Biology

Subject	Biology
Exam Board	AQA
Head of Department	Ms Clarke

Assessment

Paper 1 – AS content only		Paper 2 – A2 content only		Paper 3 – AS and A2 content	
33.3%	Written Exam, 2 hours	33.3%	Written Exam, 2 hours	33.3%	Written Exam, 2 hours

Welcome to Biology,

This transition pack will provide you with a brief outline of the course structure and a reading list of sources and videos. You may wish to use these sources before and throughout the course to improve your wider understanding. This pack also contains some interesting and fun activities to get you ready for the first few weeks of the course. Please submit your work by the set **due dates** to sixthform@sta.islington.sch.uk for the attention of Ms Clarke.

Curriculum Map Provisional (Term 1)

September - October 2020	November - December 2020
Unit 1: Biological Molecules Unit 2: Cells	Unit 4: Genetic information, variation and relationships between organisms Unit 3: Organisms Exchange Substances With Their Environment

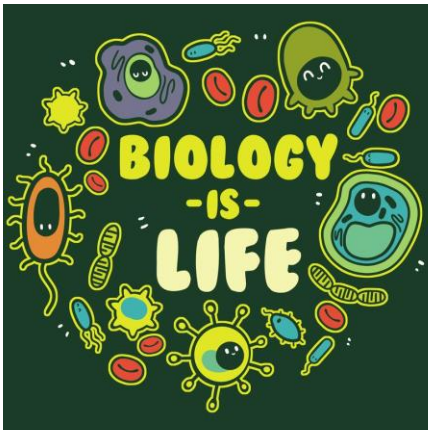
Subject Specific Reading List:	Salters/Nuffield AS/A Level Biology Understanding Biology for Advanced Level by Glen & Susan Toole Biological Science 1 & 2 by D Taylor & N Green A Dictionary of Biology by Robert Hine
Useful Websites:	https://www.aqa.org.uk/subjects/science/as-and-a-level/biology-7401-7402 www.senecalearning.com https://www.physicsandmathstutor.com/biology-revision/a-level-aqa/ http://www.a-levelnotes.co.uk/biology-aqa-as-level-notes-new-spec.html https://www.youtube.com/watch?v=eaNeyq4iEkw&list=PLkocNW0BSuEEMyVUCyaRPVj_cahCvjxAr

Part 1

Introduction

to

A Level Biology



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Task 2: 3 topics…………………………………. Pages 24-28
Task 3: Practice questions……………….…... Pages 29-46
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Transition guide: Biology

You're studying AS or A-level Biology, congratulations!

Biology is the study of living things, but not just animals and plants. You'll also learn about the molecules that make living things work, the cells that they're made from, the systems within plants and animals, and the interconnections between organisms.

Biology is different from physics and chemistry, in that living things don't always do what you expect them to do. You can't test one organism and assume all the rest will be the same, so you'll learn about the statistical analysis behind making claims.

At first, you may find the jump in demand from GCSE a little daunting, but if you follow the tips and advice in this guide, you'll soon adapt.

We recommend you keep this somewhere safe, as you may like to refer to the information in it throughout your studies.

Why study A-level Biology?

Biology A-level will give you the skills to make connections and associations with all living things around you. Biology literally means the study of life - and if that's not important, what is? Being such a broad topic, you're bound to find a specific area of interest, plus it opens the door to a fantastic range of interesting careers.

Many people use an AS or A-level in Biology in their future studies or work. Even if you don't decide to work in biology, studying it still develops useful and transferable skills for other careers. You'll develop research, problem solving and analytical skills, alongside teamwork and communication. Universities and business regard all of these very highly.

Possible degree options

According to bestcourse4me.com, the top seven degree courses taken by students who have A-level Biology are:

- Biology
- Psychology
- Sport and exercise science
- Medicine
- Anatomy
- Physiology and pathology pharmacology
- Toxicology and pharmacy chemistry.

This list is by no means exhaustive. Biology can prove useful for a wide variety of degree courses.

For more details, go to the bestcourse4me.com, or UCAS.

Which career appeals to you?

Studying Biology at A-level or degree opens up all sorts of career opportunities, such as:

- doctor
- clinical molecular geneticist
- nature conservation officer
- pharmacologist
- research scientist
- vet
- secondary school teacher
- marine biologist
- dentist.

Specification at a glance

AS and first year of A-level

1 Biological molecules.

2 Cells.

3 Organisms exchange substances with their environment.

4 Genetic information, variation and relationships between organisms.

A-level only

5 Energy transfers in and between organisms.

6 Organisms respond to changes in their internal and external environments.

7 Genetics, populations, evolution and ecosystems.

8 The control of gene expression.

The assessment for the AS consists of two exams

Paper 1	+	Paper 2
What's assessed • Any content from topics 1–4, including relevant practical skills		What's assessed • Any content from topics 1–4, including relevant practical skills
Assessed • written exam: 1 hour 30 minutes • 75 marks • 50% of AS		Assessed • written exam: 1 hour 30 minutes • 75 marks • 50% of AS
Questions • 65 marks: short answer questions • 10 marks: comprehension question		Questions • 65 marks: short answer questions • 10 marks: extended response questions

The assessment for the A-level consists of three exams

Paper 1	+	Paper 2	+	Paper 3
What's assessed • Any content from topics 1–4, including relevant practical skills		What's assessed • Any content from topics 5–8, including relevant practical skills		What's assessed • Any content from topics 1–8, including relevant practical skills
Assessed • written exam: 2 hours • 91 marks • 35% of A-level		Assessed • written exam: 2 hours • 91 marks • 35% of A-level		Assessed • written exam: 2 hours • 78 marks • 30% of A-level
Questions • 76 marks: a mixture of short and long answer questions • 15 marks: extended response questions		Questions • 76 marks: a mixture of short and long answer questions • 15 marks: comprehension question		Questions • 38 marks: structured questions, including practical techniques • 15 marks: critical analysis of given experimental data • 25 marks: one essay from a choice of two titles

Part 2

Recap of **S.I. units** and **important vocabulary** and **data analysis**

(Level: Low demand)

Task:

Complete Activities 1 to 11 (Pages 8-23)

Due date: **29th May 2020**

Email to:

sixthform@sta.islington.sch.uk

Useful information and activities

There are a number of activities throughout this resource. The answers to some of the activities are available on our secure website, e-AQA. Your teacher will be able to provide you with these answers.

SI units

Every measurement must have a size (eg 2.7) and a unit (eg metres or °C). Sometimes, there are different units available for the same type of measurement. For example, ounces, pounds, kilograms and tonnes are all used as units for mass.

To reduce confusion, and to help with conversion between different units, there is a standard system of units called the SI units which are used for most scientific purposes.

These units have all been defined by experiment so that the size of, say, a metre in the UK is the same as a metre in China.

The seven SI base units are:

Physical quantity	Usual quantity symbol	Unit	Abbreviation
mass	m	kilogram	kg
length l or x metre			m
time	t	second	s
electric current	I	ampere	A
temperature	T	kelvin	K
amount of substance	N	mole	mol
luminous intensity	(not used at A-level)	candela	cd

All other units can be derived from the SI base units.

For example, area is measured in square metres (written as m^2) and speed is measured in metres per second (written as ms^{-1}).

It is not always appropriate to use a full unit. For example, measuring the width of a hair or the distance from Manchester to London in metres would cause the numbers to be difficult to work with.

Prefixes are used to multiply each of the units. You will be familiar with centi (meaning 1/100), kilo (1000) and milli (1/1000) from centimetres, kilometres and millimetres.

There is a wide range of prefixes. The majority of quantities in scientific contexts will be quoted using the prefixes that are multiples of 1000. For example, a distance of 33 000 m would be quoted as 33 km.

