IGCSE BIOLOGY

Unit 2

Structure & Function of living organisms
Contents:

a) Levels of organisation
b) Cell structure
c) Biological molecules
d) Movement of substances into and out of cells
e) Nutrition
f) Respiration
g) Gas exchange
h) Transport
i) Excretion
j) Coordination and response
A: Levels of organisation

Levels of Organisation

**Students will be assessed on their ability to:**
2.1 describe the levels of organisation within organisms: organelles, cells, tissues, organs and systems.

Cell – the building blocks of living organisms. All have a cell membrane and are filled with a substance called cytoplasm. There are also usually organelles, including the nucleus and the mitochondria/chloroplasts.

Tissues - A group of similar specialized cells that share structure and function and work together as one unit.

Organs – 2 or more tissues, which work together as a structure to perform a specific function in the body, each with a tissue with a different role.

Systems- Group of different organs that perform one or more of the body’s main functions.
B: Cell structure

Students will be assessed on their ability to:
2.2 recognise cell structures, including the nucleus, cytoplasm, cell membrane, cell wall, chloroplast and vacuole
2.3 describe the functions of the nucleus, cytoplasm, cell membrane, cell wall, chloroplast and vacuole
2.4 describe the differences between plant and animal cells.

Cell Structure

- Plant and animals cells have different features and share some similarities.
- Diagrams show the general features of an animal and a plant cell, what all the specialized cells of that organism tend to have in common.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Both</th>
<th>Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nucleus</td>
<td>Nucleus</td>
<td>Vacuole</td>
</tr>
<tr>
<td>Cell membrane</td>
<td>Cell Membrane</td>
<td>Cell Wall</td>
</tr>
<tr>
<td>Mitochondria</td>
<td>Mitochondria</td>
<td>Chloroplasts</td>
</tr>
<tr>
<td>Cytoplasm</td>
<td>Cytoplasm</td>
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</tbody>
</table>

- The nucleus contains genes of the organism, which are carried in the chromosomes.
- The cell membrane holds the cell together and is selectively permeable, controlling what passes in and out of the cell through the membrane. Only small particles can pass through the cell membrane due to its small pores.
- The mitochondria are the organelles that carry out the reactions of respiration, turning glucose and oxygen into energy to supply to the cell.
- The cytoplasm is a gel-like substance, not quite a liquid, not quite a solid. It is a complex material and contains enzymes that control chemical processes in the cell.
- The vacuole is an organelle that stores a plant’s extra energy in the form of the liquid cell sap. Cell sap contains dissolved sugars, mineral ions, and other solutes. It also supports the shape of the plant cell. If not full, it can collapse.
- The chloroplasts contain the green pigment chlorophyll, which absorbs light energy to use in the process of photosynthesis. Photosynthesis is when light energy is used to make food for the plant. It creates glucose, cellulose and sucrose. Chloroplasts are found in the green parts of plants.
- The cell wall is an extra support structure the plant wall has. It is made out of the carbohydrate cellulose, one of the substances the chloroplasts create. It gives the plant cell a fixed shape and helps the cell deal with internal pressure due to osmosis. It is freely permeable, so it allows anything to flow through.

**Specialized Cells:**

**Palisade Leaf Cells:**

- Found in leaves of plants
- Function: Create sugars and carbohydrates through photosynthesis using chloroplasts. Responsible for most of the photosynthesis in a plant.
- Contains many chloroplasts
- Has a cell wall, vacuole and nucleus
- Packed tightly in the top half of the leaf
- Has a tall shape so there is more surface area for absorbing CO₂ (a fuel for photosynthesis) and allows for a better chance of light that is passing through to hit a chloroplast.


**Guard Cells:**

- Found in the bottom of leaves of plants
- Function 1: Allows the movement of gases in and out of plant for photosynthesis (CO\(_2\) goes in and O\(_2\) goes out) during the day.
- Function 2: Close to stop water loss via evaporation, when there is little water left.
- Are shaped like kidneys when they are turgid (full of water) and therefore open. When they close, they are flaccid (limp and have a lack of water) and are relaxed, touching each other.
- Thin outer walls and thick inner walls allow for the opening and closing function.
- The gap between them when they are turgid is called the stomata. This is where the gases go through.
- The stomata closes when the guard cells go flaccid to prevent further water loss.

**Red Blood Cells:**

- Found in the blood stream of humans as well as some other animals.
- Have a biconcave shape to increase surface area for quicker diffusion of oxygen.
- Inside of a red blood cell are haemoglobin, a substance which oxygen is attracted and bonds to, allowing for the red blood cell to carry the oxygen.
- Contains iron.
- Carries oxygen from lungs to tissues and muscles.
- Has no nucleus, allowing more haemoglobin and therefore more oxygen
Root Hair Cell:

- Found in a plant’s root hair
- Function: To absorb water for the plant through osmosis (the diffusion of water from a high to low concentration) and to absorb nutrients from the soil using active transport
- Has a protruding area that increases the surface area for maximum absorption of water and nutrients.

Sperm and Egg Cells:

- Specialized cells for reproduction in humans and other animals.

Sperm:

- Sperm is found in the testes of a male.
- Sperm consists of a nucleus and a flagellum for movement.
- Nucleus has half of the chromosomes for a human (23).
- It has a short life span and only the fittest one will reach the egg.
- Smoking decreases your sperm count and weakens remaining sperm.
- As soon as a sperm enters an egg, a reaction on the membrane occurs and no other sperm are allowed to enter the egg.

Egg:

- Found in the ovaries of a female.
- Consists of a nucleus and a membrane.
- Has a large energy reserve for nutrition for developing embryos
- Contains half the chromosomes for an embryo (23).
Questions

1  Cells and tissues

1 The drawing shows a group of three cells. Make an outline drawing to show how the cells would appear under the microscope if a thin section A-A was cut and mounted on a slide.

2 Which one of the following is most likely to be true: To see plant cells with a microscope you usually need a magnification of about (a) x5, (b) x10, (c) x100, (d) x1000?

3 Which one of the following best describes the function of a cell membrane? (a) It keeps the cell in shape. (b) It controls the substances entering and leaving the cell. (c) It controls the substances entering the cell. (d) It supports the cell structures.

4 Which of the following structures are (a) in plant and animal cells, (b) in plant cells but not in animal cells? cell wall, cytoplasm, cell membrane, mitochondria, nucleus, central vacuole, chromosomes, cell sap

5 Select the most appropriate words from the list below to complete the following paragraph:
If a cell develops in such a way that it does one particular job very efficiently, it is said to be .......... . Such a cell is also said to be ...... to its function. A nerve cell is ..... for conducting impulses. It can do this efficiently because of its ...... and the chemical reactions in its ..... shape, vacuole, adapted, cytoplasm, size, specialised, mature, mitochondria

6 Classify the following under the headings 'Cell structure', 'Tissue', 'Organ' or 'System'. bone, nucleus, skeleton, brain, nerve, mitochondrion, muscle, cytoplasm, epithelium, heart and blood vessels, stomach, alimentary canal, lung, lungs and windpipe.
C: Biological molecules

Students will be assessed on their ability to:
2.5 recall the chemical elements present in carbohydrates, proteins and lipids (fats and oils)
2.6 describe the structure of carbohydrates, proteins and lipids as large molecules made up from smaller basic units: starch and glycogen from simple sugar; protein from amino acids; lipid from fatty acids and glycerol
2.7 describe the tests for glucose and starch
2.8 understand the role of enzymes as biological catalysts in metabolic reactions
2.9 understand how the functioning of enzymes can be affected by changes in temperature
2.10 understand how the functioning of enzymes can be affected by changes in pH
2.11 describe how to carry out simple controlled experiments to illustrate how enzyme activity can be affected by changes in temperature.

Biological Molecules

- All biological molecules contain carbon, hydrogen, and oxygen

3 main groups:

1. Carbohydrates – Made up of sugars (ring-shaped molecule of C, H, and O atoms)
   - Exist as separate molecules (simple sugars) or as groups of sugar molecules linked together to make the larger polysaccharides that include starch, sucrose and maltose.
   - Used as a source of energy for cells

   Simple sugars
   - Glucose, Fructose, Galactose

   Double Sugars
   - Maltose (Glucose + Glucose)
   - Sucrose (Glucose + Fructose)

   Complex Carbohydrates
   - Plants = Starch
   - Animals = Glycogen

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2. Proteins – Made of linked amino acids (molecules of C, H, O, and N atoms)
   – Amino acids are used to form enzymes and are used as building blocks for other things in the cell
   – There are 20 different amino acids.
   – Amino acids are join together to form long chains called Polypeptides. Polypeptides can twist and coil to form proteins

3. Lipids – Made of 1 glycerol and 3 fatty acids linked together.
   – Used as insulation, as a storage of energy and are used to make the cell membrane.

   • All the molecules must be broken down into the simplest form (what they are made out of) in order to get through the cell membrane’s small pores.
   • Broken down by enzymes specific to the biological molecule.

**Chemical Tests for Glucose, Starch, Lipids & Proteins:**

**Glucose (Reducing sugar):** Benedict’s Solution (a green solution)

1. Add sample to solution
2. Heat to 95° C
3. If present, orange/red precipitate will form
   If not, it will remain green

**Starch (Non-reducing sugar):** Iodine (brown)

1. Grind up sample
2. Add distilled water
3. Add a few drops of iodine
4. If present, will turn a blue-black colour
   If not, will remain brown.

**Lipids:**

1. Add sample to ethanol
2. If present, cloudy white precipitate

**Proteins:**

1. Add sodium hydroxide to solution and shake
2. Add weak copper sulphate solution
3. If present, blue ring forms at top of solution (if shaken blue ring disappears and solution is purple)
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Enzymes:

- Proteins that react as biological catalysts that assist and/or speed up chemical reactions in organisms.
- Produced by cells.
- Function: Convert substances into products

**The Lock & Key Theory**
Enzymes have an active site (part of the enzyme which binds the substrate).
- This active site is complementary to only one type of substrate and so the enzyme and substrate are like a lock and a key. There is only one key that can fit the lock.
- Substrate is complementary to active site (all enzymes only work for specific substances).
- The substrate bonds to the active site of an enzyme. A chemical reaction occurs. A product is formed from the substrate.
- Enzymes are recycled and can be used over and over again

![Diagram of Enzyme Action](image)

Enzymes & Temperature
- Work best at a particular temperature called **optimum temperature**
- If temperature is too high, enzymes denature and cease to work
- This is because too much thermal (heat) energy will give the enzyme too much kinetic energy and physically break the bonds holding the enzyme together. If these bonds break the enzyme will change shape and therefore so too will the active site. If the active site changes then the enzyme can no longer bind the substrate and so the reaction will no longer take place.
- We say the enzyme has lost its nature or has been DENATURED.
- When an enzyme has been denatured it has NOT been DESTROYED.
- If temperature is too low, enzymes have less kinetic energy and so collide with the substrate less often reducing then chance of bonding with substrate.
Enzymes & pH
- Work best at particular pH, called optimum pH.
- Too high or too low pH can denature enzymes. This is because pH will change the bonding of the enzyme and if bonding changes the enzymes shape will also change.

Figure 6.13 Environmental factors affecting enzymes

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Questions

Food and diet

1 State three main ways in which the body uses food.

2 Write down the words missing from the following paragraph:
   Fats and carbohydrate both provide the body with .........., but fats can provide .......... as much as carbohydrates. Excess fats can be stored in the body but carbohydrates must be changed into .......... or .......... before they can be stored. The main types of carbohydrates are .........., .......... and .......... Examples of foods rich in starch are .......... and .......... foods rich in fat are .......... and ..........

3 In what form is most carbohydrate taken in the normal diet?

4 Write down the words omitted from the following paragraph:
   Proteins are made up of about 20 different .......... One example of a plant product rich in protein is .......... An animal product rich in protein is .......... When a protein is digested, it is broken down into its constituent .......... and these are later built up in the body to make new .......... Excess proteins which are not used for making new cells or tissues are converted to .......... which can be stored or used to provide ..........

5 Which of the following are not rich in carbohydrate:
   bread, fish, potatoes, beans, meat, lettuce, sugar, biscuits?

6 (a) Carbohydrates contain the elements .........., .......... and ..........
    (b) Proteins contain these elements but also .......... and ..........

7 State one benefit of including vegetable fibre (roughage) in the diet.

9 (a) Which min. vitamin is necessary for the proper development of the skeleton?
    (b) Name two foods which are a good source of this vitamin.

10 A balanced diet must contain enough energy to meet the body's needs. What else must it contain?

11 Could you survive on a diet which contained no carbohydrate?

12 Western diets are often unhealthy because they contain too much .......... and .......... and not enough ..........

13 How does refrigeration help to stop food from going bad?

14 (a) Heating a food sample with Benedict's solution is a test for ..........
(b) A test for starch is to add .......... solution to the food.
(c) In the biuret test for protein ........ and ........ solutions are added to the sample. A ........ colour indicates the presence of protein

Questions

The chemicals of living cells

1 Apart from food, what other substances do cells need to take in?

3 (a) Give three examples of cell structures which contain structural proteins.
   (b) What is the other type of protein in a cell?

