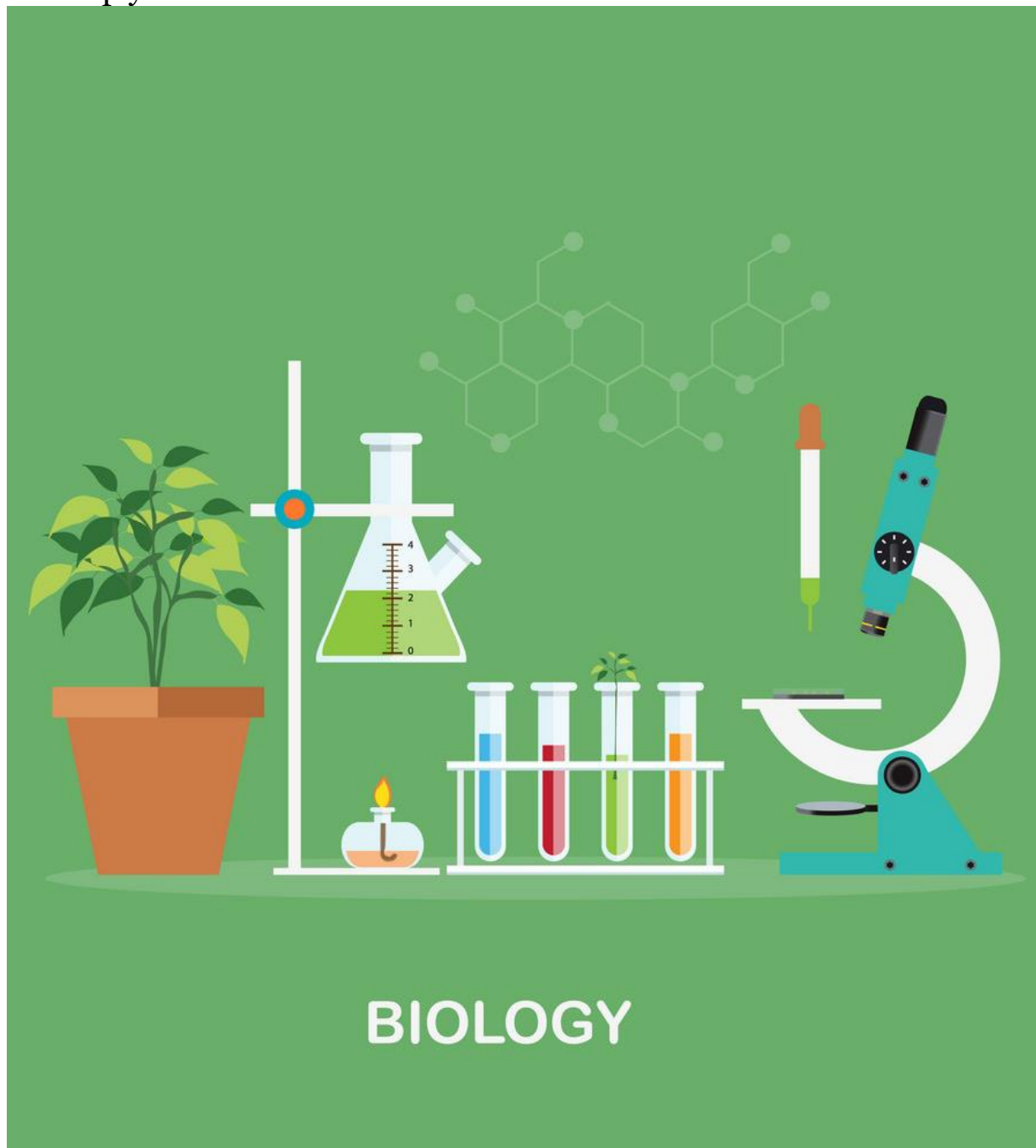


This resource will support you in the summer term to get yourself ready to study A level Biology in September. It is aimed to be used after you complete your GCSE to brush up your knowledge and develop your skills.



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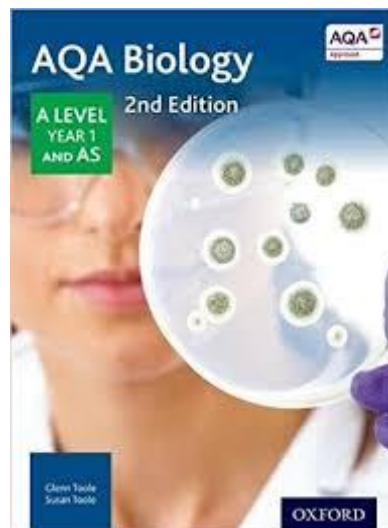
A level Biology at Kimberley College

Biology is a popular choice for students who wish to study sciences or who wish to include a science to complement their other subjects. Biology at A Level provides an excellent grounding for all biological university courses.