The most common prefixes you will encounter are:

Prefix	Symbol	Multiplication factor		
Tera	T	10^{12}	1 000 000 000 000	
Giga	G	10^{9}	1 000 000 000	
Mega	M	10^{6}	1 000 000	
kilo	k	10^{3}	1000	
deci	d	10^{-1}	0.1	1/10
centi	c	10^{-2}	0.01	1/100
milli	m	10^{-3}	0.001	1/1000
micro	µ	10^{-6}	0.000 001	1/1 000 000
nano	n	10^{-9}	0.000 000 001	1/1 000 000 000
pico	p	10^{-12}	0.000 000 000 001	1/1 000 000 000 000
femto	f	10^{-15}	0.000 000 000 000 001	1/1 000 000 000 000 000

Activity 1

Which SI unit and prefix would you use for the following quantities?

1. The time between heart beats

2. The length of a leaf

3. The distance that a migratory bird travelled each year

4. The width of a cheek cell

5. The mass of a rabbit

6. The mass of iron in the body

7. The volume of the trunk of a large tree

Sometimes, there are units that are used that are not combinations of SI units and prefixes.

These are often multiples of units that are helpful to use. For example, one litre is 0.001 m^3, or one day is 86 400 seconds.

Activity 2

Choose the most appropriate unit, and estimate the size of each of the following.

1. The mass of an elephant
2. The mass of an earthworm
3. The volume of water in a teardrop
4. The volume of water in a pond
5. The time taken for a sunflower to grow
6. The temperature difference between the blood in the heart and in the ear on a cold day

Activity 3

Put the following in order of size:

height of an elephant; length of DNA strand; width of a hair; height of a tree; width of a sodium ion; length of a nerve cell; length of a heart; width of a red blood cell; size of a virus; length of a finger; length of a mosquito; length of a human digestive system; width of a field; length of a water molecule.

Important vocabulary for practical work

You will have come across most of the words used in practical work in your GCSE studies. It is important that you use the right definition for each word.

Activity 4

Join the boxes to link the word to its definition.

Accurate	A statement suggesting what may happen in the future.
Data	An experiment that gives the same results when a different person carries it out, or a different set of equipment or technique is used.
Precise	A measurement that is close to the true value.
Prediction	An experiment that gives the same results when the same experimenter uses the same method and equipment.
Range	Physical, chemical or biological quantities or characteristics.
Repeatable	A variable that is kept constant during an experiment.
Reproducible	A variable that is measured as the outcome of an experiment.
Resolution	This is the smallest change in the quantity being measured (input) of a measuring instrument that gives a perceptible change in the reading.
Uncertainty	The interval within the true value can be expected to lie.
Variable	The spread of data, showing the maximum and minimum values of the data.
Control variable	Measurements where repeated measurements show very little spread.
Dependent variable	Information, in any form, that has been collected.

Cells

All life on Earth exists as cells. These have basic features in common.

Activity 5

Complete the table.

Structure	Function
Cell-surface membrane	
Chloroplast	
Cell vacuole	
Mitochondria	
Nucleus	
Cell wall	
Chromosomes	
Ribosomes	

Draw the structure of a plant cell and an animal cell.

On each cell, add labels showing each of the structures in the table, if they exist.

Photosynthesis and respiration

Two of the most important reactions that take place in living things are photosynthesis and respiration. They both involve transfer of energy.

Activity 6

Complete the table.

	Photosynthesis	Aerobic respiration
Which organisms carry out this process?		
Where in the organisms does the process take place?		
Energy store at the beginning of the process	Sun	
Energy store at the end of the process		In cells
Reactants needed for the process		
Products of the process		
Overall word equation		
Balanced symbol equation for the overall process		

Which of the answers for aerobic respiration would be different for anaerobic respiration? Add these answers to the table in a different colour.

Principles of moving across boundaries

In biology, many processes involve moving substances across boundaries.

Activity 7

Match the examples to the principle(s) involved. For each, give a brief description of why it is relevant.

Principles	Examples
Osmosis	**Examples:**
	Drinking a sports drink after exercise
Diffusion	Gas exchange in the lungs
	Absorbing nutrients from food into the body
Active transport	Moving ions into cells
	The effect of salt on slugs
Changing surface area or length	Penguins huddling together to keep warm
	Potato pieces get heavier when put in pure water
	Potato pieces get lighter when put in very salty water
	Cacti do not have thin, large leaves

Activity 8

Huntington's disease is an example of a disease where the mutation causing the disease is dominant.

h: normal (recessive)

H: mutation (dominant)

		Paternal alleles	
		H	h
Maternal alleles	h		
	h		

Cystic fibrosis is an example of a disease where the mutation causing the disease is recessive.

F: normal (recessive)

f: mutation (dominant)

		Paternal alleles	
		F	f
Maternal alleles	F		
	f		

For each of the Punnett squares:

1. Complete the diagrams to show the alleles for each child.
2. State which parent and child is:
   - healthy
   - has the disease
   - a carrier.

Activity 8 (continued)

Each of the following statements is false. Re-write each one so that it becomes true.

1. The first Punnett square shows that one in every four children from this couple will have Huntington's disease.

2. The second Punnett square shows that there is a one in three chance that a child born to this couple will have cystic fibrosis.

3. All children of the second couple will either be carriers or suffer from cystic fibrosis.

4. The percentage of children who are sufferers on the diagram is the same as the percentage of children each couple will have who are sufferers.

5. Having one child who is born with cystic fibrosis means that the next three children will not have the disease.

6. A 50:50 chance is the same as a 0.25 probability.

Analysing data

Biological investigations often result in large amounts of data being collected. It is important to be able to analyse this data carefully in order to pick out trends.

Activity 9: Mean, media, mode and scatter graphs

A student investigated an area of moorland where succession was occurring. She used quadrats to measure the area covered by different plant species, bare ground and surface water every 10 metres along a transect. She also recorded the depth of soil at each quadrat. Her results are shown in the table.

	Area covered in each quadrat A to E in cm^2				
	A	B	C	D	E
Bog moss	55	40	10	–	–
Bell heather	–	–	–	15	10
Sundew	10	5	–	–	–
Ling	–	–	–	15	20
Bilberry	–	–	–	15	25
Heath grass	–	–	30	10	5
Soft rush	–	30	20	5	5
Sheep's fescue	–	–	25	35	30
Bare ground	20	15	10	5	5
Surface water	15	10	5	–	–
Soil depth / cm	3.2	4.7	8.2	11.5	14.8

– indicates zero cover.

Calculate:

1. the mode area of soft rush in the sample

2. the mean soil depth

3. the median amount of bare ground in the sample.

Activity 9: Mean, media, mode and scatter graphs (continued)

Use the data from the table to plot a scatter graph of soil depth against the area covered by bare ground, soft rush and bog moss (use different colours or markers for each).

Activity 9: Mean, media, mode and scatter graphs (continued)

4. What conclusions does your graph suggest?

5. How confident are you in these conclusions?

Activity 10: Analysing tables

Lung cancer, chronic bronchitis and coronary heart disease (CHD) are associated with smoking. Tables 1 and 2 give the total numbers of deaths from these diseases in the UK in 1974.

