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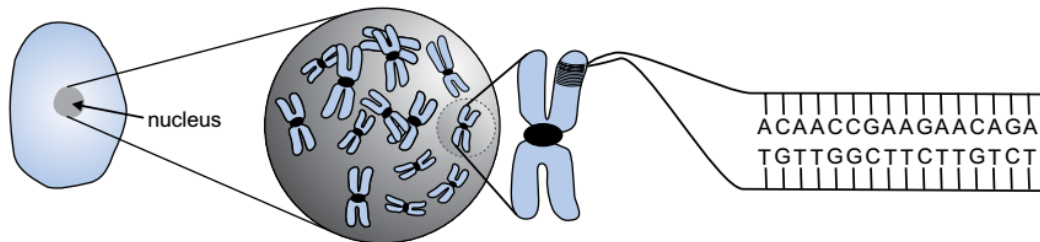
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Chromosomes

DNA is Found on Chromosomes

DNA is found in the **nucleus** of **eukaryotic cells**. It has to be **wound up** into chromosomes to fit in. Each human chromosome contains between a couple of hundred and a few thousand genes.

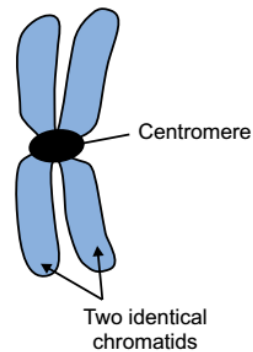


Homologous Pairs

Humans have **23 homologous pairs** of chromosomes (46 in total), e.g. two number 1s, two number 2s, two number 3s, etc. One from each pair comes from your mother and one comes from your father. Both chromosomes in a pair are the **same size** and carry the **same genes** (which is why they're called **homologous pairs**). But they usually have **different alleles** (different versions of the genes).

Chromosomes are Often Shown as X-Shaped

In loads of books chromosomes are shown as **X-shaped**. An X-shaped chromosome is actually **one chromosome** attached to an **identical copy** of itself. Don't get it confused with a homologous pair of chromosomes. They're only X-shaped just after the DNA has been **replicated** (e.g. in cell division). Each side of the X is referred to as a **chromatid** and the bit in the middle where they're attached is called the **centromere**.



It's in his DNA, D, D, D, DNA...

- 1) Where is DNA found in a eukaryotic cell?
- 2) How many homologous pairs of chromosomes do human cells have?
- 3) Are homologous pairs of chromosomes identical? Explain your answer.
- 4) What is a chromatid?
- 5) What is the name of the region where two identical chromatids are joined?

Cell Division — Mitosis

Mitosis is Needed for Growth and Repair

- 1) If you have **damaged** tissue, the cells around the damaged area divide by **mitosis** to replace the damaged cells.
- 2) Cells **also** divide by mitosis to produce new tissue for **growth**.



Asexual Reproduction Involves Mitosis

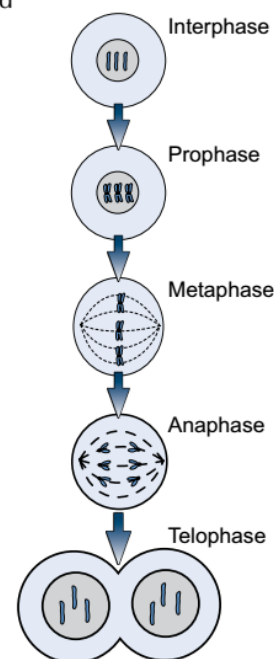
- 1) In **asexual reproduction**, a single organism produces offspring by dividing into two organisms or by splitting off a piece of itself.
- 2) All the offspring are **genetically identical** to each other and to the parent.
- 3) The cells divide by **mitosis** (like most cells).

Bacteria and many plants reproduce asexually.

In Mitosis the DNA Copies Itself, Then the Cell Divides Once

Mitosis is split up into **four** stages: **prophase**, **metaphase**, **anaphase** and **telophase**. **Before** mitosis starts, there's a period called **interphase**.

- 1) **Interphase** — Before the cell starts to divide, every DNA molecule (each chromosome) must **replicate** so that each new cell has a full copy of DNA. The new molecule remains attached to the original one at the **centromere**.
- 2) **Prophase** — Mitosis can now begin. Each DNA molecule becomes **supercoiled** and **compact**. Each chromosome can now be seen with a light microscope and appears as two **chromatids** lying side by side, joined by the centromere (i.e. X-shaped).
- 3) **Metaphase** — The **nuclear membrane** breaks down and the chromosomes **line up** along the **equator** (middle) of the cell.
- 4) **Anaphase** — The centromeres split and the **chromatids separate** and are dragged to opposite ends of the cell.
- 5) **Telophase** — A **nuclear membrane** forms around each set of chromatids (exact copies of the original chromosomes) and the **cytoplasm divides**.



Ouch, you stepped on my toe, sis... ba dum tsh

- 1) Give three uses of mitosis.
- 2) Why is DNA replicated before cell division can occur?
- 3) Do the homologous pairs separate in mitosis?
- 4) How many cells are produced when a cell divides by mitosis?

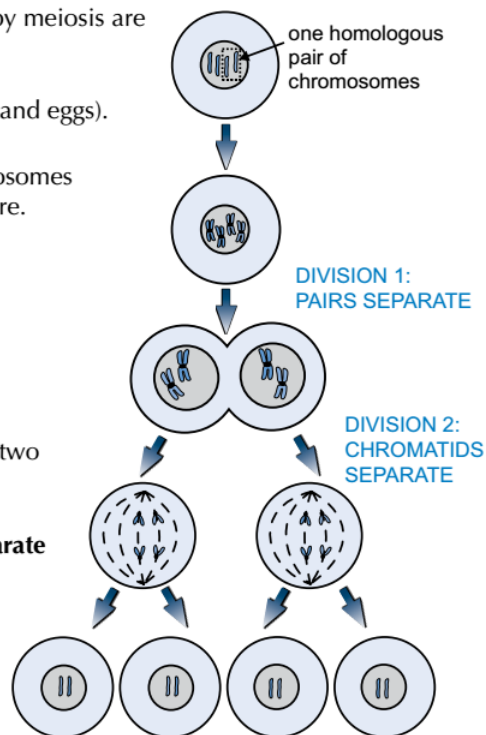
Cell Division — Meiosis

Sexual Reproduction Involves Meiosis

- 1) In **sexual reproduction**, the offspring are genetically different from their parents and from each other. This produces variation in a population.
- 2) Each parent produces sex cells (**gametes**) containing just **one set** of genetic material. This involves a special kind of cell division, called **meiosis**, and the gametes are described as being **haploid**.
- 3) During **fertilisation** the nuclei of the gametes join together to form a **zygote**. The zygote has **two complete sets** of genetic material, and is said to be **diploid**.
- 4) The zygote grows by simple cell division (**mitosis**) to form the **embryo**.