AQA A Level Biology

Kimberley college follows the AQA specification. We use the core textbook AQA Biology AS Textbook (ISBN: 978-0-19-835176-4) which is shown below. The course is split into eight teaching units:

1. Biological molecules
2. Cells
3. Organisms exchange substance with their environment
4. Genetic information, variation and relationship between organisms
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



Practical Skills

Practical work is at the heart of all good science teaching, and the required practical activities will give students the opportunity to embed their skills and knowledge. The A-level practical ensure that students can access the Common Practical Assessment Criteria (CPAC) requirements of the course.

Assessment

Paper 1	+	Paper 2	+	Paper 3
What's assessed <ul style="list-style-type: none">Any content from topics 1– 4, including relevant practical skills		What's assessed <ul style="list-style-type: none">Any content from topics 5–8, including relevant practical skills		What's assessed <ul style="list-style-type: none">Any content from topics 1–8, including relevant practical skills
Assessed <ul style="list-style-type: none">written exam: 2 hours91 marks35% of A-level		Assessed <ul style="list-style-type: none">written exam: 2 hours91 marks35% of A-level		Assessed <ul style="list-style-type: none">written exam: 2 hours78 marks30% of A-level
Questions <ul style="list-style-type: none">76 marks: a mixture of short and long answer questions15 marks: extended response questions		Questions <ul style="list-style-type: none">76 marks: a mixture of short and long answer questions15 marks: comprehension question		Questions <ul style="list-style-type: none">38 marks: structured questions, including practical techniques15 marks: critical analysis of given experimental data25 marks: one essay from a choice of two titles

Further information

<https://filestore.aqa.org.uk/resources/biology/specifications/AQA-7401-7402- SP-2015.PDF>

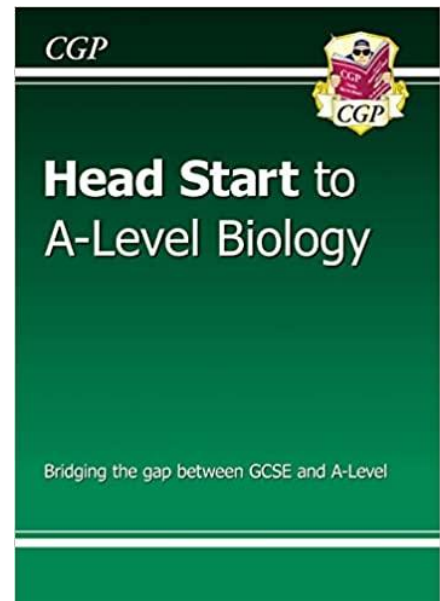
Tidying up GCSE

Two good resources to ensure you have fully understood the GCSE content and are ready for A Level:

1. Seneca Learning – check you have completed all the relevant sections. If you did combined science, you should sign up to the AQA GCSE Biology single science and complete all the parts.

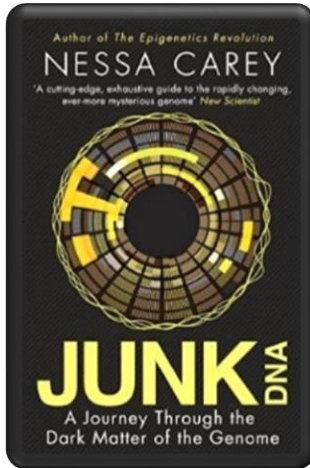


2. CGP Head Start – CGP offer a concise summary of the content that bridges GCSE and A Level – recommended for all, but an absolute must for those that did combined



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

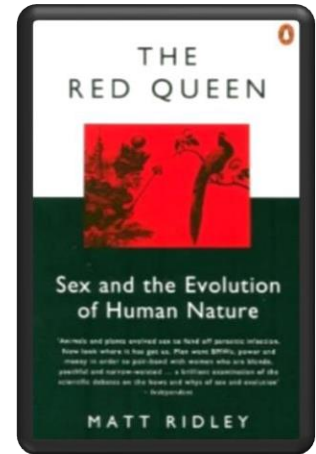


Junk DNA

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.

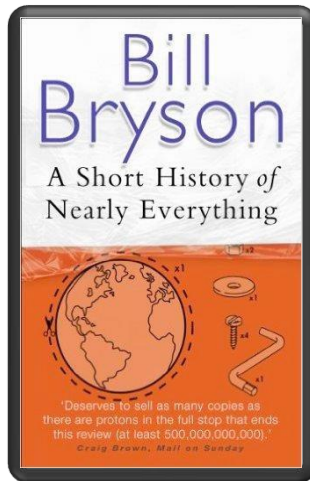
The Red Queen

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.



A Short History of Nearly Everything

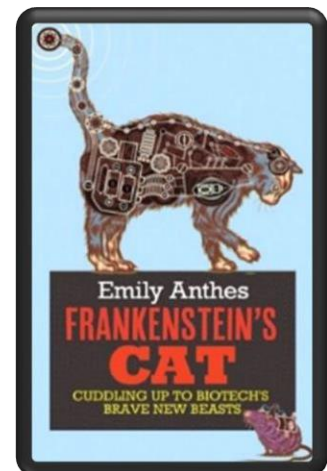
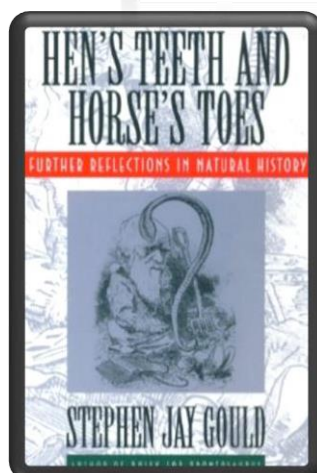
A whistle-stop tour through many aspects of history from the Big Bang to now. This is a really accessible read that will re-familiarise you with common concepts and introduce you to some of the more colourful characters from the history of science!



