Read these general suggestions before you start to colour any of the diagrams, and then follow the directions provided on the individual sheets.

1. Coloured pencils tend to be much better than either wax crayons or fibre tip pens, as they allow you to shade colours, and do not wet the paper, or 'spread' when applied. A set of about 12 colours should be enough.

2. It is not essential to colour the parts of each diagram in any particular order, but care should be taken to complete the process.

3. Colour in the open lettering and the structures which they label in the same colour. Sharp pencils will help with the lettering, which can become difficult if lazily filled in.

4. Make sure that all of a structure is coloured, and that if a structure appears more than once, that each version is coloured the same.

5. Try to colour large areas gently, and small areas brightly to make them show up.

6. Where it is suggested that you use your own colouring scheme, try to use natural colours (eg green for plants or red for blood) wherever possible, and attempt to use contrasting colours for adjacent structures, to help to distinguish between them.

7. It is worth devoting time and care to the colouring of the diagrams as this helps you to learn and produces an attractive revision aid.
Animal and plant cells

Simplified animal cell
magnified to show main structures

Cell membrane
Controls entry and exit of chemicals into and out of the cell
- a SELECTIVELY PERMEABLE BARRIER

Nucleus
(Black)
Controls all the cell's functions. Contains the GENETIC MATERIAL DNA in chromosomes

Cytoplasm
(Very pale yellow)
Solution of numerous chemicals dissolved in WATER

Mitochondrion
(Red)
Power station of cell

Mitochondrion
(Red)
Power station of the cell - releases energy in a usable form (ATP) via RESPIRATION

Large (sap) vacuole
(Very pale blue)
Contains water with a few dissolved chemicals (SAP). Provides support, together with the CELL WALL, when full of liquid

Vacuole membrane
(TONOPLAST)
Controls the exchange of chemicals between the VACUOLE and CYTOPLASM - selectively permeable

Chloroplast
(Green)
Contains green pigment CHLOROPHYLL - site of PHOTOSYNTHESIS

Cell wall
(Light brown)
Provides essential support - made of strong CELLULOSE fibres. Not selectively permeable

Simplified plant cell
magnified to show the main structures
1. List the structures found in both animal and plant cells, and then those which are found only in plant cells.

2. Which is likely to be the single most important structure in a cell, and why?

3. Plant cells tend to have a more fixed shape, and rigid structure, than animal cells, why?

4. Why do most plant cells look green?

5. Lettuce may be more than 90% water. In which compartment within the cells is most of this water likely to be?

6. Explain briefly why a picked lettuce soon becomes limp when left in the sun.

7. The more active a cell the more mitochondria. Tick the boxes of the three types of cells below which you think would have the largest numbers of mitochondria.
   - Muscle [ ]  - Skin [ ]  - Liver [ ]  - Sperm [ ]  - Fat [ ]  - Capillary [ ]

8. Cell membranes are thin, flimsy structures and yet they have a vital function; what?

9. Special structures like nuclei, chloroplasts, and mitochondria are called cell organelles. What are the advantages to cells of having all these separate compartments?

10. Complete the following paragraph using the words provided below. Each word may be used more than once or not at all.

   energy - nucleus - vacuole - exit - chemicals - mitochondria - wall - water - photosynthesis - membrane - cellulose - plant - function - separate - entry - cytoplasm - permeable - plant - chloroplasts

   Animals and plants are made up of cells. Each cell is enclosed by a ................... which is very delicate but selectively .................... , and controls the ................... and ................... of materials. In ................... cells this is reinforced by the cell ......... made of .................... . Within each cell are many ................... structures carrying out particular functions. .................... act as mini power stations releasing ................... in a usable form. .................... containing chlorophyll are the sites of .................... in plant cells, and the overall ................... of each cell is controlled by its .................... . All these structures lie within the .................... of the cell, a solution of .................... dissolved in .................... .
The main parts of a flowering plant

**Diagram of a simple flowering plant**

**Terminal bud**
(Dark brown)
Growing upwards making the plant taller

**Lateral bud**
(Dark brown)
Produces outward growth of new STEMS, LEAVES or FLOWERS

**Leaves**
(Light green)
Provide large SURFACE AREA for the absorption of LIGHT and CARBON DIOXIDE - site of PHOTOSYNTHESIS

**Stem**
(Light brown)
Supports the LEAVES and FLOWERS and transports water, minerals and food

**Flower**
(Red)
Produces new plants by SEXUAL REPRODUCTION

**Midrib**
(Dark green)
Supports leaf and contains transport systems

**Vein**
Division of MIDRIB

**Petiole**
(Dark green)
Leaf stalk

**Ground level**

**Root**

**Small root**
Covered in minute ROOT HAIRS which absorb WATER and MINERALS

**Large root**
(Orange)
Provides plant with stability by gaining sound footing in the SOIL. Transports water, minerals and food
The main parts of a flowering plant

1. List the parts of a flowering plant which make up the shoot.

2. Given the functions of terminal and lateral buds, which would you remove to encourage a plant to become bushier, and why?

3. What are the advantages, to both the leaves and flowers, of a plant growing upwards and becoming tall?

4. Why do large trees usually need a deep, stable soil to get well established?

5. To be as efficient as they can the leaves on a plant must shade one another as little as possible. On a separate sheet of paper, draw a plant from above to show how the leaves might be arranged to avoid shading one another.

