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A2 Biology Unit 4

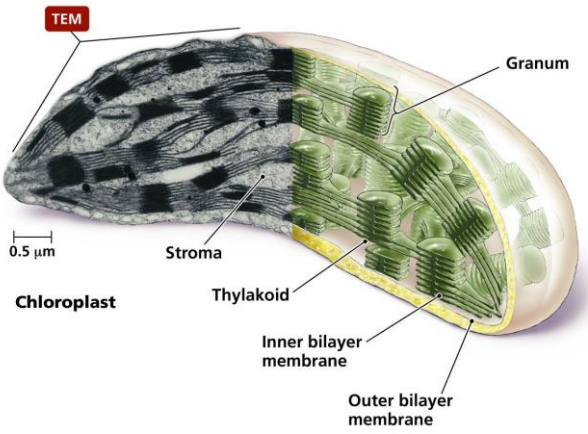
Photosynthesis & Respiration

ATP

Adenosine triphosphate stores energy in the bonds between its phosphate groups. They are broken with the minimum of activation energy and easily reform when energy is released from the oxidation reactions of respiration. This instability makes ATP only useful for short term energy needs, not storage.

ATP ADP + Pi + energy

Structure of chloroplast



Outer membrane
permeable to many small ions.
Inner membrane
has transport proteins, so controls the entry and exit of substances.
Stroma
Fluid filled matrix which contains all the enzymes for the light independent stage
Contains starch grains and oil droplets
Contains DNA and prokaryote type **ribosomes**
Thylakoid
Flattened membrane bound sac. Hold photosytems
Gran(um/a) A stack of thylakoids together
Intergranal lamellae Join one granum to another.

The light dependent reaction

Light energy is converted to chemical energy (ATP and reduced NADP)

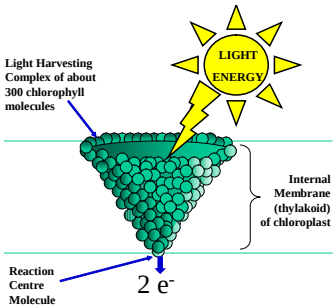


Fig. 5.4.2.2

Electrons released form the excited chlorophyll pass down a series of electron carriers (electron loss = oxidation). This releases small packets of enery which are used to make ATP from ADP and Pi

Electrons lost from the chlorophyll molecule are replaced by photolysis

$2H_2O$ -------> $4H^+$ + 4^{e-} + O_2

Result: **ATP** , **O_2** and reduced **NADP** (an electron carrier)

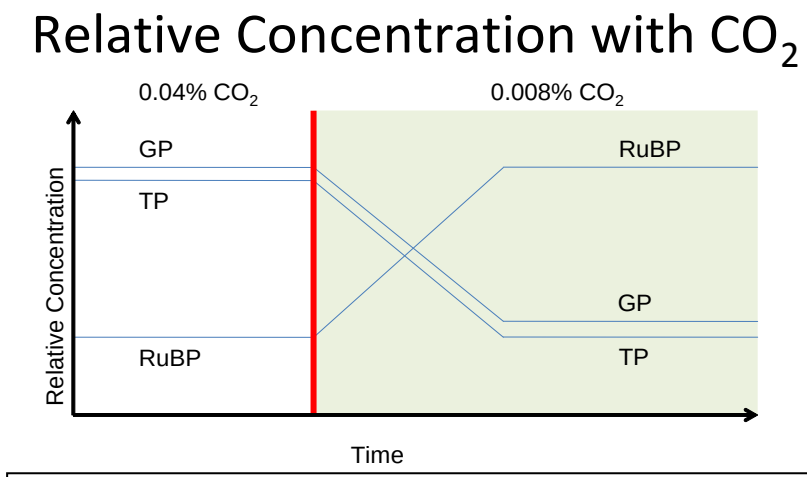
Explain what happens to each of these products

- O2
- ATP
- Reduced NADP

The light independent reaction

Draw a flow diagram below to illustrate the following stages:

1. CO2 enters the stroma of the chloroplast
2. CO2 combines with RuBP (ribulose bisphosphate) using RUBISCO enzyme
3. this forms two molecules of GP (glycerate 3-phosphate)
4. ATP and reuced NADP are used to reduce GP to TP (triose phosphate)
5. NADP is reformed and returns to accept H^+ ions from the light reaction



- Describe the effect on the quantities of GP and RuBP of the decrease in CO_2
- Suggest explanations for these changes

Factors affecting photosynthesis

Limiting factors: **LIGHT** **CO_2** **TEMPERATURE**

- **Limiting Factor**
  - A variable that limits the rate of a particular process (in this case photosynthesis).
  - If the factor is increased then the process will take place at a higher rate.
  - Where the process is affected by a number of different factors the limiting factor is the one whose magnitude limits the rate of the process.

