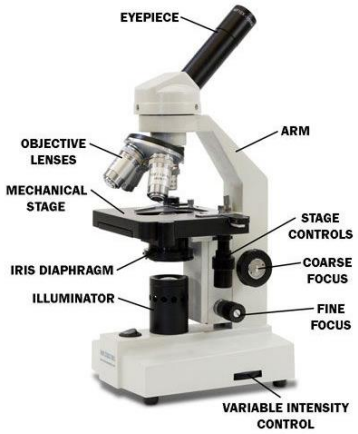
B1: Biology key concepts

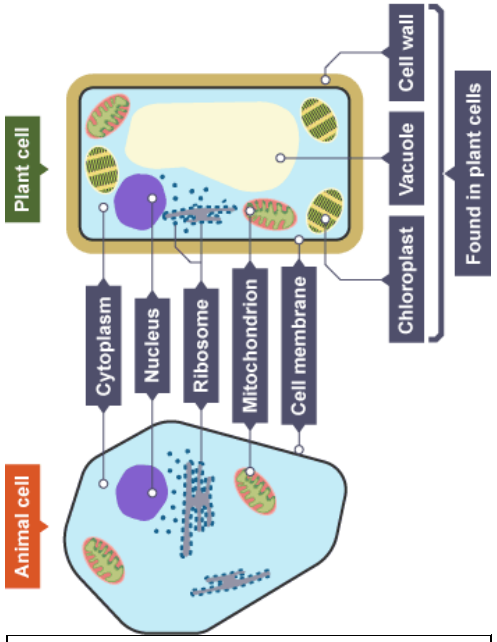
Lesson sequence

1. Microscopes
2. Plant and animal cells
3. Measuring cells
4. Core practical: using microscopes
5. Specialised cells
6. Bacterial cells
7. Digestive enzymes
8. How enzymes work
9. Factors affecting enzymes
10. Core practical: enzymes and pH
11. Cell transport
12. Core practical: osmosis in potatoes

1. Microscopes	
***Magnification**	The number of times bigger something appears under a microscope.
***Eyepiece lens**	The lens on a microscope that you look through.
***Objective lens**	The lens at the bottom of a microscope. There are normally three you can choose from.
***Total magnification**	Eyepiece lens x objective lens.
****Resolution**	The smallest distance between two points so that they can still be seen as two separate points.
****Stains**	Dyes added to microscope slides to show the details more clearly.
****Milli**	Thousandth, $1x10^{-3}$ (a millimetre is a thousandth of a metre).
****Micro**	Millionth, $1x10^{-6}$ (a micrometre is a millionth of a metre).
****Nano**	Billionth, $1x10^{-9}$ (a nanometre is a billionth of a metre).
****Pico**	Trillionth, $1x10^{-12}$ (a picometre is a trillionth of a metre).



2. Plant and animal cells	
***Cell**	The basic structural unit of all living things (the building blocks of life).
***Parts of an animal cell**	Cell membrane, cytoplasm, nucleus, ribosomes, mitochondria.
***Parts of a plant cell**	Cell membrane, cytoplasm, nucleus, ribosomes, mitochondria, cell wall, permanent vacuole, chloroplasts.
***Cell membrane**	Controls what enters and leaves the cell.
***Cytoplasm**	A jelly-like substance where chemical reactions take place.
***Nucleus**	Contains DNA and controls the cell.
***Ribosome**	Produces proteins.
***Mitochondria**	Releases energy by aerobic respiration.
***Cell wall**	Protects and supports the cell, made of cellulose.
***Permanent vacuole**	Stores sap and helps to support the cell.
***Chloroplast**	Where photosynthesis happens, contains chlorophyll.

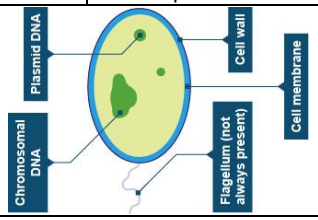


3. Measuring cells	
***Micrograph**	A picture produced by a microscope.
***Light microscope**	A microscope that uses light, can magnify up to 1500 times.
****Electron microscope**	A microscope that uses electrons to produce an image, can magnify up to 1,000,000 times.
****Actual size of a cell**	Actual size = measured size / magnification
****Convert mm to µm**	Micrometres (µm) = millimetres (mm) x 1000

4. Core practical – using microscopes (CP1)	
***CP1 – key question**	What do cells look like under a light microscope?
***CP1 – Prepare the slide**	Collect the cells you are studying and place them on the slide. Add a drop of stain and cover with a cover slip.
***CP1 – Select lens**	Choose between the 4x, 10x and 40x objective lenses.
***CP1 – Place slide in microscope**	Place slide on microscope stage, adjust the coarse focus until the lens is just touching the slide.
***CP1 – Rough focus**	Looking through the eyepiece, slowly adjust the coarse focus until you see a rough image.
***CP1 – Fine focus**	Looking through the eyepiece, slowly adjust the fine focus until you see a sharply focussed image.
***CP1 – Record the image**	Draw what you see, label any cell parts you can recognise and repeat with different objective lenses.
***CP1 - Results**	As you increase the magnification of the objective lens, the cells appear larger and more detailed.

5. Specialised cells	
****Small intestine cell**	**Job:** To absorb small food molecules produced during digestion. **Adaptations:** Tiny folds called microvilli that increase their surface area.
****Sperm cell**	**Job:** Fertilise an egg and deliver male DNA. **Adaptations:** A tail to swim, mitochondria to give energy for swimming, an acrosome to break through the egg's jelly coat, haploid nucleus with only half the total DNA.
****Egg cell**	**Job:** To be fertilised by a sperm and then develop into an embryo. **Adaptations:** Jelly coat to protect the cell, many mitochondria and nutrients to provide energy for growth, haploid nucleus with only half the total DNA.
****Ciliated epithelial cell**	**Job:** To clear mucus out of your lungs (and other internal surfaces). **Adaptations:** Small hairs on the surface – called cilia – which wave to sweep mucus along.