6. The flowers of many plants are brightly coloured and scented, why is this?

7. Why do leaves need the support of their midribs and veins, and how does this reflect their function?

8. Complete the following paragraph using the words provided below. Each word may be used more than once or not at all.


   Plants can be divided into two main parts, the ............... which is above ............... and the ............... which is below. The former consists of a supporting ............... , plus ............... , flowers and ............... . The uppermost or ............... bud grows upwards to increase the ............... of the plant, whereas the lateral buds make it ............... by growing ............... . Leaves are very ............... and light and require ............... from their ............... and veins if they are to present a large ............... to the ............... . Colourful ............... are normally exposed to attract attention from ............... . Its roots give a plant a stable ............... in the ............... and ............... essential ............... and ............... through their tiny root ............... .
Diagram to show how the various parts of a leaf combine during photosynthesis.

**Sun** (Yellow)

**Solar energy** (Yellow)

**Cuticle + epidermis**
- Transparent protective layers

**Cell wall**

**Vacuole**

**Palisade cell**

**Chloroplast** (Green)
- Contains CHLOROPHYLL.
- Actual site of PHOTOSYNTHESIS

**Stoma** pore allowing
- GAS EXCHANGE

**Phloem** (Red)
- Carries sugar to other parts of plant via PHLOEM

**Water** (Blue)

**Xylem** (Blue)
- Carries water and minerals up to leaves from ROOTS where they are absorbed

**Carbon dioxide** (Orange)
- Diffusing in through STOMA - source of CARBON for plants

**Oxygen** (Purple)
- Diffuses out through STOMA - byproduct of PHOTOSYNTHESIS - essential to ANIMALS for RESPIRATION

**Key:**

* Photosynthesis

Word equation summarising photosynthesis:

\[
\text{Carbon dioxide} + \text{Water} \rightarrow \text{Sugar} + \text{Oxygen}
\]

- Light energy (Yellow)
- Chlorophyll (Red)
- (Green)
1. What does a plant require to be able to photosynthesise, and what are the sources of the various requirements?

2. Explain why plants need a healthy root system to photosynthesise.

3. The diagram shows a net uptake of carbon dioxide and a net loss of oxygen by the leaf. When would the reverse be true and why?

4. Why is the clearing of vast areas of forest (particularly in the Amazon basin) worrying scientists?

5. Why must plants be able to make such varied use of the sugar produced in photosynthesis?

6. Sugars like glucose can act as building blocks (monomers) for long chain molecules (polymers). Name two polymers produced in plants and say what they are used for.

7. Which essential chemicals require nitrogen for their formation from sugars? Try to find out how some plants can supplement their nitrogen intake in an unusual way.

8. By reference to the summarising word-equation (overleaf) suggest a process which represents an approximate reversal of photosynthesis.

9. Explain as fully as you can why plants look green.

10. Complete the following paragraph using the words provided below. Each word may be used more than once or not at all.


   Photosynthesis is a process which is .................. to almost all .................. . It represents the main way in which usable .................. and .................. enter living systems. It involves the formation of .................. from gaseous .......................... and hydrogen from water. The .................. required to drive the reaction is provided by .................. absorbed by special coloured molecules like .................. found in the .................. of plants. In addition to sugar, molecular .................. is produced. This is required for the efficient release of energy (as ............) by both animals and plants during .................. . The sugar synthesised, mainly in the .................. of .................. cells, is used in many ways both within the .................. , and all over the plant having been .................. in the ...............
**Leaf structure and function**

**Leaf (Green) - seen from above**

- Midrib
- Vein

**Leaf (Green) - cut in half, and seen end on**

- Midrib
- Vein
- Region magnified to show details

**Leaf - cut open, magnified, and seen from side**

1. **Cuticle** (White) - Waxy, transparent coating to upper and lower surfaces
2. **Epidermis** (White) - Thin layer of transparent, protective cells - both surfaces
3. **Palisade cells** (Green) - Close-packed cells containing CHLOROPHYLL
4. **Spongy cells** (Green) - Loosely packed cells containing CHLOROPHYLL
5. **Large air spaces** - Region allowing free movement of gases - by diffusion
6. **Guard cell** (Dark green) - Controls opening + closing of STOMATAL PORE
7. **Stoma** - PORE to allow GAS EXCHANGE by DIFFUSION
8. **Xylem** (Blue) - Thick-walled tubes transporting WATER and MINERALS
9. **Phloem** (Red) - Thin-walled tubes transporting SUGARS in solution
10. **Vein** - Provides SUPPORT and TRANSPORT systems for leaf
1. Chlorophyll, the green pigment that gives leaves their colour, is found inside cells in structures called chloroplasts. Which types of cell in a leaf contain chloroplasts?

2. Chlorophyll absorbs energy from sunlight which is used in photosynthesis. Which parts of a leaf do you think are able to photosynthesise?

3. Why are the cuticle and epidermis transparent?

4. In terms of photosynthesis what are the advantages of the palisade cells being long and very closely-packed?

5. In dry weather plants can easily lose too much water, wilt and even die. How do the cuticle and the stomata (plural of stoma) help to reduce water loss?