In Meiosis, DNA Copies Itself Then the Cell Divides Twice

- 1) The **only cells** in the human body that divide by meiosis are special cells in the **testes** and **ovaries**.
- 2) These cells divide to produce **gametes** (sperm and eggs).
- 3) The DNA **replicates**, so each of the 46 chromosomes become two chromatids joined by a centromere.
- 4) The 46 chromosomes sort themselves into the **23 homologous pairs**, then the **pairs separate**. One of each pair goes to one side of the cell and one goes to the other.
- 5) The cytoplasm now divides. Each of the new cells **contains 23 chromosomes** (consisting of two chromatids joined by a centromere).
- 6) In both of these new cells the **chromatids separate** and the cytoplasm divides to form two cells.
- 7) At the end of meiosis, **four haploid cells** have been produced from every original diploid cell.



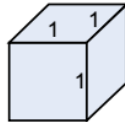
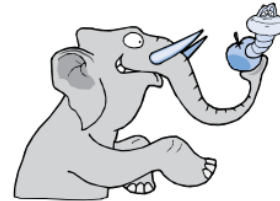
Worry not, before you know it your A-level testes will soon be ovaries...

- 1) Are gametes haploid or diploid?
- 2) Where in the human body does meiosis occur?
- 3) How many cell divisions are there in meiosis?
- 4) How many cells are produced when a cell divides by meiosis?

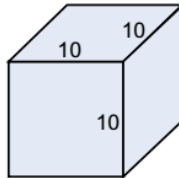
Size and Surface Area to Volume Ratio

Small Objects have Relatively Large Surface Areas

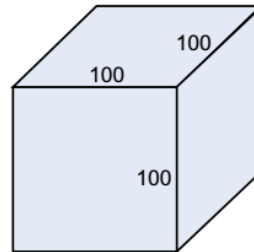
- 1) Have you ever wondered **why** there are no large single-celled organisms or why big animals are made up of **millions** of tiny cells instead of a few large ones?
- 2) The main reason relates to the changes in the **surface area to volume ratio** of an object as it increases in size.
- 3) Look at the three cubes in the diagram below. The **smallest cube** has the **biggest** surface area to volume ratio and the **biggest cube** has the **smallest** surface area to volume ratio.



Surface area = 6 cm^2
 Volume = 1 cm^3
 Surface area : Volume
 $6 : 1$



Surface area = 600 cm^2
 Volume = 1000 cm^3
 Surface area : Volume
 $0.6 : 1$



Surface area = $60,000 \text{ cm}^2$
 Volume = $1,000,000 \text{ cm}^3$
 Surface area : Volume
 $0.06 : 1$

Surface Area is Important for Exchange

- 1) Cells or organisms need to **exchange materials** and **heat** with their environment.
- 2) **More** chemical reactions happen every second in organisms with a **larger volume** than in ones with smaller volumes.
- 3) Therefore **more** oxygen, nutrients, waste products and heat need to be exchanged across the membrane of cells of larger organisms.
- 4) With increasing volume this becomes an **ever-increasing problem**.

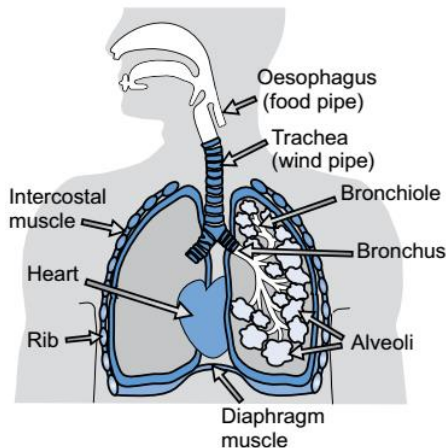
My surface area just keeps growing... so does my volume (it's the pies)...

- 1) Which has the bigger surface area to volume ratio, a small organism or a large organism?
- 2) An animal has a surface area of 7.5 cm^2 and a volume of 1 cm^3 .
What is its surface area to volume ratio?
- 3) Which animal has the greatest surface area to volume ratio
— Animal A ($9.8 : 1$), Animal B ($0.98 : 1$)?
- 4) Give three materials that need to be exchanged across the membranes of organisms' cells.

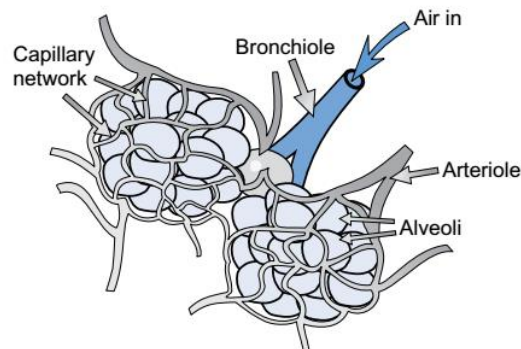
Structure of the Thorax

Lungs have a Very Large Gas Exchange Surface

Large, active animals, like mammals, have evolved complex **blood systems** and **lungs** to provide a **large surface area** for the efficient diffusion of oxygen and carbon dioxide.



Gas exchange takes place in millions of tiny air sacs, called **alveoli**.



Alveoli have Adaptations that Increase the Diffusion Rate

- 1) The walls of the alveoli consist of a **single layer** of thin, flattened, epithelial cells. Diffusion happens **faster** when molecules only have to travel **short** distances.
- 2) Diffusion is faster when there's a **bigger difference** in concentrations between two regions. The blood flowing through the rich network of capillaries around the alveoli **carries away** the oxygen that has diffused through the alveolar walls. This ensures that there's always a **higher concentration of oxygen** inside the alveoli than in the blood. The reverse is true for **carbon dioxide**.
- 3) The alveolar walls are **fully permeable** to dissolved gases. Oxygen and carbon dioxide can pass easily through the cell membranes of the epithelial cells.

I like my alveoli filled with spinach and ricotta...

