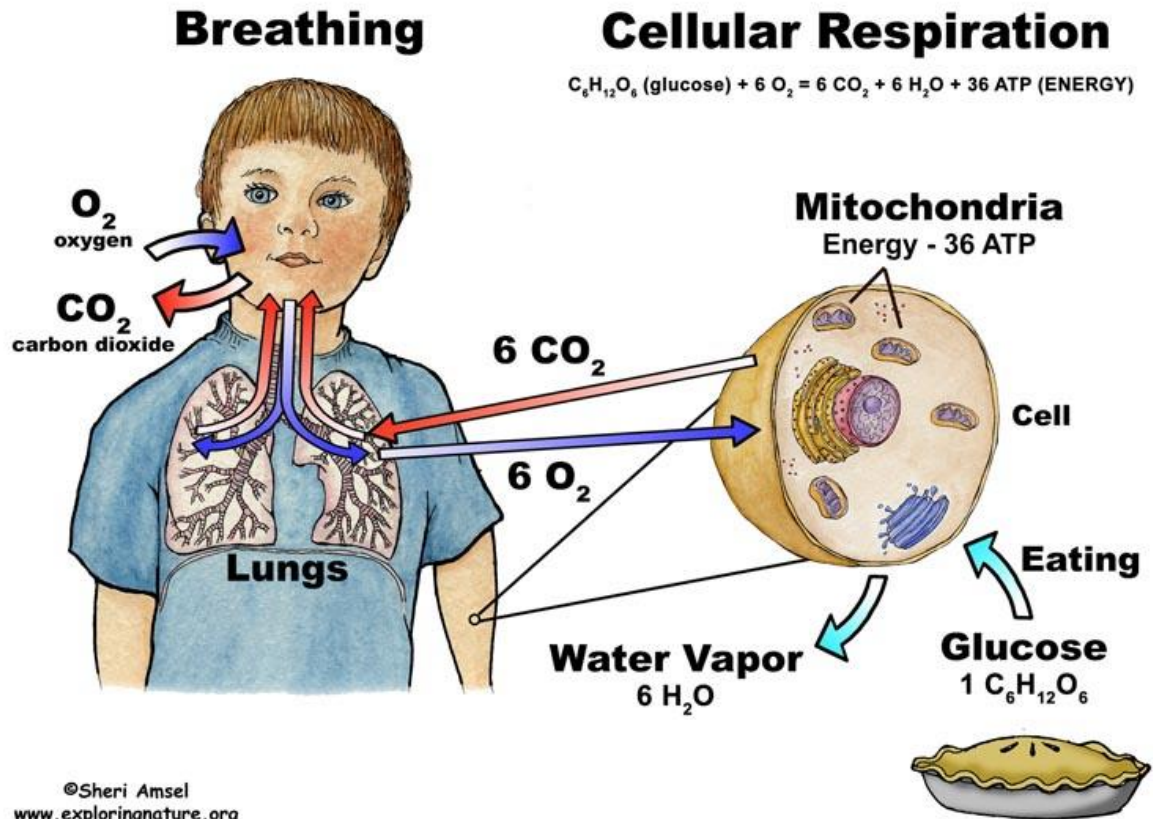


Cell Respiration

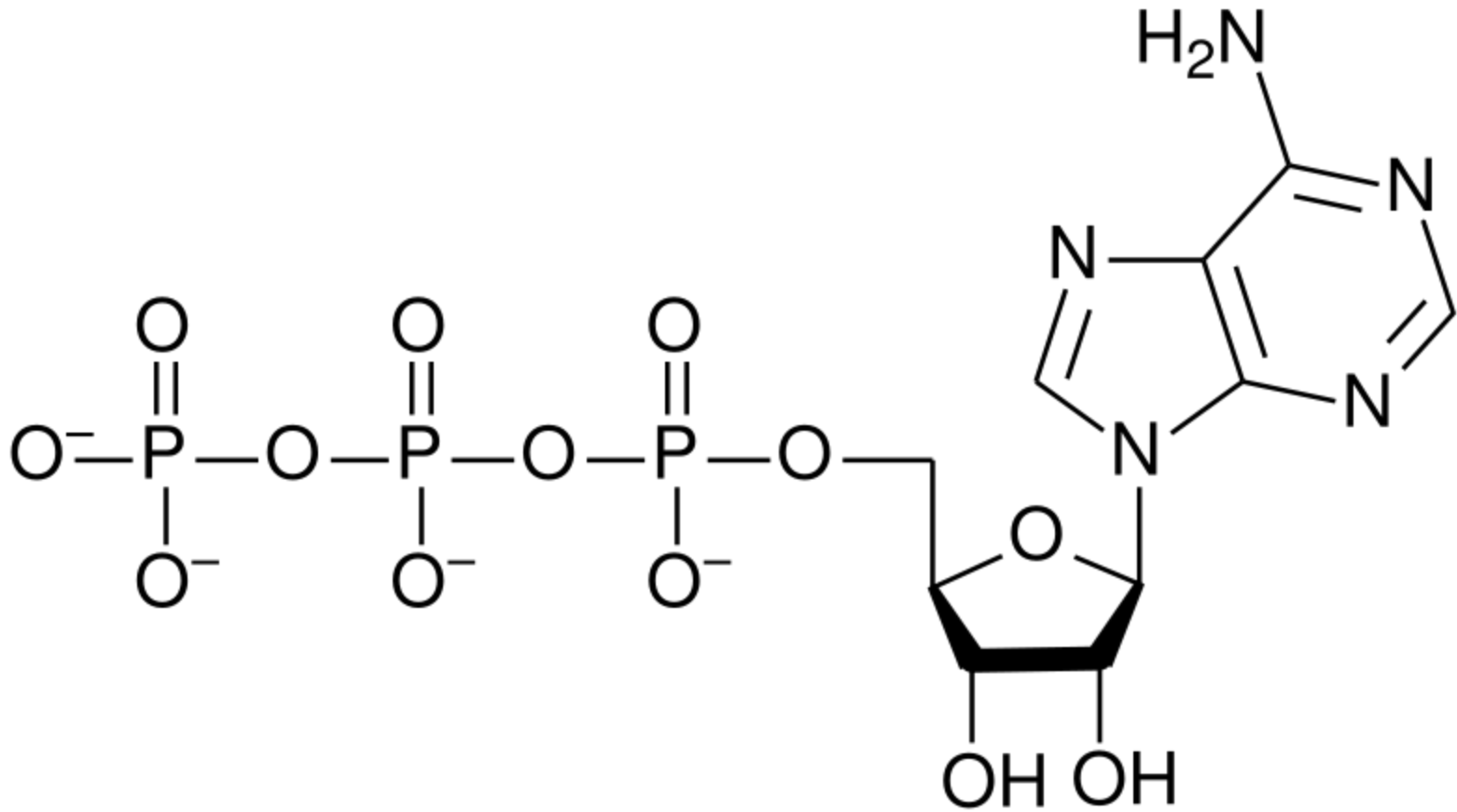
- Definition: The process by which cells produce energy (ATP) from carbohydrates
- Occurs in mitochondria
- Occurs in both autotrophs and heterotrophs (all eukaryotic organisms)

Equation

- $\text{Glucose} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{energy (ATP)}$