6. Leaves are usually very thin, flat and light. Bearing in mind that they are a plant’s photosynthetic organs, why do you think that leaves have such a structure?

7. The large air spaces amongst the spongy cells allow the rapid diffusion of gases to and from all the cells of the leaf. Which gases are most involved in photosynthesis?

8. Where does the water travelling in the xylem enter the plant, and in which direction(s) does it travel?

9. Where are the sugars travelling in the phloem produced, and to where are they transported?

10. Fill in the blanks in the following paragraph using the words below. Not every word will necessarily be used, and each may be used more than once.

Leaves are adapted to ................................... sunlight. Their surprisingly complex structure makes them very ......................................................... organs. Below the .......................................................... outer layers are the ................................................................. cells which contain numerous .......................................................... The green ................................................................. inside these absorbs light ................................................................. which is used in .................................................................. The ................................................................. cells create large air ................................................................., through which essential ................................................................. can move freely. Tiny pores (which are normally on the ................................................................. of the leaf) called ................................................................. allow an ................................................................. of gases between the inside and the ................................................................. of the leaf. Veins provide support and contain both the ................................................................. and the .................................................................. These are ................................................................. systems which bring ................................................................. and minerals to the leaves, and carry sugar ................................................................. away from them during the day.
The digestive system

Salivary glands
(Dark brown)
Produce SALIVA which lubricates food for swallowing and helps clean the teeth - secretes enzyme SALIVARY AMYLASE

Oesophagus
(Light green)
Pushes food down to STOMACH by muscular action - PERISTALSIS

Stomach
(Yellow)
Elastic storage sac, churns food; some digestion (protein) and absorption (water) - secretes enzyme GASTRIC PROTEASE

Liver
(Red)
Major chemical processing plant for the whole body - produces BILE which is passed to the GALL BLADDER

Gall Bladder
(Dark green)
Concentrates BILE which helps digest fat in the SMALL INTESTINE

Small intestine
(DUODENUM + ILEUM)
(Dark blue)
Major site of DIGESTION and ABSORPTION of FOOD - secretes enzymes including PROTEASES and MALTASE

Appendix
(Black)
No useful function in man

Pancreas
(Orange)
-produces ENZYME-rich juice for digestion in the SMALL INTESTINE. Enzymes include PROTEASES, LIPASE and AMYLASE

Colon
(LARGE INTESTINE)
(Light blue)
Reabsorbs WATER from undigested food and waste

Rectum
(Purple)
Compacts undigested food and waste to form FAECES

Anus

Diagram showing the main parts of the digestive system - not to scale
The digestive system

1. List, in order, the structures through which food passes on a complete journey through the digestive system.

2. Name the special structures (through which food does not pass) which produce and secrete digestive juices.

3. Suggest how our eating habits would need to alter without a stomach.

4. What, in your experience, tends to stimulate the salivary glands to secrete saliva, and what is the advantage of this?

5. Why does the small intestine need to be so long (up to 7-8m!)? In what other ways is it adapted to its functions?

6. What, in simple terms, causes diarrhoea?

7. Explain, briefly, what the terms ingestion, digestion, absorption and egestion mean.

8. Complete the following paragraph using the words provided below. Each word may be used more than once or not at all.


Before being ................................ most foods need to be ........................................ broken down by the ......................... and .................................. by mixing with saliva. Swallowed food is forced down the ........................................ to the ................................ by peristalsis. Here food from a meal is ....................., thoroughly mixed and partly ..................... Once in the ........................................ it meets the ........................................ of the gall bladder and .................................. in conjunction with the digestive juice produced by the ..................... of the intestine itself these complete the ................. breakdown of the food using ..................... The wall of the small intestine is specially ..................... to absorb the products of ..................... which are then carried away in the ..................... Undigested and waste material then passes into the ..................... where it is dried by the ................................ of water. In the ..................... the material is ..................... to form faeces, and this is then egested via the anus.
An incisor tooth cut open to show its main parts

Key:
1 Crown
2 Root
3 Enamel
4 Dentine
5 Pulp cavity
6 Gum
7 Cement
8 Fibres
9 Jaw
10 Nerve
11 Blood vessels

Portion of TOOTH visible above the GUM
Portion of TOOTH lying below level of GUM - attached to JAW
(White) Extremely hard material forming sharp points and edges - dead
(Orange) Hard, BONE-like material containing LIVING cells
Central space containing BLOOD VESSELS and NERVES
(Pink) Soft tissue surrounding bone - must be kept clean and healthy
(Green) Helps attach root to jaw and acts as a shock absorber
(Blue) Combine with CEMENT to anchor ROOT to JAW
(Black) BONE providing solid footing for ROOT of TOOTH
(Black) SENSORY endings responding particularly to HOT and COLD
(Black) Supply OXYGEN and nutrients to living cells of TOOTH
1. For the development of strong, healthy teeth we require enough calcium, phosphate and fluoride. What are good sources for these in the diet, and where are they found in teeth?

2. For the decay of a tooth to become really painful, which layers must be worn through, and what actually triggers the painful response?

3. Why is it important to have teeth firmly, but not too rigidly, attached to the jaw bones?

4. Enamel is the hardest substance produced by animals but it is quite easily attacked chemically. What can dissolve enamel?