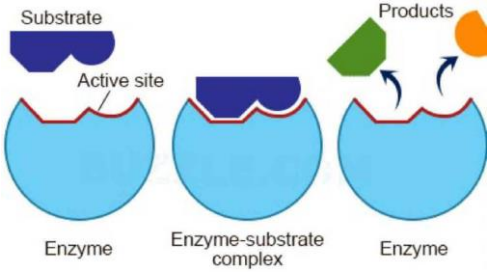
6. Bacterial cells	
***Parts of a bacterial cell**	**All bacteria:** Cell membrane, cell wall, cytoplasm, ribosomes, chromosomal DNA, plasmid DNA **Some bacteria:** flagellum.
****Chromosomal DNA**	Large piece of DNA containing most genes.
****Plasmid DNA**	Small loops of DNA containing a few genes.
****Flagellum**	A tail used for movement.
****Eukaryotic cells**	Cells with a nucleus.
****Prokaryotic cells**	Cells without a nucleus.
***Standard form**	A way of writing numbers in terms of powers of ten. E.g. $0.015 = 1.5 \times 10^{-2}$ $0.000458 = 4.56 \times 10^{-4}$ The index of ten (the 'minus' number) tell you which decimal point to start on.



7. Digestive enzymes	
***Digestion**	Breaking large food molecules down into ones small enough to absorbed by the small intestine.
***Catalyst**	A substance that speeds up a chemical reaction without being used up.
***Enzyme**	A protein that works as a catalyst to speed up the reactions in our cells.
***Digestive enzymes**	Enzymes that break large food molecules down into smaller ones.

****Amylase**	**Where found:** saliva, small intestine **What it does:** breaks down starch into simple sugars such as maltose
****Lipase**	**Where found:** small intestine **What it does:** breaks down fats into fatty acids and glycerol
****Protease**	**Where found:** stomach (pepsin), small intestine (trypsin) **What it does:** breaks down proteins into amino acids

8. How enzymes work	
***Substrate**	The chemical(s) that an enzyme works on.
***Active site**	An area of an enzyme with the same shape as the substrate.
****Lock and key mechanism**	The substrate moves into the active site and reacts to form the products. The products leave the active site so another substrate can then enter and so on.
****Specificity**	Each enzyme can only work on one substrate because the shape of the active site has to match.
***Denature**	When the shape of the active site changes shape so the enzyme stops working.



9. Factor affecting enzymes	
***Optimum temperature**	The temperature when an enzyme works fastest (about 37^{O} for human enzymes).
****Changing the temperature**	**Increasing to optimum**: rate increases because particles move faster **Increasing past optimum:** rate decreases as enzyme denatures

***Optimum pH**	The pH when enzymes work fastest (around pH 6-8 for most human enzymes)
****Changing pH**	Rate decreases as you move away from the optimum because the enzyme denatures.
****Increasing substrate concentration**	At first the rate increases, but then it levels out as the enzyme is working as fast as possible.

10. Core practical – enzymes and pH (CP2)	
***CP2 – key question**	How does the rate that amylase works change as you change the pH?
***CP2 – Prepare your reactants**	Place starch solution, amylase solution and pH 7 buffer into separate test tubes and warm them in a water bath at $40^{o}C$
***CP2 – Prepare your dropping tile**	Place a few drops of iodine solution into each well of a spotting tile.
***CP2 – Start the reaction**	Mix reactants together, start the stop watch and keep the mixture warm in the water bath.
***CP2 – Test for starch**	Remove a small amount of mixture and place in a well on the spotting tile.
***CP2 – Record your results**	Repeat the test until the mixture does not go black (no starch). Record the time.
***CP2 – Vary the pH**	Repeat with different pH buffers from pH 3 to pH 10
***CP2 – Results**	The amylase works fastest around pH 7 and more slowly at pH high or lower than this.

11. Cell transport	
***Concentration**	The number of particles in a given volume (the strength of a solution).
****Concentration gradient**	The difference in concentration between two neighbouring areas.
***Diffusion**	The movement of particles from high to low concentration (down a concentration gradient).

***Diffusion examples**	**Lungs:** oxygen into blood, carbon dioxide out of blood **Leaf:** carbon dioxide into leaf, oxygen out of leaf.
****Partially permeable membrane**	A membrane that allows some molecules but not others to pass through it (like a cell membrane).
****Osmosis**	The movement of water across a partially permeable membrane from high water/low solute conc to low water/high solute conc.
****Osmosis examples**	Water into plant roots, water in/out of any cells.
***Active transport**	Using energy to move substances from low to high concentration (up a concentration gradient).
***Active transport examples**	Minerals being absorbed into plant roots.

12. Core practical – osmosis in potatoes (CP3)	
***CP3 – Prepare potatoes**	Cut six similar pieces of potato, blot them dry and weigh them.
***CP3 – Run the experiment**	Place each potato piece in a test tube with sucrose (sugar) solutions with concentrations from 0% to 50%
***CP3 – Record results**	Blot each potato piece dry and re-weigh it.
***CP3 – Calculate percentage mass change**	% change = (final value – starting value) / starting value x 100
***CP3 – Results**	Potato in weaker sucrose solutions gain mass because water enters potatoes by osmosis, those in stronger solutions lose mass as water leaves by osmosis.