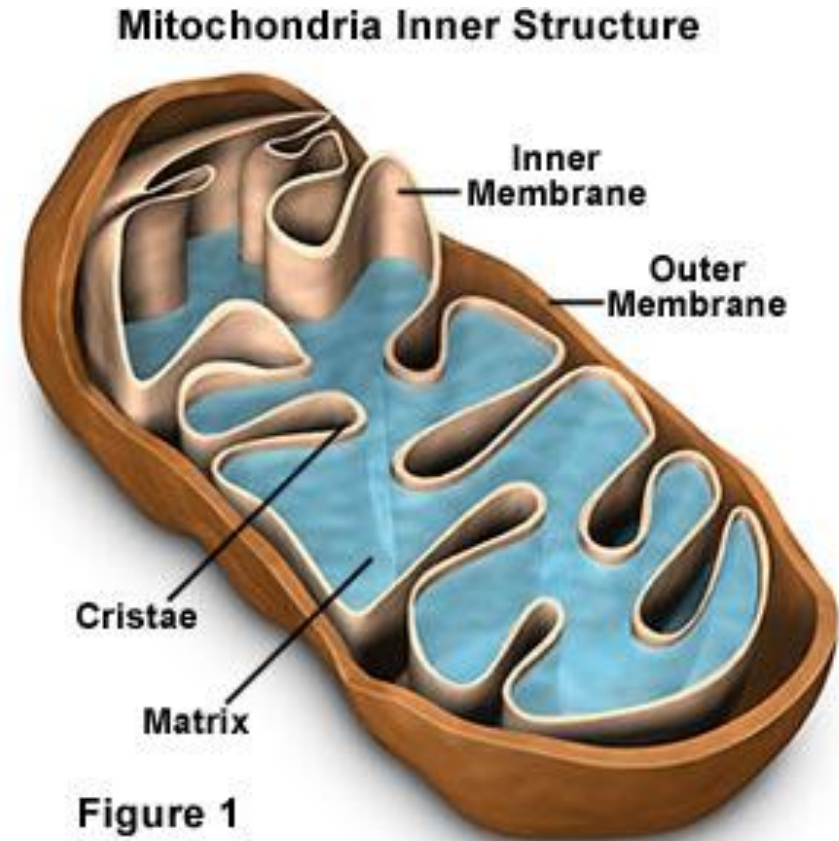


ATP = Adenosine Triphosphate



Cell Respiration

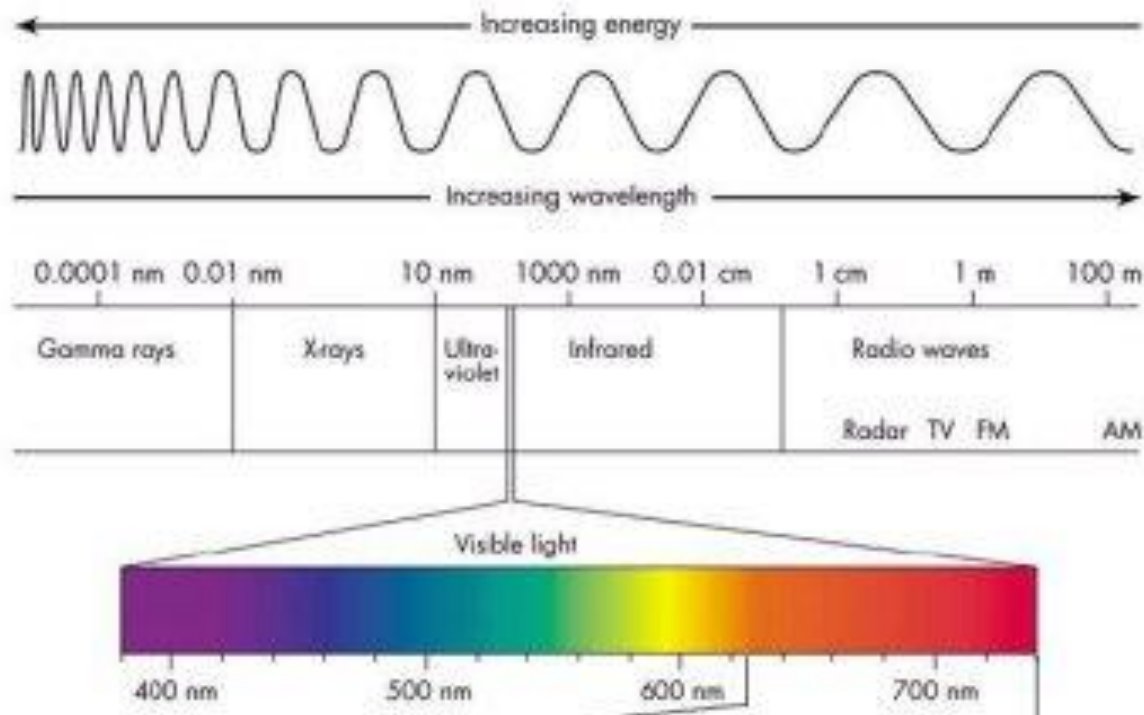
- 3 parts
- Glycolysis = cytoplasm
- Krebs Cycle = matrix of mitochondria
- Electron Transport Chain = inner membrane of mitochondria
- Inner membrane = cristae