5. Dental caries (tooth decay) are very common, but a major cause of tooth loss which leads to the need for dentures (false teeth), is gum infections. Why do you think this is?

6. Bacteria feed readily on sugary foods and in doing so produce acidic by-products. Why, therefore, is it so important to keep our teeth clean?

7. Plaque is based on a mineral deposit like that found in kettles (particularly in hard water areas). As it builds up it can irritate the gums and increase the chance of infection. What other problem does it encourage?

8. Complete the following paragraph below using the words provided. Each word may be used more than once or not at all.


Teeth are designed for the ................. of food and its preparation for ...................... . They are covered in .................... which is extremely ................ and forms very ................ points and ..................... . It is almost entirely composed of .................... and is non-living. Beneath it lies the dentine which is hard and .............. - like, and contains living ............... . These are ...................... with oxygen and ....................... by the blood vessels in the ................ cavity. The ............... of the tooth is ...................... to the ............... bone by cement and ....................... , which hold it firmly, but not too ....................... in place. Incisor teeth are found at the ............... of the mouth and are for cropping and ............... at food. The three other kinds of teeth found in mammals are ...................... , premolars and ...................... . A mammal's ............... will determine how well ............... each type of tooth is.
Diffusion: The NET movement of the particles of a substance from a region in which they are in a relatively high concentration, to a region in which they are in a relatively low concentration (may or may not be across a membrane).

**Net movement**
- Green: Molecules will be moving in all directions but more left (L) -> right (R) than R -> L.

**Concentration gradient**
- Brown: Provides the driving force for the NET MOVEMENT of molecules.

**Membrane**
- Yellow: Membrane which is PERMEABLE to the molecules may or may not be present.

**Region of higher concentration**
- Purple: Molecule

**Region of lower concentration**
- Purple: Molecule

Osmosis: This is a special type of DIFFUSION where there is a NET MOVEMENT of WATER across a SELECTIVELY PERMEABLE MEMBRANE from a relatively dilute solution to a relatively concentrated one.

**Dilute sugar solution**
- Water molecule: Blue
  - Relatively small

**More concentrated sugar solution**
- Sugar molecule: Red
  - Relatively large

**Net movement of water**
- Orange: Osmosis
  - Across the selectively permeable membrane

**Selectively permeable membrane**
- Yellow

**Sugar molecule**
- Red
  - Too large to pass through PORES in the membrane
1. **Diffusion** involves the movement of particles (atoms, molecules or ions); is it going to occur faster in **gases** or **liquids**? Try to explain why.

2. Why has the term **net movement**, rather than ‘movement’, been used to describe what is happening in **diffusion**?

3. If enough time is allowed to elapse what will happen in the upper half of the top diagram overleaf? Will there still be any **net movement**?

4. With reference to your answer to question three, redraw the osmosis diagram overleaf to show what happened to the concentration **gradient** as a result of the **diffusion**.

5. Why do the sugar molecules not even out their concentration in the first of the osmosis diagrams overleaf?

6. **Osmosis** can only occur in the presence of a **selectively permeable membrane**; why?

7. As **osmosis** progresses what will happen to the concentrations of the two sugar solutions, and the net movement of water molecules?

8. Complete the following paragraph using the words provided below. Each word may be used more than once or not at all.

   **selectively** - **faster** - **move** - **osmotic** - **dilute** - **water** - **atoms** - **sugar** - **completely** - **movement** - **concentrated** - **net** - **gases** - **temperature** - **random** - **separated** - **mixed** - **gradient** - **evenly** - **ions** - **slower** - **diffuse**

   In fluids (............... and liquids) particles (............... , molecules and .............. ) are free to ............... . As the ......................... rises they tend to move ....................... . Their movement is ......................... , which means that in time they tend to become ......................... distributed. This redistribution will be seen as a ............... movement from a region where the particle is ......................... to another where it is ......................... (ie the particles move down a concentration ......................... ). In osmosis ................. molecules ................. through a ......................... permeable membrane which prevents the ......................... of larger molecules like ................. . Where two sugar solutions are ................. by such a membrane, the ................. movement of water will be from the more ................. solution to the more ................. solution.
Key:

1. **ABSORPTION** of water from SOIL via ROOT HAIR via OSMOSIS (MINERAL IONS actively PUMPED in)
2. **MOVEMENT** of water through ROOT CELLS to XYLEM - again by OSMOSIS
3. **MOVEMENT** of water up through XYLEM of root in an unbroken stream
4. **MOVEMENT** of water up XYLEM of ROOT and STEM - the TRANSPERSION STREAM
5. **MOVEMENT** of water through XYLEM of LEAF STALK and VEINS of LEAF
6. **EVAPORATION** of water into the large AIR SPACES within the LEAF - DIFFUSES rapidly to all cells
7. **REACTION** of water with CARBON DIOXIDE in SUNLIGHT to produce SUGAR in PHOTOSYNTHESIS
8. **TRANSPERSION** of water out of leaf via STOMA (opening controlled by GUARD CELLS) - RATE of water loss dependent on: STOMATAL OPENING, TEMPERATURE, HUMIDITY, WIND SPEED
   (Greatest on SUNNY, HOT, DRY, WINDY day. Least on CLOUDY, COLD, WET, STILL day)
Uptake and loss of water by plants

1. Outline the route taken by water as it passes from the soil, through the plant, and out into the atmosphere.

2. Where, and by what processes, does water normally enter and leave plants? Try to give a simple explanation of each.

3. Why can pulling a plant out of the ground seriously damage its ability to absorb water when it is replanted; even if its roots look intact?