- 1) Why have large mammals evolved complex blood systems and lungs?
- 2) In which part of the lungs does gas exchange take place?
- 3) Describe the shape of the cells that make up the walls of the alveoli and explain how their shape suits their function.
- 4) What type of cell are the alveoli walls made of?
- 5) a) Why does oxygen diffuse from inside the alveoli into the blood?
b) Name another gas that can pass easily through the walls of the alveoli.

Breathing In and Breathing Out

Why do We Need to Breathe?

Ventilation (breathing) ensures that air with a **high concentration of oxygen** is taken into the lungs, and air with a **high concentration of carbon dioxide** is removed from the lungs. This maintains high **concentration gradients** between air (inside your alveoli) and blood, **increasing** the rate of diffusion of oxygen and carbon dioxide.

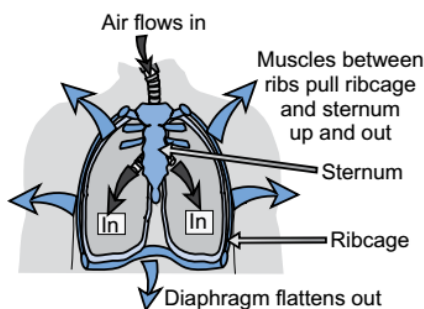
If Volume Increases, Air Pressure Decreases

If the **volume** of an enclosed space is **increased**, the **pressure** inside it will **decrease**.

- 1) The lungs are suspended in the **airtight thorax**.
- 2) Increasing the volume of the thorax decreases the air pressure in the lungs to below atmospheric pressure. Air flows **into** the lungs, inflating them until the pressure in the alveoli equals that of the atmosphere.
- 3) Decreasing the volume of the thorax increases the pressure in the lungs and air **flows out** until the pressure in the alveoli drops to atmospheric pressure.

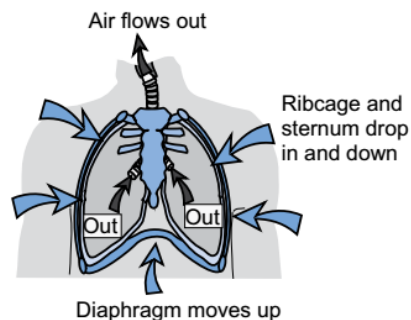
Breathing In...

- 1) **Intercostal muscles** and **diaphragm** (a muscular sheet) **contract**.
- 2) Thorax volume **increases**.
- 3) This decreases the pressure, so air **flows in**.



...and Breathing Out

- 1) **Intercostal muscles** and **diaphragm relax**.
- 2) Thorax volume **decreases**.
- 3) This increases the pressure, so air **flows out**.



We're heading inter-costal waters — look out for rocks at the sternum...

- 1) Describe the relationship between volume and pressure in an enclosed space.
- 2) Does the volume of the thorax increase or decrease when you breathe out?
- 3) Which two sets of muscles contract when we breathe in?

Disease

Disease can be Caused by Many Things

- 1) **Pathogens** — these are organisms that can cause disease, e.g. bacteria and viruses. **Infectious diseases** are caused by pathogens and can be passed from person to person, e.g. TB, malaria and HIV.
- 2) **Genetic defects** — some diseases are caused by **mutations** in a person's genes, e.g. cystic fibrosis is caused by a mutation in a gene for a protein.
- 3) **Lifestyle** — certain lifestyles **increase the risk** of getting some diseases, e.g. smokers are more likely to get lung cancer.

Risk Factors for Disease

- 1) A risk factor is something that **increases the chances** of something bad happening. For example, smoking is a risk factor for heart disease — if you smoke you're **more likely** to get heart disease.
- 2) Risk factors **don't always** lead to disease though. For example, using sunbeds is a risk factor for skin cancer — if you use sunbeds you increase your risk of skin cancer, but you won't necessarily get the disease.
- 3) Some risk factors are **unavoidable** because they're **inherited**, e.g. certain versions of genes increase your risk of getting breast cancer.
- 4) Some risk factors are **avoidable** because they're associated with your **lifestyle**. For example, a diet high in salt is a risk factor for high blood pressure — if you change your lifestyle to reduce your salt intake you reduce the risk.

Here's a table showing some common **lifestyle** risk factors and the diseases they're associated with:

| Risk factor | Diseases |
|---------------------------|--|
| Smoking | Mouth, lung and throat cancer, emphysema and other lung diseases, cardiovascular disease |
| Drinking too much alcohol | Mouth, stomach, liver and breast cancer, possibly many other cancers, cardiovascular disease |
| High blood pressure | Cardiovascular disease, diabetes |
| Overweight/obese | Various cancers, cardiovascular disease, diabetes |
| Unbalanced diet | Various cancers, cardiovascular disease, diabetes |
| Using sun beds too much | Skin cancer |

Taking your Nan's fashion advice — a risk factor for embarrassment...

- 1) What are pathogens?
- 2) Give an example of an infectious disease.
- 3) What is a risk factor?
- 4) List two diseases that smoking is a risk factor for.

Immunity

Phagocytes Engulf Pathogens

- 1) If a pathogen gets into the body it's detected by a type of white blood cell called a **phagocyte**.
- 2) It's actually the **molecules** on the **surface** of the pathogen that the phagocytes detect. These molecules are called **antigens**.
- 3) Human cells have antigens on their surface too, but phagocytes can tell the difference between 'self' (your own) and 'foreign' antigens.
- 4) Phagocytes **engulf** pathogens that are carrying foreign antigens and destroy them.

There are lots of **different types** of white blood cells.

White Blood Cells Produce Antibodies

- 1) Some white blood cells produce **antibodies** that **bind to** antigens.
- 2) The ones that produce antibodies are called **B-cells** (they're sometimes called B-lymphocytes — pronounced: lim-fo-sites).
- 3) When the antibody binds to the antigen it brings about the **death** of the pathogen carrying it.

Another Type of White Blood Cell is Involved

- 1) **T-cells** (or T-lymphocytes) are a type of white blood cell that are involved in **communication** between phagocytes and B-cells.
- 2) When a phagocyte has engulfed a pathogen it signals to the T-cell that it's found something. The T-cell then **activates** the B-cells to produce antibodies.

