4. Metabolism

= all the chemical reactions that build up and tear down molecules within the cell
- involves energy production and use within the cell
- all organisms require energy in order to complete life processes
  ie. active transport, reproduction, movement, growth and repair, etc.
- this energy is obtained on a cellular level

What is ATP - https://www.youtube.com/watch?v=xN16-24QIsI

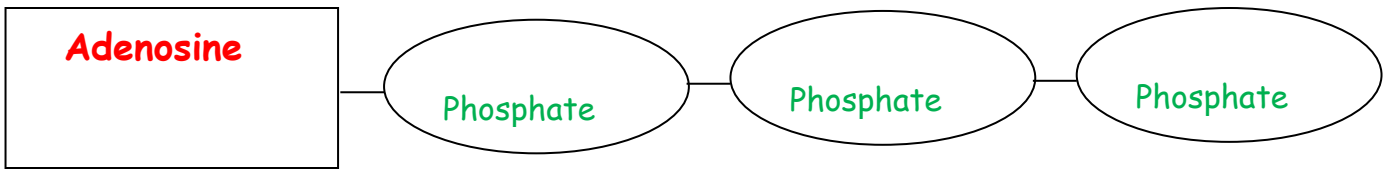
A) Energy

= the capacity for doing work or causing change
- cannot be created or destroyed, only changed from 1 form to another
  : ie. heart attack victims receive electrical energy which is converted to mechanical energy
- there are many forms of energy (light, heat, chemical, electrical, mechanical, etc.) however, ultimate energy source for all living organisms is the sun

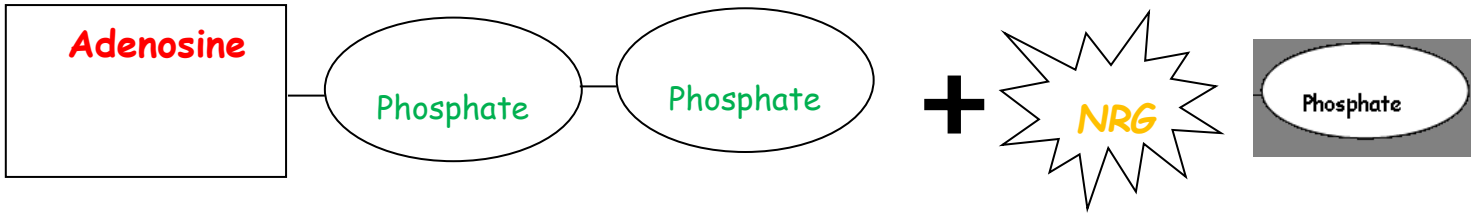
1. Energy Storage and Transformation

- energy storage and conversion processes are critical for sustaining life
- ATP (adenosine triphosphate) is a compound that stores chemical energy in cells

: energy is kept in these small packets so that it can be used quite readily



: whenever energy is needed, the terminal (end) phosphate breaks off of ATP
= a bit of energy is released and ADP (adenosine diphosphate) is left

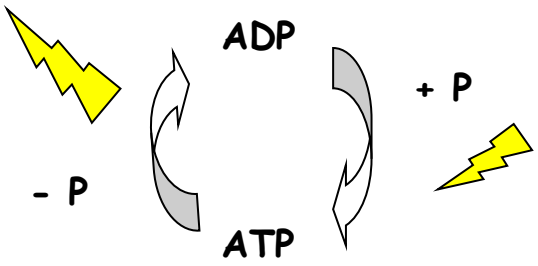


= ie. keeping four $5 bills for buying things instead of a single $20 bill

: ADP can be used as an energy source (strip end phosphate → AMP) but is not an efficient energy source (like using quarters to purchase goods).

= is an energy carrier

(picks up NRG released during special chemical reactions and uses it to attach a phosphate and form ATP again)



= **CYCLIC**

: these special reactions involve the transfer of electrons from 1 atom/molecule to another releasing NRG quickly in large amounts

