Topic 4 – Bioenergetics

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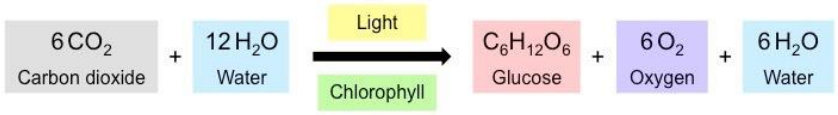
4.1 Photosynthesis

4.1.1 Photosynthetic reaction

Photosynthesis

- An endothermic reaction in which energy comes from sunlight is transferred from environment to the chloroplasts by light

Equation



Adaptations of leaves

1. **Large surface area** - absorb light
2. **Thin walls** - short diffusion distance
3. **Chlorophyll in chloroplasts** - absorb light
4. **Veins** - transport water in xylem & glucose in phloem
5. **Air spaces** - CO_2 in, O_2 out by diffusion

Uses of glucose

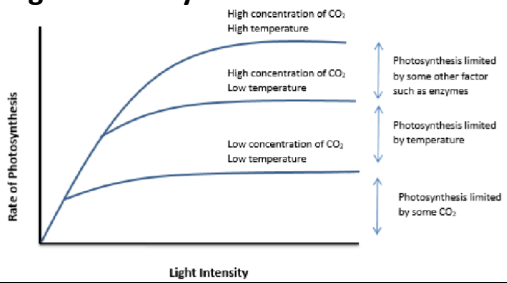
1. **Respiration** - release energy
2. **Produce amino acid** - make protein
3. **Produce cellulose** - strengthen cell wall
4. **Store as lipids** in seeds
5. **Store as insoluble starch** in root, stem & leaves

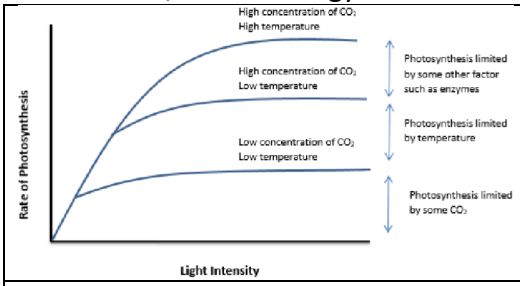
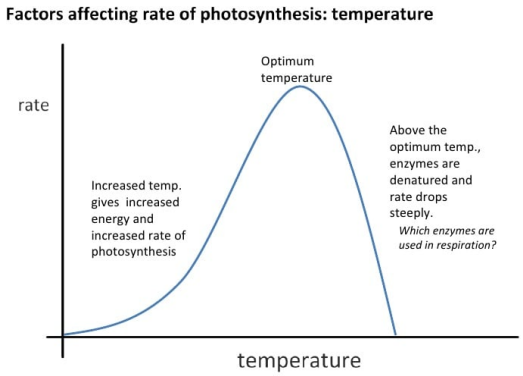
How do plants make proteins?

- Amino acids made from glucose and plants combine these with nitrate ions absorbed from the soil to make proteins.

4.1.2 Rate of photosynthesis

What will affect rate of photosynthesis? (limiting factors)

Light intensity 	• ↑light, ↑rate
CO_2 concentration	• ↑CO_2, ↑rate • Rate stays constant at 200 arbitrary units

<table>
<tr><td> 
</td><td></td></tr>
<tr><td>Temperature
 
</td><td>• Reaction controlled by enzymes
• ↑CO_2, ↑rate coz molecules moves faster, ↑chemical reaction
• If too high (45°C), enzymes denatured, ↓rate</td></tr>
<tr><td>Amount of chlorophyll</td><td>• Light absorption</td></tr>
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Greenhouse

- Increase light, temp, CO2 - increase crop yield
- Gain max rate of photosynthesis while maintaining profit

Light intensity $\propto 1/d^2$

How can you measure the rate of photosynthesis?

- Place the plant underwater and measure the volume of oxygen made or count the number of bubbles in a given time. The more gas made, the faster the rate of photosynthesis.

How can you test if a plant for starch?

- Boil in ethanol to destroy waxy cuticle and remove the colour. Then add iodine to the leaf. If the iodine turns blue it contains starch

Investigate pop size of plant species using random sampling with quadrats

1. Place two 20m tape measure (labelled X & Y) at right angles to each other to form a square area
2. Use a random number generator and pick 2 numbers as a coordinate.
3. Place quadrat on ground at the co-ordinates
4. Count & record all no of plants you are investigating inside quadrat
5. Repeat 1-4 for 10 times
6. Calculate mean no of organisms per quadrat
7. Estimate pop of species using

Distribution

- Place randomly
- At random no

Investigate effect of light intensity on plant distribution using transect line

1. Stretch tape measure to mark out a line (transect) in area you want to study
2. Place quadrat at exactly 2m on tape measure (to get data about position of organism in relation to distance from sea)
3. Count & record all no of plants you are investigating inside quadrat
4. Use light meter to measure light intensity at the position
5. Repeat 1-5 for more than 3 times

How to improve accuracy?