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.



An easy read..

Frankenstein's cat

Discover how glow in the dark fish are made and more great Biotechnology breakthroughs.

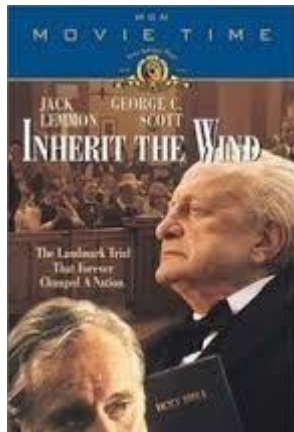
Movie Recommendations

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.



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?



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.



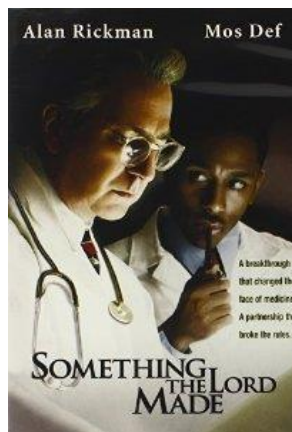
Andromeda Strain (1971)

Science fiction by the great thriller writer Michael Crichton (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.

You might also enjoy GATTACCA, The Island and My Sister's Keeper. 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, Seaspiracy.

Presentation Recommendations

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.



Developing Knowledge and Tasks

A level Biology will use your knowledge from GCSE and build on this to help you understand new and more demanding ideas. Complete the following tasks to make sure your knowledge is up to date and you are ready to start studying: **You don't need to complete all 10 tasks** but your Biology teachers in September may want to see evidence that you have completed at least two!

DNA and the Genetic Code

In living organisms, nucleic acids (DNA and RNA) have important roles and functions related to their properties. The sequence of bases in the DNA molecule determines the structure of proteins, including enzymes.

The double helix and its four bases store the information that is passed from generation to generation. The sequence of the base pairs adenine, thymine, cytosine and guanine tell ribosomes in the cytoplasm how to construct amino acids into polypeptides and produce every characteristic we see. DNA can mutate leading to diseases including cancer and sometimes anomalies in the genetic code are passed from parents to babies in disease such as cystic fibrosis, or can be developed in unborn foetuses such as Down's Syndrome.

Read the information on these websites (you could make more Cornell notes if you wish):

<http://www.bbc.co.uk/education/guides/z36mmp3/revision>

<http://www.s-cool.co.uk/a-level/biology/dna-and-genetic-code>

And take a look at these videos:

<http://ed.ted.com/lessons/the-twisting-tale-of-dna-judith-hauck>

<http://ed.ted.com/lessons/where-do-genes-come-from-carl-zimmer>

Task 1:

Produce a wall display to put up in your classroom in September. You might make a poster or do this using PowerPoint or similar. Your display should use images, keywords and simple explanations to:

Define gene, chromosome, DNA and base pair

Describe the structure and function of DNA and RNA

Explain how DNA is copied in the body

Outline some of the problems that occur with DNA replication and what the consequences of this might be.

Evolution

Transfer of genetic information from one generation to the next can ensure continuity of species or lead to variation within a species and possible formation of new species. Reproductive isolation can lead to accumulation of different genetic information in populations potentially leading to formation of new species (speciation). Sequencing projects have read the genomes of organisms ranging from microbes and plants to humans. This allows the sequences of the proteins that derive from the genetic code to be predicted. Gene technologies allow study and alteration of gene function in order to better understand organism function and to design new industrial and medical processes.

Read the information on these websites (you could make more Cornell notes if you wish):

<http://www.bbc.co.uk/education/guides/z237hyc/revision/4>

<http://www.s-cool.co.uk/a-level/biology/evolution>

And take a look at these videos:

<http://ed.ted.com/lessons/how-to-sequence-the-human-genome-mark-j-kiel>

<http://ed.ted.com/lessons/the-race-to-sequence-the-human-genome-tien-nguyen>

Task 2:

Produce a one page revision guide for an AS Biology student that recaps the key words and concepts in this topic.

Describe speciation

Explain what a genome is

Give examples of how this information has already been used to develop new treatments and technologies.

Biodiversity

The variety of life, both past and present, is extensive, but the biochemical basis of life is similar for all living things. Biodiversity refers to the variety and complexity of life and may be considered at different levels. Biodiversity can be measured, for example within a habitat or at the genetic level. Classification is a means of organising the variety of life based on relationships between organisms and is built around the concept of species. Originally classification systems were based on observable features but more recent approaches draw on a wider range of evidence to clarify relationships between organisms. Adaptations of organisms to their environments can be behavioural, physiological and anatomical. Adaptation and selection are major factors in evolution and make a significant contribution to the diversity of living organisms.