Photosynthesis: The Details

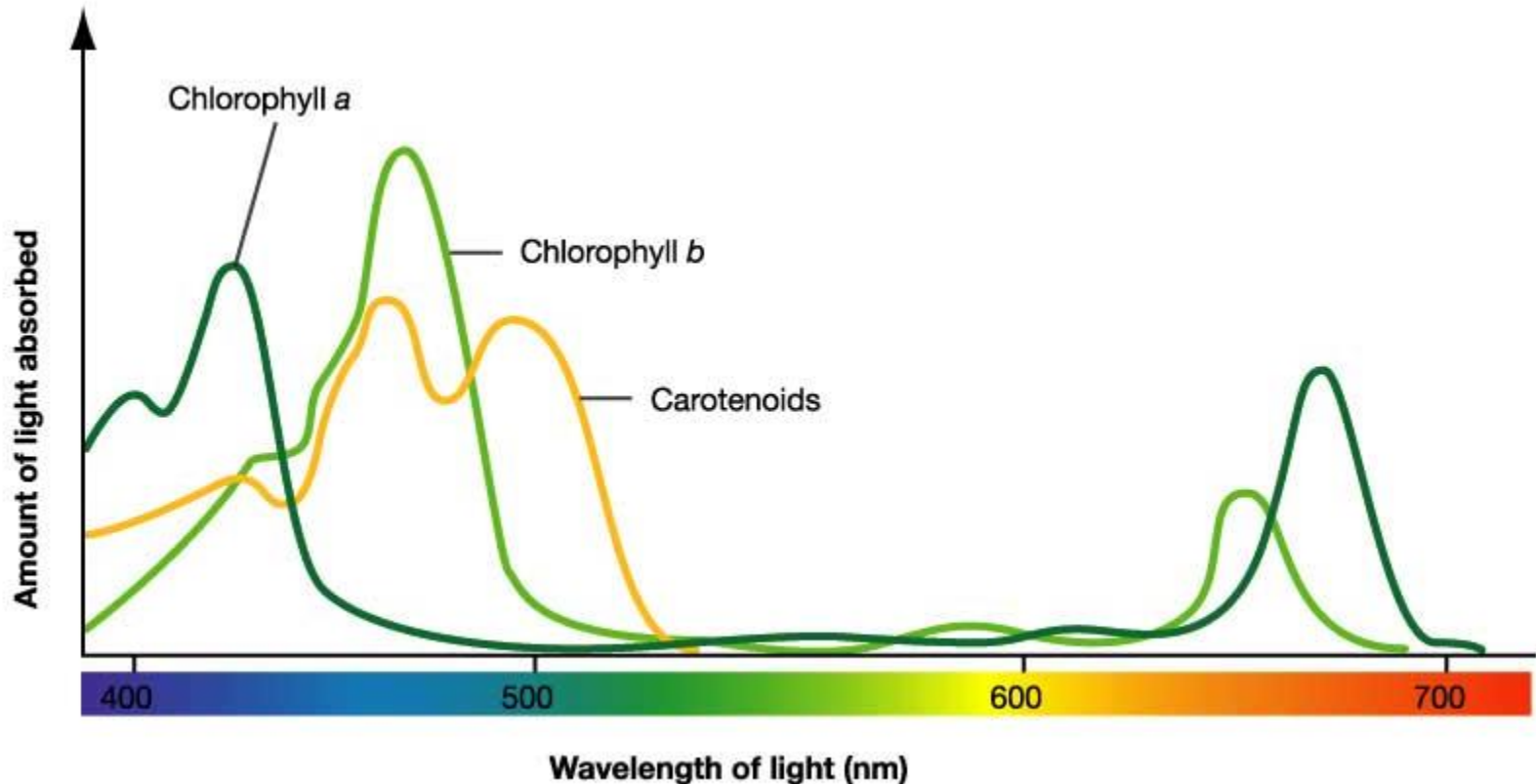
Light

- Different wavelengths make up the light we see
- If we see green, then the green wavelength is being reflected back at us