Vaccination Gives You Immunity

- 1) If you're **vaccinated** against a pathogen you can't get that disease (you're **immune**).
- 2) Vaccines **contain antigens** from a pathogen in a form that can't harm you, e.g. attached to dead bacteria.
- 3) Your body produces **antibodies** against the antigens so, if the same pathogen (carrying the same antigens) tries to invade again, the immune system can respond **really quickly** and you won't suffer from any **symptoms**.
- 4) Vaccines don't stop the pathogen getting **into** the body, they just **get rid of it** really quickly when it does.

I seem to be immune to learning all this Biology...

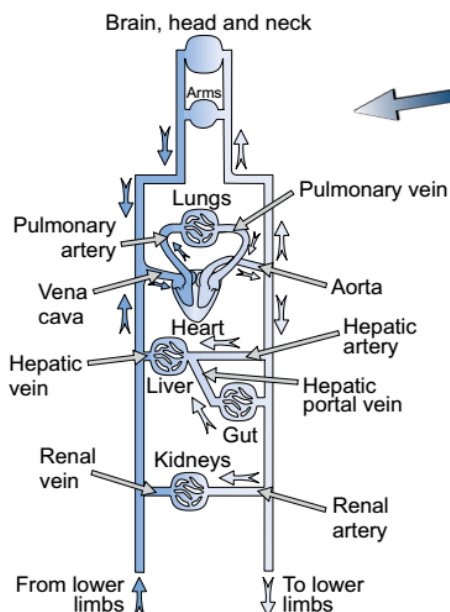
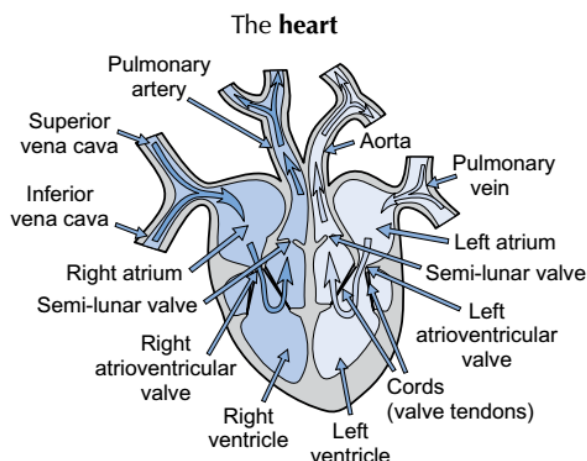
- 1) What do phagocytes detect?
- 2) What kind of white blood cells produce antibodies?
- 3) What is the role of T-cells?
- 4) What do vaccines contain?

The Circulatory System

Large Animals Need a Circulatory System

- 1) Diffusion is only efficient over **short distances**, so any animal bigger than a simple worm needs a system that will bring glucose and oxygen into close contact with individual cells.
- 2) In humans, the **heart** pumps blood around the body through **blood vessels**.

The heart has **four chambers** — two **atria** and two **ventricles**.



- 3) The blood vessels carry blood around the **entire body** and go to **every organ** before returning the blood to the heart.
- 4) There are **three** main types of blood vessel:
 - **Arteries** carry blood **away** from the heart.
 - **Veins** carry blood **to** the heart.
 - **Capillaries** are where the exchange between the blood and the cells takes place.
- 5) As the blood flows through the **tissues**, dissolved substances such as glucose, oxygen and carbon dioxide are **exchanged** between the blood and the cells.

The main artery in the human body is the **aorta**. It carries oxygenated blood **from the heart** to the rest of the body.

A circulatory system — going round and round the M25...

- 1) Name the organ that pumps blood around the body.
- 2) Name the four chambers of the heart.
- 3) Name the three main types of blood vessel.
- 4) In which type of blood vessel are substances exchanged between the blood and the cells?

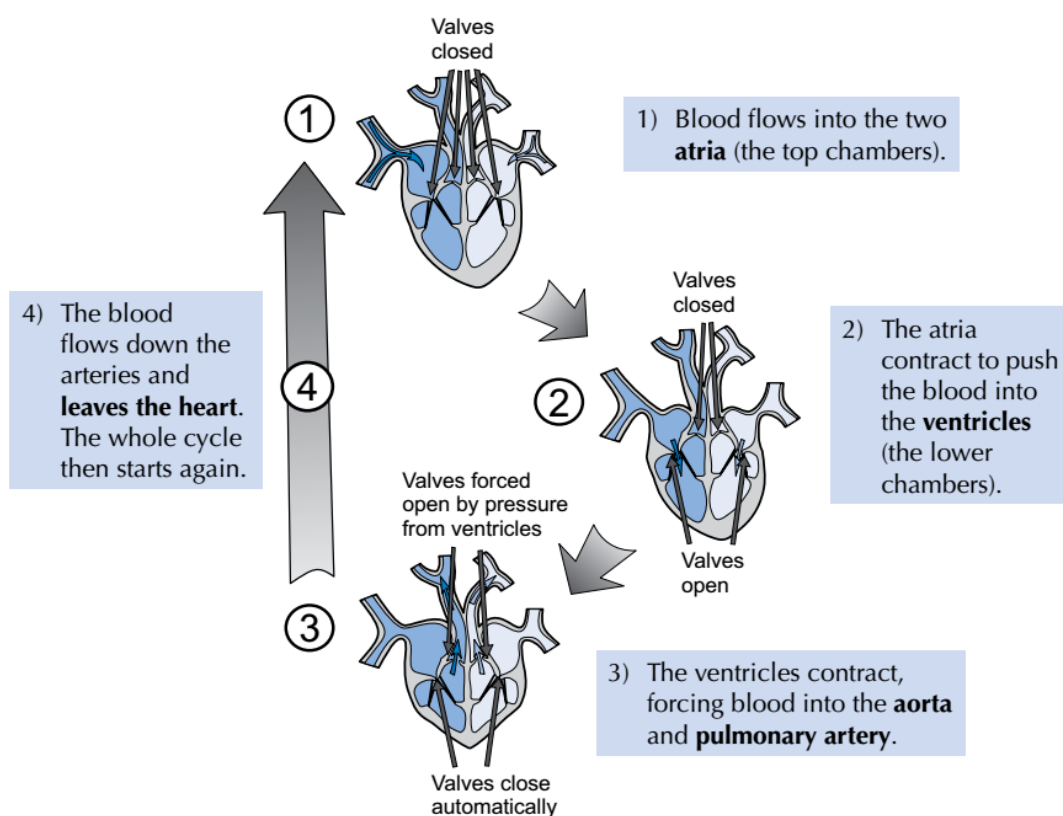
The Heart

Important Facts to Remember

- 1) The heart acts like two separate **pumps**. The **right side** sends blood to the **lungs** and the **left side** pumps blood around the rest of the **body**.
- 2) Blood always flows from a region of **higher pressure** to a region of **lower pressure**.
- 3) **Valves** in the heart prevent the blood from flowing backwards.
- 4) **No energy** is required to make the valves work — it's the **blood pressing** on the valves that makes them **open and close**.