4 Name the chemical elements present in a protein.

5 What name is given to the sub-units which make up all proteins?

6 A protein molecule which is denatured, has
   (a) split into smaller molecules
   (b) changed its shape
   (c) combined with another molecule
   (d) been diluted..

7 What kind of substance is a lipid?

8 In a cell, where are lipids found?

9 (a) What are the two types of chemical compound which combine to form a lipid?
   (b) What elements are present in a lipid?

10 (a) Name four examples of compounds which are classed as carbohydrate.
    (b) What elements are present in carbohydrates?

11 Write the formula for glucose.

12 If  glucose molecule draw (a) a maltose molecule, (b) part of a starch molecule.

13 Select the most appropriate words from the list below to complete the following paragraph
   All cells contain ....... which are ....... and act as ....... which ....... chemical reactions. The reactions do not ....... the ....... which can take part in further reactions.
   substances, proteins, enzymes, catalysts, speed up, use up, slow down

14 Enzymes will usually react with only one substance. This can be explained by the 'lock and key' theory. If this theory is correct, which of the following substances, represented by P, Q, R and S would be acted on by enzyme A?
15 If an enzyme-controlled reaction normally takes place at 10°C, in general terms how will the reaction be affected by
(a) a fall in temperature to 2°C,
(b) a rise in temperature to 20°C.
(c) a rise in temperature to 65°C?

16 If an enzyme is denatured, why does it no longer work?

17 The graph shows the rate of an enzyme reaction at different levels of acidity or alkalinity (pH). From the graph, what is the optimum pH for this enzyme?
(a) pH 2  (c) pH 10
(b) pH 7  (d) none of these.

18 A protein-digesting enzyme when mixed with starch solution would
(a) have no action  (c) produce glucose
(b) produce amino acids  (d) digest the starch?

19 Select the most appropriate words from the list below to complete the following paragraph.
All enzymes are produced inside ....... Enzymes which do their work outside cells are called ....... Enzymes which do their work inside cells are called ....... Most of our digestive enzymes are examples of ....... enzymes.

animals, extra-cellular, intra-cellular, cells, digestive, nuclei, catalysts.

21 What does the enzyme catalase do?

22 Substance A is being investigated to see if it is an enzyme. When substance A is mixed with substance B a reaction takes place. A control experiment is conducted using a sample of A which has been boiled.
(a) Why is boiling used as a control?
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(b) If the reaction still worked after A had been boiled, what might be your interpretation?

23 In an investigation to compare the rates at which starch is being broken down by an enzyme
   (a) what test is used
   (b) how do you know when the reaction is completed?
D: Movement of substances into and out of cells

Movement of Substances into and out of Cells:

3 main ways of movement:

1. Diffusion

Definition: The net movement of molecules from a region of high concentration to a region of low concentration to form an equilibrium (due to random movement and collision of molecules, they will spread themselves out evenly).

- Requires no energy (passive)
- Can occur across the membrane of cells.
- Molecules are moving down the concentration gradient in diffusion.
- The greater the difference in concentration, the faster the molecules diffuse.
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Diffusion in cells:
- Cell membranes are partially permeable (only some substances can diffuse across).

Diffusion of gases in leaves:
- CO₂ diffuses into the leaf through the stomata from the air. It then travels to the palisade leaf cells and diffuse into them to be part of photosynthesis.
- O₂ from photosynthesis and water vapour diffuse out of the stomata.

Diffusion of gases in lungs:
- Lungs contain millions of air sacs called alveoli, where oxygen goes when you breathe in.
- They have a scrunched up form so there is greater surface area for diffusion.
- They also have a moist lining and thin walls.
- Surrounded by capillaries
- As red blood cells flow past CO₂ diffuses out of the cell into the alveoli and O₂ diffuses from the alveoli into the red blood cell, which then travels to the heart and then to muscles and tissues.
## 2. Osmosis (specialized type of diffusion)

Definition: The diffusion of water from high to low concentrations across partially permeable membranes to form equilibrium.

### Osmosis in Plants:
- When there is more water outside of plant cells than inside, the water diffuses into the cell causing it to be turgid and increase pressure against the cell wall. Turgid cells help keep a plant upright.
- When there is more water inside of the cell, water diffuses out and the plant cells become flaccid, causing the plant to limp.

**Note: Turgid Cells Support Plant Tissues**
- When plant’s are well watered, they stand up straighter because their cells are turgid
- Turgid cells create pressure in their cell walls, causing the cells to become stiff and thereby giving support to the entire plant.
- When cells become flaccid due to lack of water, the plant isn’t supported and wilts.

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Osmosis in Animals Cells:
- If animal cell is placed in pure water, water will diffuse into the cell until it bursts.
- If animals cell is placed in concentrated solution with little water, water will diffuse out of the cell and the cell will shrivel up.
- A greater surface area to volume area, a greater concentration difference, and higher temperatures increase rate of diffusion of water.

3. Active Transport (opposite of diffusion)

Definition: The movement of particles from a low concentration to a high concentration. This requires energy.

- Goes against the concentration gradient.
- Occurs in gut when there are fewer nutrients in the gut than in the blood. The gut uses active transport to get the nutrients into the blood.
- Occurs in root hair cells with minerals when there are more nutrients in cell than soil. Uses active transport to continue absorbing the nutrients from the soil into the cell.
Root Hair Cell

Movement of Substances

**Active Transport in Root Hair Cells.**

The tips of the roots that are deep in the soil, have root hairs. These are very thin hair-like cells that emerge from the root tip.

Root hair cells have to be able to absorb large amounts of water, as the transpiration stream pulls up water to the leaves. As the process relies on diffusion, the cells must present a large surface area to the surrounding soil (the rate of diffusion is directly proportional to the surface area - Ficks Law). Thus, the cell wall facing the soil is elongated outwards.

![Diagram of root hair cell and soil particles]

The root hairs are in the soil. Inside the root hairs there is a lot of water because the cytoplasm and vacuole are rich in water. They also have lots of minerals and nutrients.

When it rains, or when we water the plants, there is more water in the soil than in the cell, so water enters by osmosis.

When we give nutrients to the soil, by adding fertilisers, manure etc., the minerals enter the root hairs by passive diffusion.

But sometimes, in the soil, there may be less nutrients, and sometimes, less water too. But the plant still needs to absorb water and minerals, because the root hairs need to take these up from the soil and supply all the other cells in the plant. So in this case, nutrients and minerals enter the root hair by

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Mrs. J. Ebejer Grech B.Ed.(Hons.)

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Leaf Structure

- Has a large internal surface area to volume ratio to allow the efficient absorption of carbon dioxide and removal of oxygen.
- Is thin and flat, to provide a surface area for maximum absorption of sunlight.

Waxy Cuticle – waterproof layer that limits water loss by preventing evaporation (is also transparent)

Epidermis Cells – create the wax of the cuticle and are transparent to allow light to shine through

Palisade Cells – The cells responsible for photosynthesis (SEE SPECIALISED CELLS)
  – Tightly packed together in the top half of the leaf so that as many as possible can receive sunlight.

Spongy Mesophyll Cells – Form the main gas exchange surface of the leaf
  - Round and loosely packed
  - Have air spaces to allow gases to get to and from the palisade cells
  - Absorb carbon dioxide, release oxygen and water vapour
  - Have a few chloroplasts by not nearly as many as palisade cells

Guard Cells and Stomata – Allow movement of gases into and out of the leaf and control whether or not the plant is transpiring. (SEE SPECIALIZED CELLS SECTION)
Leaf Vein – Contains the phloem tissue (transports products of photosynthesis to and from the leaf)
  – Contains the phloem tissue (transports water and minerals to the leaf)

**What affects the rate of diffusion in and out of cells?**

1 **Temperature**
   The greater the temperature the more thermal (heat) energy the solution has.
   The more thermal energy the more kinetic energy the particles of the solution have
   The more kinetic energy the particles have the more the particles move and the faster they move
   The faster the particles move the more quickly they will spread out or DIFFUSE

2 **Concentration gradient**
   The greater the difference in concentration of particles between two areas the greater the speed of diffusion

3 **Surface Area : Volume Ratio**
   The greater the surface area the more space there is for particles to diffuse across.
   A large surface area:volume ratio means that there is a large surface area compared to the volume that is being taken up.
Questions

How substances get in and out of cells

1 Containers X and Y each hold one litre of air. X also contains 0.4 g of a gas and Y contains 0.6 g of the same gas. The two containers are connected together as shown in the diagram.

(a) Which way will the gas diffuse?
(b) After a long period of time, what will be the concentration of the gas (in grams per litre) in each container?

2 The diagram represents (not to scale) molecules of a salt dissolved in the bottom layer of water in a beaker. Make two similar diagrams to show the distribution of salt molecules (a) after a few minutes, (b) after several hours.

3 When a cell is respiring aerobically, which two gases are likely to be diffusing in and out of the cell, and in which direction will they be diffusing?

4 The graph shows the concentration of a substance inside and outside a cell.
(a) If the substance is free to move by diffusion, which way will it move
   (i) inside the cell
   (ii) between the cell and the medium outside the cell?
(b) If, after some hours, the concentration has not changed, what assumption would you make about the movement of the substance across the cell membrane?

5 (a) Which one of the following is the best definition of osmosis?
   (i) The movement of water from a concentrated solution to a dilute solution across a partially permeable membrane.
   (ii) The movement of a dissolved substance from a concentrated solution to a dilute solution across a partially permeable membrane.

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(iii) The movement of water from a dilute solution to a concentrated solution across a partially permeable membrane.
(iv) The uptake of water by a living cell.
(b) Which of the statements is an acceptable description of diffusion?

6 The diagram shows a vessel which contains a concentrated and a dilute solution separated by a partially permeable membrane. Draw a similar diagram to show the liquid levels after an hour or two.

7 Which statement is correct?
   (a) A concentrated solution has a high osmotic potential (water potential).
   (b) A concentrated solution has a low osmotic potential (water potential).

8 The drawing shows the outline of a human cell. Copy the drawing and make two further drawings to show how the cell would appear if it were to be immersed for a few minutes in a solution with
   (a) a lower osmotic potential (water potential) than its own cytoplasm
   (b) a higher osmotic potential (water potential) than its own cytoplasm.

9 Why is it important that a cell membrane does not allow all dissolved substances to diffuse freely through it?

10 The concentration of the tissue fluid, which bathes all cells in the body, is kept more or less constant. Why is this important?

11 When meat is salted, bacteria cannot grow on it. Suggest a reason for this.

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E: Nutrition

Flowering plants

Students will be assessed on their ability to:
2.17 describe the process of photosynthesis and understand its importance in the conversion of light energy to chemical energy
2.18 recall the word equation and the balanced chemical symbol equation for photosynthesis
2.19 understand how carbon dioxide concentration, light intensity and temperature affect the rate of photosynthesis
2.20 explain how the structure of the leaf is adapted for photosynthesis
2.21 recall that plants require mineral ions for growth and that magnesium ions are needed for chlorophyll and nitrate ions are needed for amino acids
2.22 describe simple controlled experiments to investigate photosynthesis, showing the evolution of oxygen from a water plant, the production of starch and the requirements of light, carbon dioxide and chlorophyll

Nutrition in Flowering Plants

- Plants are autotrophs → they can make their own energy
- Process used to create glucose (food) is photosynthesis
- P.S. occurs in the chloroplasts of a plant cell, which have the pigment chlorophyll, which is responsible for absorbing the sunlight.
- Chlorophyll only absorbs the red and blue ends of the visible light spectrum, but not the green light in the middle, which is reflected back. This is why it looks green.
- Chloroplasts are usually found in the palisade cells of the leaves.
- In P.S., plants take carbon dioxide from the air and water from the soil
- Energy from the sunlight is then used to convert them into glucose and oxygen.

Equation of Photosynthesis:

\[
\text{Carbon Dioxide + Water} \xrightarrow{\text{Chlorophyll}} \text{Glucose + Oxygen} \xrightarrow{\text{Light}}
\]

\[
6\text{CO}_2 + 6\text{H}_2\text{O} \xrightarrow{\text{Chlorophyll}} \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \xrightarrow{\text{Light}}
\]

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- Most of the oxygen is given off of as a waste product, but some is used for respiration (releasing energy from food)

Starch:
- Much of the glucose from P.S. is converted into starch.
- Def: The storage compound of glucose (plant version of glycogen)
- Made of lots of glucose molecules joined together.
- Is insoluble, so doesn’t allow for diffusion to occur and doesn’t affect osmosis diffusion.
- Energy needed to convert glucose into starch comes from respiration.

Sucrose:
- Some glucose from P.S is converted into sucrose.
- Used for carrying food to other parts of plants in the phloem.
- Still soluble, but not as reactive as glucose.
- Made of two glucose molecules joined together.
- Energy needed to convert glucose into sucrose comes from respiration.