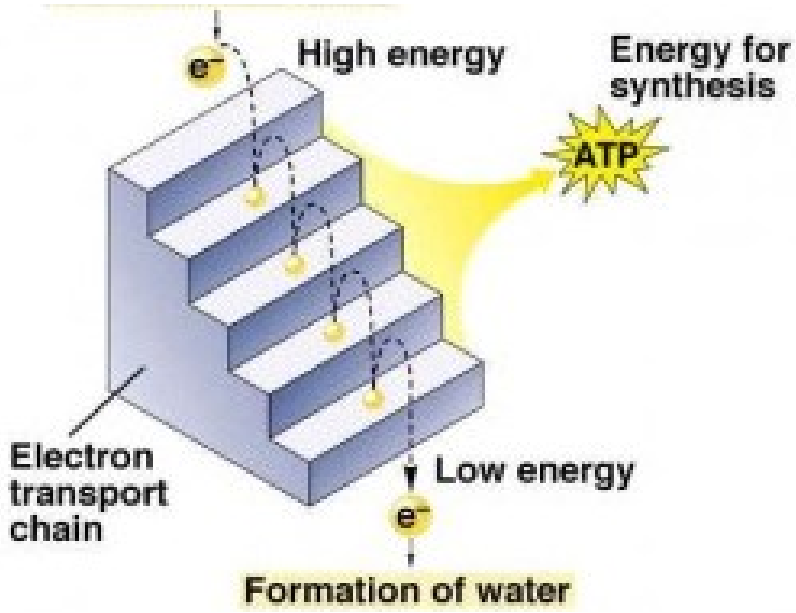
2. Electron Transport Systems

- rapid release of energy is not suited for cells

: causes damage (cells = proteins; energy = heat)

= NRG is released by the transfer of electrons is released in a small amounts as particles are passed from 1 acceptor molecule to another

- ie. like a hot potato or going down a series of steps

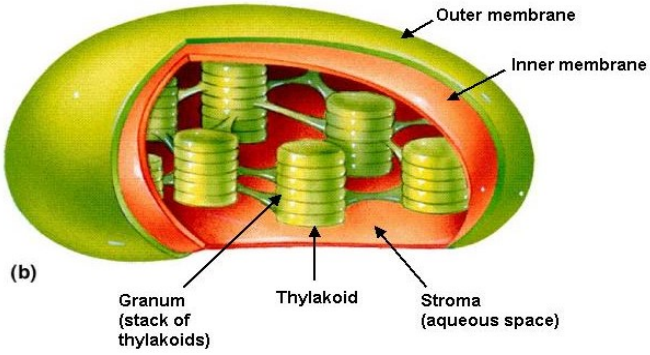


Types of Metabolic Reactions = photosynthesis, respiration, and fermentation

B) Photosynthesis (pp. 97 fwd)

Amoeba Sisters Photosynthesis - https://www.youtube.com/watch?v=uixA8ZXx0KU

- General Formula: $6CO_2 + 6H_2O$ + Solar NRG $\xrightarrow{\text{chlorophyll}}$ $C_6H_{12}O_6 + 6O_2$
- process through which solar energy is converted into chemical energy stored in the bonds of glucose molecules
- occurs in the chloroplasts of photosynthetic organisms
- Involves 2 stages:
  - **Light-Dependent Reactions**
  - **Light-Independent Reactions** (Calvin Cycle)



i) Light- Dependent Reactions

- ***Site:*** *in the disk shaped thylakoids of the grana*
- ***Purpose:*** *Produce ATP & harvest H^+ ions to use in the Light Independent Reactions*
- ***Involves the use of solar NRG to:***
  - Energize electrons
  - Split water molecules

a) Energy Production

- Chlorophyll absorbs photons of sunlight strike (solar NRG) causing it to release 2 high energy electrons to the
- These electrons pass down an Electron Transport Chain (Photosystem II) releasing energy to form ATP from ADP with help from the enzyme ATP synthase
- These same electrons reach the base of the ETS in Photosystem II and are re-energized by the Sun and passed down a second shorter ETC (Photosystem I) releasing more NRG which is used to form more ATP from ADP