Read the information on these websites (you could make more Cornell notes if you wish):

<http://www.s-cool.co.uk/a-level/biology/ecological-concepts>

<http://www.s-cool.co.uk/a-level/biology/classification>

And take a look at these videos:

<http://ed.ted.com/lessons/why-is-biodiversity-so-important-kim-preshoff>

<http://ed.ted.com/lessons/can-wildlife-adapt-to-climate-change-erin-eastwood>

Task 3:

Write a persuasive letter to an MP, organisation or pressure group promoting conservation to maintain biodiversity.

Your letter should:

Define what is meant by species and classification

Describe how species are classified

Explain one way scientists can collect data about a habitat, giving an example

Explain adaptation and how habitat change may pose a threat to niche species

Exchange and Transport

Organisms need to exchange substances selectively with their environment and this takes place at exchange surfaces. Factors such as size or metabolic rate affect the requirements of organisms and this gives rise to adaptations such as specialised exchange surfaces and mass transport systems. Substances are exchanged by passive or active transport across exchange surfaces. The structure of the plasma membrane enables control of the passage of substances into and out of cells

Read the information on these websites (you could make more Cornell notes if you wish):

<http://www.s-cool.co.uk/a-level/biology/gas-exchange>

<http://www.s-cool.co.uk/a-level/biology/nutrition-and-digestion/revise-it/human-digestive-system>

And take a look at these videos:

<http://ed.ted.com/lessons/insights-into-cell-membranes-via-dish-detergent-ethan-perlstein>

<http://ed.ted.com/lessons/what-do-the-lungs-do-emma-bryce>

Task 4 :

Create a poster or display to go in your classroom in September. Your poster should either: compare exchange surfaces in mammals and fish or compare exchange surfaces in the lungs and the intestines. You could use a Venn diagram to do this. Your poster should:

Describe diffusion, osmosis and active transport

Explain why oxygen and glucose need to be absorbed and waste products removed

Compare and contrast your chosen focus.

Cells

The cell is a unifying concept in biology, you will come across it many times during your two years of A level study. Prokaryotic and eukaryotic cells can be distinguished on the basis of their structure and ultrastructure. In complex multicellular organisms cells are organised into tissues, tissues into organs and organs into systems. During the cell cycle genetic information is copied and passed to daughter cells. Daughter cells formed during mitosis have identical copies of genes while cells formed during meiosis are not genetically identical

Read the information on these websites (you could make more Cornell notes if you wish):

<http://www.s-cool.co.uk/a-level/biology/cells-and-organelles>

<http://www.bbc.co.uk/education/guides/zvjycdm/revision>

And take a look at these videos:

<https://www.youtube.com/watch?v=gcTuQpuJyD8>

<https://www.youtube.com/watch?v=L0k-enzoeOM>

<https://www.youtube.com/watch?v=qCLmR9-YY7o>

Task 5:

Produce a one page revision guide to share with your class in September summarising one of the following topics: Cells and Cell Ultrastructure, Prokaryotes and Eukaryotes, or Mitosis and Meiosis.

Whichever topic you choose, your revision guide should include:

Key words and definitions

Clearly labelled diagrams

Short explanations of key ideas or processes.

Biological Molecules

Biological molecules are often polymers and are based on a small number of chemical elements. In living organisms carbohydrates, proteins, lipids, inorganic ions and water all have important roles and functions related to their properties. DNA determines the structure of proteins, including enzymes. Enzymes catalyse the reactions that determine structures and functions from cellular to whole-organism level. Enzymes are proteins with a mechanism of action and other properties determined by their tertiary structure. ATP provides the immediate source of energy for biological processes.

Read the information on these websites (you could make more Cornell notes if you wish):

<http://www.s-cool.co.uk/a-level/biology/biological-molecules-and-enzymes>

<http://www.bbc.co.uk/education/guides/zb739j6/revision>

And take a look at these videos:

<https://www.youtube.com/watch?v=H8WJ2KENIK0>

<http://ed.ted.com/lessons/activation-energy-kickstarting-chemical-reactions-vance-kite>

Task 6:

Krabbe disease occurs when a person doesn't have a certain enzyme in their body. The disease effects the nervous system. Write a letter to a GP or a sufferer to explain what an enzyme is.

Your poster should:

Describe the structure of an enzyme

Explain what enzymes do inside the body

Ecosystems

Ecosystems range in size from the very large to the very small. Biomass transfers through ecosystems and the efficiency of transfer through different trophic levels can be measured. Microorganisms play a key role in recycling chemical elements. Ecosystems are dynamic systems, usually moving from colonisation to climax communities in a process known as succession. The dynamic equilibrium of populations is affected by a range of factors. Humans are part of the ecological balance and their activities affect it both directly and indirectly. Effective management of the conflict between human needs and conservation help to maintain sustainability of resources.