- Repeat experiment in different area randomly in the same field

4.1.3 Uses of glucose from photosynthesis

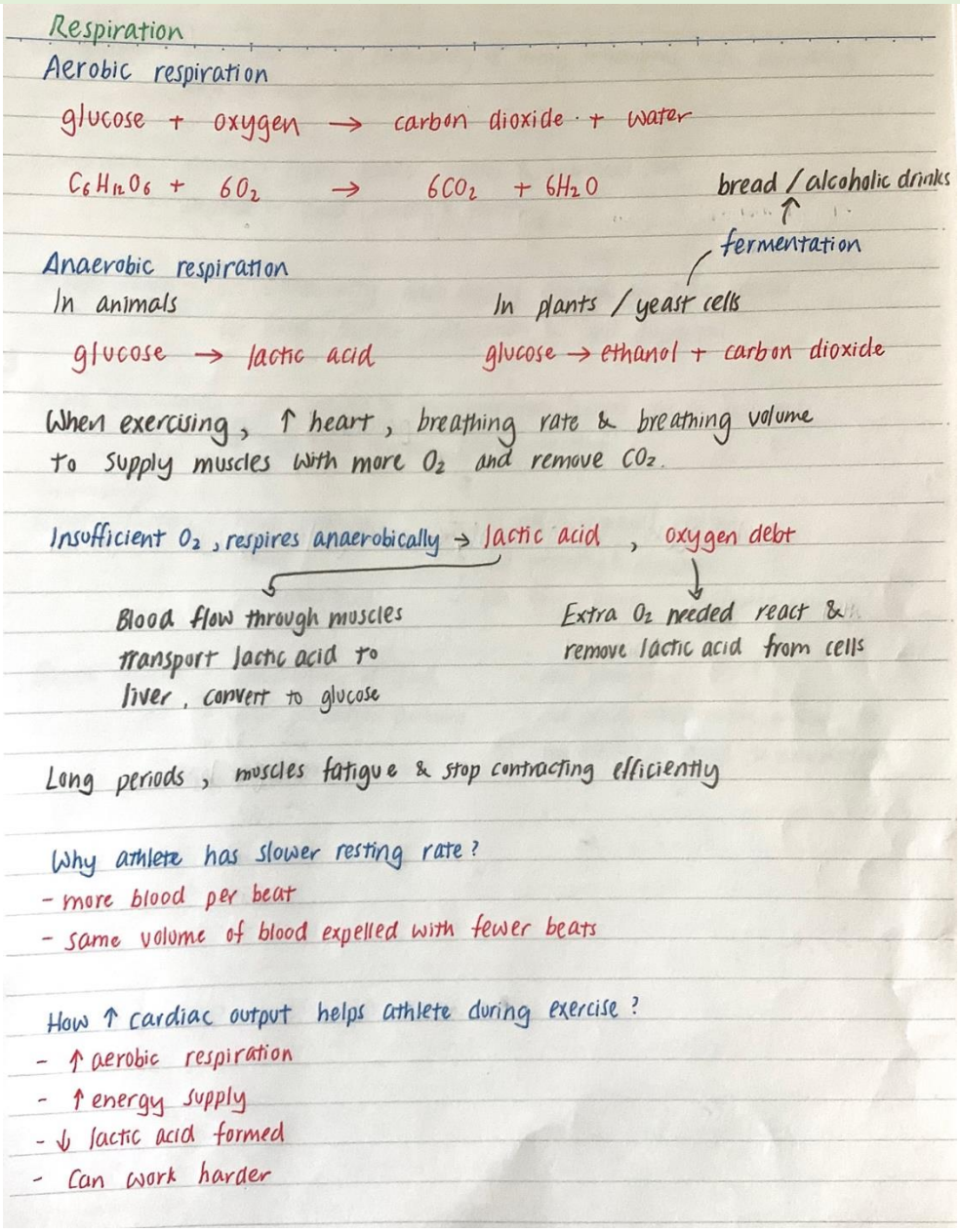
The glucose produced in photosynthesis may be

- used for **respiration**
- converted into **insoluble starch** for **storage**
- used to produce **fat** or **oil** for **storage**
- used to produce **cellulose** - strengthens the cell wall
- used to produce **amino acids** - protein synthesis

To produce proteins, plants also use **nitrate ions** that are absorbed from the soil

4.2 Respiration

4.2.1 Aerobic and anaerobic respiration



Cellular respiration

- An exothermic reaction which is continuously occurring in living cells

Organisms need energy for

- Chemical reactions to build larger molecules
- Movement
- Keeping warm

As oxidation of glucose is incomplete in anaerobic respiration, much less energy is transferred than in aerobic respiration

Fermentation

- Anaerobic respiration in yeast cells
- Has economic importance in the manufacture of bread & alcoholic drinks

4.2.2 Response to exercise

- During exercise the human body reacts to the increased demand for energy
- The heart rate, breathing rate and breath volume increase during exercise to supply the muscles with more oxygenated blood
    - If insufficient oxygen is supplied - anaerobic respiration takes place in muscles
    - Incomplete oxidation of glucose causes build-up of lactic acid & creates an oxygen debt
- During long periods of vigorous activity muscles become fatigued and stop contracting efficiently
- Blood flowing through the muscles transports the lactic acid to the liver where it is converted back into glucose
- Oxygen debt - amount of extra oxygen the body needs after exercise to react with the accumulated lactic acid and remove it from the cells

Explain how change in stroke volume / heart rate / breathing rate / breathing depth during exercise helps an athlete.

- Increases stroke volume means that with each heart beat the heart pumps more blood around the body
- Increases supply of O2 & glucose to muscle cells for more respiration to release more energy for muscle contraction

4.2.3 Metabolism

Metabolism - sum of all the reactions in cell / body

Energy transferred by respiration in cells is used by organism for continual enzyme-controlled processes of metabolism that synthesise new molecules.

Metabolism includes

- Conversion of glucose to starch, glycogen & cellulose
- Formation of lipid molecules from a molecule of glycerol & 3 molecules of fatty acids
- Use of glucose & nitrate ions to form amino acids which in turn are used to synthesise proteins
- Respiration
- Breakdown of excess proteins to form urea for excretion