b) Harvesting of Hydrogen ions

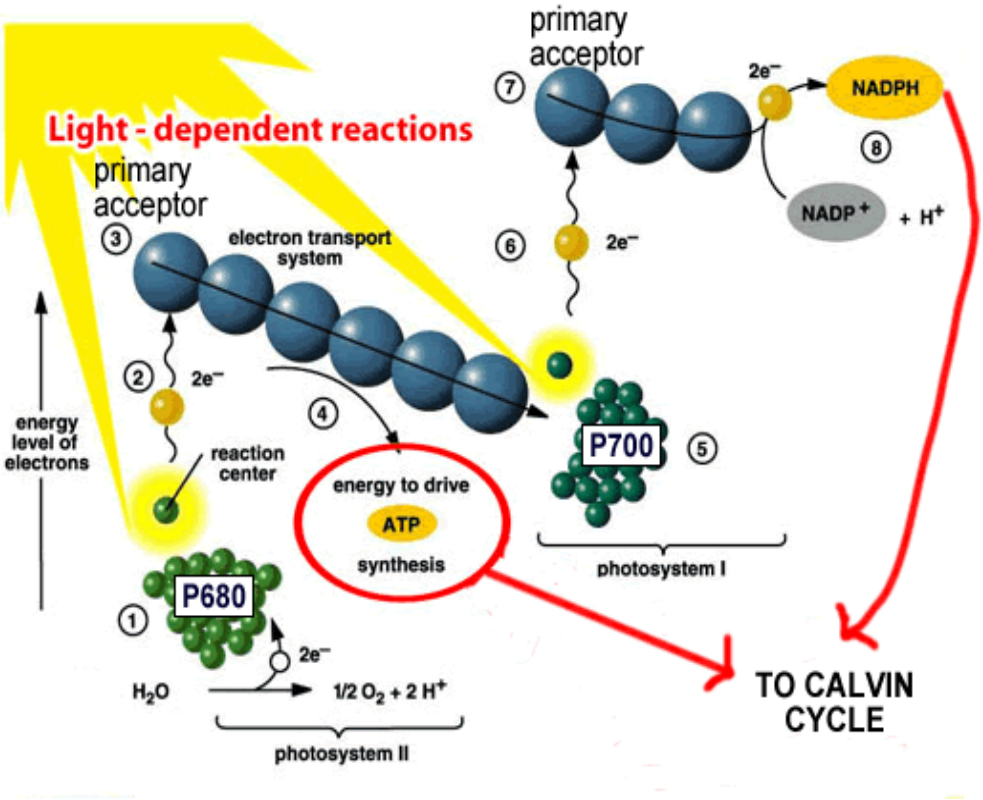
c) Solar NRG splits water into H^+ ions, an O atom & 2 electrons

→ electrons = will replace the 2 e^-'s lost by chlorophyll a

→ H^+ ions = picked up by the carrier molecule NADP, forming NADPH, which will be used in the Light Independent Reactions to make glucose

→ Oxygen = given off as a byproduct in the form of O_2 gas

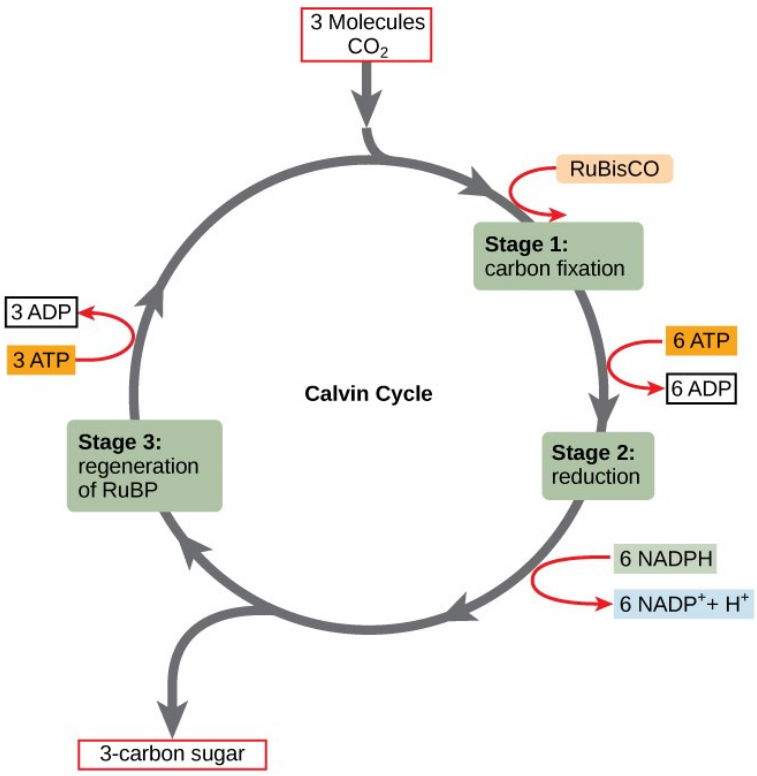
**All molecules of NADPH & ATP created in the Light Phase are used in the Calvin Cycle