Table 1 Men

Age/years	Number of deaths (in thousands)		
	lung cancer	chronic bronchitis	coronary heart disease
35-64	11.5	4.2	31.7
65-74	12.6	8.5	33.3
75+	5.8	8.1	29.1
Total (35-75+)	29.9	20.8	94.1

Table 2 Women

Age/years	Number of deaths (in thousands)		
	lung cancer	chronic bronchitis	coronary heart disease
35–64	3.2	1.3	8.4
65–74	2.6	1.9	18.2
75+	1.8	3.5	42.3
Total (35–75+)	7.6	6.7	68.9

Activity 10: Analysing tables (continued)

1. Of the men who died aged 35-64 from one of these three causes, what percentage of them died of lung cancer?

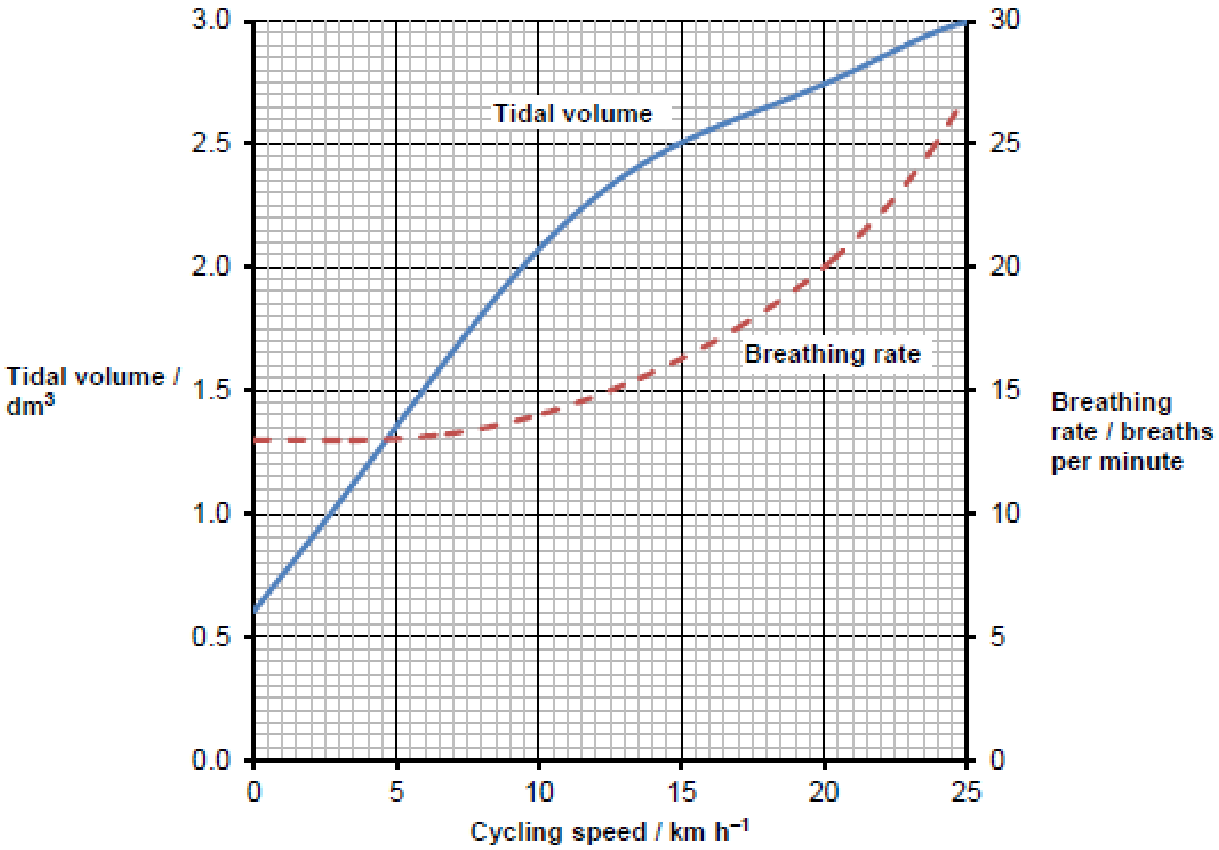
2. What percentage of deaths from chronic bronchitis in women happened to women aged 65-74?

3. Deaths from lung cancer drop as people get older. Is there a bigger percentage difference for men or women from 35-64 to 75+?

4. What fraction of coronary heart disease deaths of men over 34 are in the 75+ bracket? What about for women?

Activity 11: Analysing complex graphs

The volume of air breathed in and out of the lungs during each breath is called the tidal volume. The breathing rate and tidal volume were measured for a cyclist pedaling at different speeds. The graph shows the results.



1. What was the tidal volume when the cycling speed was 17 km h^{-1}?
2. What was the breathing rate when the cycling speed was 8 km h^{-1}?
3. What was the change in breathing rate when the cyclist changed from 10 to 20 km h^{-1}? Express this as a percentage.
4. At what speed did the breathing rate start to increase?
5. The tidal volume increased linearly with cycling speed up to about 10 km h^{-1}. Calculate the increase in volume for each increase in speed of 1 km h^{-1}.
6. For this initial linear section, what is the equation of the tidal volume line? Hint:

use $y=mx + c$

Part 3

Prerequisite knowledge check:

1. Vocabulary
2. Plants and animal cell structure
3. Biological molecules

(Level: Standard demand)

Task: Answer all the questions on the above 3 topics (pages 25-28)

Due date: 26th June 2020

Email to: sixthform@sta.islington.sch.uk

Vocabulary

It is very important that you are able to use scientific vocabulary accurately. There are many biological terms that you will be familiar with from your GCSE science course and it is now essential that you can understand and use them appropriately. Complete the following task and questions, and then compare your results with the Answers. Revise any areas where you have made mistakes.

Task

Use the biological terms below to complete the definitions in the table. Some terms have not been included to provide an extra challenge.

tissue photosynthesis cytoplasm living organisms high homeostasis internal concentrated	enzyme active transport DNA diffusion protein identical similar	bacteria nucleus active site low dilute water chain

Scientific word	Definition
Activation energy	Energy needed to make a reaction take place
……………..	Place on the enzyme molecule where the substrate fits
A…………….. t……………..	Movement of substance against a concentration gradient requiring ……………..
……………..	A single-celled micro-organism with no nucleus
Cell	Fundamental building block of …………….. ……………..
Chromosome	Made up from ...., found in the nucleus
C……………..	Found in all living cells where chemical reactions take place
Denatured	When the shape of an enzyme molecule changes so it is not able to function
D……………..	Net movement of molecules from an area of .... concentration to one of .... concentration
E……………..	Biological catalyst that .... the rate of reaction
Food ……………..	Feeding relationship between different organisms in an ecosystem
Gene	A part of DNA that codes for a ……………..
H……………..	Maintaining a constant ....environment
Mitosis	Cell division in which two .... daughter cells are produced
N……………..	An organelle that contains the genetic material and controls cell activity

Vocabulary

Scientific word	Definition
Osmosis	Diffusion of …………….. from a …………….. to a more …………….. solution
P……………..	Process carried out by …………….. in which light.................... is used to produce glucose
Respiration	Process where g… ....is broken down to provide energy in all cells
T……………..	A group of cells that have a.................... structure and function

Questions

1 Where in the cell do the chemical reactions take place?

2 In which process is light energy used to produce glucose?

3 Define the term 'respiration'.

4 What is a gene?

5 What is the term used to describe the loss of function by enzymes?

6 What is tissue made up of?

Plant and Animal Cell Structure

Cells are the basic building blocks of all living things. There are many similarities and differences between plant and animal cells that you would have studied in your GCSE science course. Complete the following tasks and questions.

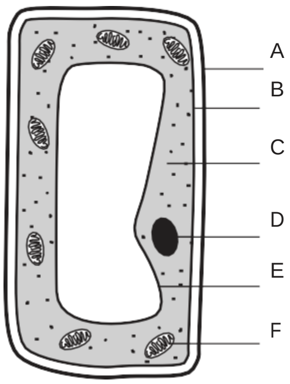
Task 1

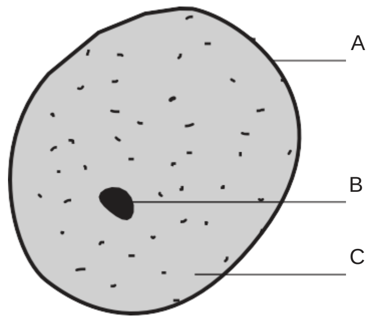
Complete the table below, stating the function of each feature. Tick (✓) which cell type the feature is present in and place a cross (✗) where it does not exist.

Feature	Function	Plant	Animal
Cellulose cell wall			
Cell (plasma) membrane			
Nucleus			
Cytoplasm			
Large permanent vacuole			

Task 2

Label the plant and animal cells below.





Questions

1 What structures are usually present in all cells, whether plant or animal?

2 Which cell structure is responsible for controlling the entry and exit of substances into and out of the cell?

3 What structures are only present in palisade cells?

4 Which process occurs in the chloroplast?

5 State the function of the nucleus.

6 Where in the plant cell would you find cell sap?

7 What is the function of the cellulose cell wall?

8 Where in the cell do most of the chemical reactions take place?

Biological Molecules

Different types of food are needed in correct amounts to maintain a healthy body. The main food groups are carbohydrates, lipids and proteins.