Inorganic Ions:
- Plants also require some inorganic ions which they absorb from the soil:
  - Nitrate Ions – used to produce amino acids (proteins)
  - Magnesium Ions – required for making chlorophyll
- Deficiency of either causes yellowing in the green parts of plants.

Limiting Factors of Photosynthesis
- The things that are needed for photosynthesis, can limit the rate of photosynthesis if there is not a big enough amount of one of them.
- At any given time one of the limiting factors is keeping the photosynthesis down at the rate it is.
- The one that is limiting the rate the most is called limiting factors. The limiting factors are:
  - Chlorophyll → the amount affects how much light can be absorbed
  - Carbon Dioxide → needed for photosynthesis to occur
  - Water → needed for photosynthesis to occur
  - Light → needed for photosynthesis to occur
  - Temperature → affects the enzymes that control rates of chemical reactions of P.S.

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• At some point, a maximum of a limiting factor is reached (the plant can’t take any more of it) and something else becomes the limiting factor.
• Eventually the rate of photosynthesis will reach a maximum.

Example:
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Flowering Plant Structures

- Flower: Needed for reproduction, seeds formed here
- Leaves: For photosynthesis to make glucose and other sugars
- Buds: Growing point on stem, some are flower buds
- Stem: Supports the plant, also contains transport system (xylem and phloem)
- Roots: For water and mineral salt uptake, also act as anchors for the plant in soil

Leaf Structure

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- Absorb carbon dioxide, release oxygen and water vapour
- Have a few chloroplasts by not nearly as many as palisade cells

Guard Cells and Stomata – Allow movement of gases into and out of the leaf and control whether or not the plant is transpiring.
(SEE SPECIALIZED CELLS SECTION)

Leaf Vein – Contains the phloem tissue (transports products of photosynthesis to and from the leaf)
– Contains the phloem tissue (transports water and minerals to the leaf)
Questions

Photosynthesis and nutrition in plants

1 Select the most appropriate words from the list below to complete the following paragraph:
A green plant can make all the substances it needs. It builds up carbohydrates by the process of ....... In this process, it combines ....... from the ....... with ....... from the ....... to form ....... The ....... needed for this process comes from ....... which is absorbed by the ....... in the ....... of leaf cells. The waste product of the process is .........

soil, energy, oxygen, glucose, chloroplasts, mineral salts, cells, photosynthesis, air, respiration, sunlight, water, nitrogen, chlorophyll, carbon dioxide.

2 Complete the following equation which summarises the process of photosynthesis

.....CO... + 6 ........... C.......... + 6 ....

3 What gases will be taken in and given out by a green plant (a) in darkness, (b) in bright sunlight?

4 Is it possible for a plant to be photosynthesising and respiring at the same time?

5 (a) What carbohydrates does a plant make from glucose?
   (b) Which of these carbohydrates is transported round the plant?
   (c) Which carbohydrate is the main storage substance?

6 (a) What additional substances does a plant need to make amino acids and proteins from glucose?
   (b) Where do these substances come from?

7 What ions must a plant obtain from the soil in order to make (a) ATP, (b) chlorophyll?

9 (a) How would you destarch the leaves of a potted plant?
   (b) How would you check that the destarching had been effective?

10 In a school laboratory, what is usually regarded as evidence that photosynthesis has occurred in a plant?

11 In designing an experiment to find out whether light is needed for photosynthesis
   (a) what is the principle of the design
   (b) what control would you use?

Andy Todd
A leaf is detached from a tree and tested with iodine. The leaf turns dark blue.
(a) What does this result tell you?
(b) Why is this result not sufficient evidence to confirm that photosynthesis had taken place in the leaf?
Humans

Students will be assessed on their ability to:

2.23 understand that a balanced diet should include appropriate proportions of carbohydrate, protein, lipid, vitamins, minerals, water and dietary fibre
2.24 recall sources and describe functions of carbohydrate, protein, lipid (fats and oils), vitamins A, C and D, and the mineral ions calcium and iron, water and dietary fibre as components of the diet
2.25 understand that energy requirements vary with activity levels, age and pregnancy
2.26 recognise the structures of the human alimentary canal and describe in outline the functions of the mouth, oesophagus, stomach, small intestine, large intestine and pancreas
2.27 understand the processes of ingestion, digestion, absorption, assimilation and egestion
2.28 explain how and why food is moved through the gut by peristalsis
2.29 understand the role of digestive enzymes to include the digestion of starch to glucose by amylase and maltase, the digestion of proteins to amino acids by proteases and the digestion of lipids to fatty acids and glycerol by lipases
2.30 recall that bile is produced by the liver and stored in the gall bladder, and understand the role of bile in neutralising stomach acid and emulsifying lipids
2.31 explain how the structure of a villus helps absorption of the products of digestion in the small intestine
2.32 recall how to carry out a simple experiment to determine the energy content in a food sample.

Nutrition in Humans

A balanced diet contains:

**Proteins** – Broken down into amino acids
  - Amino acids make enzymes and other proteins needed by cells
  - Sources include eggs, milk, milk products, meat, fish, legumes, nuts, and seeds

**Carbohydrates** – Broken down into starch and glucose
  - Starch and glucose are needed for energy in cells to enable life processes of cells
  - Sources include rice, bread, potatoes, pasta, and yams

**Fat** – Broken down into fatty acids and glycerol
  - Used for insulation to maintain body temperature and for a store of energy
  - Sources include meat, oils, milk, nuts, avocados, and oily fish

Andy Todd
Vitamins and Minerals – Needed for the correct functioning of the body
- Cannot be produced by the body
- Cooking foods destroys some vitamins (therefore, it is important to eat raw fruits and veggies)
  - **Vitamin A** – Good source is carrots & liver and it ensure good eyesight, bones and skin
  - **Vitamin C** – source is citrus fruit and ensure healthy gums
  - **Vitamin D** – Source is oily fish and sunlight, and it ensures healthy bones and skin
  - **Calcium** – Good source is dairy products and it ensure healthy bones
  - **Iron** – Good source is red meat and spinach. It is needed for haemoglobin a protein that is found in red blood cells to carry oxygen

Fibre – Made up of the cell walls of plants
- Adds bulk to food so that it can be easily moved along the digestive system by peristalsis
- Prevents constipation and might prevent bowel cancer

Water – The major constituent of the body of living organisms
- Necessary for all life processes
- Continually lost through excretion and must be replaced regularly in order to maintain homeostasis

**Bad:**

Saturated Fat – Animal Fat
- Causes cholesterol to build up in blood vessels, making them narrower
- Heart needs to then work harder to push blood through the narrowed vessels.
- Therefore, increases risk of heart attack

Diet depends on:

- How active the person is
- The age and gender of the person
- The body size of the person

The average person has energy requirements of about 2000Kcal for women and 2500Kcal for men.
These are only average guideline figures
If you are very active or are a pregnant women then these values will be too low to sustain a healthy lifestyle and individuals will need to consume more food to meet their energy requirements.

Andy Todd
Unit 2

**Digestion**

- In order for the body to receive nutrition, the nutrients must be able to enter the blood to travel to every part of the body.
- The breaking down of the large, insoluble molecules of most of the food that humans eat into small, soluble molecules is called digestion.

2 Stages of Digestion:

- **Physical Digestion** – the breakdown of food in the mouth by the teeth and tongue into smaller pieces
- **Chemical Digestion** – the breakdown of large food molecules into smaller ones by enzymes

(Some molecules are already small enough to pass through the gut wall and do not need to be digested.)

The breakdown of food for absorption by chemical digestion (enzymes are shown above arrows):

- Digestive enzymes are a type of enzyme used in chemical digestion.
- They are produced in the cells lining parts of the digestive system and are secreted to mix with the food.

Digestive Enzymes:

- **Protease** – Breaks down proteins to amino acids
  - Produced by the stomach wall
- **Lipase** – Breaks down fats to 3 fatty acids and 1 glycerol
  - Produced by the pancreas
- **Amylase** – Breaks down starch to single sugars (glucose) and disaccharides (maltose)
  - Produced by the salivary glands
- **Maltase, Sucrase, and Lactase** – Breaks down the sugars maltose, sucrose and lactose (respectively)
  - All produced by the small intestine
Unit 2

Substances that Help Digestion:

- **Bile** – **Emulsifies fats.** (Breaks down large fat droplets into smaller ones)
  - The emulsification means a larger surface area for the lipase to work on.
  - Also neutralises stomach acid
  - It is produced in the liver
  - Stored in the gall bladder
  - Passes along the bile duct into the duodenum

- **Hydrochloric acid** – Kills bacteria in food
  - Creates low (acidic) pH in the stomach that enzymes work best at
  - Secreted in the stomach

- **Sodium Hydrogen Carbonate** – Neutralises the acid leaving the stomach to ensure that the enzymes in the stomach can work
  - Secreted from the pancreas
The Digestive System

- Also called the alimentary canal
- Several different processes are involved:

  Ingestion – taking food into the body
  Digestion – breaking down food into small molecules
  Absorption – absorbing digested food into the blood
  Egestion – removal of indigestible material (faeces) from the body

  **WARNING: EGESTION IS NOT THE SAME THING AS EXCRETION**

- All of the processes take place in different parts of the system.

  Food moves through the system due to contractions of the muscles in the walls of the alimentary canal called peristalsis. The muscles squeeze the food along.
Absorption of Food:

- After digestion, food enters the blood to be transported around the body.
- This occurs in the main part of the small intestine, the ileum.
- The lining of the ileum is covered in millions of small projections called villi.
- The villi give the ileum a larger surface area (300m²), thereby increasing the speed of absorption into the blood.

Adaptations of the Ileum:
- Long (6-7 metres)
- Covered with villi
- Villi are covered in microvilli

Adaptations of Villi:
- Thin, permeable walls (one cell thick)
- Contain an network of blood capillaries, which maintain the concentration gradient for quick diffusion to the blood
- Contain lymph vessels (lacteals), tubes in the middle of each villi, that absorb the products of fat digestion
Assimilation:

- Def: The processes by which the food molecules in the blood are transported around the body and then absorbed into the cells of the tissues of the body.
- The blood vessel from the ileum join up to form a large blood vessel called the **hepatic portal vein**, which takes the nutrients straight to the liver.
- The liver acts as a processor, breaking some molecules down even further, building up and storing others. Also sends some off some molecules into the blood to go to other parts of the body.
- Nutrients are transferred from liver to blood via **active transport** because the concentration of nutrients in blood is always higher than in the liver.
- This requires energy.
- Nutrients diffuse from the blood vessels into the cells of the tissues.

- Vitamins, A, B, D, and iron are stored in liver cells.

Regulating blood sugar levels:

- Glucose is sent though the blood to cells of body.
- Insulin from the pancreas stimulates excess glucose to be converted into glycogen and stored in the liver.
- When blood sugar levels fall to low, glycogen is converted back into glucose, stimulated by glucagon.
- If glycogen stores are full, extra is converted into fat to be stored in tissues around the body.
- Regulation of blood glucose is part of homeostasis.
Regulation of Amino Acids:

- Active cells need amino acids to build proteins.
- Excess amino acids cannot be stored.
- Some kinds of amino acids can be converted into other kinds that are need.
- The others are deaminated.
- **Deamination** – The process by which amino acids are broken down in the liver and parts of the molecules are recycled
- Main part of molecule is converted into glucose (or other compounds)
- Amino part is excreted in the form of urea.
- Urea is carried in blood to kidneys and excreted in urine.
Questions

Digestion

1 Which one of the following structures is not part of the alimentary canal?
(a) duodenum               (c) liver
(b) mouth                      (d) stomach:

2 Name two digestive glands.

3 What name is given to the muscular contraction which moves food along the alimentary canal?

4 What do digestive enzymes do to food?

5 What are the final digestion products of (a) protein, (b) fat, (c) starch?

6 How does chewing food help to speed up digestion?

7 Name the enzyme present in saliva and say what type of food it acts on.

8 Are the contents of the stomach (a) acid, (b) alkaline, (c) neutral?

9 What class of food is partially digested in the stomach?

10 What is the name of the enzyme in gastric juice?

11 What types of enzymes are produced by the pancreas?

12 Into which part of the alimentary canal does the pancreas secrete pancreatic juice?

13 What is the function of bile in digestion?

14 State three ways in which the absorbing surface of the small intestine is increased.

15 Into what body fluids do (a) glucose, (b) fatty acids, glycerol (c) amino acids pass?

16 Fill in the missing words..
The blood from the intestine goes first to the ........ before entering the general circulation. If the glucose concentration in the blood is above a certain level, it is changed to ........ and stored. Glucose which passes into the general circulation is taken up by the body cells and used to provide ........ If there are excess amino acids

Andy Todd
in the blood from the intestine, the liver converts them to ....... which is stored, and ....... which is excreted by the kidneys.