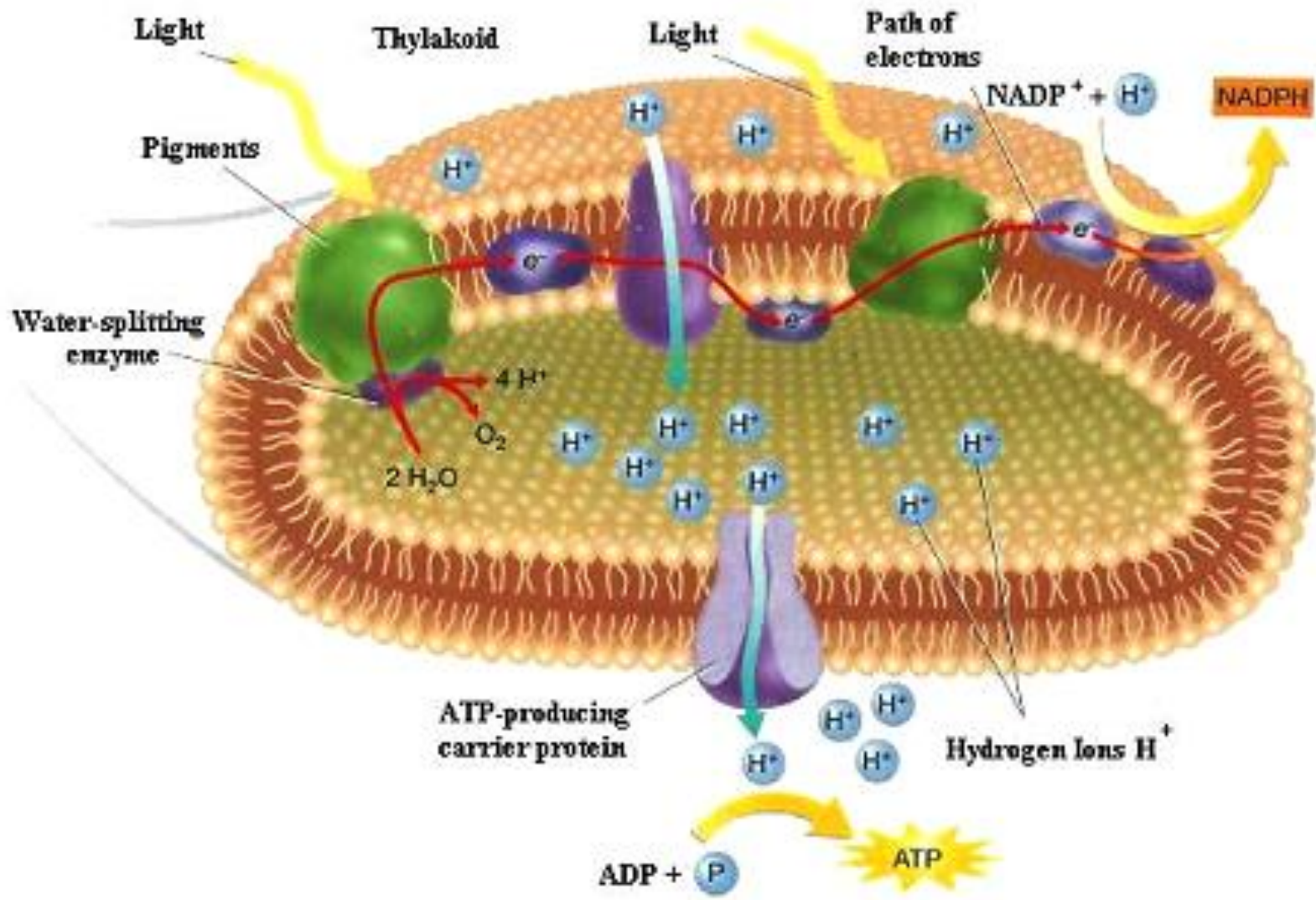
Pigments in Plants

- Certain pigments in plants are used to capture the light wavelengths



Light Reaction

- Light hits the chlorophyll (pigment) in the thylakoid membrane
- An electron gets excited by the light and moves along a series of proteins (electron transport chain) in the membrane
 - This powers the movement of H^+ into the disk