4. How have many desert plants become adapted to gather, and store, water as efficiently as possible?

5. Describe briefly how xylem is adapted to its role as a water transport system.

6. Under what climatic conditions is water loss from a plant going to be at a maximum, and how have plants become adapted to minimise transpiration?

7. Suggest one reason why deciduous trees have evolved to drop their leaves in autumn.

8. Complete the following paragraph using the words provided below. Each word may be used more than once or not at all.

   continuous - stomata - uptake - 60% - stem - loss - photosynthesis - up - attraction - leaves - hairs - osmotic - reduce - xylem - transpiration - 90% - pulled - increase - molecules - evaporation

   Plants may be more than .............. water. Ensuring adequate ................. and controlling .............. of water is essential to them. Root .............. enormously .............. the surface area available for the ................. uptake of water. Further osmosis helps transport the water into the .............. of the root, which is ................. with the xylem of the .............. and ............... Water moves ........ through the plant in an unbroken column, .............. by .............. in the leaves and the strong .............. between neighbouring water ............... In the leaves, water acts as a source of hydrogen to .............. carbon dioxide forming sugars via .............. , and is lost through the .............. via .............. .
Structure and function of the heart

**Pulmonary artery**
Carries DEOXYGENATED BLOOD to the LUNGS

**Semilunar valve**
(Green)
Prevents backflow of blood into VENTRICLE when heart RELAXES (ALSO found in AORTA)

**Aorta**
Great ARTERY carrying OXYGENATED BLOOD to all parts of the body

**Left atrium**
Receives OXYGENATED BLOOD from the PULMONARY VEINS

**Great veins**
(VENAE CAVAЕ)
Return DEOXYGENATED BLOOD to the heart from the body

**Pulmonary veins**
Carry OXYGENATED BLOOD back from the LUNGS to the HEART

**Right atrium**
Receives DEOXYGENATED BLOOD from the GREAT VEINS

**Large valve**
(BICUSPID)
(Yellow)
Prevents backflow of blood into ATRIUM when VENTRICLE contracts

**Left ventricle (LV)**
Very MUSCULAR chamber which pumps OXYGENATED BLOOD to the rest of the body

**Heart muscle**
(Dark red)
Contracts RHYTHMICALLY and without FATIGUING to PUMP blood

**Right ventricle (RV)**
Less muscular chamber which pumps DEOXYGENATED BLOOD to the LUNGS

Heart - cross-section to show the main parts
Numbers indicate the route taken by blood flowing through the four chambers of the heart, after returning from the body

**Deoxygenated blood** (Blue) Direction of flow

**Oxygenated blood** (Light red) Direction of flow
1. How many chambers are there in a heart?

2. Try to explain why the right hand side of the heart appears on the left of the diagram.

3. Taking into account their different jobs, explain why the left ventricle is so much more muscular than the right ventricle.

4. After standing up for some time our leg muscles get tired and we sit down for a rest. Why is it important for the heart (cardiac) muscle not to tire in this way?

5. List, in order, all the chambers and vessels that blood passes through, on one complete journey through both sides of the heart.

6. Use simple diagrams to demonstrate how a semilunar valve allows blood to flow through it freely in one direction, but not at all in the other.

7. Explain as clearly as you can why we are said to have a double circulation.

8. Complete the following paragraph using the words provided below. Each word may be used more than once or not at all.


Our hearts are really two .............. stuck together. Each pump has two chambers, a thin-walled .............. and a thick-walled .............. . The right hand pump is .............. and less .............. , and drives deoxygenated blood to the .............. . The left hand pump forces .............. blood out through the .............. and on to the rest of the body. The heart itself is made of a special .............. which does not fatigue. Blood flows into both sides of the heart when it is .............. between beats. Each .............. then contracts, squeezing blood into the .............., stretching its wall. Then the .............. ventricles contract forcing blood under high .............. into the .............. artery and .............. . To make sure that blood does not flow back into the .............. when the ventricle contracts, there is a large .............. between the .............. . Similarly the .............. valves prevent backflow into the ventricles from the .............. while the heart is resting.
The composition of blood

**Plasma (Yellow)**
Straw-coloured solution of chemicals dissolved in water. Substances transported round the body in the PLASMA include: GLUCOSE, MINERAL IONS, PROTEINS and HORMONES

**Platelets (Light blue)**
Small cell fragments which help the clotting of blood. This minimises blood loss and the entry of foreign bodies into the circulation

(Light blue)

**White Cells (White) (Leucocytes)**
The largest blood cells - help defend the body against disease and occur in two main forms: PHAGOCYTES and LYMPHOCYTES

- **Phagocyte** - eats bacteria and is able to move out of CAPILLARIES to find and destroy bacteria
- **Nucleus (Black)**
- **Lymphocyte** - produces antibodies which neutralise VIRUSES and BACTERIA

**Red Cells (Red)**
Contain red HAEMOGLOBIN which reacts reversibly with OXYGEN and carries it to all the cells of the body, from the LUNGS. Also involved in the transport of CARBON DIOXIDE from the cells of the body back to the LUNGS. RED CELLS have no NUCLEUS and their flexible shape allows movement through narrow capillaries

Seen from above

Seen from one side
1. Which type of blood cell is present in the largest numbers?