Complete the following task and questions.

Task

Complete the table below by placing a tick (✓) if the statement is correct for each food group or a cross (✗) if incorrect.

Statement	Carbohydrates	Lipids	Proteins
Major component found in the plant cell wall – cellulose			
Provides thermal insulation			
Can be either found as fats (animals) or oils (plants)			
Needed to build up muscles in animals			
Main compound used in respiration			
Amino acids are the building blocks			
Made up of fatty acids and glycerol			
Examples include enzymes, hormones and haemoglobin			
Includes glucose, sucrose and starch			
Denature/break down at high temperature			

Questions

1 Name the compound that is the source of energy in respiration.

2 What are built up from amino acids?

3 Which compound serves as a reserve source of energy in plants and animals?

4 What has a structural role in the plant cell wall?

5 List two functions of lipids.

6 What compound is made up of glycerol and fatty acids?

7 This forms compounds that carry oxygen in the blood.

8 Name the storage molecule found in plant cells.

Part 4

Learning Definitions, Key terms & more Maths Skills:

*1. **Practical Science**: Define terms*
*2. **Foundation Biology**: Learn and Recall answers.*
*3. **Maths**: Check your skills*
(Level: High demand)

Task: Follow the instructions given and do all the Practice questions (pages 29-46)

Due Date: Sep 2020
Bring to first lesson

Retrieval questions

You need to be confident about the definitions of terms that describe measurements and results in A Level Biology.

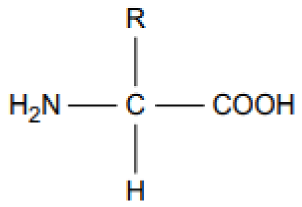
Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

Practical science key terms

When is a measurement valid?	when it measures what it is supposed to be measuring
When is a result accurate?	when it is close to the true value
What are precise results?	when repeat measurements are consistent/agree closely with each other
What is repeatability?	how precise repeated measurements are when they are taken by the *same* person, using the *same* equipment, under the *same* conditions
What is reproducibility?	how precise repeated measurements are when they are taken by *different* people, using *different* equipment
What is the uncertainty of a measurement?	the interval within which the true value is expected to lie
Define measurement error	the difference between a measured value and the true value
What type of error is caused by results varying around the true value in an unpredictable way?	random error
What is a systematic error?	a consistent difference between the measured values and true values
What does zero error mean?	a measuring instrument gives a false reading when the true value should be zero
Which variable is changed or selected by the investigator?	independent variable
What is a dependent variable?	a variable that is measured every time the independent variable is changed
Define a fair test	a test in which only the independent variable is allowed to affect the dependent variable
What are control variables?	variables that should be kept constant to avoid them affecting the dependent variable

Biological molecules

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

What are monomers?	smaller units from which larger molecules are made
What are polymers?	molecules made from a large number of monomers joined together
What is a condensation reaction?	a reaction that joins two molecules together to form a chemical bond whilst eliminating of a molecule of water
What is a hydrolysis reaction?	a reaction that breaks a chemical bond between two molecules and involves the use of a water molecule
What is a monosaccharide?	monomers from which larger carbohydrates are made
How is a glycosidic bond formed?	a condensation reaction between two monosaccharides
Name the three main examples of polysaccharides	glycogen, starch, cellulose
Describe Benedict's test for reducing sugars	gently heat a solution of a food sample with an equal volume of Benedict's solution for five minutes, the solution turns orange/brown if reducing sugar is present
Name the two main groups of lipids	phospholipids, triglycerides (fats and oils)
Give four roles of lipids	source of energy, waterproofing, insulation, protection
What is an ester bond?	a bond formed by a condensation reaction between glycerol and a fatty acid
Describe the emulsion test for lipids	mix the sample with ethanol in a clean test tube, shake the sample, add water, shake the sample again, a cloudy white colour indicates that lipid is present
What are the monomers that make up proteins?	amino acids
Draw the structure of an amino acid	
How is a peptide bond formed?	a condensation reaction between two amino acids
What is a polypeptide?	many amino acids joined together
Describe the biuret test for proteins	mix the sample with sodium hydroxide solution at room temperature, add very dilute copper(II) sulfate solution, mix gently, a purple colour indicates that peptide bonds are present
How does an enzyme affect a reaction?	it lowers the activation energy
Give five factors which can affect enzyme action	temperature, pH, enzyme concentration, substrate concentration, inhibitor concentration
What is a competitive inhibitor?	a molecule with a similar shape to the substrate, allowing it to occupy the active site of the enzyme
What is a non-competitive inhibitor?	a molecule that changes the shape of the enzyme by binding somewhere other than the active site.

Basic components of living systems

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

What is the formula to calculate magnification?	$\text{magnification} = \frac{\text{size of image}}{\text{actual size of object}}$
Why are cells stained before being viewed with a light microscope?	staining increases contrast between different cell components, makes them visible, and allows them to be identified
What is an eyepiece graticule?	a glass disc that fits on top of the eyepiece lens that is marked with a fine scale from 1 to 100
What is a stage micrometer?	a microscope slide with a very accurate scale in micrometers (μ) engraved on it
What is a scientific drawing?	a labelled line drawing that is used to highlight particular features and does not include unnecessary detail or shading, it should always have a title and state the magnification
What is magnification?	how many times larger an image is than the actual size of the object being viewed
What is resolution?	the ability to see individual objects as separate entities
What is the function of the nucleus?	controls the metabolic activities of the cell as it contains genetic information in the form of DNA
What is the nucleolus?	area within the nucleus that is responsible for producing ribosomes
What is the function of mitochondria?	site of production of ATP in the final stages of cellular respiration
What are vesicles?	membranous sacs that are used to transport materials in the cell
What are lysosomes?	specialised forms of vesicles with hydrolytic enzymes that break down waste material in cells
What is the role of the cytoskeleton?	controls cell movement, movement of organelles within the cell, and provides mechanical strength to the cell
Name the three types of cytoskeletal filaments	microfilaments, microtubules, and intermediate fibres
Give two types of extension that protrude from some cells	flagella (whip-like protrusions) and cilia (tail-like protrusions)
What is the endoplasmic reticulum (ER)?	a network of membranes enclosing flattened sacs called cisternae
What are the functions of the two types of ER?	smooth ER – lipid and carbohydrate synthesis, and storage rough ER – synthesis and transport of proteins
What is the function of the Golgi apparatus?	plays a part in modifying proteins and packaging them into vesicles

Maths skills

1 Numbers and units

1.1 Units and prefixes

A key criterion for success in biological maths lies in the use of correct units and the management of numbers. The units scientists use are from the *Système Internationale* – the SI units. In biology, the most commonly used SI base units are metre (m), kilogram (kg), second (s), and mole (mol). Biologists also use SI derived units, such as square metre (m^2), cubic metre (m^3), degree Celsius (°C), and litre (l).

To accommodate the huge range of dimensions in our measurements they may be further modified using appropriate prefixes. For example, one thousandth of a second is a millisecond (ms). Some of these prefixes are illustrated in the table below.

Multiplication factor	Prefix	Symbol
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n

Practice questions

1 A burger contains 4 500 000 J of energy. Write this in:

a kilojoules **b** megajoules.

2 HIV is a virus with a diameter of between 9.0×10^{-8} m and 1.20×10^{-7} m.
Write this range in nanometres.

1.2 Powers and indices

Ten squared = 10 × 10 = 100 and can be written as 10^2. This is also called 'ten to the power of 2'.

Ten cubed is 'ten to the power of three' and can be written as $10^3 = 1000$.

The power is also called the index.

Fractions have negative indices:

one tenth = $10^{-1} = 1/10 = 0.1$
one hundredth = $10^{-2} = 1/100 = 0.01$

Any number to the power of 0 is equal to 1, for example, $29^0 = 1$.

If the index is 1, the value is unchanged, for example, $17^1 = 17$.