The Cardiac Cycle

The **cardiac cycle** is the sequence of events that occurs during **one heartbeat**.



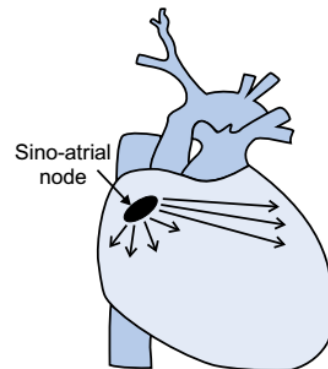
The **ventricles** are much more **powerful** than the atria and, when they contract, the **heart valves** pop shut automatically to prevent **backflow** into the atria. The ventricle walls are **thicker** because they need to push the blood further (e.g. the **left ventricle** has to push blood all the way round the body).

As soon as the ventricles relax, the valves at the top of the heart **pop shut** to prevent backflow of blood (back into the ventricles) as the blood in the arteries is now under **a fair bit of pressure**.

The Heart

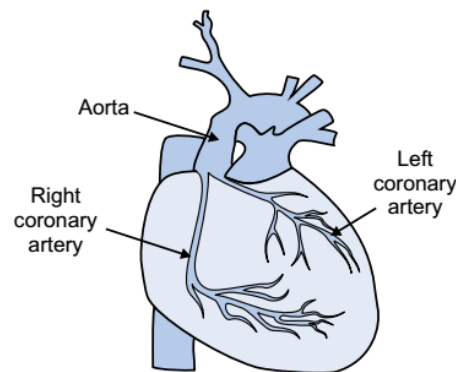
The Heart has its Own Pacemaker

- 1) **Most muscles** require **nerve impulses** from the central nervous system to make them **contract**.
- 2) The heart **produces** its own **electrical impulses**.
- 3) A group of specialised cells called the **sino-atrial node**, in the wall of the right atrium, sends out **regular impulses**.
- 4) These spread across the atria, making them **contract**.



Arteries Supply The Heart Muscle with Blood

- 1) Heart muscle, like all tissue, needs **oxygen** and **glucose** so it can respire and release the energy it needs to function.
- 2) It gets these things from the **blood**.
- 3) The heart muscle is supplied with blood by the **coronary arteries** (the word coronary is used to refer to the heart).
- 4) The two main coronary arteries come off the **aorta**.
- 5) The coronary arteries are quite **thin** (especially compared to the aorta).



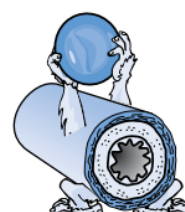
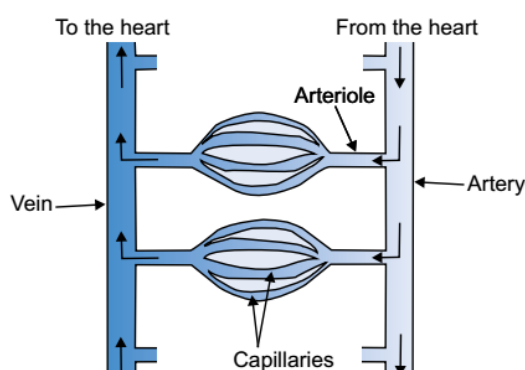
Aorta get on with learning this stuff, I suppose...

- 1) Does the right hand side of the heart pump blood to the body or to the lungs?
- 2) What is the function of the heart valves?
- 3) Do heart valves require energy to open and close?
- 4) Where does the blood go after leaving the atria?
- 5) Why are the walls of the ventricles thicker than the walls of the atria?
- 6) The sino-atrial node is sometimes called the heart's natural pacemaker. What is its function?
- 7) Why does heart muscle require a blood supply?
- 8) Name the blood vessels that supply the heart muscle with blood.

Blood Vessels

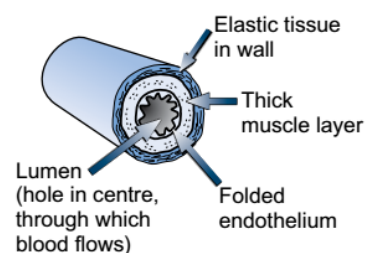
Arteries, Arterioles, Capillaries and Veins

- 1) **Arteries** carry blood away from the heart.
- 2) They subdivide into smaller vessels called **arterioles**.
- 3) Arterioles subdivide into microscopic vessels called **capillaries**.
- 4) Capillaries join up to form **veins**.
- 5) Veins **return** blood to the **heart**.



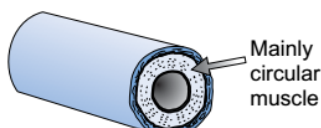
Arteries are Elastic

- 1) Arteries have a **thick wall** compared to the diameter of the lumen. There's an outer layer of **fibrous tissue**, then a thick layer of **elastic tissue** and **smooth muscle**, then a very thin inner layer of folded **endothelial tissue**.
- 2) When the ventricles contract, blood enters the arteries at **high pressure**. This **stretches** the folded endothelium and elastic walls. When the ventricles relax, it's the elastic recoil of the artery wall (when the wall shrinks back to its original size) that keeps the blood pressure up. Important organs, like the kidneys, wouldn't be able to function if the blood pressure dropped too far between heartbeats.



Arterioles can Contract

- 1) Arterioles are **narrower** than arteries and they have a higher proportion of **smooth muscle fibres** and a lower proportion of **elastic tissue**.

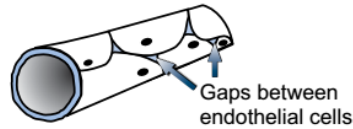


- 2) When the circular muscle fibres of an arteriole contract, the diameter of the lumen is reduced, so **less blood flows** through that vessel. This means that arterioles can **control** the amount of blood flowing to a particular organ.

Blood Vessels

Capillaries can Only be Seen With a Microscope

Capillary walls consist of a single layer of **endothelial cells** (cells that line the blood vessels). Some capillaries have **tiny gaps** between the endothelial cells.