2. Approximately what percentage of the blood is made up of cells and what of plasma?

3. Explain why plasma has such importance as a transport medium.

4. In what two ways do the two types of leucocytes help our bodies to fight off disease?

5. What gives the blood its characteristic colour?

6. How would you describe the shape of a red blood cell, and what do you think the advantages of this unusual shape might be?

7. Red blood cells do not have nuclei and contain little else but haemoglobin. What are the advantages and disadvantages of this?

8. Complete the following paragraph using the words given below. Each word may be used more than once, or not at all.
   disease - shape - cells - chemicals - numerous - body - bacteria - components - haemoglobin
   flowing - fragments - antibodies - sacs - plasma - oxygen - bacteria - lymphocytes - leucocytes - clotting - phagocytes

   Blood is a free ................ liquid composed of straw-coloured ................ and various .................. . The largest, .................. , each have a nucleus and occur in two main forms .................. and .................. . By eating .................. and producing .................. they help to combat .................. . The tiny cell .................. , platelets, are important in triggering blood .................. . Red cells are much the most .................. and are very highly adapted to their function. They have an unusual .................. and are like tiny ........... of .................. . .................. combines reversibly with haemoglobin and is carried from the lungs to all the cells of the .................. in the blood.
**Respiration** - a series of enzyme-controlled reactions in which energy is released from foods by their oxidation, within living cells.

**Word equation summarising respiration**

\[
\text{Sugar} + \text{Oxygen} \rightarrow \text{Carbon dioxide} + \text{water} + \text{ENERGY (ATP)}
\]

**Enzymes**

- **Sugar** (Light red)
- **Oxygen** (Purple)
- **Carbon dioxide** (Orange)
- **Water** (Blue)
- **ENERGY (ATP)** (Green)
1. List the reactants, and then the products, of the overall respiratory reaction. If the reactions are to proceed at the required rate what else is required?

2. Why is respiration such an important process in all living cells? Illustrate your answer with examples.

3. How is oxygen carried in the blood; where does it enter the blood, and by what process?

4. What is the usual fuel for respiration, and what general chemical process does it undergo to release its stored energy?

5. What other types of fuel does the body contain and where are they found?

6. The combustion of petrol in a car engine releases about as much energy per gramme of fuel, as the respiration of sugar in cells. Try to outline the fundamental differences between the processes.

7. Carbon dioxide and water are products of respiration. In what other essential process in living systems are they used as reactants?

8. Try to write a balanced equation for respiration using chemical symbols (the words enzymes and energy may be reused).

9. Complete the following paragraph using the words provided below. Each word may be used more than once or not at all.


Living systems are based on ................., interacting ............... reactions. Most of these require .............., which must be available in a form which can be ............... within cells. This energy, as ............, is released by .................. This ...................... process involves the ................. of foods, like ............... , in a large number of small steps. These individual .................. are each catalysed by a specific .................., and allow the energy to be released in a .................. fashion. Most of respiration takes place within the ................. of cells. .................. is used to oxidise the fuel (sugar), and .................. and ................. are released as by-products.
The mechanism of breathing

**Human thorax - cut open and seen from side**

Inhalation: The VOLUME inside the airtight THORAX is increased, causing the PRESSURE to drop. AIR is PUSHED in by the HIGHER PRESSURE outside, via the nose and mouth.

**Air** (Light blue) being forced into the expanding LUNGS

**Spine**
Bony column to which ribs are attached

**Lung** (Light green)
filling with air which stretches the ELASTIC tissue and refreshes air in ALVEOLI for GAS EXCHANGE

**Intercostal muscles** (Red)
Upward and outward movement of the RIBCAGE produced by contraction of the

**Sternum**
BREASTBONE to which RIBS are attached

**Diaphragm muscle** (Red)
Contracts to pull down and flatten the DIAPHRAGM

Downward flattening of DIAPHRAGM compressing contents of ABDOMEN (Light brown)

**Diaphragm** (Light brown)
Pulled down flat to help increase the VOLUME of the THORAX

Exhalation: The volume of the THORAX decreases and the PRESSURE increases as the stretched ELASTIC TISSUE of the LUNGS recoils and the contents of the ABDOMEN push upward. AIR flows outwards.

**Intercostal muscles** (Red)
Downward and inward movement of the RIBCAGE produced by relaxation of the

**Wall of thorax**
creates an airtight compartment for the LUNGS

**Diaphragm muscle** (Red)
Relaxes

**Abdominal contents move up** (Light brown)

**Air** (Light blue)
Moving out as LUNGS recoil

**Lung** (Light green)
Stretched ELASTIC tissue recoils and VOLUME decreases causing PRESSURE to increase

**Diaphragm** (Light brown)
Returns to DOMED state
1. At the start of Inhalation which two sets of muscles bring about the increase in volume of the thorax, and how do they do so?