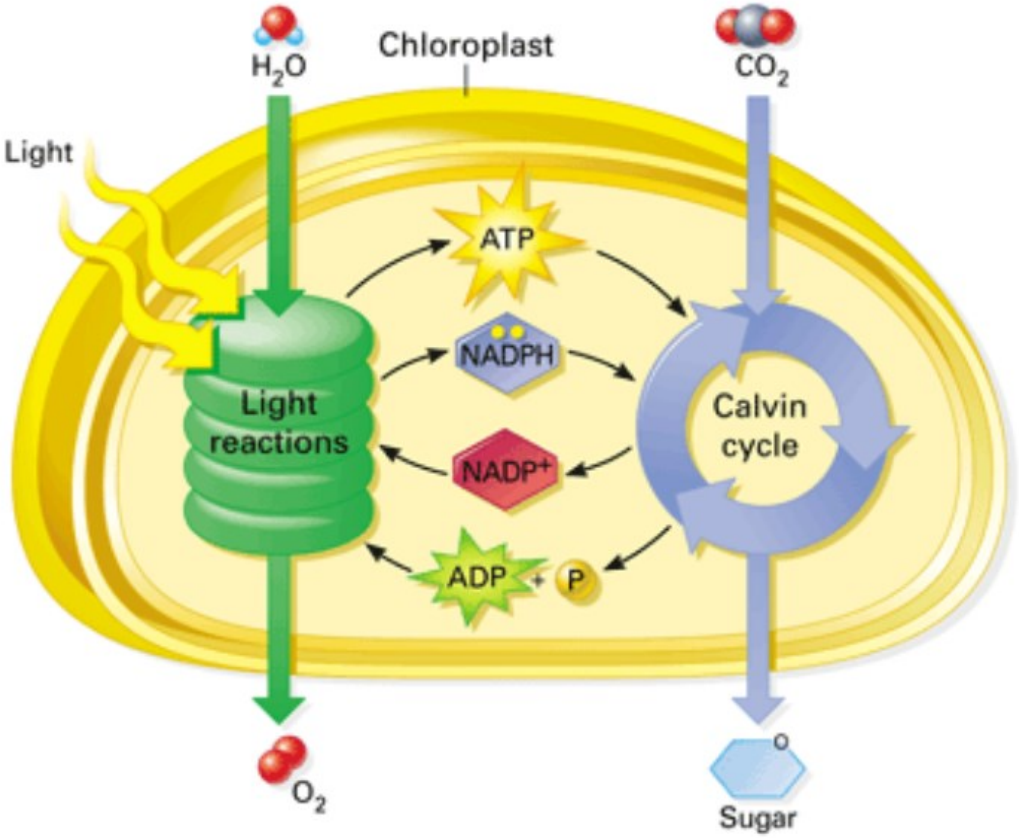

Light - dependent reactions
primary acceptor
primary acceptor
electron transport system
energy level of electrons
reaction center
energy to drive ATP synthesis
P680
P700
2e⁻
NADPH
NADP⁺ + H⁺
H₂O
1/2 O₂ + 2 H⁺
photosystem I
photosystem II
TO CALVIN CYCLE
1
2
3
4
5
6
7
8

ii) Light Independent Reactions (Calvin-Benson Cycle)

- **Site:** *in the gel between the grana called stroma*
- **Purpose:** *Build carbohydrate molecules using products of the light-dependent reactions*
- **Involves using ATP to**
  - Join carbon dioxide molecules (fixing) together with hydrogen ions to make carbohydrates (ie. Sugar, starch, etc)
- **Process**
  - CO_2 molecules from the atmosphere enters the chloroplasts
  - Energy from ATP is used to join 3 CO_2 molecules together with the help of a carrier molecule, Rubisco (RuBP) forming PGA
  - Energy from ATP is used to join the PGA molecules with H^+ ions donated by NADPH to form PGAL (aka GP3)
  - Both ADP and NADP are recycled to the Light-Dependent Phase
  - PGAL can be used as it is or molecules of PGAL can be combined to form more complex carbohydrates (ie. Glucose, sucrose, starch)

***Does not** require solar energy as it uses the energy stored in the ATP molecules = occurs day and night*





What gas is released in the Light Dependent Reactions?

1. Carbon dioxide
2. Oxygen
3. Water vapour
4. All of the above

What is made in Photosystem I & II?

1. $C_6H_{12}O_6$
2. ATP
3. CO_2
4. All of the above

What new gas enters the Calvin Cycle?

1. Carbon dioxide
2. Oxygen
3. Water vapour
4. All of the above

What is produced by the Calvin Cycle?

1. Sugars
2. ATP and NADPH
3. O_2
4. All of the above