When multiplying powers of ten, you must *add* the indices.

So 100 × 1000 = 100 000 is the same as $10^2 \times 10^3 = 10^{2+3} = 10^5$

When dividing powers of ten, you must *subtract* the indices.

So 100/1000 = 1/10 = 10^{-1} is the same as $10^2/10^3 = 10^{2-3} = 10^{-1}$

But you can only do this when the numbers with the indices are the same.

So $10^2 \times 2^3 = 100 \times 8 = 800$

And you can't do this when adding or subtracting.

$10^2 + 10^3 = 100 + 1000 = 1100$

$10^2 - 10^3 = 100 - 1000 = -900$

Remember: You can only add and subtract the indices when you are multiplying or dividing the numbers, not adding or subtracting them.

Practice questions

3 Calculate the following values. Give your answers using indices.

a $10^8 \times 10^3$ **b** $10^7 \times 10^2 \times 10^3$

c $10^3 + 10^3$ **d** $10^2 - 10^{-2}$

4 Calculate the following values. Give your answers with and without using indices.

a $10^5 \div 10^4$ **b** $10^3 \div 10^6$

c $10^2 \div 10^{-4}$ **d** $100^2 \div 10^2$

1.3 Converting units

When doing calculations, it is important to express your answer using sensible numbers. For example, an answer of 6230 μm would have been more meaningful expressed as 6.2 mm.

If you convert between units and round numbers properly, it allows quoted measurements to be understood within the scale of the observations.

To convert 488 889 m into km:

A kilo is 10^3 so you need to divide by this number, or move the decimal point three places to the left.

488 889 ÷ 10^3 = 488.889 km

However, suppose you are converting from mm to km: you need to go from 10^3 to 10^{-3}, or move the decimal point six places to the left.

333 mm is 0.000 333 km

Alternatively, if you want to convert from 333 mm to nm, you would have to go from 10^{-9} to 10^{-3}, or move the decimal point six places to the right.

333 mm is 333 000 000 nm

Practice questions

5 Calculate the following conversions:

a 0.004 m into mm **b** 130 000 ms into s

c 31.3 ml into μl **d** 104 ng into mg

6 Give the following values in a different unit so they make more sense to the reader.

Choose the final units yourself. (Hint: make the final number as close in magnitude to zero as you can. For example, you would convert 1000 m into 1 km.)

a 0.000 057 m **b** 8 600 000 μl **c** 68 000 ms **d** 0.009 cm

2 Decimals, standard form, and significant figures

2.1 Decimal numbers

A decimal number has a decimal point. Each figure *before* the point is a whole number, and the figures *after* the point represent fractions.

The number of decimal places is the number of figures *after* the decimal point. For example, the number 47.38 has 2 decimal places, and 47.380 is the same number to 3 decimal places.

In science, you must write your answer to a sensible number of decimal places.

Practice questions

1 New antibiotics are being tested. A student calculates the area of clear zones in Petri dishes in which the antibiotics have been used. List these in order from smallest to largest.

$0.0214\ cm^2$ $0.03\ cm^2$ $0.0218\ cm^2$ $0.034\ cm^2$

2 A student measures the heights of a number of different plants. List these in order from smallest to largest.

22.003 cm 22.25 cm 12.901 cm 12.03 cm 22 cm

2.2 Standard form

Sometimes biologists need to work with numbers that are very small, such as dimensions of organelles, or very large, such as populations of bacteria. In such cases, the use of scientific notation or standard form is very useful, because it allows the numbers to be written easily.

Standard form is expressing numbers in powers of ten, for example, 1.5×10^7 microorganisms.

Look at this worked example. The number of cells in the human body is approximately 37 200 000 000 000. To write this in standard form, follow these steps:

Step 1: Write down the smallest number between 1 and 10 that can be derived from the number to be converted. In this case it would be 3.72

Step 2: Write the number of times the decimal place will have to shift to expand this to the original number as powers of ten. On paper this can be done by hopping the decimal over each number like this:

until the end of the number is reached.

In this example that requires 13 shifts, so the standard form should be written as 3.72×10^{13}.

For very small numbers the same rules apply, except that the decimal point has to hop backwards. For example, 0.000 000 45 would be written as 4.5×10^{-7}.

Practice questions

3 Change the following values to standard form.

a 3060 kJ **b** 140 000 kg **c** 0.000 18 m **d** 0.000 004 m

4 Give the following numbers in standard form.

a 100 **b** 10 000 **c** 0.01 **d** 21 000 000

5 Give the following as decimals.

a 10^6 **b** 4.7×10^9 **c** 1.2×10^{12} **d** 7.96×10^{-4}

2.3 Significant figures

When you use a calculator to work out a numerical answer, you know that this often results in a large number of decimal places and, in most cases, the final few digits are 'not significant'. It is important to record your data and your answers to calculations to a reasonable number of significant figures. Too many and your answer is claiming an accuracy that it does not have, too few and you are not showing the precision and care required in scientific analysis.

Numbers to 3 significant figures (3 s.f.):

7.88 25.4 741

Bigger and smaller numbers with 3 significant figures:

0.000147 0.0147 0.245 39 400 96 200 000 (notice that the zeros before the figures and after the figures are *not* significant – they just show you how large the number is by the position of the decimal point).

Numbers to 3 significant figures where the zeros *are* significant:

207 4050 1.01 (any zeros between the other significant figures *are* significant). Standard form numbers with 3 significant figures:

9.42×10^{-5} 1.56×10^{8}

If the value you wanted to write to 3.s.f. was 590, then to show the zero was significant you would have to write:

590 (to 3.s.f.) or 5.90×10^2

Remember: For calculations, use the same number of figures as the data in the question with the lowest number of significant figures. It is not possible for the answer to be more accurate than the data in the question.

Practice questions

6 Write the following numbers to **i** 2 s.f. and **ii** 3 s.f.

a 7644 g

b 27.54 m

c 4.3333 g

d 5.995×10^{2} cm^3

7 The average mass of oxygen produced by an oak tree is 11800 g per year.

Give this mass in standard form and quote your answer to 2 significant figures.

3 Working with formulae

It is often necessary to use a mathematical formula to calculate quantities. You may be tested on your ability to substitute numbers into formulae or to rearrange formulae to find specific values.

3.1 Substituting into formulae

Think about the data you are given in the question. Write down the equation and then think about how to get the data to substitute into the equation. Look at this worked example.

A cheek cell has a 0.06 mm diameter. Under a microscope it has a diameter 12 mm. What is the magnification?

$$\text{magnification} = \text{image size (mm)} \div \text{object size (mm)} \text{ or } M = \frac{I}{O}$$

Substitute the values and calculate the answer:

$$M = 12\text{ mm}/0.06\text{ mm} = 12/0.06 = 200$$

Answer: magnification = ×200 (magnification has no units)

Sometimes an equation is more complicated and the steps need to be carried out in a certain order to succeed. A general principle applies here, usually known by the mnemonic BIDMAS. This stands for **B**rackets, **I**ndices (functions such as squaring or powers), **D**ivision, **M**ultiplication, **A**ddition, **S**ubtraction.

Practice questions

1 Calculate the magnification of a hair that has a width of 6.6 mm on a photograph. The hair is 165 µm wide.

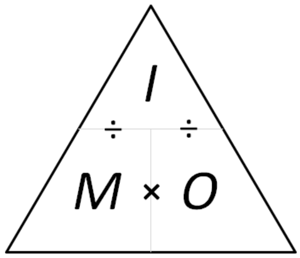
2 Estimate the area of a leaf by treating it as a triangle with base 2 cm and height 9 cm.

3 Estimate the area of a cell by treating it as a circle with a diameter of 0.7 µm. Give your answer in μm^2.

4 An *Amoeba* population starts with 24 cells. Calculate how many *Amoeba* cells would be present in the culture after 7 days if each cell divides once every 20 hours. Use the equation $N_t = N_0 \times 2^n$ where N_t = number after time t, N_0 = initial population, n = number of divisions in the given time t.