2. In breathing at rest which set of muscles is the most important. What happens to the relative importance of the two sets after exercise?

3. It is essential that the thorax is airtight. Explain why this is so, and why the two lungs are in separate, airtight compartments.

4. What actually causes air to flow into the lungs during Inhalation?

5. What is the principal driving force for exhalation at rest?

6. Exhalation can be an active or forced process (although it is not normally so). Try blowing out as much air as possible from your own lungs to find out which sets of muscles are involved, and then explain what happens.

7. We have conscious control over the muscles of our arms and legs but the muscles in the wall of the intestine are controlled unconsciously. What is rather unusual about the muscles associated with breathing?

8. Complete the following paragraph using the words provided below. Each word may be used more than once or not at all. pressure - stretches - recoil - oxygen - thorax - diaphragm - fresh - exchange - lungs - ribcage - elastic - Inhalation - Intercostal - carbon dioxide - spine - airtight - surface - contraction - sternum - ventilated - increasing - exhalation

For the efficient ................. of gases (uptake of ................. and release of ......................................... ) the air around the actual exchange ................. must not be allowed to become stale, ie the air must be ......................... . This process involves drawing in ......................... air, ......................... , and removing some of the used air, exhalation. Air will be pushed into the......................... , which are in an ......................... , chamber the ......................... , if the ......................... inside, falls below that outside. This is achieved by ......................... the volume of the chest by pulling down the normally domed ......................... , and raising and moving out the ......................... . Both of these are achieved by the ......................... of muscles. The air entering the lungs ......................... them, and when the ......................... and diaphragm muscles relax the ......................... tissues in the lungs ......................... , forcing air out.
The thorax and lungs

1. Trachea (Light blue) - Tube (windpipe) linking nose and mouth to LUNGS
2. Cartilage (Orange) - C-shaped rings to stop TRACHEA collapsing
3. Bronchus (Light blue) - TRACHEA divides into two BRONCHI, one to each lung
4. Bronchioles (Dark blue) - Tree of tubes spreading throughout the LUNGS
5. Alveoli (Purple) - Minute air sacs (like leaves on BRONCHIAL TREE) - site of GAS EXCHANGE - many millions in each lung
6. Right lung (Light green) - Large, spongy, ELASTIC organ for gas exchange with an excellent blood supply. Lies in AIRTIGHT cavity
7. Abdomen (Red) - Body compartment containing liver, stomach and gut
8. Diaphragm muscle (Light brown) - Controls position of DIAPHRAGM (domed or flat)
9. Diaphragm (Light brown) - Sheet of TENDON separating thorax and abdomen
10. Intercostal muscles (Red) - Lift and pull out RIBCAGE, or pull it down and in
11. Rib (Yellow) - Part of bony cage to support + protect heart and lungs
12. Heart (Dark red) - Muscular pump driving blood through the circulation
13. Pleural cavity (Grey) - Contains lubricating fluid within membrane sac

A human thorax cut open to show its main structures
The thorax and lungs

1. Why is the left lung smaller than the right?

2. Explain, in simple terms, what the pleural cavity surrounding the lungs contains, and what its function is.

3. Why do the lungs need a very good blood supply?

4. How are the alveoli adapted to their function as a gas exchange surface?

5. The lungs, bronchi and trachea are prone to a variety of infections, why?

6. Why are the reinforcing rings of cartilage on the trachea C-shaped, with the gap at the back? (Try to think about the position and function of another tube which runs parallel to the trachea down through the neck.)

7. Asthma is a common and unpleasant complaint which involves wheezing attacks. Try to explain what causes this difficulty in breathing, and in very simple terms, how you think the standard treatments work.

8. Complete the following paragraph using the words provided below. Each word may be used more than once or not at all.


The lungs are large, spongy organs which lie in the .................. which is ................... . The only connection, via the .................. and .................. , to the air outside is the .................. .

This divides to form two .................. . These in turn split up into smaller and smaller .................. . All the larger tubes are .................. with cartilage to prevent them .................. . The tiniest .................. . end in minute air sacs, .................. , which have incredibly thin .................. , and are in close contact with numerous blood .................. .

The lungs and .................. are .................. by the ribcage, and can move freely within it because of the .................. fluid and its enclosing .................. . The .................. is separated from the abdomen by the .................. .
**Structure of a synovial joint**

An elbow cut open to show its main parts (RADIUS of forearm not shown)

**Key:**

1. **Humerus** (Yellow) - BONE of the upper arm - acts as a strong, rigid LEVER against which MUSCLES can PULL

2. **Ligament capsule** (Green) - Tough, FIBROUS tissue enclosing and protecting the joint - holds bones together

3. **Synovial membrane** (Dark blue) - Produces (SECRETES) SYNOVIAL FLUID

4. **Synovial fluid** (Light blue) - LUBRICATES the joint allowing free movement

5. **Articular cartilage** (Grey) - Tough, SMOOTH material covering the end of each bone - prevents grinding of surfaces

6. **Ulna** (Yellow) - One of the two bones of the forearm: meets HUMERUS at the ELBOW (hinge-like SYNOVIAL JOINT)

7. **Tendon** (Orange) - Very strong, INEXTENSIBLE, FIBROUS tissue which joins MUSCLE to BONE - transmits pull of contracting muscle to levers of the skeleton

8. **Triceps muscle** (Dark red) - CONTRACTILE tissue which by contracting pulls on its TENDON and EXTENDS (straightens) the ELBOW
1. If a surgeon was to operate on the cartilage in an elbow, list, in order, the tissues that would be cut through to reach the cartilage.