Sketch a graph to show how Light and CO_2 act as a limiting factor in Photosynthesis

Measuring photosynthesis

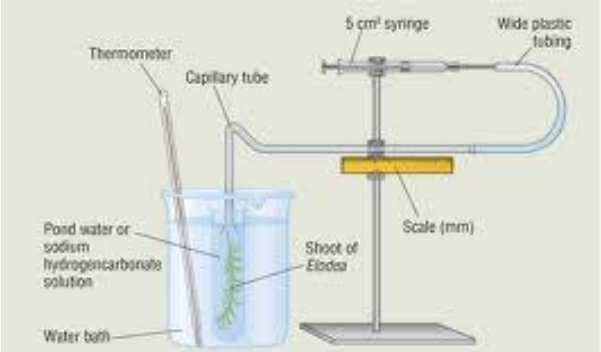


Figure 1 A photosynthometer – apparatus used to measure the rate of photosynthesis under various conditions

explain how it is used:

Respiration

Glycolysis: The splitting of Glucose into 2 molecules of pyruvate

- Occurs in the cytoplasm of the cell (not the mitochondria)
- Does not involve oxygen (is anaerobic process)
- Results in two molecules of **pyruvate**

Stages: *draw a flow chart underneath to summarise these stages*

1. Glucose is phosphorylated. 2 molecules of **ATP** used to supply phosphate and activation energy.
2. **Phosphorylated glucose** splits into two molecules of **triose phosphate**
3. Triose phosphate is oxidised releasing **two hydrogens** to reduce the hydrogen carrier **NAD.**
4. Triose phosphate molecules give up their phosphates to make 2 x **ATP** from ADP. This results in two molecules of **pyruvate**

NB:

- **The potential energy in pyruvate can only be released in the presence of oxygen**
- **2 molecules of pyruvate are produced from each glucose molecule**

The link reaction *summarise in a flow diagram below*

1. Pyruvate is actively transported into the matrix of a **mitochondrion**
2. **Oxidative decarboxylation** occurs, releasing H to reduce **NAD** and **CO_2**
3. The 2 carbon fragment combines with **Coenzyme A** to form a 2 carbon molecule called **Acetyl Coenzyme A**

Summary flow diagram

Kreb's cycle (occurs in the matrix of the mitochondrion)

1. Acetyl CoA combines with a 4 carbon molecule to produce a 6 carbon molecule
2. **Substrate phosphorylation** occurs. The 6 carbon molecule gives up **carbon dioxide** and **hydrogens** to reform the 4 carbon molecule. One molecule of **ATP** is formed in this process
3. The hydrogens are accepted by carriers (coenzymes) NAD and FAD

Summary flow diagram:

Electron Transport chain and ATP synthesis.

OIL RIG oxidation is loss / reduction is gain (of H and electrons)

This process occurs on the inner membrane (**cristae**) of mitochondria

1. H atoms combine with the coenzymes NAD and FAD which are attached to the cristae
2. Reduced NAD and FAD give up electrons to the first of a series of electron carriers. The H^+ ions (protons) are pumped across the inner mitochondrial membrane.
3. The electrons pass down a series of electron carriers and the H^+ ions continue to accumulate between the inner and outer membrane.
4. The H^+ ions diffuse back through a special enzyme controlled site in the membrane along their concentration gradient. This movement is coupled to the production of **ATP**
5. At the end of the chain the electrons are reunited with H+ ions and combine with **oxygen** to produce the waste product **water**

Flow diagram:

Anaerobic respiration

Plants and yeast. Pyruvate is broken down to CO_2 and ethanol

Pyruvate + reduced NAD ----------> ethanol + CO_2 + NAD

Animals: Pyruvate is broken down to lactate.

Pyruvate + reduced NAD ----------> lactate + NAD