17 What does the liver do to (a) hormones, (b) alcohol, (c) vitamin A?

18 Name the structures labelled A to I.
F: Respiration

**Students will be assessed on their ability to:**

- 2.33 recall that the process of respiration releases energy in living organisms
- 2.34 describe the differences between aerobic and anaerobic respiration
- 2.35 recall the word equation and the balanced chemical symbol equation for aerobic respiration in living organisms
- 2.36 recall the word equation for anaerobic respiration in plants and in animals
- 2.37 describe simple controlled experiments to demonstrate the evolution of carbon dioxide and heat from respiring seeds or other suitable living organisms.

**Respiration**

**WARNING: DOES NOT MEAN BREATHING**

- Def: The process of converting glucose to energy
- Goes on in every cell in your body
- Energy is used to build up larger molecules, contract muscles, for active transport, cell division, to maintain a steady body temperature, and other life processes.
- All living things respire.

**Aerobic Respiration**

(This is the way we usually respire)

Equation for Aerobic Respiration:

\[
\text{Glucose} + \text{Oxygen} \rightarrow \text{Water} + \text{Carbon Dioxide} (+ \text{Energy})
\]

\[
C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2 (+ 2900 \text{ KJ})
\]

- The opposite of photosynthesis (w/o energy)
- Called ‘aerobic’ respiration because it uses oxygen.
- Carbon dioxide and water are the waste products of aerobic respiration.
- Happens in the cell’s mitochondria.

- Different foods contain different amounts of energy.
- Amount of energy in food is measured using a calorimeter.
- Energy is now measured in joules.

- During exercise, rate of aerobic respiration increases so:
  - Muscle cells need more glucose and oxygen

Andy Todd
More glucose is removed from the blood
Breathing becomes faster and deeper to take in more oxygen
The heart increases to deliver the oxygen and glucose to the muscle cells more quickly

**Anaerobic Respiration**

- **Anaerobic respiration** – respiration with no oxygen
- Used when there is not enough oxygen for aerobic respiration. In humans, it’s used when oxygen in muscles is being used up faster than it can be delivered.
- Releases much less energy than aerobic respiration.

Anaerobic Respiration in Human Cells:

\[ \text{Glucose} \rightarrow \text{Lactic Acid} + \text{Energy} \]

Fermentation (Anaerobic Respiration in Plants and Yeast):

\[ \text{Glucose} \rightarrow \text{Ethanol} + \text{Carbon Dioxide} + \text{Energy} \]

\[ \text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2 \]

(Yeast is used to brew beer and other alcoholic drinks because it uses anaerobic respiration to make the alcohol and the CO₂ to make it fizzy.)

**The Oxygen Debt:**

- The lactic acid that builds up during anaerobic respiration in humans is poisonous.
- It has to be broken down and O₂ is needed to do this.
- You breathe quickly after exercise to take in extra O₂ to remove the lactic acid.
- The volume of O₂ needed to completely oxidise the lactic acid is called the oxygen debt.
- Heart rate and breathing return to normal once lactic acid has been broken down
- Indication of someone’s fitness: how long it takes their heart rate to return back to normal (the recovery time)
Questions

Energy from respiration

1 Select the most appropriate word from the list below to complete the following paragraph:
   Respiration is the release of .......... from ..........and takes place in all ........ of the
   body .......... In the course of respiration, .......... is broken down to .......... and ...........
   If oxygen is used for this process, the respiration is called .......... If oxygen is not used
   in the process, the respiration is called .......... Each stage of respiration is speeded up by a particular ..........

   cells, food, carbon dioxide, enzyme, muscles, aerobic, oxygen, water, vitamin,
   protein, energy, anaerobic.

2 Complete the following equation which summarises aerobic respiration of glucose:
   C .......... + ...O... ....O... + ....H:O + 2830 ..........

3 What are the products of alcoholic fermentation?

4 In which cell structures does respiration mainly occur?

5 If a person is lying quite still, what does he or she need energy for?

6 Which of the two forms of respiration (aerobic and anaerobic) provides more
   energy from a given quantity of food?

7 (a) What are the intermediate products of anaerobic respiration in an active
   muscle?
   (b) Which of them is associated with oxygen debt?
   (c) In what way is this product associated with the 'oxygen debt?'

8 Which two of the following statements are incorrect?
   (a) Anaerobic respiration uses oxygen to release energy from food.
   (b) Aerobic respiration releases oxygen from food during oxidation.
   (c) Aerobic respiration converts food to carbon dioxide and water.
   (d) Anaerobic respiration releases energy from food without using oxygen.

9 (a) Which one of the following would be acceptable evidence that some form of
   respiration was taking place in a living tissue
   (i) oxygen being taken up
   (ii) oxygen being given out
   (iii) water vapour being produced
   (iv) food being used up
   (b) Why are the others unacceptable?

Andy Todd
If a tissue was heated to 65ºC for 10 minutes, respiration would cease even if oxygen and food were supplied. Why is this?

What name is given to the whole range of chemical changes which are needed just to keep an organism alive?

(a) basal metabolism (c) catabolism
(b) anabolism (d) metabolism

(a) What chemical is normally used to test for the presence of carbon dioxide?
(b) What is the result of the test if carbon dioxide is present?

Blood from a donor is sterile and stored in a sealed bag, but it is still kept at 4°C. What is the advantage of keeping it at this low temperature?
G: Gas exchange

Students will be assessed on their ability to:

2.38 understand the role of diffusion in gas exchange

Flowering plants

Students will be assessed on their ability to:

2.39 understand gas exchange (of carbon dioxide and oxygen) in relation to respiration and photosynthesis
2.40 understand that respiration continues during the day and night, but that the net exchange of carbon dioxide and oxygen depends on the intensity of light
2.41 explain how the structure of the leaf is adapted for gas exchange
2.42 describe the role of stomata in gas exchange
2.43 describe simple controlled experiments to investigate the effect of light on net gas exchange from a leaf, using hydrogen-carbonate indicator

Gas Exchange in Plants

- Gases enter and leave the leaf by means of **diffusion**.
- Gas exchange is necessary for both photosynthesis and for respiration.
- Net exchange of CO₂ and O₂ depends on the rate of Photosynthesis depends on the intensity of the light during the day.
Unit 2

- When the plant is photosynthesising, CO₂ enters the plant through the stomata and some oxygen, a product of Photosynthesis leaves the plant.
- During the day, rate of Photosynthesis is higher than the rate of respiration, so overall
- Plant’s respire all the time, and at night leftover oxygen is used from Photosynthesis or absorbed through stomata.
- This means there is a greater demand of gas exchange during day than night.

- Opening and closing of stomata is controlled by changes in shape of guard cells
- Stomata usually close at night to prevent water loss and because demand for gas exchange isn’t as great (only respiration occurring).
- At dawn and dusk, the rates of photosynthesis and respiration are the same.
- No gases enter or leave the plant because oxygen from photosynthesis is used in respiration and carbon dioxide from respiration is used in photosynthesis.
- These points of time are known as the compensation points.

Leaf Structure

- Has a large internal surface area to volume ration to allow the efficient absorption of carbon dioxide and removal of oxygen.
- Is thin and flat, to provide a surface area for maximum absorption of sunlight.

Andy Todd
Waxy Cuticle – waterproof layer that limits water loss by preventing evaporation (is also transparent)

Epidermis Cells – create the wax of the cuticle and are transparent to allow light to shine through

Palisade Cells – The cells responsible for photosynthesis (SEE SPECIALISED CELLS)
  – Tightly packed together in the top half of the leaf so that as many as possible can receive sunlight.

Spongy Mesophyll Cells – Form the main gas exchange surface of the leaf
  - Round and loosely packed
  - Have air spaces to allow gases to get to and from the palisade cells
  - Absorb carbon dioxide, release oxygen and water vapour
  - Have a few chloroplasts by not nearly as many as palisade cells

Guard Cells and Stomata – Allow movement of gases into and out of the leaf and control whether or not the plant is transpiring. (SEE SPECIALIZED CELLS SECTION)

Leaf Vein – Contains the phloem tissue (transports products of photosynthesis to and from the leaf)
  – Contains the phloem tissue (transports water and minerals to the leaf)

<table>
<thead>
<tr>
<th>Rule of Thumb for Stomata:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open during day</td>
</tr>
<tr>
<td>Closed at night</td>
</tr>
</tbody>
</table>

Andy Todd
Students will be assessed on their ability to:

- 2.44 describe the structure of the thorax, including the ribs, intercostal muscles, diaphragm, trachea, bronchi, bronchioles, alveoli and pleural membranes
- 2.45 understand the role of the intercostal muscles and the diaphragm in ventilation
- 2.46 explain how alveoli are adapted for gas exchange by diffusion between air in the lungs and blood in capillaries
- 2.47 understand the biological consequences of smoking in relation to the lungs and the circulatory system
- 2.48 describe a simple experiment to investigate the effect of exercise on breathing in humans.

Gas Exchange in Humans:

WARNING: BREATHING IS NOT RESPIRATION

- Although the system responsible for breathing is called the respiratory system, respiration is not breathing. Breathing is usually called ventilation. The respiratory system can also be called the gas exchange system.

Andy Todd
Structure of the Respiratory System:

Pathway of Oxygen as We Breathe in:

1. Air travels down the trachea (windpipe). Cilia inside of the trachea remove dirt and microbes, which leaves the body as mucus.
2. Air continues into the lungs through the bronchi, which split up into a network of bronchioles in the lungs.
3. Air then enters into millions of small bags called alveoli, where gas exchange occurs. \( O_2 \) diffuses into the capillaries that surround each alveolus, while \( CO_2 \) diffuses out of them.

- Alveoli have a rich blood supply so that the concentration gradient is maintained and \( O_2 \) and \( CO_2 \).
Inhalation and Exhalation:

- A.k.a. breathing in or breathing out
- Happens because of changes in volume of the thorax (upper part of the body).
- The change in volume in turn changes the pressure in the lungs, causing air to enter or leave the lungs.
- Changes are cause by contraction and relaxation of the intercostal muscles and the movement of the diaphragm.
- Two sets of intercostal muscles: internal and external. External is mainly used in inhalation and exhalation. Internal is only used when you are forcing air in and out.

**How Inhalation Occurs:**

1. Diaphragm contracts and flattens.
2. The external intercostal muscles contract.
(Therefore)
3. The ribs to move upward and outward.
(Therefore)
4. Volume of thorax increases.
5. Air pressure inside decreases.
(Therefore)
6. Air enters the lungs.

- Air pressure inside the lungs is lower than air pressure outside the body, causing air to rush in (pressure gradient).
- Rings of cartilage in the trachea, bronchi and bronchioles keep the air passages open and prevent them from collapsing when the air pressure decreases.

**How Exhalation Occurs:**

1. The diaphragm relaxes and returns to its domed shape.
2. External intercostal muscles relax.
(Therefore)
3. Ribs move down to their original position.
(Therefore)
4. Volume of the thorax decreases.
5. Air pressure inside increases.
(Therefore)
6. Air leaves the lungs.

- Air pressure inside the lungs is higher than air pressure outside the body, causing air to leave (pressure gradient).

Andy Todd
Composition of Inhaled and Exhaled Air:

- Air we breathe in and out contains many gases.
- Oxygen diffuses into capillaries and travels in arteries and arterioles to tissues of the body.
- CO₂ and water vapour are part of the air we breathe out.
- Other gases are unaffected.

Alveoli:

- The site of gas exchange in humans (where O₂ diffuses out of and CO₂ into)
- Purpose is to transfer O₂ to blood and transfer CO₂ out of blood and out of the body.

 Adaptations of the Alveoli:

- Thin permeable walls – only one cell thick for a short pathway for diffusion
- Moist lining – oxygen dissolves first before diffusing through
- Shape – the bunched up shape creates a larger surface area than a spherical shape, increasing speed of diffusion of gases
- Copious blood supply – many capillaries so that concentration gradient is maintained, allowing rapid diffusion
- Lots of them – millions of them for maximum exchange possible

Andy Todd
What Happens:

1. Deoxygenated blood begins to pass the alveoli.
2. CO$_2$ diffuses out of red blood cells into alveoli from high $\rightarrow$ low concentration
3. O$_2$ diffuses from alveoli into red blood cells from high $\rightarrow$ low concentration
4. Oxygenated blood continues on

**Smoking**

- Tobacco contains nicotine, which increases blood pressure, is addictive and can lead to the formation of blood clots, increasing the chances of heart disease.
- Tobacco smoke also contains tar.
- Tar irritates the lining of the air passages in the lungs, inflaming them and causing bronchitis.
- Can also cause lung cancer
- Damages the cilia lining of the trachea and causes extra mucus to be made, which the cilia can no longer remove. The mucus then trips into the lungs.
- Bacteria can breed in the mucus, so the person can is more likely to get chest infections.
- Smoker’s cough occurs when the smoker’s body tries to get rid of the mucus.
- Alveoli are damaged, as the tar decreases their surface area, making it more difficult to absorb O$_2$ and release CO$_2$.
- Carbon monoxide in smoke combines irreversible with the haemoglobin in red blood cells.
- This makes it so there are fewer red blood cells to carry oxygen.
Questions

Breathing

1 (a) Energy is obtained from food by a process called .....(A).....
   (b) The intake of oxygen and output of carbon dioxide at a respiratory surface is called .....(B).....
   (c) The process of renewing air in the lungs is called .....(C).....
   (d) Which of the processes A-C are included in the term 'breathing'?