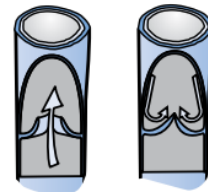
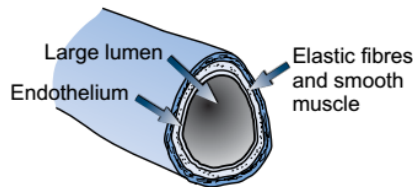


Capillaries are Well Suited to Their Job

- 1) The **very thin walls** and the **gaps** between the cells allow water and substances like glucose and oxygen to **diffuse quickly** from the blood into the cells. Waste products, such as carbon dioxide and urea, diffuse from the cells into the blood.
- 2) Organs contain thousands of capillaries, so altogether there's a **huge surface area** for the exchange of substances.
- 3) Blood flows quite **slowly** through capillaries. This allows **more time** for diffusion to occur.

Veins Have Valves

- 1) A vein has a **large lumen** and a relatively thin wall containing some elastic tissue and smooth muscle. Veins also have **valves** that prevent the blood flowing backwards.
- 2) When the **leg muscles** contract they bulge and press on the walls of the veins, pushing the blood up the veins. When the muscles relax, the valves close. This action helps the blood **return** to the heart.



HMS Vein — a superior vessel...

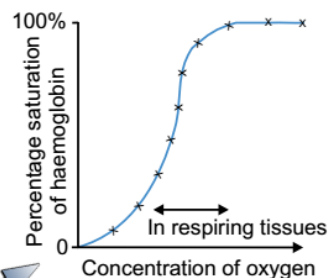
- 1) What is the role of arteries in the circulatory system?
- 2) Explain the importance of the elastic tissue in the walls of arteries.
- 3) Describe how arterioles can control the amount of blood flowing to an organ.
- 4) Capillaries have very thin walls, which sometimes have gaps in them. Explain how these characteristics make capillaries suited to their job.
- 5) What structure do veins contain, that other blood vessels don't have?
- 6) Explain how leg muscles help return blood to the heart.

Blood

Haemoglobin has Special Properties

- 1) The blood's main function is to **transport** materials to and from cells.
- 2) So the blood can do this, red blood cells are packed with **haemoglobin**, a protein that contains iron and can **carry oxygen**.
- 3) When oxygen combines with haemoglobin it forms **oxyhaemoglobin**.
- 4) When there's a lot of oxygen present, one molecule of haemoglobin can combine with **four** molecules of oxygen — the haemoglobin is **100% saturated**.
- 5) When less oxygen is present, fewer molecules of oxygen combine and the haemoglobin is **less than 100% saturated**.

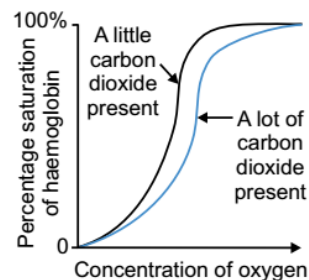
It would be reasonable to expect that a graph of '% saturation of haemoglobin' against 'concentration of oxygen' would be a straight line (i.e. that the two would be proportional). However, when experiments are carried out and the results plotted, the line of best fit is **S-shaped**.



- 6) Haemoglobin has special properties that allow it to become fully saturated with oxygen in the capillaries around the **alveoli** of the lungs, where there's a **high concentration of oxygen**.
- 7) Then when it reaches respiring tissue, where there's **less oxygen**, it can give up almost all of its oxygen immediately — so the rate of respiration in the tissues isn't slowed down because of an oxygen shortage.

Carbon Dioxide Changes the Properties of Haemoglobin

- 1) Respiring tissues produce **carbon dioxide**.
- 2) If there's not a lot of carbon dioxide present, the haemoglobin is **less efficient** at **taking up** oxygen (i.e. it needs to be exposed to more oxygen before it becomes fully saturated).
- 3) But, when there's a lot of carbon dioxide present, the haemoglobin becomes **more efficient** at **releasing** oxygen (i.e. it can release more oxygen molecules in areas of fairly high oxygen demand).
- 4) This is good because it means that **rapidly respiring tissues**, e.g. contracting leg muscles and brain cells, get **more oxygen**.
- 5) This effect of carbon dioxide concentration on the oxygen-binding properties of haemoglobin is known as the **Bohr effect**.



The Bohr effect — caused by reading this page...

- 1) Name the substance picked up by the blood in the lungs.
- 2) How many molecules of oxygen are bound to a haemoglobin molecule when it's fully saturated?
- 3) Which gas affects the oxygen-binding properties of haemoglobin?
- 4) Under what circumstances does a tissue require the most oxygen?

Variation and Evolution

We all Vary

- 1) All organisms are **different** from each other, e.g. giraffes are loads different from zebras, which are different from lions and tigers and bears...
- 2) Organisms of the **same species** also show **some variation**, e.g. humans show variation in height, weight, favourite colour of shoe polish...
- 3) Organisms of the **same species** are similar because they all have the **same genes** but they vary because they have **different versions** of those genes (called **alleles**). E.g. humans all have a gene for blood type, but they can have A, B or O alleles.

Variation Means Some Organisms are Better Adapted

- 1) An adaptation is a **characteristic** that helps an organism to **survive** and **have children**, e.g. polar bears have **thick, white fur** to stay warm and camouflaged in the snow.
- 2) **Characteristics vary** in a population so some organisms are **better adapted** for certain conditions than others, e.g. polar bears with thicker fur are better adapted to survive in a cold environment than polar bears with thinner fur. The slightly different adaptations you get **within species** (e.g. slightly thicker fur on one polar bear compared to another) are coded for by **different alleles**.

Evolution

- 1) Evolution is the **gradual change** in the **characteristics** of a population from one generation to the next. The theory of evolution is that all organisms evolved from a **common ancestor** (organism) over **millions of years**.
- 2) There's **more than one** mechanism by which evolution occurs — one is **natural selection**.



Natural Selection

- 1) Organisms from the **same population** all **vary** (e.g. different length of fur).
- 2) Organisms **compete** with each other for food, shelter, water, etc.
- 3) Those with **better adaptations** (caused by different **alleles**) are more likely to find food, shelter, water, etc., **survive** and have little **kiddies**. So they **pass on** the alleles for their better adaptations. E.g. bears with longer fur will stay warmer and be more likely to survive, and so have kids with longer fur.
- 4) Over time, the **number** of organisms with the better adaptations (alleles) **increases**.
- 5) The **whole population** of organisms **evolves** to have the better adaptations (alleles).