Read the information on these websites (you could make more Cornell notes if you wish):

<http://www.bbc.co.uk/education/guides/z7vqtfr/revision>

<http://www.s-cool.co.uk/a-level/biology/ecological-concepts>

And take a look at these videos:

<https://www.youtube.com/watch?v=jZKIHe2LDP8>

<https://www.youtube.com/watch?v=E8dkWQVFAoA>

Task 7:

Produce a newspaper or magazine article about one ecosystem (e.g. the arctic, the Sahara, the rainforest, or something closer to home like your local woodland, nature reserve or shore line).

Your article should include:

Key words and definitions

Pictures or diagrams of your chosen ecosystem.

A description of the changes that have occurred in this ecosystem

An explanation of the threats and future changes that may further alter this ecosystem.

Control Systems

Homeostasis is the maintenance of a constant internal environment. Negative feedback helps maintain an optimal internal state in the context of a dynamic equilibrium. Positive feedback also occurs. Stimuli, both internal and external, are detected leading to responses. The genome is regulated by a number of factors. Coordination may be chemical or electrical in nature

Read the information on these websites (you could make more Cornell notes if you wish):

<http://www.s-cool.co.uk/a-level/biology/homeostasis>

<http://www.bbc.co.uk/education/topics/z8kxpv4>

And take a look at these videos:

<https://www.youtube.com/watch?v=x4PPZCLnVKA>

<https://www.youtube.com/watch?v=x4PPZCLnVKA>

Task 8:

Produce a poster to display in your classroom in September summarising one of the following topics: Temperature Control, Water and the Kidneys, Glucose, or The Liver.

Whichever topic you choose, your poster or display should include:

Key words and definitions

Clearly labelled diagrams

Short explanations of key ideas or processes.

Energy for Biological Processes

In cellular respiration, glycolysis takes place in the cytoplasm and the remaining steps in the mitochondria. ATP synthesis is associated with the electron transfer chain in the membranes of mitochondria and chloroplasts in photosynthesis energy is transferred to ATP in the light- dependent stage and the ATP is utilised during synthesis in the light-independent stage.

Read the information on these websites (you could make more Cornell notes if you wish):

<http://www.bbc.co.uk/education/guides/z7vqtfr/revision>

<http://www.s-cool.co.uk/a-level/biology/ecological-concepts>

And take a look at these videos:

<https://www.youtube.com/watch?v=jZKIHe2LDP8>

<https://www.youtube.com/watch?v=E8dkWQVFAoA>

Task 9:

Produce a newspaper or magazine article about one ecosystem (e.g. The Arctic, the Sahara, ta rainforest or something closer to home like your local woodland, nature reserve or shore line).

Your article should include:

Key words and definitions

Pictures or diagrams of your chosen ecosystem.

A description of the changes that have occurred in this ecosystem

An explanation of the threats and future changes that may further alter this ecosystem.

Scientific and Investigative Skills

As part of your A level you will complete a practical assessment. This will require you to carry out a series of practical activities as well as planning how to do them, analysing the results and evaluating the methods. This will require you to: use appropriate apparatus to record a range of quantitative measurements (to include mass, time, volume, temperature, length and pH), use appropriate instrumentation to record quantitative measurements, such as a colorimeter or photometer, use laboratory glassware apparatus for a variety of experimental techniques to include serial dilutions, use of light microscope at high power and low power, including use of a graticule, produce scientific drawing from observation with annotations, use qualitative reagents to identify biological molecules, separate biological compounds using thin layer/paper chromatography or electrophoresis, safely and ethically use organisms, use microbiological aseptic techniques, including the use of agar plates and broth, safely use instruments for dissection of an animal organ, or plant organ, use sampling techniques in fieldwork.

Task 10:

Produce a glossary for the following key words:

accuracy, anomaly, calibration, causal link, chance, confounding variable, control experiment, control group, control variable, correlation, dependent variable, errors, evidence, fair test, hypothesis, independent, null hypothesis, precision, probability, protocol, random distribution, random error, raw data, reliability, systematic error, true value, validity, zero error,

Science on Social Media

Science communication is essential in the modern world and all the big scientific companies, researchers and institutions have their own social media accounts. Here are some of our top tips to keep up to date with developing news or interesting stories:

Follow on Twitter:

Commander Chris Hadfield – former resident aboard the International Space Station @cmdrhadfield

Tiktaalik roseae – a 375 million year old fossil fish with its own Twitter account!
@tiktaalikroseae

Neil dGrasse Tyson – Director of the Hayden Planetarium in New York
@neiltyson

Sci Curious – feed from writer and Bethany Brookshire tweeting about good, bad and weird neuroscience
@scicurious

The SETI Institute – The Search for Extra Terrestrial Intelligence, be the first to know what they find!
@setiinstitute

Carl Zimmer – Science writer Carl blogs about the life sciences
@carlzimmer

Virginia Hughes – science journalist and blogger for National Geographic, keep up to date with neuroscience, genetics and behaviour
@virginiahughes

Maryn McKenna – science journalist who writes about antibiotic resistance
@marynmck



Find on Facebook:

Nature - the profile page for nature.com for news, features, research and events from Nature Publishing Group

Marin Conservation Institute – publishes the latest science to identify important marine ecosystems around the world.