2 Name, in the correct order, the structures that incoming air would pass through between the nasal cavity and the alveolus.

3 What is the function of the rings of cartilage in the respiratory passages?

4 Using the words 'cilia' and 'mucus', describe, very briefly, how the body gets rid of dust which enters the lungs.

5 Which of the following is correct:
   When we inhale
   (a) our intercostal muscles contract and our ribs move down
   (b) our diaphragm muscles contract and the ribs move up
   (c) our diaphragm muscles contract and the ribs move down
   (d) our intercostal muscles contract and the diaphragm muscles relax.

6 In what two ways will the composition of blood coming from the pulmonary artery differ from that going to the pulmonary vein?

7 Inhaled air contains about 21% oxygen. What is the approximate percentage concentration of oxygen in exhaled air?

8 What process causes oxygen to pass from the alveoli into the lung capillaries?

9 Which of the following diseases are unlikely to be caused by smoking: (a) lung cancer, (b) tuberculosis, (c) bronchitis, (d) colds, (e) heart attacks?
H: Transport

Transport Systems

Students will be assessed on their ability to:

2.49 understand why simple, unicellular organisms can rely on diffusion for movement of substances in and out of the cell
2.50 understand the need for a transport system in multicellular organisms

Flowering plants

Students will be assessed on their ability to:

2.51 describe the role of phloem in transporting sucrose and amino acids between the leaves and other parts of the plant
2.52 describe the role of the xylem in transporting water and mineral salts from the roots to other parts of the plant
2.53 explain how water is absorbed by root hair cells
2.54 recall that transpiration is the evaporation of water from the surface of a plant
2.55 explain how the rate of transpiration is affected by changes in humidity, wind speed, temperature and light intensity
2.56 describe experiments that investigate the role of environmental factors in determining the rate of transpiration from a leafy shoot

Transport in Plants

- Transportation systems are used to get nutrients to all cells in organisms and to remove all waste products.
- In plants, water and dissolved substances are transported through two types of vessels, called xylem and phloem.

Andy Todd
Xylem vessels – long tubes made out of lignified dead cells. Lignification gives support to plant.
- Carry water and dissolved minerals up from roots to rest of plant in one direction (unidirectional).

Phloem vessels – tubes of living cells with perforated end-plates that carry products of photosynthesis, mainly dissolved food materials (sucrose, fats, amino acids) from leaves to other parts of plants.
- Movement of food is called translocation.
- Sucrose is energy for the rest of the plant and amino acids (protein) is used to help shoots and roots grow.
- Flows both up and down and is not unidirectional.

- In roots, xylem and phloem vessels are grouped separately
- In the stem and leaves, they are found together in vascular bundles.
- They are still completely separate systems.
Unit 2

Plant roots

Plant Stems

Plant Leaves

Andy Todd
How Plants Gain Water

- Done through the process of **osmosis** (the diffusion of water from high conc. to low conc through a partially permeable membrane e.g. a cell membrane)
- Roots are covered in tiny **root hair cells**, **increasing surface** for absorption.

1. Water enters via **osmosis** (solution inside the cells are more concentrated than the water in the soil).
2. Water moves through cells by osmosis until reaching the xylem vessels, which carry the water up to the leaf.
Transpiration (How Plants Lose Water)

Benefits of Transpiration:

- Creates a stream that brings up water and minerals from the soil.
- Water evaporation cools the plant.

How It Occurs:

1. Water moves out of the xylem and enters the leaf cells by osmosis.
2. Water evaporates from the surface of the cells inside the leaf and diffuses out through the open stomata.
3. Evaporation causes more water to rise up the xylem.
Unit 2

Shortage of water in leaves draws more water of from the rest of the plant, which draws up more from the roots.

- Flow of water is known as the transpiration stream.
- Transpiration happens faster when the plant is in a hot, windy, dry, and/or sunny environment:
- When it gets too hot out, leaves curl up to create a small area where an equilibrium of water can be reached inside and outside the plant.
QUESTIONS

Plant structure and function

1. The drawing represents a vertical section through a leaf x 200
   (a) Name the parts indicated by the letters A - E.
   (b) What differences can you see between the palisade cells and the spongy mesophyll cells?
   (c) What is the function of C?
   (d) (i) Name the features represented in the diagram, which are thought to adapt the leaf to its function in photosynthesis.
      (ii) Say how these features help to promote this process.
   (e) State three other structural features, not shown in the drawing, which are thought to be adaptations to the process of photosynthesis in most leaves. Explain briefly how these features contribute to the efficiency of photosynthesis.

2. Which of the following are most likely to be true? When the stomata are open, the leaf is
   (a) absorbing oxygen
   (b) giving off water vapour
   (c) absorbing carbon dioxide
   (d) giving off carbon dioxide
   (e) giving off oxygen.

3. (a) How many stomata are shown in this drawing of leaf epidermis?
   (b) How many of the stomata are open?
   (c) How many are likely to be open at night?
   (d) What is the magnification of the drawing?

4. (a) What process is responsible for the movement of carbon dioxide into a leaf?
   (b) In what conditions might the same process cause oxygen to enter a leaf?
The diagrams represent transverse sections through a root and a stem.
(a) Say which one represents the stem and which one represents the root, giving your reasons.
(b) Name the parts of these organs represented by the letters A-J.
Questions

Transport in plants

1 All of the following statements are true but which one is the most precise?
Water is conducted through plant stems in
  (a) the xylem, (b) vascular bundles, (c) vessels, (d) veins.

2 Which of the following statements is the most accurate?
  (a) Food can travel up the stem in the phloem.
  (b) Food can travel down the stem in the phloem.
  (c) Food can travel up or down the stem in the phloem.
  (d) Food can travel up or down the stem in the xylem.

3 Roots have no chlorophyll and grow in darkness. So how do roots obtain their food?

4 Which of the following conditions is least likely to increase the rate of transpiration in a plant?
  (a) a rise in temperature  (c) increased air movement
  (b) an increase in humidity  (d) increased sunlight

5 Which of the following statements are true of transpiration
  (a) it draws water up the stem
  (b) it draws dissolved salts up the stem
  (c) it draws food up the stem
  (d) it has a cooling effect on the leaves
  (e) it speeds up photosynthesis?

6 Osmosis and transpiration both play a part in the movement of water through a plant. Which of these two processes makes the greater contribution to the movement of water up the trunk of a tree?

7 Which of the following statements are true?
A potometer is an apparatus which can be used to:
  (a) measure the rate of water uptake in a shoot
  (b) measure the rate of transpiration in a shoot
  (c) measure the rate of photosynthesis in a shoot
  (d) compare rates of transpiration in different conditions

8 Most of the water taken up by a plant passes through it and is evaporated to the atmosphere. What use is made of the tiny fraction of this water which is retained by the plant?
9 A student set up a potometer in the laboratory and measured the rate of movement of water in the capillary. An average of four readings gave a rate of 50mm per minute. The apparatus was then taken outside, where there was a light breeze. Four more readings were taken without delay. The average of these readings was 130 mm per minute. The student concluded that exposure of the shoot to rapid air movement had increased the rate of transpiration. Criticise the design of the experiment and the student's conclusions.

10 The drawing on the right represents a design for a potometer. Criticise the design and practicability of the apparatus.

11 A pot plant was watered and the pot enclosed in a plastic bag tied securely round the base of the stem. The plant was weighed at 9 a.m. and 4 p.m. During this time it lost 32g in weight.
   (a) From these results, what was the plant’s rate of transpiration?
   (b) Why might this calculated rate be slightly inaccurate (i) in daylight, (ii) in darkness?
   (c) What was the point of (i) watering the plant, (ii) enclosing the pot in a plastic bag?
Humans

Students will be assessed on their ability to:

2.57 recall the composition of the blood: red blood cells, white blood cells, platelets and plasma
2.58 understand the role of plasma in the transport of carbon dioxide, digested food, urea, hormones and heat energy
2.59 describe the adaptations of red blood cells for the transport of oxygen, including shape, structure and the presence of haemoglobin
2.60 describe how the immune system responds to disease using white blood cells, illustrated by phagocytes ingesting pathogens and lymphocytes releasing antibodies specific to the pathogen
2.61 understand that vaccination results in the manufacture of memory cells, which enable future antibody production to the pathogen to occur sooner, faster and in greater quantity
2.62 recall that platelets are involved in blood clotting, which prevents blood loss and the entry of microorganisms
2.63 describe the structure of the heart and how it functions
2.64 understand that the heart rate changes during exercise and under the influence of adrenaline
2.65 describe the structure of arteries, veins and capillaries and understand their roles
2.66 recall the general plan of the circulation system to include the blood vessels to and from the heart, the lungs, the liver and the kidneys.

Transport in Humans

- Blood is the body’s transport system.
- It carries substances around the body, including oxygen.

Red Blood Cells:

- Carry oxygen and Carbon dioxide.
- Have a biconcave shape to give maximum surface area for absorption of O₂.
- Also provides some flexibility so they can squeeze right up against capillary walls to reduce diffusion distance for oxygen and carbon dioxide in and out of RBC at alveoli in lungs
- Have no nucleus, making maximum space for haemoglobin.
- Contain haemoglobin. Haemoglobin contains iron which binds with O₂.
- Haemoglobin in red blood cells combines with O₂ to form oxyhaemoglobin.
- In organs & tissues, oxyhaemoglobin splits up back into O₂ & haemoglobin.

Andy Todd
White Blood Cells:

- Defend against disease.
- Have a big nucleus.
- There are 2 types;

1. **Phagocytes**
   - Engulf unwelcome pathogens and micro-organisms by a process called Phagocytosis.

2. **Lymphocytes**
   - Produce antibodies to bind with pathogens and keep them from harming a cell until the white cell engulfs it.
   - Produce antitoxins to neutralise toxins from pathogens and microorganisms.
Unit 2

Vaccinations:
- A vaccine is a dose of dead or inactive pathogens
- Provide artificial but active immunity for the body.
- Allows the body to match the correct antibodies to the pathogens antigens without the body suffering from their presence
- The body keeps these white blood cells with a memory of the antigens (Memory cells) for future infections
- Provides immunity for if/when the body meets the real pathogen as it can make the correct antibodies quickly and destroy it before any symptoms appear.

Plasma:
- Straw coloured liquid in blood that carries everything including:
  - Red and white blood cells
  - Platelets
  - Nutrients (glucose and amino acids)
  - Carbon Dioxide
  - Urea
  - Hormones
  - Antibodies and antitoxins from white blood cells
  - Heat energy

Platelets:
- Help the blood to clot healing wounds, preventing pathogens from entering the body.
- Stops blood flow out of wound
- Prevents infection by stopping microorganisms from entering the blood
- Made from small fragments of destroyed cells
- Have no nucleus

Andy Todd
The Circulatory System

- Blood flows through the body via, arteries, veins, and capillaries.
- The heart pumps the blood to keep it flowing.
- All of these constitute the circulatory system.

Cycle:

- Blood leave the heart through arteries.
- Returns via veins.
- Capillaries connect the two.

The Heart:
Two muscular pumps that pump blood by expanding in size, filling with blood and then contracting, forcing blood out.

1. Right side pumps blood to lungs to collect oxygen.
2. Left side pumps oxygenated blood to rest of body.
3. Deoxygenated returns to right side.

- Contains four valves and four chambers, two valves and chambers per side.
- Four chambers are two atria and two ventricles, one per each side.
- Atria collect blood.
- Ventricles force blood out.
- Atria connect to ventricles.
- Valves ensure that blood flows through heart in one direction.

**How Heart Pumps:**

1. Blood flows into 2 atria
2. Atria contract gently to push blood into ventricles.
3. Atrio-ventricular valves (tricuspid on the right side and bicuspid on the left side of the heart) between atria and ventricles open
4. Blood fills the ventricles
5. As pressure builds in the ventricles the atrio-ventricular valves close
6. Ventricles contract forcing blood into aorta and pulmonary artery
7. The contraction of the ventricles starts from the apex of the heart
8. Blood flows out of the heart into the arteries.
9. Semi-lunar valves open at the top of the ventricles where they meet the arteries
10. Heart relaxes
11. Atria fill up and cycle starts again

**Double Circulation:**

- Humans have double circulation.
- Blood travels twice through the heart and the heart pumps the blood twice.
- Because the pressure needed to push blood through lungs is smaller than pressure needed to push it through the whole body.
- Therefore, the left side of the heart which pumps blood to the body is more muscular.
- If it was all one pump, capillaries in the lungs would burst from the high pressure and the pressure wouldn’t be high enough to get around the entire body.
Unit 2

Major Blood Vessels of the body

Andy Todd
The Heart beat

What Controls the Heart?

The heart muscle is **Myogenic** which means that it initiates and coordinate sits own heart beat.