2. The knees, and other joints of the legs, need to withstand large and repeated impact shocks. How must the articular cartilage act?

3. Why do tendons need to be inextensible, rather than elastic, if they are to function correctly?

4. The elbow allows movement only in one plane (it acts like a hinge). This is not true of all joints. Experiment carefully with your other joints to discover the amount of freedom they provide, and then summarise your findings in a table on a separate sheet of paper.

5. Ligaments hold the separate bones together at joints. They must clearly be very strong, but what else must they be? (Consider all the twisting and stretching involved.)

6. Bone, which is a surprisingly active living tissue, repairs itself very well, whereas ligaments and tendons recover only slowly, if at all, when badly damaged; why?

7. Complete the following paragraph using the words provided below. Each word may be used more than once or not at all.

   surface - limbs - ligaments - extend - smooth - fluid - flex - movement - impact - synovial
   secreted - humerus - tendons - skeleton - damage - ulna - protected - joints - membrane
   cartilage - lubricated - contract - muscles

   For the various bones of the ......................... to operate effectively, smooth .................. must be possible at the ............... between them (particularly in the .................... ). To prevent ............... from grinding and ...................... shock, the ends of the bones at joints are coated with tough, .................., articular .................. In ...................... joints this .................. is well .................. by synovial .................. . This is ...................... by the synovial .................. . The whole joint is held together and ...................... by a capsule containing strong, elastic .................. . The joint is actually operated by ...................... which actively .................. and pull on ...................... which act across the joint to either .................. (straighten), or .................. (bend) it.
**Key:**

1. **Conjunctiva** *(White)*
   Thin TRANSPARENT layer (EPITHELIUM)

2. **Cornea** *(White)*
   Curved TRANSPARENT disc which focuses light

3. **Pupil**
   Circular opening whose size is controlled by IRIS

4. **Lens** *(Very pale yellow)*
   Flexible lens - shape changes -> ACCOMMODATION

5. **Iris** *(Brown)*
   Coloured disc which controls pupil diameter and thus the amount of light entering the eye

6. **Aqueous humour** *(Very pale blue)*
   Transparent, incompressible watery liquid - helps focusing and to maintain eye's shape

7. **Suspensory ligament** *(Purple)*
   Ring of strong fibres supporting LENS

8. **Ciliary muscle** *(Dark green)*
   Pulls on LIGAMENT to change shape of LENS

9. **Ciliary body** *(Light green)*
   Thick edge of CHOROID containing blood vessels and MUSCLE

10. **Vitreous humour** *(Very pale blue)*
    Jelly-like substance like aqueous humour helps with focusing and maintenance of eye shape

11. **Sclerotic coat** *(Pale orange)*
    Tough outer coat - maintains shape with 6 + 10

12. **Choroid** *(Black)*
    Black pigment stops internal reflection, blood supplies RETINA with food + oxygen

13. **Retina** *(Light red)*
    Contains light sensitive ROD and CONE cells

14. **Yellow spot** *(Dark yellow)*
    Part of RETINA -> acutest vision - all CONE cells

15. **Blind spot**
    Where OPTIC NERVE leaves eye - no RODS or CONES

16. **Optic nerve** *(Light brown)*
    Nerve fibres from RETINA to the BRAIN

17. **Muscle** *(Dark red)*
    Swivels EYE within its socket to change field of view
1. List, in order, the parts of the eye through which light passes on its way to the light sensitive cells of the retina.

2. If you were able to peel open an eye from the middle of one side, layer by layer, in what order would the various layers appear?

3. Explain how the ciliary muscle is able to control the shape of the lens and thus the focusing of light onto the retina.

4. Explain why it is so important for the eye to maintain a constant shape, and how the sclerotic coat and humours, operating together, manage to do this.

5. The iris controls the amount of light entering the eye by altering the size of the pupil. Under what circumstances is the pupil very small, and conversely very large?

6. Light focused onto one part of the retina does not produce an image. Explain why.

7. Which type of light sensitive cell in the retina gives the sharpest image? Explain how you arrived at your answer.

8. Complete the following paragraph using the words provided below. Each word may be used more than once or not at all.


Our eyes are near.......................... structures whose shape is maintained by the ................ , fibrous ........................................... aqueous and vitreous................................. The light ..................... rod and ............... cells lie at the .............. of the eye which means that..................... must pass through several other parts to reach them. Some of these parts .......... the light to give a clear ............... . Although the main focusing is done by the ................ , the .................., by changing its shape, allows the eye to focus on objects at different............... . The shape of the lens is altered by varying the.................. in the suspensory .................... . This in turn is controlled by the circular ................... . Messages from the rods and cones, which have been .................. by light, are sent to the brain for ................... via the fibres of the ..................... nerve. The heavily ..................... choroid, which has a good .................. supply, nourishes the ...................
Companions to Biology and Human Biology

Set B

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