3.2 Rearranging formulae

Sometimes you will need to rearrange an equation to calculate the answer to a question. For example, the relationship between magnification, image size, and actual size of specimens in micrographs usually uses the equation $M = \frac{I}{O}$, where M is magnification, I is size of the image, and O = actual size of the object.



You can use the algebra you have learnt in Maths to rearrange equations, or you can use a triangle like the one shown.

Cover the quantity you want to find. This leaves you with either a fraction or a multiplication:

$M = I \div O$ $\quad$ $O = I \div M$ $\quad$ $I = M \times O$

Practice questions

1 A fat cell is 0.1 mm in diameter. Calculate the size of the diameter seen through a microscope with a magnification of ×50.

2 A Petri dish shows a circular colony of bacteria with a cross-sectional area of 5.3 cm^2. Calculate the radius of this area.

3 In a photograph, a red blood cell is 14.5 mm in diameter. The magnification stated on the image is ×2000. Calculate the real diameter of the red blood cell.

4 Rearrange the equation 34 = 2*a*/135 × 100 and find the value of *a.*

5 The cardiac output of a patient was found to be 2.5 $dm^3\,min^{-1}$ and their heart rate was 77 bpm. Calculate the stroke volume of the patient.

Use the equation: cardiac output = stroke volume × heart rate.

6 In a food chain, efficiency = $\frac{\text{biomass transferred}}{\text{biomass taken in}} \times 100$

A farmer fed 25 kg of grain to his chicken. The chicken gained weight with an efficiency of 0.84. Calculate the weight gained by the chicken.

4 Magnification

To look at small biological specimens you use a microscope to magnify the image that is observed. The microscope was developed in the 17th century. Anton van Leeuwenhoek used a single lens and Robert Hooke used two lenses. The lenses focus light from the specimen onto your retina to produce a magnified virtual image. The magnification at which observations are made depends on the lenses used.

4.1 Calculating the magnifying power of lenses

Lenses each have a magnifying power, defined as the number of times the image is larger than the real object. The magnifying power is written on the lens.

To find the magnification of the virtual image that you are observing, multiply the magnification powers of each lens used. For example, if the eyepiece lens is ×10 and the objective lens is ×40 the total magnification of the virtual image is 10 × 40 = 400.

Practice questions

1 Calculate the magnification of the virtual image produced by the following combinations of lenses:

a objective ×10 and eyepiece ×12

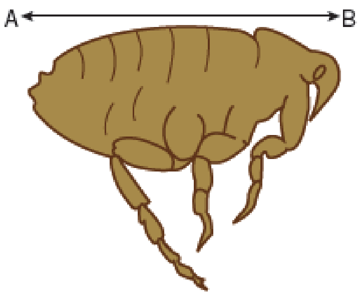
b objective ×40 and eyepiece ×15

4.2 Calculating the magnification of images

Drawings and photographs of biological specimens should always have a magnification factor stated. This indicates how much larger or smaller the image is compared with the real specimen.

The magnification is calculated by comparing the sizes of the image and the real specimen. Look at this worked example.

The image shows a flea which is 1.3 mm long. To calculate the magnification of the image, measure the image (or the scale bar if given) on the paper (in this example, the body length as indicated by the line A–B).



For this image, the length of the image is 42 mm and the length of the real specimen is 1.3 mm.

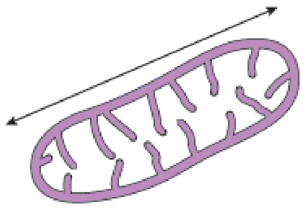
$$\text{magnification} = \frac{\text{length of image}}{\text{length of real specimen}} = 42/1.3 = 32.31$$

The magnification factor should therefore be written as ×32.31

Remember: Use the same units. A common error is to mix units when performing these calculations. Begin each time by converting measurements to the same units for both the real specimen and the image.

Practice questions

2 Calculate the magnification factor of a mitochondrion that is 1.5 µm long.



4.3 Calculating real dimensions

Magnification factors on images can be used to calculate the actual size of features shown on drawings and photographs of biological specimens. For example, in a photomicrograph of a cell, individual features can be measured if the magnification is stated. Look at this worked example.

The magnification factor for the image of the open stoma is ×5000.

This can be used to find out the actual size of any part of the cell, for example, the length of one guard cell, measured from A to B.

Step 1: Measure the length of the guard cell as precisely as possible. In this example the image of the guard cell is 52 mm long.

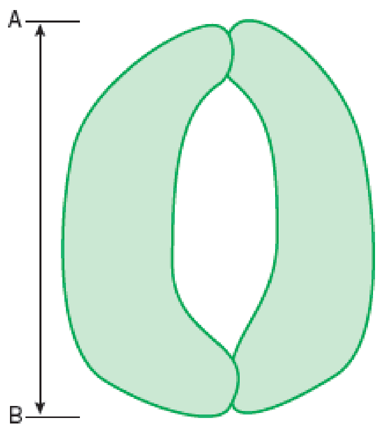
Step 2: Convert this measurement to units appropriate to the image. In this case you should use µm because it is a cell.

So the magnified image is 52 × 1000 = 52 000 µm

Step 3: Rearrange the magnification equation (see Topic 3.2) to get:

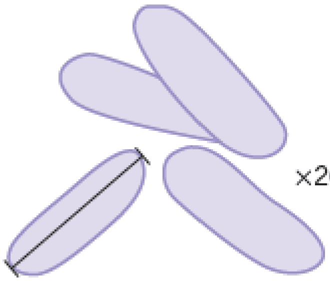
real size = size of image/magnification = 52 000/5000 = 10.4

So the real length of the guard cell is 10.4 µm.



Practice questions

3 Use the magnification factor to determine the actual size of a bacterial cell.



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5 Percentages and uncertainty

A percentage is simply a fraction expressed as a decimal. It is important to be able to calculate routinely, but is often incorrectly calculated in exams. These pages should allow you to practise this skill.

5.1 Calculating percentages as proportions

To work out a percentage, you must identify or calculate the total number using the equation:

$$\text{percentage} = \frac{\text{number you want as a percentage of total number}}{\text{total number}} \times 100\%$$

For example, in a population, the number of people who have brown hair was counted.

The results showed that in the total population of 4600 people, 1800 people had brown hair.

The percentage of people with brown hair is found by calculating:

$$\frac{\text{number of people with brown hair}}{\text{total number of people}} \times 100$$

$$= \frac{1800}{4600} \times 100 = 39.1\%$$

Practice questions

1 The table below shows some data about energy absorbed by a tree in a year and how some of it is transferred.

Energy absorbed by the tree in a year	3 600 000 kJ/m^2
Energy transferred to primary consumers	2240 kJ/m^2
Energy transferred to secondary consumers	480 kJ/m^2

Calculate the percentage of energy absorbed by the tree that is transferred to

a primary consumers

b secondary consumers.

2 One in 17 people in the UK has diabetes.
Calculate the percentage of the UK population that have diabetes.

5.2 Calculating the percentage change

When you work out an increase or a decrease as a percentage change, you must identify, or calculate, the total original amount:

$$\% \text{ increase} = \frac{\text{increase}}{\text{original amount}} \times 100$$

$$\% \text{ decrease} = \frac{\text{decrease}}{\text{original amount}} \times 100$$

Remember: When you calculate a percentage change, use the total *before* the increase or decrease, not the final total.

Practice questions

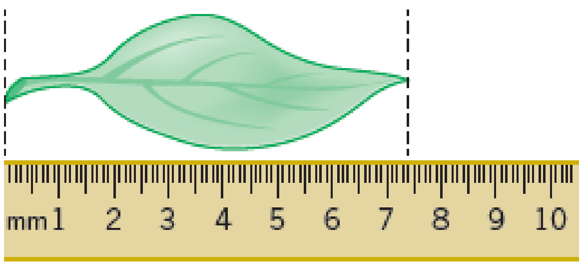
3 Convert the following mass changes as percentage changes.