Other factors however can influence heart rate, stroke volume and blood pressure.

**Heart rate:** The rate at which the heart beats. It is measured in beats per minute

**Stroke Volume:** The volume of blood that the heart beats in one heart cycle.

**Blood Pressure:** The measure of the pressure of your blood as your heart is contracting and relaxing

- Adrenaline – hormone that prepares the body for action and increases heart rate, which increases blood pressure, too. This increases supply of oxygen to respiring tissues for aerobic respiration.
- Increased Levels of Carbon Dioxide – Due to exercise

What Increases Blood Pressure:

- Salt – increases osmotic potential of blood. Water is pulled from cells by osmosis to get equilibrium of water. The extra water increases the volume of blood, thereby increasing pressure.

**Heath Risks of Not Normal Blood Pressure:**

- High BP increases risk of stroke (blood vessels in brain burst)
- Low BP increases risk of kidney failure (inability to filter blood)

- **Veins carry blood to the heart from body tissues** (usually deoxygenated blood except the Pulmonary vein).
- **Arteries carry blood from the heart to body tissues** (usually oxygenated blood except the Pulmonary artery).
Arteries:

- Carry oxygenated blood away from the heart (usually).
- Arteries carry the blood at high pressure to parts of the body.
- Artery walls are thick, strong, and elastic to deal with the high pressure.
- Lumen down the middle is small, keeping the blood pressure high.
Capillaries:

- Capillaries are small vessels that provide blood to every cell in the body, supplying oxygen and glucose and taking away carbon dioxide and urea.
- Are very thin – only one cell thick.
- Are too small to see

Veins:

- Carry deoxygenated blood back to the heart (usually)
- Carry blood back to the heart at low pressure.
- Have large lumens to help blood flow.
- Have valves to prevent back flow as they go up the body.

Pulmonary Artery and Vein:

- Pulmonary artery and pulmonary vein go to and from the lungs and heart.
- The pulmonary artery carries deoxygenated blood.
- The pulmonary vein carries oxygenated blood.
QUESTIONS

The blood circulatory system

1 How do white blood cells differ from red blood cells
   (a) in their structure,
   (b) their function?

2 Where are blood cells made in the body?

3 Name two proteins carried in the plasma.

4 What else is carried in the plasma?

5 Put the following events in their correct order starting with the first one listed:
   atria fill with blood, semi-lunar valves close, tricuspid and bicuspid valves close, ventricles contract, semi-lunar valves open, atria contract, ventricles relax, tricuspid and bicuspid valves open

6 Fill in the missing words.
   Oxygenated blood from the lungs returns to the ...(A).... atrium of the heart in the ...(B).... vein. From here it enters the ...(C).... ventricle and leaves the heart in the ...(D).... to go to the body. From the body ......(E)....blood returns via the ...(F)....to the ...(G).... atrium, and then leaves the heart in the ...(H).... artery to go to the ...(I)....

7 Which one of the following is not a characteristic of capillary blood vessels?
   (a) Repeatedly branched.
   (b) Small diameter.
   (c) Permeable to salts (ions)
   (d) Thick walled.

8 Arteries carry blood ...... the heart. Veins carry blood ......the heart.

9 In which parts of the circulatory system are there valves?

10 Complete the table.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Transported by the blood</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From</td>
</tr>
<tr>
<td>Oxygen</td>
<td>(A) whole body</td>
</tr>
<tr>
<td>(B)</td>
<td>whole body</td>
</tr>
<tr>
<td>(C)</td>
<td>Liver</td>
</tr>
<tr>
<td>(D)</td>
<td>Intestine</td>
</tr>
<tr>
<td>Heat</td>
<td>(F)</td>
</tr>
</tbody>
</table>
11 After a period of vigorous activity you would expect blood leaving a muscle to have
(a) less carbon dioxide, less oxygen and less glucose
(b) more carbon dioxide, more oxygen and less glucose
(c) more carbon dioxide, more oxygen and more glucose
(d) more carbon dioxide, less oxygen and less glucose.
I: Excretion

Flowering plants

Students will be assessed on their ability to:

2.67 recall the origin of carbon dioxide and oxygen as waste products of metabolism and their loss from the stomata of a leaf

Excretion in Plants

- Waste products are CO₂ from respiration and O₂ from Photosynthesis
- Leave through stomata as part of gas exchange.

Humans

Students will be assessed on their ability to:

2.68 recall that the lungs, kidneys and skin are organs of excretion
2.69 understand how the kidney carries out its roles of excretion and of osmoregulation
2.70 describe the structure of the urinary system, including the kidneys, ureters, bladder and urethra
2.71 describe the structure of a nephron, to include Bowman’s capsule and glomerulus, convoluted tubules, loop of Henlé and collecting duct
2.72 describe ultrafiltration in the Bowman’s capsule and the composition of the glomerular filtrate
2.73 understand that water is reabsorbed into the blood from the collecting duct
2.74 understand that selective reabsorption of glucose occurs at the proximal convoluted tubule
2.75 describe the role of ADH in regulating the water content of the blood
2.76 recall that urine contains water, urea and salts.
Excretion in Humans

- Organs of excretion: lungs, skin, kidneys
- Lungs: excrete water vapour and waste gases (such as CO₂)
- Skin: excretes water and salt in form of sweat
- Kidneys: excrete water, salt, and urea

- Kidneys are the main organs for excretion.

Kidneys:

- Control amount of water released from body in urine (controlled by Anti-Diuretic Hormone)
- Also regulates amount of salt and excretes any excess
- Removes urea, formed in liver for breakdown of excess amino acids.
How Kidneys Filter Blood:

1. Blood enter kidneys through renal arteries
2. Renal arteries divide into arterioles.
3. Arterioles divide into capillaries.
4. Capillaries form a glomerulus, a tight coil of many capillaries, in the top of the nephron.
5. Blood is filtered in the **ultrafiltration** process, where blood is put under high pressure generated from a wide afferent arteriole and a narrow efferent arteriole
6. A glomerular filtrate is squeezed out. The filtrate contains glucose, amino acids, hormones, vitamins, slats, urea, and water.
7. Proteins, Red Blood Cells & White Blood Cells are **TOO BIG** to leave the blood.
8. The filtrate goes into the Bowman’s capsule of the nephron.
9. Glucose, amino acids, some salts and some water are reabsorbed by active transport from the proximal convoluted tubule by a process called **selective reabsorption**.
10. Filtrate now containing excess salt, water, all the urea travels down the loop of Henlé and through the distal convoluted tube, where some water and ions are reabsorbed.
11. In collecting duct, more water is reabsorbed. The amount of water reabsorbed depends on the levels of ADH (Anti-Diuretic Hormone). The more ADH there is, more water reabsorbed.
12. The urine, comprised of the urea, water and salt that are left, travels through the ureter to the bladder until it is excreted via the urethra.
13. Capillaries join up to form renal veins, which carry filtered blood away from kidneys.
Recap:

Ultrafiltration – High pressure built up, squeezing water, urea, ions, amino acids and glucose out of blood into Bowman’s Capsule

Selective reabsorption – As the filtrate flows through the nephron, Glucose, amino acids and some salts and some water go back into the blood.

Release of Wastes – Urea, excess ions, and excess water aren’t reabsorbed. These are released out of the body as urine.

Osmoregulation:

Def: regulation of the body’s water carried out by the collecting duct

- Monitored by the hypothalamus in the brain
- ADH (Anti-Diuretic Hormone) makes the collecting duct walls more permeable and so water is absorbed back into the blood.
- If there is too little water, hypothalamus stimulates the pituitary gland to release more ADH to kidneys to reabsorb more water.
  - Urine is dark in colour and in small volumes
- If there is too much water, hypothalamus stimulates pituitary gland to release less ADH so more water is lost via the urine.
  - Urine is colourless and in large volumes

Problems with the kidney:

Proteins in urine
If proteins are found in a patient's urine, it is a sign of High Blood pressure. Proteins are usually too big to pass through into the Bowmans capsule from the Glomerulus
If high blood pressure the proteins are forced through and are present in the urine

Glucose in urine
If glucose is present in a patient's urine, it is a sign that the person has diabetes
Diabetes results in very high levels of glucose in the blood
Too much glucose will mean that not all of it can be reabsorbed back into the blood by selective reabsorption and so ends up in the urine

Kidney failure
If a person's kidney stops to work they will not be able to remove urea from the body and not be able to control how much they urinate
Unit 2

In this situation a patient can take one of two choices, either dialysis or a kidney transplant

**Dialysis**
Passing blood through a dialysis machine which will filter the waste and excess materials out of the blood
Questions

Excretion and the kidneys

1 Name four substances that have to be excreted from the body.

2 Name three organs which have an excretory function.

3 Supply the missing words in the following paragraph:
   Blood is taken to the kidney in the .... (A) .... artery, which divides up into many
   arterioles. The arterioles enter the .... (B) .... of the kidney and supply thousands of
   glomeruli. In each glomerulus, .... (C) .... forces plasma minus its .... (D) .... out of the
   capillaries, and it collects in the .... (E) .... .This liquid passes down the .... (F) ....
   where .... (G) .... , ....(H) .... and .... (I) .... are reabsorbed into the blood. The remaining
   liquid, called ..... (J) ..... passes down the ..... (K) ..... and collects in the ..... (L) ..... before being expelled from the body.

4 In hot weather the urine becomes
   (a) more concentrated and lighter in colour;
   (b) more concentrated and darker in colour
   (c) less concentrated and lighter in colour
   (d) less concentrated and darker in colour.

5 Which of the following substances would you not normally expect to find in a
   sample of urine?
   (a) uric acid, (b) ammonia, (c) glucose, (d) sodium chloride, (e) urea.

6 Blood in the renal vein differs from that in the renal artery by having
   (a) less oxygen, more carbon dioxide and less urea
   (b) more oxygen, more carbon dioxide and less urea
   (c) less oxygen, less carbon dioxide and less urea
   (d) less oxygen, more carbon dioxide and more urea,

7 In what ways is water lost from the body?

8 If the concentration of solutes in the blood rises above a certain level, then
   (a) more water is reabsorbed in the kidney tubules
   (b) less water is reabsorbed in the kidney tubules
   (c) more salt is reabsorbed in the kidney tubules
   (d) less glucose is reabsorbed in the kidney tubules,
In a dialysis machine, which one of the following combination of substances is allowed to escape from the patient’s blood into the bathing solution?

(a) Salts, water and glucose.
(b) Salts, urea and glucose.
(c) Water, urea and uric acid.
(d) Water, uric acid and glucose.
J: Coordination & response

Students will be assessed on their ability to:
2.77 understand that organisms are able to respond to changes in their environment
2.78 understand that homeostasis is the maintenance of a constant internal environment and that body water content and body temperature are both examples of homeostasis
2.79 understand that a coordinated response requires a stimulus, a receptor and an effector

Coordination and Response

- Sensitivity – the ability to recognise and respond stimuli
- Stimulus – a change in an organism’s external or internal condition
- Receptors – mechanisms in the body that detect stimuli
- Effectors – mechanisms in the body that carry out the response to a stimuli

Flowering plants

Students will be assessed on their ability to:
2.80 understand that plants respond to stimuli
2.81 describe the geotropic responses of roots and stems
2.82 describe positive phototropism of stems

Coordination and Response in Plants

Tropisms:

- Def: directional growth responses to stimuli
- Controlled by auxins (a kind of hormone)

Examples:

- Geotropism – growth in response to gravity
- Phototropism – growth in response to light
  - Positive phototropism – grows towards light
  - Negative phototropism – grows away from light

Andy Todd
Auxin:

- Made in the tips of the shoot and roots of a plant
- Diffuses from tips to stimulate or inhibit cell growth
- If the tip is removed, auxin is also removed and cell may stop growing
- Also inhibits growth of side shoots
- If tip is removed, side shoots are produced and plant becomes ‘bushier’

Shoots

- Auxin causes **cell elongation** on the side where it diffuses to in shoots

---

1. **Light:**

   - Example of positive phototropism

   **Growth response:**
   - Shoot tip exposed to light
   - Auxin diffuses away from the light
   - Cell elongation occurs on the darker side of the plant
   - Therefore, darker side grows more than the lighter side and **shoot bends towards light**
Unit 2

2. Gravity

- Example of geotropism

Growth response:
- Shoot is growing sideways
- Auxin diffuses to lower side of shoot
- Cell elongation occurs
- Bottom side grows more and shoot bends away from gravity

Roots

- Auxin inhibits growth on the side it diffuses to in roots

1. Gravity

- Example of geotropism

Growth response:
- Root is growing sideways
- Auxin diffuses to the lower side
- Auxin inhibits growth
- Top side grows more and the root bends towards gravity
Unit 2

2. Moisture

Growth response:
- Root detects more moisture on one side of the root than the other
- Auxin diffuses to the side with more moisture
- Auxin inhibits growth
- Drier side grows more than the one with more moisture and the root bends towards the moisture