Light Reaction

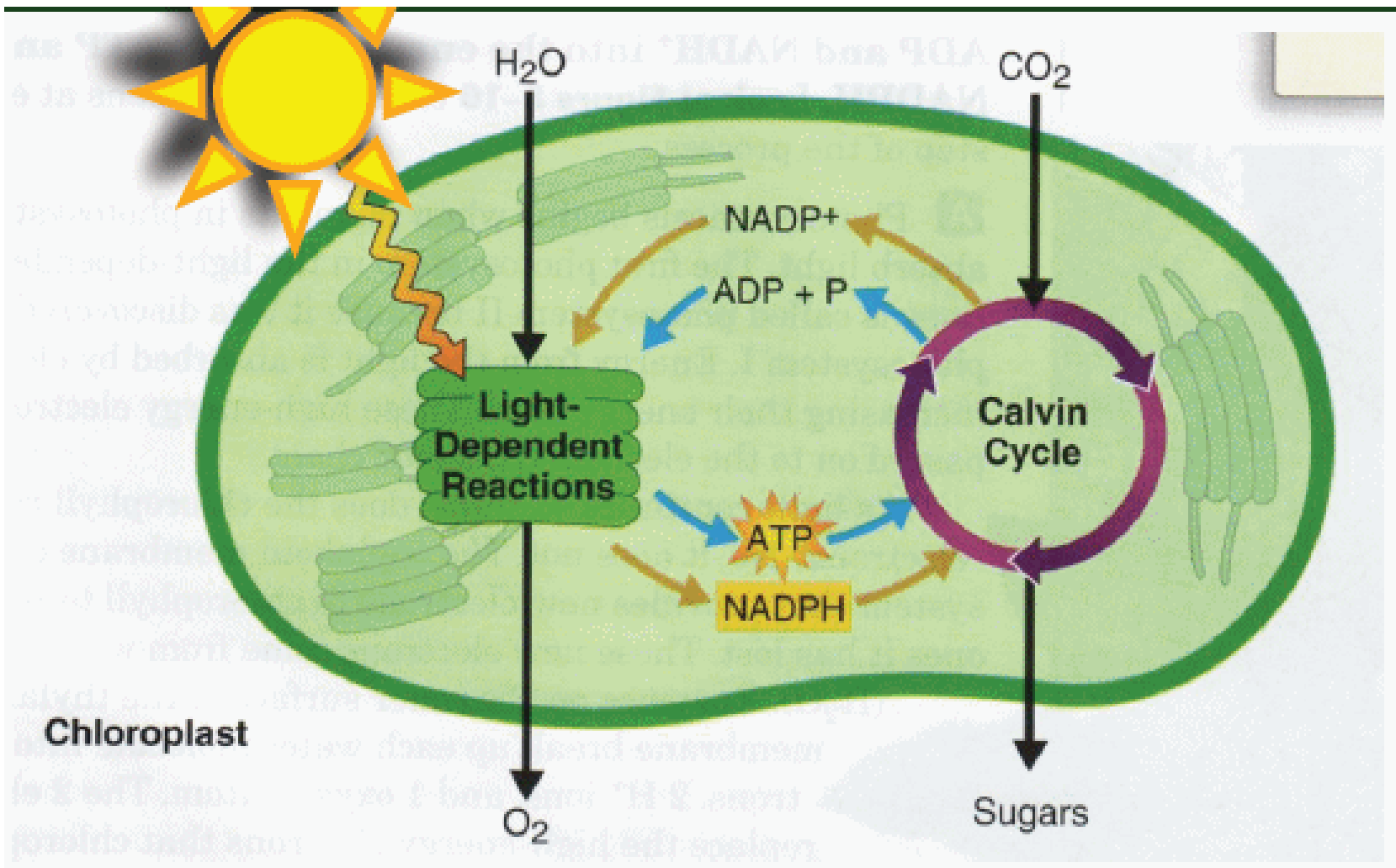
- The lost electron gets replaced when a water molecule splits into oxygen and hydrogen within the disk
 - Oxygen (O_2) leaves the plant and H^+ gets added to the growing concentration inside the disk

Light Reaction

- Another ray of light hits another group of chlorophyll in the membrane
- The electron gets excited again
- The electron is used to make a carrier molecule called NADPH