National Geographic - since 1888, National Geographic has travelled the Earth, sharing its amazing stories in pictures and words.

Science News Magazine - Science covers important and emerging research in all fields of science.

BBC Science News - The latest BBC Science and Environment News: breaking news, analysis and debate on science and nature around the world.



Science Websites

These websites all offer an amazing collection of resources that you should use again and again through out your course.



Probably the best website on Biology....

Learn Genetics from Utah University has so much that is pitched at an appropriate level for you and has lots of interactive resources to explore, everything from why some people can taste bitter berries to how we clone mice or make glow in the dark jelly fish.

<http://learn.genetics.utah.edu/>



DNA from the beginning is full of interactive animations that tell the story of DNA from its discovery through to advanced year 13 concepts. One to book mark!

<http://www.dnaftb.org/>



In the summer you will most likely start to learn about Biodiversity and Evolution. Many Zoos have great websites, especially London Zoo. Read about some of the case studies on conservation, such as the Giant Pangolin, the only mammal with scales. <https://www.zsl.org/conservation>



At GCSE you learnt how genetic diseases are inherited. In this virtual fly lab you get to breed fruit flies to investigate how different features are passed on.

<http://sciencecourseware.org/vcise/drosophila/>



Ok, so not a website, but a video you definitely want to watch. One of the first topics you will learn about is the amazing structure of the cell. This BBC film shows the fascinating workings of a cell... a touch more detailed than the "fried egg" model you might have seen.

http://www.dailymotion.com/video/xzh0kb_the-hidden-life-of-the-cell_shortfilms

If this link expires – google "BBC hidden life of the cell"

Things to Do

There are loads of citizen science projects you can take part in either from the comfort of your bedroom, out and about, or when on holiday. Wikipedia does a comprehensive list of all the current projects taking place. Google 'citizen science project'



AgeGuess



MOOC

Want to stand above the rest when it comes to UCAS? Now is the time to act.

MOOCs are online courses run by nearly all Universities. They are short FREE courses that you take part in. They are usually quite specialist, but aimed at the public, not the genius!

There are lots of websites that help you find a course, such as edX and Future learn.

You can take part in any course, but there are usually start and finish dates. They mostly involve taking part in web chats, watching videos and interactives.



Completing a MOOC will look great on your Personal statement and they are dead easy to take part in!



Transition Baseline Assessment

The following 40-minute test is designed to test your recall, analysis and evaluative skills and knowledge.
Remember to use your exam technique: look at the command words and the number of marks each question is worth.
The answers will also be emailed to you so you can mark your answers yourself!

1. a) What are the four base pairs found in DNA?

.....
(2)

- b) What does DNA code for?

.....
(1)

- c) Which organelle in a cell carries out this function?

.....
(1)

2. a) What theory did Charles Darwin propose?

.....
(1)

- b) Why did many people not believe Darwin at the time?

.....
(1)

- c) Describe how fossils are formed.

.....
.....
.....
(3)

- d) The fossil record shows us that there have been some species that have formed and some that have become extinct.

- i) What is meant by the term 'species'?

.....
(2)

- ii) Describe how a new species may arise:

.....
.....
.....(3)

3. Ecologists regularly study habitats to measure the species present and the effect of any changes. One team of ecologists investigated the habitat shown in the picture below:

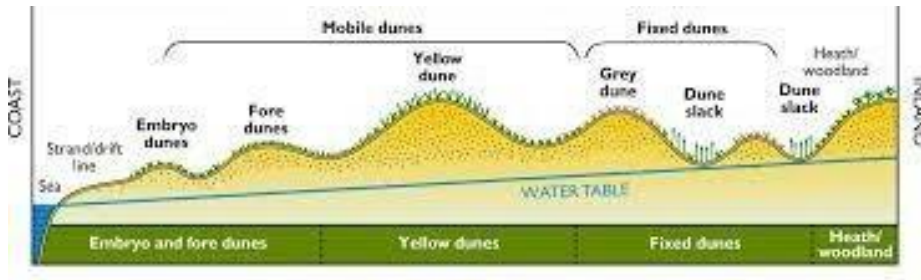


Image taken from <http://www.macaulay.ac.uk/soilquality/Dune%20Succession.pdf>

a) Define the following keywords:

i) Population

.....

ii) Community

.....

(2)

b) Give an example of one biotic factor and one abiotic factor that would be present in this habitat

Biotic:

Abiotic:

(2)

c) Describe how the ecologists would go about measuring the species present between the coast and the inland.

.....

.....

.....

.....

.....

.....

(6)

4. Every living organism is made of cells.

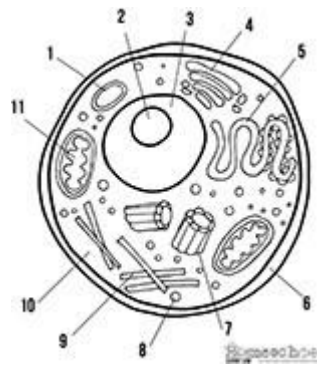


Image taken from <http://prestigebux.com/worksheet/label-an-animal-cell-worksheet>

a) Label the following parts of the animal cell:

2

5

8

(3)

b) Describe how is the structure of the cell membrane related to its function?