Commercial Use of Plant Hormones

Producing Seedless Fruit:
- Fruits with seeds normally grown when flowers are pollinated
- Growth hormones (such as synthetic auxin) are applied to unpollinated flowers causing fruit to grow, but not the seeds inside of them

Fruit Ripening:
- Ripening of fruit is controlled so that they are just ripe enough when purchased by consumers and are not damaged in transportation
- Fruit are picked while they are unripe (therefore firmer and less easily damaged)
- Ripening hormone is applied and fruit ripens during its journey

Using Cuttings to Grow Plants:
- Cuttings is a part of a plant that has been cut off
- Cuttings usually don’t grow when planted
- When rooting compound (containing growth hormones) is added, roots grow and become new plans
- Allows growers to produce clones of one really good plant quickly

Killing Weeds:
- Most weeds are broad-leaved, while grass (and some crops) are narrow-leaved
- Selective weedkillers are plant growth hormones that only affect broad-leaved plants
- The hormones disrupt growth patterns and eventually kills the plants
- This is useful for killing weeds without harming every other plant
## Minerals in Plants

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Used For</th>
<th>Deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrate</td>
<td>• Amino Acids (proteins)</td>
<td>• Stunted Growth</td>
</tr>
<tr>
<td></td>
<td>• Chlorophyll</td>
<td>• Old Leaves → Yellow</td>
</tr>
<tr>
<td></td>
<td>• DNA</td>
<td></td>
</tr>
<tr>
<td>Phosphate</td>
<td>• Cell Membrane</td>
<td>• Younger Leaves → Purple Tips</td>
</tr>
<tr>
<td></td>
<td>• DNA</td>
<td>• Poor Root Growth</td>
</tr>
<tr>
<td>Potassium</td>
<td>• Allows enzymes in resp.</td>
<td>• All Leaves → Yellow + Dead Spots</td>
</tr>
<tr>
<td></td>
<td>and p.s. to work</td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>• Chlorophyll</td>
<td>• All Leaves → Yellow</td>
</tr>
</tbody>
</table>

- Fertilisers supply nutrients and put these ions back into the soil
Humans

Students will be assessed on their ability to:

2.83 describe how responses can be controlled by nervous or by hormonal communication and understand the differences between the two systems
2.84 recall that the central nervous system consists of the brain and spinal cord and is linked to sense organs by nerves
2.85 understand that stimulation of receptors in the sense organs sends electrical impulses along nerves into and out of the central nervous system, resulting in rapid responses
2.86 describe the structure and functioning of a simple reflex arc illustrated by the withdrawal of a finger from a hot object
2.87 describe the structure and function of the eye as a receptor
2.88 understand the function of the eye in focusing near and distant objects, and in responding to changes in light intensity
2.89 describe the role of the skin in temperature regulation, with reference to sweating, vasoconstriction and vasodilation
2.90 understand the sources, roles and effects of the following hormones: ADH, adrenaline, insulin, testosterone, progesterone and oestrogen.

Coordination and Response in Humans

Two Systems that Regulate Coordination and Response:

1. The Nervous System
2. The Endocrine System

The Nervous System:

- Controls the reaction to a change in a human’s environment and ensures that the reaction maintains homeostasis in the body.
- Functions by sending impulses (electrical messages) along nerves to and from different parts of the body.
- The Central Nervous System (aka CNS or coordinator) consists of the brain and the spinal cord and regulates all impulses.
- Impulses (aka stimuli) travel quickly (from 1-120 m/s) and travel from neuron to neuron.
- Sense organs detect the stimuli. Sense organs include eyes, ears, nose, tongue, and skin.
- Stimuli include light, sound, smells, taste, touch, pressure, pain, and temperature.

Nervous System:

Andy Todd
Unit 2

- Interprets and responds to changes in environment
- Comprised of the central nervous system (CNS) and the peripheral nervous system
  - CNS → Brain + Spinal Cord
  - Peripheral → Peripheral Nerves + Sense Organs
- Messages passed through system via electro-chemical impulses
- Responses are usually very rapid

Endocrine System:

- Usually uses negative feedback (a corrective mechanism) to detect changes
- Uses hormones, a kind of chemical communication, to make changes
- Hormones are secreted by endocrine glands
- They act only on target cells/organs
- Helps maintain body functions
- Response usually is a lot slower but affects the body longer

Both work together to maintain homeostasis.

Homeostasis – the maintenance of the body’s internal environments (regardless of fluctuations in the external system.

To maintain homeostasis, body levels of some substances need to be controlled at the right amount:

1. Ion Content
2. Water Content
3. Sugar Content
4. Temperature

And wastes need to be removed:

1. Removal of CO₂
2. Removal of Urea

Homeostasis:

- In order for cells to stay alive and work properly, homeostasis must be maintained.

Controlling Blood Sugar Levels:

- Blood sugar = glucose
- Important to have constant supply of glucose to provide energy to cells.
- Glucose transported around body by blood.

Andy Todd
Unit 2

- Consuming food raises blood sugar levels.
- The hormones insulin and glucagon also control blood sugar level by switching on and off supply of glucose.
- The pancreas makes the insulin and glucagon.
- Insulin controls the glucose level in the blood by converting excess glucose into insoluble glycogen to be stored in the liver.
- Glucose is constantly being used up due to respiration from exercise.
- When glucose falls too low, the pancreas secretes glucagon.
- Glucagon converts stored glycogen back into glucose, which raises blood sugar levels back to normal.

Blood Sugar Levels:

- The amount of glucose in the blood has to be maintained to a certain level
- Glucose level is regulated by the hypothalamus
- If the blood sugar level gets too high, negative feedback signals the pancreas to release insulin, which turns excess glucose into glycogen to be stored in the liver
- If the blood sugar levels get too low, negative feedback signals the pancreas to release glucagon, which turns glycogen into glucose, which goes back into the blood
- People who have diabetes can’t secrete insulin and have a hard time keeping their blood sugar under control

\[ \text{↑ Blood Glucose} \]
\[ \text{Insulin released from pancreas} \]
\[ \text{Converts glucose into glycogen} \]
\[ \text{Stored in muscles and liver} \]
\[ \text{↓ Blood Glucose} \]

\[ \text{↓ Blood Glucose} \]
\[ \text{Glucagon released from pancreas} \]
\[ \text{Converts glycogen into glucose} \]
\[ \text{Glucose released into blood} \]
Diabetes:

- Some people cannot make enough insulin to control their blood sugar levels.
- Without insulin, glucose is not converted into glycogen and glucose has a hard time entering your cells.
- Blood sugar levels can get dangerously high.
- One way to test for diabetes is to test for the presence of glucose in urine because the body resorts to using urine to get rid of some of the excess glucose.
- Symptoms of diabetes:
  - Feeling tired
  - Loss of energy
  - Producing lots of urine
  - Always thirsty
- Ways of Managing Diabetes:
  - Can have controlled diet (avoiding sugar and carbs)
  - Or you can inject with insulin
- Production of insulin in mass scale occurs through use of genetically engineered bacteria.

Controlling Temperature:

- Core temperature (internal temp.) should be around 37° Celsius.
- Temperature must remain at level where enzymes work best.
- Body temperature is also called our core temperature
- Heat is always being released by respiration and is being transferred to our surroundings
- To maintain a constant body temperature, the two have to balance
- However, depending on the external temperature more or less heat can be lost in order to maintain homeostasis
Unit 2

- If body temperature rises, negative feedback causes the body to do things that will reduce the core temperature
- If body temperature lowers, negative feedback causes the body to do things that will increase the core temperature
- Temperature is monitored by the hypothalamus. Body temperature uses negative feedback system, which detects changes.
- How the Body Controls Temperature:
  1. Thermo regulation centre in brain (hypothalamus) detects change in temperature
  2. Corrective mechanism is carried out to return body temperature back to normal.

- Internal body temperature affected by:
  - Heat from respiration
  - External temperatures rising or falling
  - Fevers from diseases

\[ \text{Diagram showing thermo regulation system} \]

Cooling Body Down:

- 3 ways:
  - Vaso Dilation: capillaries widen. Creating more surface area for heat to be lost by radiation
  - Sweating rate increases. As it evaporates, it cools skin.
  - Hairs lie flat, ensuring no insulating layer of air.

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Reducing Heat Loss:

- 4 ways:
  - Vas Constriction- capillaries narrow ensuring less radiation of heat occurs from blood vessels
  - Less sweat is produced
  - Hairs erect (goose bumps) to trap insulating layer of air
  - Muscles shiver – spontaneous muscle contraction generating heat

(SEE DIAGRAM ON PREVIOUS PAGE)

Hypothermia:

- Occurs when the body becomes too cold
- Usually when core temperature falls to 35°C Celsius or lower
- Wet water can make you more vulnerable because water draws heat out from skin
Unit 2

Controlling Water Levels:

- Loss of water occurs when you:
  - Breathe (water vapour)
  - Sweat
  - Urinate
- Kidneys regulate the amount of salt and water lost in your urine. The amount depends on your body’s condition.
- If in excess of water, kidneys will remove it in urine.
- If short of water, kidneys will conserve it.
- Urine disposes of water, ions, and urea.
- Hypothalamus monitors the water content of blood and controls amount of anti-diuretic hormone sent to kidneys.
- Anti-diuretic hormone (ADH) affects amount of water lost in urine by changing permeability (size of pores) of the collecting duct.
- The more permeable the collecting duct, the more water reabsorbed back into the body.
- ADH is made in the pituitary gland.
- Diuretic - makes you urinate
  Anti-Diuretic - stops you from urinating

\[ \text{↑ Blood Water Level} \rightarrow \text{↓ ADH} \rightarrow \text{↓ Water reabsorbed} \rightarrow \text{↑ Urine} \]

\[ \text{↓ Blood Water Level} \rightarrow \text{↑ ADH} \rightarrow \text{↑ Water reabsorbed} \rightarrow \text{↓ Urine} \]
How Kidneys Work:

- Excess water, excess ions, and urea are all bad for the body if they remain in it.
- Urea is formed in the liver from the breakdown of excess amino acids.
- They are waste products of the body that the kidneys.
- Excretion – removal of liquids from the body
  Egestion – removal of solid wastes from the body

Process:

1. Blood enters the kidneys through renal arteries, which divide into arterioles, which in turn divide into capillaries.
2. The capillaries coil into many glomeruli, which are contained in the Bowman’s capsule, a cup shaped structure, the first part of the nephron.
3. Ultrafiltration occurs in the Bowman’s capsule. The capillaries in the glomerulus are put under high pressure, squeezing water, urea, ions, and glucose out of the blood into the Bowman’s capsule.
4. All of the glucose and a sufficient amount of water and ions are reabsorbed as they travel through the nephron by active transport. The loop of Henlé contributes greatly to reabsorption.

5. More water is reabsorbed in the collecting duct depending on the amount of ADH.

6. Urea, ions, and the remaining water leave the nephron into the ureter, which carries the resulting urine out of the kidney and into the bladder.

7. Filtered capillaries rejoin to form the renal veins, which carry clean blood away from the kidneys back into the body.
The Nervous System

Central Nervous System (CNS):

- Where information is processed and decisions are made
- Brain coordinates the actions of the body
- Different areas of the brain coordinate different actions
- All voluntary actions involve the brain, as well as some involuntary
- Spinal cord connects brain with the peripheral nervous system and contains relay neurones

Types of Nerve Cells:

1. Sensory Neurones: Carry signals from receptors to the CNS
2. Motor Neurones: Carry signals from the CNS to effectors
3. Relay Neurones: Connects other neurons together
Neurones:

- Can be very long
- Grouped together in bundles called nerves
- Have dendrites to collect and pass on signals
- Wrapped in a layer of fat and protein called the myelin sheath
- The myelin sheath insulates cells along the axon
- This causes the impulse to bounce, increasing it’s speed
- Have a synapse between each one
- Synapse are gaps in between neurons where the two connect

Fatty Sheath of Myelin:

- Def: Surrounds and insulates the axon of the neuron.
- The fat doesn’t conduct electricity causing the electrical impulse to jump along the axon.
- The jumping of the impulse causes less resistance and ∴ travels quicker.

Multiple Sclerosis – disease that disintegrates the myelin sheath, drastically slowing impulses

Synapse between Neurons:

- Def: The gap between two neurons
- Neurons are never directly connected

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How Impulses Travel through the Synapse:

1. Impulse reaches end of axon.
2. Turns into a chemical (neurotransmitters) that diffuses across the synapse.
3. Neurotransmitters are then received by the receptacles of the next neuron and transformed back into an impulse.
4. The impulse is carried along the receiving neuron.

Drugs:

- Drugs **mimic** or **inhibit** impulses in the neuron
- Can promote by increasing amount of neurotransmitters ∴ more impulses in receiving neuron.