Sucrose conc. / mol dm^{-3}	Initial mass / g	Final mass / g	Mass change / g	Percentage change in mass
0.9	1.79	1.06		
0.7	1.86	1.30		
0.5	1.95	1.70		
0.3	1.63	1.76		
0.1	1.82	2.55		

5.3 Measurement uncertainties

When you measure something, there will always be a small difference between the measured value and the true value. This may be because of the size of the scale divisions on your measuring equipment, or the difficulty of taking the measurement. This is called an uncertainty.

To estimate the uncertainty of a measurement with an instrument with a marked scale such as a ruler, a good rule of thumb is to let the uncertainty be equal to half the smallest division on the scale being used.



Using a ruler with a mm scale, the length of the leaf seems to be 74 mm. The smallest division is 1 mm, so the uncertainty is 0.5 mm.

The true length is therefore 74 mm +/− 0.5 mm.

Practice questions

4 Give the uncertainty for the following pieces of equipment:

a large measuring cylinder with 2 cm^3 divisions

b digital stopwatch timer measuring to the nearest hundredth of a second

c thermometer with 0.1 °C divisions.

5.4 Calculating percentage uncertainties

The uncertainty is the range of possible error either side of the true value due to the scale being used, so the value recorded for the measurement = closest estimate +/− uncertainty.

The difference between the true value and the maximum or minimum value is called the **absolute error**.

Once the absolute error has been established for a particular measurement, it is possible to express this as a percentage uncertainty or **relative error**. The calculation to use is:

$$\text{relative error} = \frac{\text{absolute error}}{\text{measured value}} \times 100\%$$

In the leaf example above, the absolute error is +/−0.5 mm.

The relative error is

therefore: 0.5/74 ×

100% = 0.7%

Practice questions

5 Complete the table to show the missing values in the last two columns.

Measurement made	Equipment used	Absolute error	Relative error
Length of a fluid column in a respirometer is 6 mm	mm scale	0.5 mm	
Volume of a syringe is 12 cm^3 of liquid	0.5 cm^3 divisions		
Change in mass of 1.6 g	balance with 2 d.p.		

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6 Scatter graphs and lines of best fit

The purpose of a scatter graph with a line of best fit is to allow visualisation of a trend in a set of data. The graph can be used to make calculations, such as rates, and also to judge the correlation between variables. It is easy to draw such a graph but also quite easy to make simple mistakes.

6.1 Plotting scatter graphs

The rules when plotting graphs are:

- Ensure that the graph occupies the majority of the space available:
  - In exams, this means more than half the space
  - Look for the largest number to help you decide the best scale
  - The scale should be based on 1, 2, or 5, or multiples of those numbers
- Ensure that the dependent variable that you measured is on the *y*-axis and the independent variable that you varied is on the *x*-axis
- Mark axes using a ruler and divide them clearly and equidistantly (i.e. 10, 20, 30, 40 not 10, 15, 20, 30, 45)
- Ensure that both axes have full titles and units are clearly labelled
- Plot the points accurately using sharp pencil ‘x’ marks so the exact position of the point is obvious
- Draw a neat best fit line, either a smooth curve or a ruled line. It does not have to pass through all the points. Move the ruler around aiming for:
  - as many points as possible on the line
  - the same number of points above and below the line
- If the line starts linear and then curves, be careful not to have a sharp corner where the two lines join. Your curve should be smooth
- Confine your line to the range of the points. Never extrapolate the line beyond the range within which you measured
- Add a clear, concise title.

Remember: Take care, use only pencil and check the positions of your points.

Practice questions

1 Use your calculated data in Topic 5.2 question 3 to plot a graph of % mass change against sucrose concentration.

2 For each of the tables of data:

a Plot a scatter graph

b Draw a line of best fit

c Describe the correlation

Turbidity of casein samples at different pH	
pH	**% transmission (blue light)**
9.00	99
8.00	99
6.00	87
5.00	67
4.75	26
4.50	30
4.00	24
3.75	43
3.50	64

Sodium bicarbonate concentration / %	Rate of oxygen production by pondweed / $mm^3\ s^{-1}$
6.5	1.6
5.0	2.1
3.5	1.2
2.0	0.8
1.0	0.5
0.5	0.2

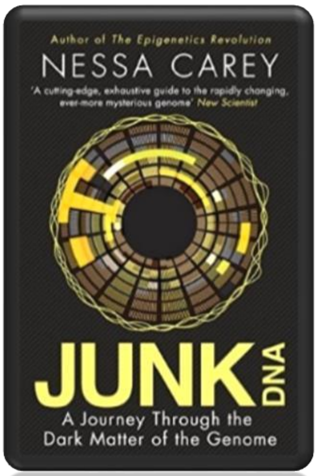
Part 5

Biology Beyond A Level Curriculum

Recommendation of books, videos and websites.

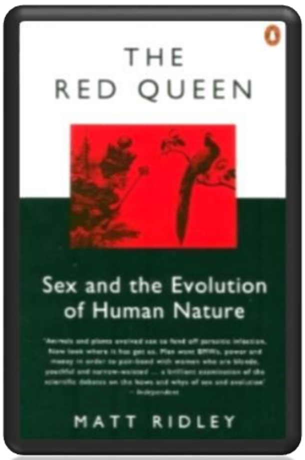
Book Recommendations

Kick back this summer with a good read. The books below are all popular science books and great for extending your understanding of Biology

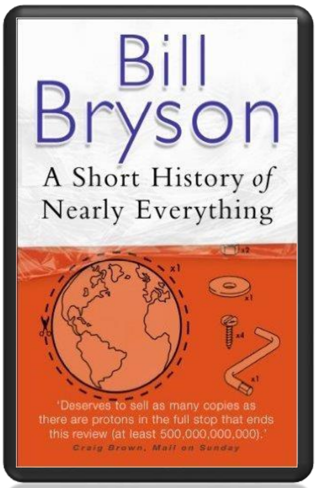


The Red Queen

It's all about sex. Or sexual selection at least. This book will really help your understanding of evolution and particularly the fascinating role of sex in evolution. Available at amazon.co.uk



Junk DNA
Our DNA is so much more complex than you probably realize, this book will really deepen your understanding of all the work you will do on Genetics. Available at amazon.co.uk



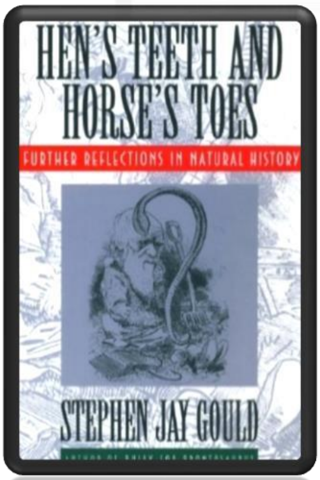
A Short History of Nearly Everything

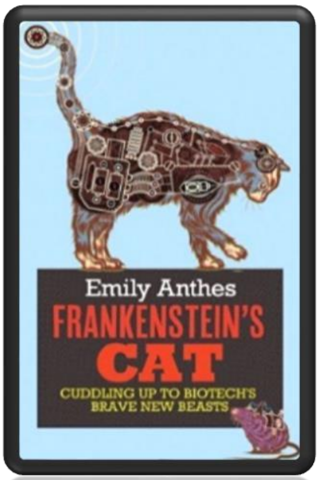
A whistle-stop tour through many aspects of history from the Big Bang to now. This is a really accessible read that will re-familiarise you with common concepts and introduce you to some of the more colourful characters from the history of science! Available at amazon.co.uk

Studying Geography as well?