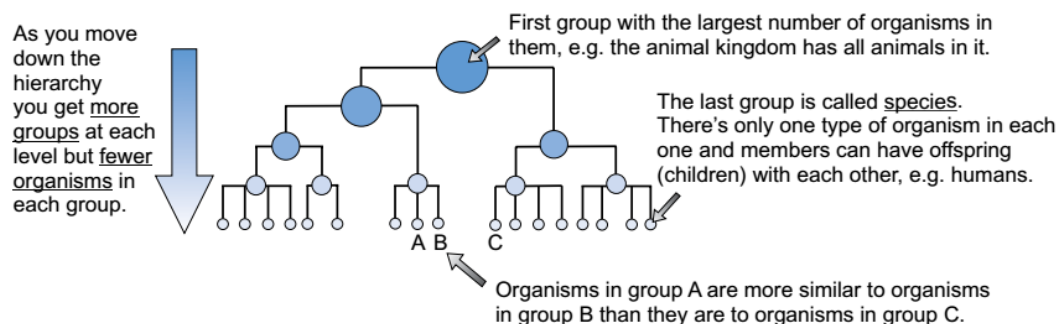
Bah, evolution takes ages. I want wings NOW...

- 1) What is an allele?
- 2) What is an adaptation?
- 3) Briefly describe natural selection.

Classification

Classification Systems

- 1) Classification is just **sorting** organisms into different **groups** and **naming them**.
- 2) It makes it **easier** for scientists to **study** organisms without getting **confused**, because every type of organism has a different name, e.g. *Homo sapien* (humans) or *Ursus maritimus* (polar bears).
- 3) Organisms are arranged into different groups depending on their **similarities** and **differences**, e.g. all animals are grouped together, and all plants are grouped together in a separate group because they're different to animals.
- 4) Organisms are placed in groups in **classification hierarchies** (pronounced: hire-arc-ees) — the biggest groups (e.g. animals, plants) are **split** into **smaller groups** (e.g. animals with a backbone in one group and animals without a backbone in another). These groups are **split again** into more smaller groups, and so on.



A **species** is a group of organisms that **look similar** and can reproduce to give **fertile offspring** (their children can also reproduce).

Classification Systems are Based on Lots of Things

- 1) **Older** classification systems grouped organisms based only on how they look, e.g. four limbs, six eyes, bum chin...
- 2) **Newer systems** use looks and lots of other things:
 - **DNA** — how similar and different the base sequence is (e.g. ATTTAC vs. ATTTAT).
 - **Other molecules** — e.g. proteins and enzymes.
 - **Early development** — how they grow from an embryo to a baby.

My poor brother — at least he's not classified with the apes any more...

- 1) What does classification involve?
- 2) What is a species?
- 3) List four things newer classification systems use to group organisms.

Xylem and Phloem

Xylem Tissue Transports Water and Minerals from Roots

Water from the soil **enters** the roots by **osmosis**. Then it travels through the root to the **xylem** — this is the tissue that **transports water** through the plant and up to the leaves. Water can travel through the roots in **two** ways:

The **symplast system**:

- Some water moves through the root via the **cytoplasm** of the root cells. The water has to cross the **cell membrane**, which regulates the passage of the water and dissolved minerals.

The **apoplast system**:

- The water moves through the **cell walls** and the **spaces between the cells**.
- There are **no membranes** to regulate the passage.

Water Travels Up the Plant Through the Xylem Tissue

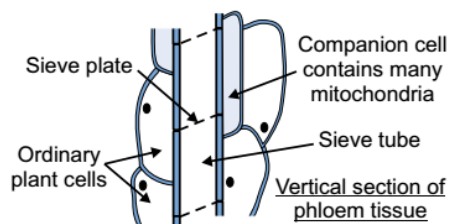
The cells that make up the tubes (vessels) of **xylem tissue** are dead, waterproof and hollow. This means water can **move** through them easily. Water is **pulled up** through the xylem tissue by a combination of factors: **cohesion**, **tension** and **adhesion**:

- 1) Water **evaporates** from inside the leaf leaving a higher concentration of solutes.
- 2) Water from the nearest xylem vessel enters by **osmosis**.
- 3) Water molecules stick together because of weak hydrogen bonds between them — this is called **cohesion**.
- 4) As water molecules leave the xylem vessel they **pull up** further molecules, so the whole column of water is pulled up.
- 5) Evaporation pulls the water column upwards and gravity pulls it down, so the water column is under **tension**.
- 6) The **adhesion** of water molecules to the sides of the xylem vessels stops the column breaking.

Phloem Transports Organic Compounds

Sugars and other organic compounds are **transported** through plants in **phloem tissue**. Phloem tissue is also arranged in **tubes** so the solutions of sugar, etc. can **move** through them easily.

- 1) The movement of carbohydrates and other organic compounds in plants is known as **translocation**.
- 2) It occurs in the **sieve tubes** of the **phloem tissue**.
- 3) **Companion cells** next to the sieve tubes are believed to **actively transport** sugar into the sieve tubes, and then water follows by **osmosis**.



Relax, sit back and just go with the phloem...

- 1) In the symplast system, which part of the cell does water move through?
- 2) Why is the column of water in the xylem under tension?
- 3) What substances are transported in the phloem tissue?

Answers

Section 1 — Biological Molecules

Page 1 — Proteins

- 1 The order in which the amino acids are arranged in a protein chain.
- 2 Hydrogen bonds (weak forces of chemical attraction).

Page 2 — Carbohydrates

- 1 E.g. glucose and fructose.
- 2 Maltose
- 3 Any two from: e.g. starch, cellulose, amylose and amylopectin.

Page 3 — Lipids

- 1 Carbon, hydrogen, and oxygen.
- 2 Every carbon atom in saturated fatty acid chains is joined by a single bond. Unsaturated fatty acids have one or more double bonds in their carbon chains.
- 3 Triglycerides have three fatty acid chains attached to a glycerol molecule. Phospholipids have two fatty acid chains and a phosphate group attached to a glycerol molecule.

Page 4 — Enzymes

- 1 Increase the rate of/speed up biochemical reactions. / Act as biological catalysts.
- 2 Activation energy is the energy required to get a reaction started.
- 3 Break down food into smaller molecules.