Reflexes:

Simple Reflex:

- The simplest type of response
- Reflexes are rapid and automatic responses to specific stimuli
- They usually protect the body from damage
- Also known as spinal reflexes because they are processed by the spinal cord, not the brain
- The spinal cord sends a signal back to the effector
- Effectors are parts of the body that respond (muscles or glands)
- The signal bypasses the brain so that it is quicker and therefore less damage is done

Reflex Arc:

- The pathway of a simple reflex

**Stimulus** → **Receptor** → **Sensory Neurone** → **Relay Neurone in the CNS** → **Motor Neurone** → **Effector** → **Response**
- Receptors are cells located in sense organs that collect information.
- There are many different types of receptors, depending on the sense organ, and are all sensitive to different types of stimuli.

Example: touching a hot stove

**The Eye**
- Sense organ that detects light
Iris:

- Ring-shaped, coloured part of the eye
- Controls the amount of by using muscles to make the pupil bigger or smaller
- Muscles \(\rightarrow\) Radial and Circular
- Bright light (eye doesn’t need as much light):
  - Radial muscles relax
  - Circular muscles contract
  - Pupil gets smaller (**Constricted**)
- Dim light (eye needs more light to see):
  - Radial muscles contract
  - Circular muscles relax
  - Pupil gets bigger (**Dilated**)

Accommodation (Focusing):

- **Cornea** \(\rightarrow\) The thick and clear front part of eye that focuses light rays
- It does most of the bending of light rays (approximately 2/3)
- **Lens** \(\rightarrow\) Structure in the eye behind the cornea that provides finer focus onto retina
- Distant objects:
  - Rays of light are almost parallel as they enter the eye
  - Requires less bending from lens (**Cornea** does most of the bending on its own)
  - Muscles in the ciliary body relax
  - Lens is pulled into thin shape by suspensory ligaments
  - Rays of light are focused only a little more
- Near objects:
  - Rays of light are ‘diverging’ as they enter the eye
  - Requires the lens to bend more to focus properly
  - Muscles in the ciliary body contract, slackening suspensory ligaments
  - Lens swells into rounded shape
  - Light bends more to focus on retina
Unit 2

Accommodation for a near target

Accommodation for a far target

Structure of the Eye:

- Suspensory ligaments
- Anterior chamber containing aqueous humour
- Conjunctiva
- Sclera (white of eye)
- Choroid
- Retina
- Fovea
- Vitreous humour
- Pupil
- Cornea
- Iris (coloured part of eye)
- Posterior chamber
- Ciliary body (containing ciliary muscle)
- Blind spot
- Tendon of rectus muscle
- Optic nerve

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Other structures:

- **Rods:** - Process light
  - Only see in black & white
  - Found on the retina
  - More sensitive in dim light

- **Cones:** - Process colours
  - Also found on the retina
  - Don’t work well in dim light

- **Forea:** Part of the retina that is packed with cones. It gives a really sharp image when looking straight at something.

The Endocrine System

**Hormones:**

- Part of the endocrine system
- Are chemical messengers
- Made in the endocrine glands
- Endocrine glands do not have ducts to transport hormones
- Instead, hormones are secreted into the blood to be carried around the body in the blood plasma
- Exocrine glands have ducts and store things until required
- Some affect several parts of the body, but most affect just certain part called the target organs
- Every cell has receptors and hormones match certain receptors so they know where to target
- Changes caused by hormones are usually slower and longer-lasting than those by the nervous system

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Adrenal Glands:

- Produce adrenaline
- Adrenaline:
  - Hormone released in times of excitement, anger, fright or stress
  - Prepares body for ‘fight or flight’
  - Quicker and shorter-lasting than most hormones
- Effects:
  - Increases heart rate
  - Increases depth of breathing/breathing rate (for aerobic respiration)
  - Increases sweating
  - Hairs stand on end (furry animals look larger)
  - Glucose released from liver and muscles (for aerobic respiration)
  - Dilated pupils (more receptive)
  - Paling of the skin (blood is redirected to muscles)

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Unit 2

Pituitary Gland:
- Produces growth hormones (for physical development in children), ADH, LH, FSH

Thyroid Gland:
- Produces thyroxine
- Thyroxine helps mental and physical development in children

Pancreas:
- Secretes insulin and glucagon
- Both hormones control blood glucose levels and target the liver
- Insulin lowers BGL (by converting excess glucose into glycogen)
- Glucagon raises BGL (by converting stored glycogen into glucose)
- Glycogen is stored in the liver, glucose is in the blood
- Glucose is needed for respiration and needs to be kept at a steady level
- Diabetics can’t control BGL

Testes (males only):
- Secretes testosterone (male sex hormone)

Ovaries (females only):
- Secretes progesterone and oestrogen (female sex hormone)
- Controls menstrual cycle

Medical Uses of Hormones:
- Hormones can be made for people who don’t naturally make them in the correct quantities
- Insulin is made so diabetics can control their blood glucose levels
- Insulin is injected to counteract rising BGL after a meal
- Produced by genetically engineered bacteria
- Oestrogen and progesterone are used in contraceptive pills so that no eggs mature to be released.
- FSH is used as fertility drug
- Growth hormone is given to those that can’t produce enough naturally
- Some athletes illegally use hormones to enhance their performance

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Unit 2

**The Endocrine System:**

- Aka Hormone System
- Hormones are chemical messengers in the body.
- Only affect target organs (most hormones are complementary to a specific target organ).
- Produced by glands.
- Travel via the bloodstream.
- Changes are generally slower and long lasting.

**Adrenaline:**

- Causes “fight or flight” response.
- Prepares your body for action

**Advantages:**

1. Glycogen (in liver) $\longrightarrow$ Glucose (travels in blood) $\longrightarrow$ Muscles converts to energises
2. $\uparrow$ Heart Rate $\rightarrow$ $\uparrow$ O$_2$ intake
3. Vaso Constriction in gut – blood vessels narrow $\therefore$ less glucose
   Vaso Dilation in muscles- blood vessels widen $\therefore$ more glucose in right place

**Disadvantages:**

1. Stress placed on body if adrenaline is used to much
2. $\uparrow$ Blood Pressure $\therefore$ $\uparrow$ risk of heart disease
3. Strains heart due to $\uparrow$ heart rate

**Difference between Nervous System and Endocrine System:**

<table>
<thead>
<tr>
<th>Nervous system</th>
<th>Hormonal system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information passes as electrical impulses along neurons</td>
<td>Information passes as chemical messengers in the blood</td>
</tr>
<tr>
<td>Effects are rapid and short-lived</td>
<td>Effects are usually slow and longer lasting</td>
</tr>
<tr>
<td>Affects particular organs</td>
<td>Affects the whole of the body</td>
</tr>
<tr>
<td>Often involves reflexes</td>
<td>Controls growth, development, metabolism and reproduction</td>
</tr>
</tbody>
</table>

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Adolescence:

- When puberty starts, the pituitary gland begins to make hormones that make the sex organs active.
- Sex organs produce sex hormones that create secondary sexual characteristics. E.g. women: development of breasts, start of menstrual cycle
  - men: voice breaks, facial hair, ability to become more muscular
- Also in men: testes start making testosterone
  - women: ovaries start making oestrogen.
- Phase of adolescence = duration of puberty

Homeostasis and the Endocrine System:

- Def of homeostasis: keeping internal environment constant despite changes in external environment
- Controlled internal conditions of the body:
  - Water content - loss of water occurs when we breathe (water vapour), urinate, and sweat.
  - Ion (salt) content – loss of ions occur when we urinate and when we sweat
  - Temperature – to maintain the temperature at which our body's enzymes work best.
    - Too High -> Denaturing of enzymes
    - Too Low -> Gives less energy to enzymes ∴ making enzymes slower
  - Blood sugar levels - to provide cells with a constant supply of energy.
- Hormones are involved in maintaining homeostasis.
- Hormones are affected by negative feedback.
- If level of hormones is too high, gland detects it and makes less
Questions

Co-ordination

1 Name the two systems which help to co-ordinate the body’s actions.

2 Name the two structures which make up the central nervous system.

3 (a) The nerve fibres which carry impulses from the sense organs to the central nervous system are called ..... A ..... fibres.
   (b) The nerve fibres which carry impulses from the central nervous system to the glands and muscles are called ..... B ..... fibres.

4 Complete the passage below, selecting the appropriate words from the list below.
   A neurone (nerve cell) consists of a ..... A ..... containing a nucleus surrounded by ..... B ..... Branching filaments, called ..... C ..... , extend from the cell surface and make ..... D ..... , with other neurones. In ..... E ..... and ..... F ..... neurones, one of the filaments is very long and is called „ „ , G ..... 

   sensory, nerve fibre, cell body, impulses, dendrons, dendrites, motor, contact, axons, synapses, cytoplasm

5 Which one of the following is the most likely speed of conduction of a nerve impulse?
   10 metres per second
   50 metres per second
   1000 metres per second.

6 Which one of the following best explains how we can tell which part of the body a sensory nerve impulse comes from?
   (a) Impulses from each part of the body are different.
   (b) Each part of the body is connected to its own region of the brain.
   (c) Sensations of touch, heat, light etc. are carried by nerve fibres to the brain.
   (d) We learn from experience where the impulses come from.

8 Give three examples of reflex actions.

9 Complete the passage below, selecting the most appropriate words from the list below. In a spinal reflex a ..... A ..... is stimulated to produce a nerve impulse which travels in a ..... B ..... fibre to the ..... C ..... Here, the nerve fibre makes a ..... D ..... with a relay (association) ..... E ..... which transmits the impulse to a ..... F ..... fibre. This fibre conducts the impulse to an ..... G ..... organ such as muscle.

   effector, tendon, sensory, sense organ, motor, nerve, brain, spinal cord, active, synapse, neurone

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10 In a reflex knee-jerk, what is (a) the receptor, (b) the effector?

11 Match the following structures and functions of the brain.
   (a) Cerebellum.  (i) Memory and reasoning.
   (b) Medulla.    (ii) Balance and muscular co-ordination.
   (c) Cerebral hemisphere (iii) Control of heart beat and breathing.
   (d) Mid-brain.  (iv) Eye movements.

12 In the table below, enter some general points of contrast between the nervous and endocrine systems.

<table>
<thead>
<tr>
<th></th>
<th>Nervous system</th>
<th>Endocrine system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed of conduction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Route of conduction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area affected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of response</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13 Which one of the following statements about adrenaline is correct?
(a) It increases heart rate and increases release of glucose from the liver.
(b) It increases heart rate and reduces release of glucose from the liver.
(c) It reduces heart rate and increases release of glucose from the liver.
(d) It reduces heart rate and reduces release of glucose from the liver.

14 Name the two hormones produced by the pancreas and say (a) in what circumstances, (b) in what way, they adjust the glucose concentration in the blood.

15 Name the hormones produced by (a) the testes, (b) the ovaries.

16 (a) Name the condition and
     (b) describe the effects of the failure of the pancreas to produce sufficient-insulin.
     (c) How is this condition treated?
Unit 2

The senses

1 Complete the sentence below using the three most appropriate words from the list.
A .....(A) ..... such as touch, is detected by a ..... (B) ..... and we may make a ..... (C) ..... .
response, change, organ, stimulus, movement, receptor, effector

2 List four stimuli which can be detected by the skin.

3 By what means do we become aware of a stimulus?

4 Name the four taste sensations that we can distinguish.

5 Give the names of the parts of the eye labelled in the diagram.

6 Which one of the following statements is incorrect?
When a bright light shines in the eye
(a) impulses travel in the optic nerve
(b) the radial fibres in the iris contract.
(c) the retina responds
(d) the pupil becomes smaller.

7 What is the cause of the blind spot in the field of vision?
(a) There are no nerves in the blind spot.
(b) There are only cones in the blind spot.
(c) There are no sensory cells in the blind spot.
(d) The image is not formed on the blind spot.

8 (a) Which region of the retina gives the most accurate interpretation of the image?
(b) What type of light-sensitive cell is present in this region?

9 Which parts of the eye refract (‘bend’) the light in such a way as to form an image on the retina?

11 Which is the correct statement?
To focus a distant object
(a) the ciliary muscle contracts and the lens gets thicker
(b) the ciliary muscle relaxes and the lens gets thinner
(c) the ciliary muscle contracts and the lens gets thinner
(d) the ciliary muscle relaxes and the lens gets thicker.

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Questions

The skin, and temperature control

1 From the list below, select the most appropriate words or phrases to complete the following sentences.
   (a) Our skin protects us against .....(A) .....and .....(B).....
   (b) Our skin helps to control ..... (C) ..... and .....(D) ..... 

   touch and pressure, ultraviolet light, bacteria, evaporation of water, heat from the sun, body temperature.

5 What are likely to be (a) the coldest, (b) the warmest parts of the body?

7 List the ways in which the body might lose heat.

8 What (a) internal, (b) external events contribute to gain of heat in the body?

9 (a) What is 'vaso-constriction'?
   (b) What are the effects of vaso-constriction in the skin?

10 Why should shivering contribute to heat gain in the body?

11 (a) What is meant by 'vaso-dilation'?
   (b) What are the effects of vaso-dilation in the skin?

12 Sweating, by itself, will not cool the body. What has to happen to sweat if it is to have a cooling effect?

13 What do you understand by the term hypothermia?