Hen's teeth and horses toes

Stephen Jay Gould is a great Evolution writer and this book discusses lots of fascinating stories about Geology and evolution. Available at amazon.co.uk

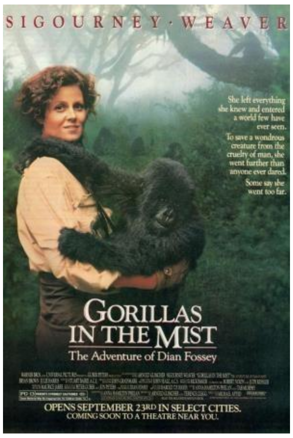




An easy read..
Frankenstein's cat
Discover how glow in the dark fish are made and more great Biotechnology breakthroughs. Available at amazon.co.uk

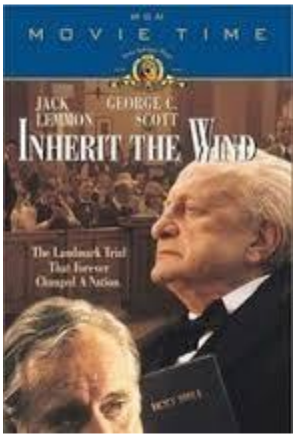
Movie Recommendations

Everyone loves a good story and everyone loves some great science. Here are some of the picks of the best films based on real life scientists and discoveries. You won't find Jurassic Park on this list, we've looked back over the last 50 years to give you our top 5 films you might not have seen before. Great watching for a rainy day.

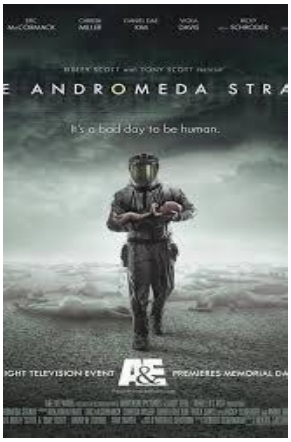


Gorillas in the Mist (1988)
An absolute classic that retells the true story of the life and work of Dian Fossey and her work studying and protecting mountain gorillas from poachers and habitat loss. A tear jerker.

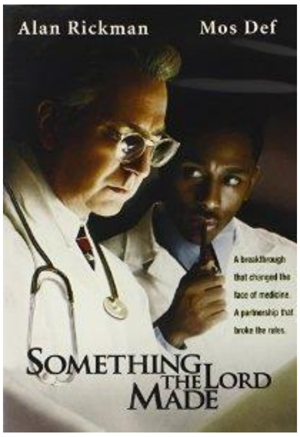
Inherit The Wind (1960)
Great if you can find it. Based on a real life trial of a teacher accused of the crime of teaching Darwinian evolution in school in America. Does the debate rumble on today?



Andromeda Strain (1971)
Science fiction by the great thriller writer Michael Cricthon (he of Jurassic Park fame). Humans begin dying when an alien microbe arrives on Earth.



Lorenzo's Oil (1992)
Based on a true story. A young child suffers from an autoimmune disease. The parents research and challenge doctors to develop a new cure for his disease.



Something the Lord Made (2004)
Professor Snape (the late great Alan Rickman) in a very different role. The film tells the story of the scientists at the cutting edge of early heart surgery as well as issues surrounding racism at the time.

There are some great TV series and box sets available too, you might want to check out: Blue Planet, Planet Earth, The Ascent of Man, Catastrophe, Frozen Planet, Life Story, The Hunt and Monsoon.

If you have 30 minutes to spare, here are some great presentations (and free!) from world leading scientists and researchers on a variety of topics. They provide some interesting answers and ask some thought-provoking questions. Use the link or scan the QR code to view:

A New Superweapon in the Fight Against Cancer
Available at :
http://www.ted.com/talks/paula_hammond_a_new_superweapon_in_the_fight_against_cancer?language=en
Cancer is a very clever, adaptable disease. To defeat it, says medical researcher and educator Paula Hammond, we need a new and powerful mode of attack.

Why Bees are Disappearing
Available at :
http://www.ted.com/talks/marla_spivak_why_bees_are_disappearing?language=en
Honeybees have thrived for 50 million years, each colony 40 to 50,000 individuals coordinated in amazing harmony. So why, seven years ago, did colonies start dying en-masse?

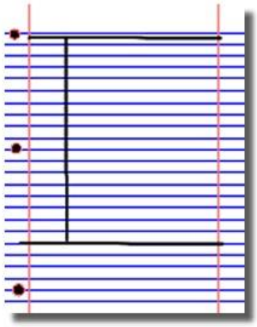
Why Doctors Don't Know About the Drugs They Prescribe
Available at :
http://www.ted.com/talks/ben_goldacre_what_doctors_don_t_know_about_the_drugs_they_prescribe?language=en
When a new drug gets tested, the results of the trials should be published for the rest of the medical world — except much of the time, negative or inconclusive findings go unreported, leaving doctors and researchers in the dark.

Growing New Organs
Available at :
http://www.ted.com/talks/anthony_atala_growing_organs_engineering_tissue?language=en
Anthony Atalla's state-of-the-art lab grows human organs — from muscles to blood vessels to bladders, and more.

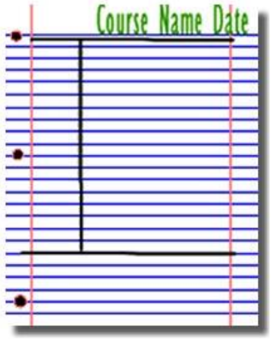
Research activities

Research, reading and note making are essential skills for A level Biology study. For the following task you are going to produce 'Cornell Notes' to summarise your reading.

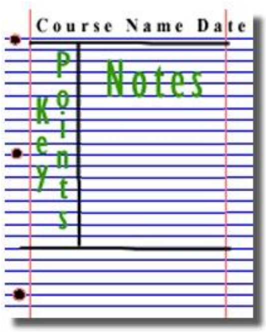
1. Divide your page into three sections like this



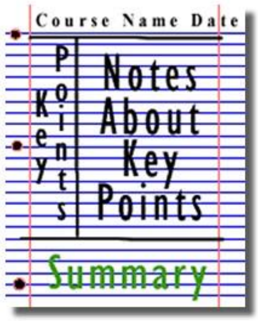
2. Write the name, date and topic at the top of the page



3. Use the large box notes. Leave identify a space between separate idea. box Abbreviate where possible.



4. Review and to make the key points in the left hand



5. Write a summary of the main ideas in the bottom space

Images taken from http://coe.jmu.edu/learningtoolbox/cornellnotes.html

Research activities

The Big Picture is an excellent publication from the Wellcome Trust. Along with the magazine, the company produces posters, videos and other resources aimed at students studying for GCSEs and A level.
For each of the following topics, you are going to use the resources to produce one page of Cornell style notes.
Use the links of scan the QR code to take you to the resources.

Topic 1: The Cell
Available at: http://bigpictureeducation.com/cell
The cell is the building block of life. Each of us starts from a single cell, a zygote, and grows into a complex organism made of trillions of cells. In this issue, we explore what we know – and what we don't yet know – about the cells that are the basis of us all and how they reproduce, grow, move, communicate and die.

Topic 2: The Immune System
Available at:
http://bigpictureeducation.com/immune
The immune system is what keeps us healthy in spite of the many organisms and substances that can do us harm. In this issue, explore how our bodies are designed to prevent potentially harmful objects from getting inside, and what happens when bacteria, viruses, fungi or other foreign organisms or substances breach these barriers.

Topic 3: Exercise, Energy and Movement
Available at:
http://bigpictureeducation.com/exercise-energy-and-movement
All living things move. Whether it's a plant growing towards the sun, bacteria swimming away from a toxin or you walking home, anything alive must move to survive. For humans though, movement is more than just survival – we move for fun, to compete and to be healthy. In this issue we look at the biological systems that keep us moving and consider some of the psychological, social and ethical aspects of exercise and sport.

Topic 4: Populations Available at: http://bigpictureeducation.com/populations What's the first thing that pops into your mind when you read the word population? Most likely it's the ever-increasing human population on earth. You're a member of that population, which is the term for all the members of a single species living together in the same location. The term population isn't just used to describe humans; it includes other animals, plants and microbes too. In this issue, we learn more about how populations grow, change and move, and why understanding them is so important.

Topic 4: Populations
Available at: http://bigpictureeducation.com/health-and-climate-change
The Earth's climate is changing. In fact, it has always been changing. What is different now is the speed of change and the main cause of change – human activities. This issue asks: What are the biggest threats to human health? Who will suffer as the climate changes? What can be done to minimise harm? And how do we cope with uncertainty?