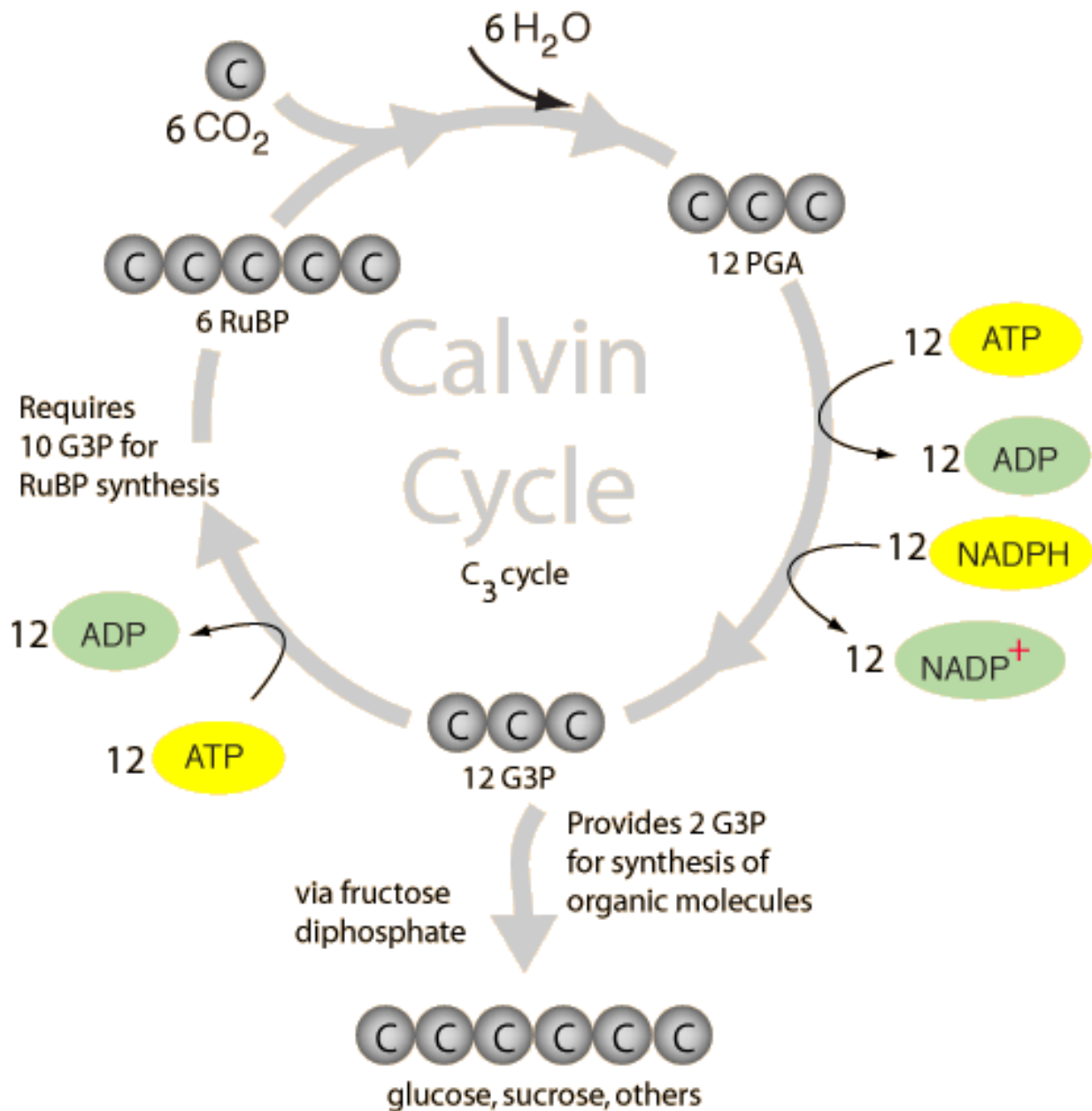
Light Reaction

- Then, ATP is built when the build up of H⁺ in the thylakoid causes them to move out through a special protein – ATP synthase
 - This is an enzyme in the thylakoid membrane
- ATP synthase causes a P to get added to ADP to create ATP
- End Result: NADPH and ATP...O₂ leaves the cell and then the plant



Calvin Cycle

- NADPH and ATP move to the stroma to be used in the next series of steps
- CO₂ comes into the cell and into the chloroplast and attaches to a 5-carbon molecule that is already in the organelle