.....
.....
.....

(3)

5. A medical research team investigated how quickly the body deals with glucose after a meal. They studied the blood glucose concentration of people who exercised versus those who did not. Here are their results:

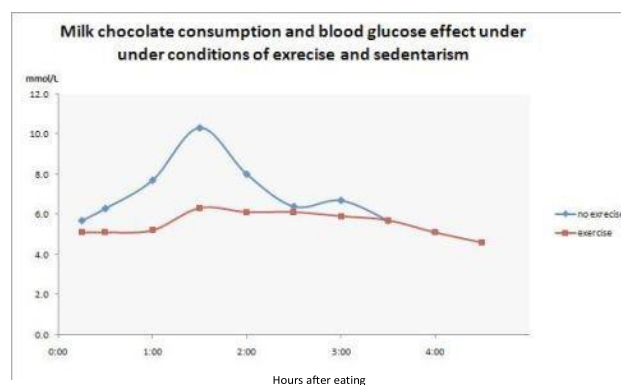


Image taken from <https://memoirsofanamnesic.wordpress.com/category/blood-glucose/>

a) What organ in the body regulates blood glucose concentration?

.....

(1)

b) Explain how the stages that would bring about a return to normal blood glucose concentrations.

.....

.....

.....

.....

(4)

c) Name one variable the researchers will have controlled.

.....

(1)

d) The researchers made the following conclusion:

“Blood glucose returns to normal values for all people after 4 hours”

To what extent do you agree with this conclusion.

.....

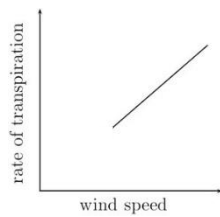
.....

.....

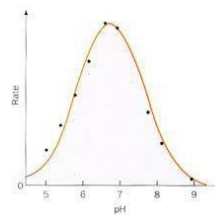
.....

(3)

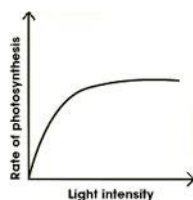
6. Scientists need to be able to interpret data in graphs to decide if there are trends in the results.
For each graph below, describe the trend.



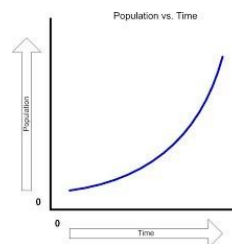
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.....



.....



.....(4)

Key Ideas

The questions and answers on the next few pages cover some key practical terms that you should be familiar with as well as some of the key content you will cover in your first half term in college. Learn the answers to the questions, 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 <i>same</i> person, using the <i>same</i> equipment, under the <i>same</i> conditions
What is reproducibility?	how precise repeated measurements are when they are taken by <i>different</i> people, using <i>different</i> 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 (A Level Chapter 1)

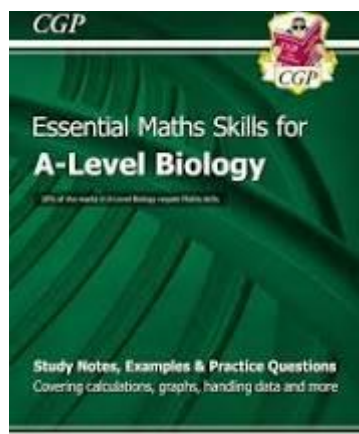
What are monomers?	smaller units from which larger molecules are made
What are polymers?	molecules made from a large number of monomers joined together
What is a condensation reaction?	a reaction that joins two molecules together to form a chemical bond whilst eliminating of a molecule of water
What 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	$ \begin{array}{c} \text{R} \\ \\ \text{H}_2\text{N} - \text{C} - \text{COOH} \\ \\ \text{H} \end{array} $
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.

Cells (A Level Chapter 3)

What is the formula to calculate magnification?	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 –

You will be provided with the answers to all these Qs so please mark them yourself. If you feel you struggle with maths you should consider getting a copy of this book:



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 (m²), cubic metre (m³), 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 = $10 \times 10 = 100$ 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 $100 \times 1000 = 100\,000$ 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 $6230\ \mu\text{m}$ would have been more meaningful expressed as $6.2\ \text{mm}$.

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

To convert $488\,889\ \text{m}$ 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.

$488\,889 \div 10^3 = 488.889\ \text{km}$

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.

$333\ \text{mm}$ is $0.000\,333\ \text{km}$

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

$333\ \text{mm}$ is $333\,000\,000\ \text{nm}$

Practice question

5 Calculate the following conversions:

a $0.004\ \text{m}$ into mm

b $130\,000\ \text{ms}$ into s

c $31.3\ \text{ml}$ into μl

d $104\ \text{ng}$ 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 $1000\ \text{m}$ into $1\ \text{km}$.)

a $0.000\,057\ \text{m}$

b $8\,600\,000\ \mu\text{l}$

c $68\,000\ \text{ms}$ **d** $0.009\ \text{cm}$

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 cm² 0.03 cm² 0.0218 cm² 0.034 cm²

- 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:

6.3900000000

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:

0.000 147 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 question

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 $5.995 \times 10^2 \text{ cm}^3$

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?