Page 5 — Enzymes

- 1 The substrate molecule must be the correct shape to fit into the active site.
- 2 The shape of the active site has changed and the substrate will no longer fit.
- 3 Acids and alkalis can denature enzymes by disrupting the weak hydrogen bonds in the enzymes' tertiary structure and changing the shape of their active sites.

Section 2 — Cell Structure

Page 6 — Eukaryotic and Prokaryotic Cells

- 1 E.g. a bacterium.
- 2 E.g. nucleus, cytoplasm, cell-surface membrane and mitochondria.
- 3 They provide a source of energy for the cell.

Page 7 — Microscopes

- 1 Any 3 from: nucleus, cell membrane, cytoplasm, mitochondria.
- 2 An electron microscope.
- 3 An electron micrograph.

Page 8 — Functions of the Nucleus, Mitochondria and Cell Wall

- 1 The nucleus.
- 2 The mitochondria.
- 3 There is a smooth outer membrane and a folded inner membrane.
- 4 glucose + oxygen → carbon dioxide + water + (energy)

- 5 Adenosine triphosphate/ATP.

- 6 Cellulose

Page 10 — Cell Membranes

- 1 Phospholipids and protein molecules.
- 2 Diffusion, osmosis, facilitated diffusion and active transport.
- 3 Osmosis
- 4 Water potential
- 5 Carrier and channel proteins.
- 6 To provide the energy needed for the process.

Section 3 — Genetics and Cell Division

Page 11 — DNA and Protein Synthesis

- 1 Double helix
- 2 Four
- 3 Adenine, cytosine, guanine and thymine.
- 4 Each base forms hydrogen bonds to a base on the other strand.
- 5 This is when pairs of complementary bases join together. A pairs with T and C pairs with G.
- 6 A section of DNA that codes for a particular protein.
- 7 The order of bases in a gene.

Page 12 — RNA and Protein Synthesis

- 1 Because the DNA molecule containing the gene is in the nucleus and is too big to leave the nucleus. But protein synthesis takes place in the cytoplasm, so a copy of the gene that is smaller and can leave the nucleus needs to be made.
- 2 Messenger
- 3 Uracil (U)
- 4 UAACGCGU

Page 13 — Mutations

- 1 Three (three bases are called a triplet).
- 2 Changes to the base sequence of DNA.
- 3 Increase the frequency of mutations.

Page 14 — Chromosomes

- 1 In the nucleus.
- 2 23
- 3 No. They're the same size and carry the same genes but they usually have different alleles.
- 4 An identical copy of a chromosome.
- 5 Centromere

Page 15 — Cell Division — Mitosis

- 1 Growth, repair, asexual reproduction.
- 2 So each new cell has a full copy of DNA.
- 3 No (the chromatids separate).
- 4 Two

Page 16 — Cell Division — Meiosis

- 1 Haploid
- 2 In the testes and the ovaries.
- 3 Two

Answers

4 Four

Section 4 — Exchange

Page 17 — Size and Surface Area to Volume Ratio

- 1 A small organism.
- 2 7.5 : 1 or 7.5 to 1
- 3 Animal A
- 4 E.g. oxygen, waste products, nutrients.

Page 18 — Structure of the Thorax

- 1 To provide a large surface area for the efficient diffusion of carbon dioxide and oxygen.
- 2 The alveoli.
- 3 The cells are thin and flattened. The gases can diffuse across the cells quickly because the distance is small.
- 4 Epithelial cells
- 5 a) There is a higher concentration of oxygen inside the alveoli than in the blood.
b) Carbon dioxide

Page 19 — Breathing In and Breathing Out

- 1 When the volume increases, the pressure decreases (and when the volume decreases, the pressure increases).
- 2 Decrease
- 3 The intercostal muscles and the diaphragm muscles.

Section 5 — Disease and Immunity

Page 20 — Disease

- 1 Organisms that can cause disease.
- 2 E.g. TB, malaria, HIV.
- 3 Something that increases the chances of something bad happening.
- 4 Any two from: mouth, lung and throat cancer, emphysema and other lung diseases, cardiovascular disease.

Page 21 — Immunity

- 1 Foreign antigens.
- 2 B-cells (B-lymphocytes).
- 3 To communicate between phagocytes and B-cells / to activate B-cells.
- 4 Antigens from a pathogen in a form that can't harm you.

Section 6 — The Circulatory System

Page 22 — The Circulatory System

- 1 The heart.
- 2 The right and left atria, the right and left ventricles.
- 3 Arteries, veins and capillaries.
- 4 Capillaries

Page 24 — The Heart

- 1 Lungs
- 2 To keep the blood flowing one way/prevent blood flowing backwards.

3 No

- 4 Into the ventricles.
- 5 Because the ventricles have to pump blood further than the atria.
- 6 To produce the regular electrical impulses that make the atria contract.
- 7 So it can get oxygen and glucose for respiration (for energy).
- 8 The coronary arteries.

Page 26 — Blood Vessels

- 1 They carry blood away from the heart.
- 2 The elastic stretching and recoil of the artery walls helps to keep blood pressure up and allow important organs to function.
- 3 When the circular muscle fibres in the walls of arterioles contract, they reduce the size of their lumen. This reduces the amount of blood flowing to the organs that they supply.
- 4 They allow water and other substances (like glucose and oxygen) to diffuse quickly between the blood in the capillaries and the cells.
- 5 Valves
- 6 When leg muscles contract, they push blood up the veins, and when they relax, the valves in the veins close. These actions help push blood back to the heart.

Page 27 — Blood

- 1 Oxygen
- 2 Four
- 3 Carbon dioxide
- 4 When it's rapidly respiring.

Section 7 — Variation, Evolution and Classification

Page 28 — Variation and Evolution

- 1 An alternative version of a gene.
- 2 Any characteristic of an organism that increases its chance of survival.
- 3 Organisms with good adaptations survive, have children and so pass on the alleles for those good adaptations.

Page 29 — Classification

- 1 Sorting organisms into groups (based on their similarities and differences) and naming them.
- 2 A group of organisms that look similar and can reproduce to give fertile offspring.
- 3 How they look, DNA, other molecules (e.g. proteins and enzymes) and early development.

Section 8 — Plants

Page 30 — Xylem and Phloem

- 1 Cytoplasm
- 2 Evaporation is pulling the water column up and gravity is pulling it down.
- 3 Sugars and other organic compounds.

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