Calvin Cycle

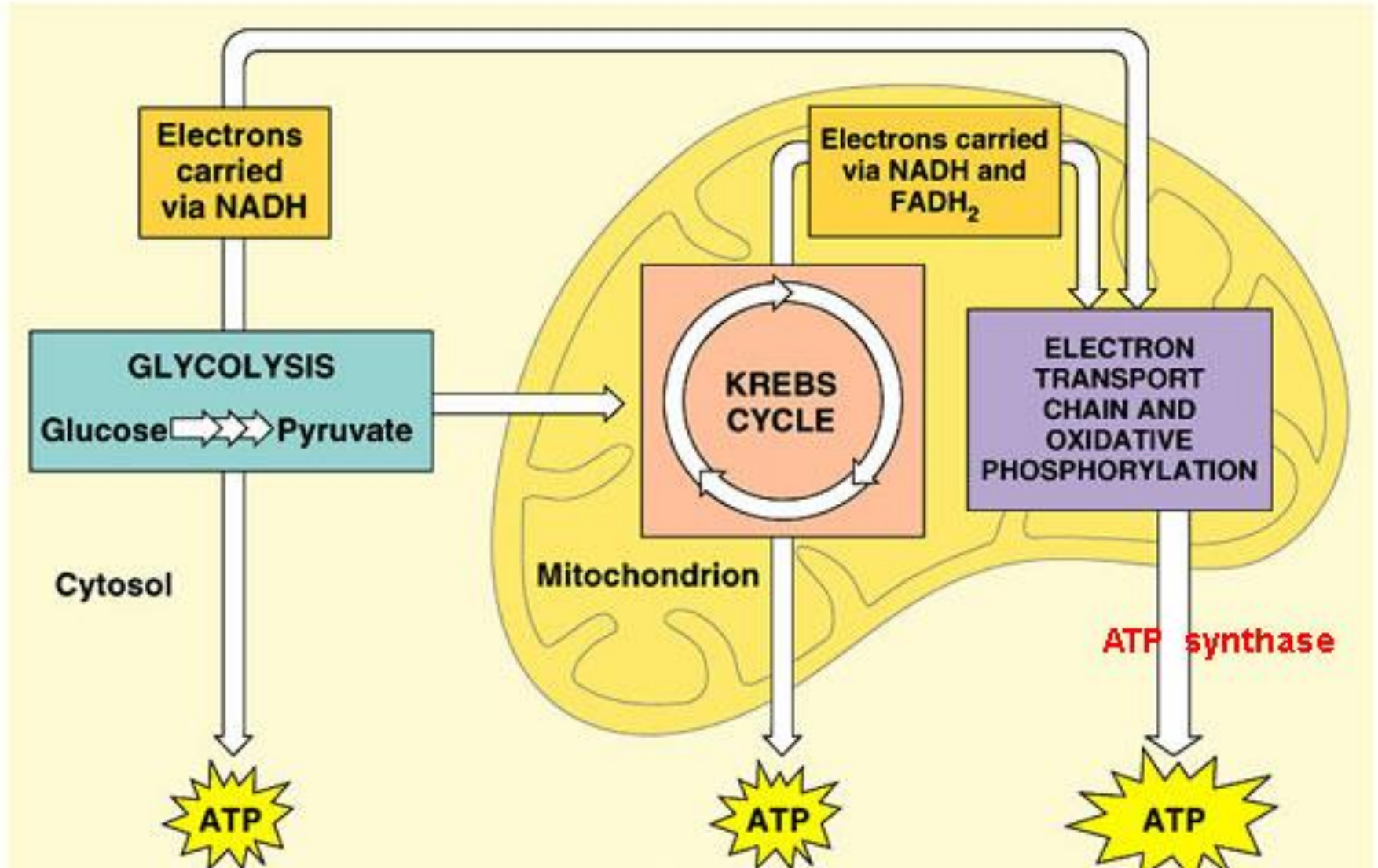
- This new 6-carbon molecule goes through a series of changes with the help of ATP and NADPH
- This makes 1 sugar and the rest of the elements reform the original 5-carbon molecule

Factors affecting photosynthesis

- Light intensity / amount
 - Temperature
 - Amount of CO₂ available
-
- Changes in the above factors will either increase or decrease photosynthesis

Cellular Respiration: The Details

Cell Respiration



Step 1: Glycolysis

- Glucose comes into the cell and is too big to fit into the mitochondria
- Glucose (6-C) is broken down into two 3 carbon molecules and a carrier molecule is formed
- End Results of this step: **2 ATP** and NADH

Step 2: Krebs Cycle

In the Mitochondria – if O_2 is present

- The 3-Carbon molecule breaks off a CO_2 which leaves the cell
- The new 2-Carbon molecule binds to a 4-Carbon molecule (already present in the organelle) and goes through a series of steps
- End results: **2 ATP**, NADH, and $FADH_2$ (another type of carrier molecule)
 - CO_2 leaves

Step 3: Electron Transport Chain

- All the NADH and FADH_2 pop off their H to start the movement of electrons through the series of proteins in the membrane of the mitochondria
- H^+ moves across the inner membrane by active transport through a protein
- The electrons eventually get donated to O_2 and a left over H^+ to make H_2O
 - Without O_2 present this step cannot occur

Electron Transport Chain

- Meanwhile, H^+ builds up between the two membranes of the mitochondria and then diffuses back in through a special protein – ATP synthase (enzyme)
 - This allows a P to add to ADP to make ATP
- End Results: **34 ATP**
- Total ATP count for cell respiration = 38

Fermentation (Anaerobic Respiration)

- 2 Types: alcoholic fermentation and lactic acid fermentation

If **NO** O₂ is present:

- After glycolysis, the 3 carbon molecule is converted into lactic acid (animals) or ethyl alcohol (fungus and bacteria) instead of moving into the next 2 steps
- End Result: only 2 ATP from glycolysis
 - This is less than cellular respiration