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

Substitute the values and calculate the answer:

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

Answer: magnification = $\times 200$ (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 .
- 5 In a quadrat sample, an area was found to contain 96 aphids, 4 ladybirds, 22 grasshoppers, and 3 ground beetles. Calculate the diversity of the site using the equation $D = 1 - \Sigma \left(\frac{n}{N} \right)^2$ where n = number of each species, N = grand total of all species, and D = diversity.

Remember: In this equation there is a part that needs to be done several times then summed, shown by the symbol Σ .

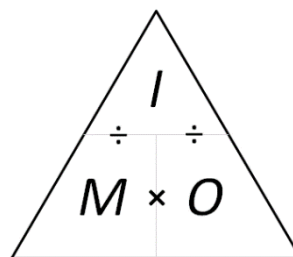
3.2 Rearranging formulae

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:

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



Practice questions

- 6 A fat cell is 0.1 mm in diameter. Calculate the size of the diameter seen through a microscope with a magnification of $\times 50$.
- 7 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.
- 8 In a photograph, a red blood cell is 14.5 mm in diameter. The magnification stated on the image is $\times 2000$. Calculate the real diameter of the red blood cell.
- 9 Rearrange the equation $34 = 2a/135 \times 100$ and find the value of a .

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 $\times 10$ and the objective lens is $\times 40$ the total magnification of the virtual image is $10 \times 40 = 400$.

Practice questions

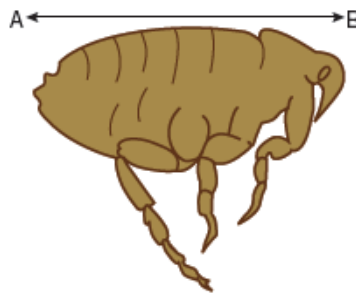
- 1 Calculate the magnification of the virtual image produced by the following combinations of lenses:
- a objective $\times 10$ and eyepiece $\times 12$ b objective $\times 40$ and eyepiece $\times 15$

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.

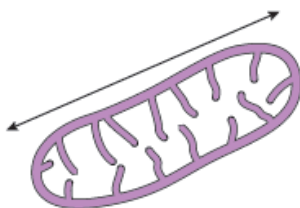
$$\text{magnification} = \frac{\text{length of image}}{\text{length of real specimen}} = 42/1.3 = 32.31$$

The magnification factor should therefore be written as $\times 32.31$

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 question

- 2 Calculate the magnification factor of a mitochondrion that is $1.5 \mu\text{m}$ 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 $\times 5000$.

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.

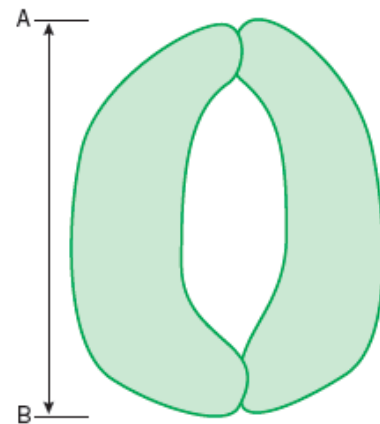
In this case you should use μm because it is a cell.

So the magnified image is $52 \times 1000 = 52\,000\ \mu\text{m}$

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

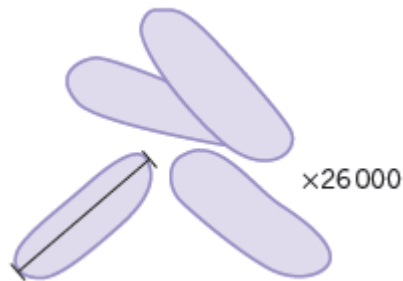
real size = size of image/magnification = $52\,000/5000 = 10.4$

So the real length of the guard cell is $10.4\ \mu\text{m}$.



Practice question

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



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:

$$\begin{aligned} & \frac{\text{number of people with brown hair}}{\text{total number of people}} \times 100 \\ &= \frac{1800}{4600} \times 100 = 39.1\% \end{aligned}$$

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

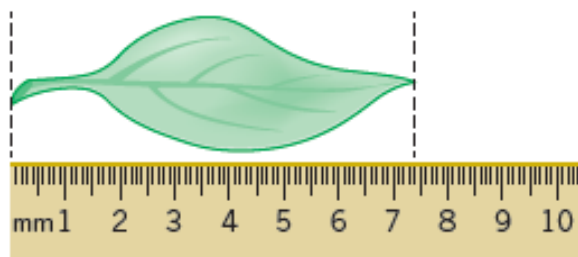
- 3 Convert the following mass changes as percentage changes.

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 \pm 0.5 mm.

Practice question

- 4 Give the uncertainty for the following pieces of equipment:
- a large measuring cylinder with 2 cm³ 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 \pm 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 \pm 0.5 mm.

The relative error is therefore:

$$0.5/74 \times 100\% = 0.7\%$$

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.		

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.

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

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

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