Year 9 AQA GCSE Science (TERM 1 BIOLOGY)

Topic 1: Cell Biology

4.1.1 Cell structure			
4.1.1.1 Eukaryotes and prokaryotes	☺	😐	☹
<u>Plant and animal cells</u> (eukaryotic cells) have a **cell membrane**, **cytoplasm** and genetic material enclosed in a **nucleus**.			
<u>Bacterial cells</u> (prokaryotic cells) are much smaller in comparison. They have **cytoplasm** and a **cell membrane** surrounded by a **cell wall**. The genetic material is not enclosed in a nucleus. It is a single **DNA loop** and there may be one or more small rings of DNA called **plasmids**.			
<u>Students should be able to:</u> ★ Demonstrate an understanding of the scale and size of cells and be able to make order of magnitude calculations, including the use of standard form.			
WS 4.4 Use prefixes **centi**, **milli**, **micro** and **nano**.			
4.1.1.2 Animal and plant cells	☺	😐	☹
Most <u>animal cells</u> have the following parts: • a **nucleus**, which controls the activities of the cell • **cytoplasm**, in which most of the chemical reactions take place • a **cell membrane**, which controls the passage of substances into and out of the cell **mitochondria**, which is where aerobic respiration takes place **ribosomes**, which are where protein synthesis occurs.			
In addition to the parts found in animal cells, <u>plant cells</u> often have: **chloroplasts**, which absorb light to make food by photosynthesis a **permanent vacuole** filled with cell sap.			
<u>Plant and algal cells</u> also have a **cell wall** made of **cellulose**, which strengthens the cell.			
<u>Students should be able to:</u> ★ **Explain** how the main **sub-cellular structures**, including the nucleus, cell membranes, mitochondria, chloroplasts in plant cells and plasmids in bacterial cells are related to their **functions**.			
★ Use estimations and explain what they should be used to judge the relative size or area of subcellular structures.			
WS 1.2 Recognise, draw and interpret images of cells.			
REQUIRED PRACTICAL – Microscopy. **AT 1 & 7**			
4.1.1.3 Cell specialisation	☺	😐	☹
Cells may be specialised to carry out a particular function: **sperm cells**, **nerve cells** and **muscle cells** in animals **root hair cells**, **xylem** and **phloem cells** in plants.			

<u>Students should be able to, when provided with appropriate information</u>: ★ **Explain** how the **structure** of different types of cell relate to their **function** in a tissue, an organ or organ system, or the whole organism.			
4.1.1.4 Cell differentiation	☺	😐	☹
As an organism develops, cells **differentiate** to form different types of cells. • Most types of animal cell differentiate at an early stage. • Many types of plant cells retain the ability to differentiate throughout life.			

In mature animals, cell division is mainly restricted to **repair** and **replacement**. As a cell **differentiates** it acquires different sub-cellular structures to enable it to carry out a certain function. It has become a **specialised cell**.			
<u>Students should be able to:</u> ★ **Explain** the importance of **cell differentiation**.			
4.1.1.5 Microscopy	☺	😐	☹
An **electron microscope** has much higher **magnification** and **resolving power** than a light microscope. This means that it can be used to study cells in much finer detail. This has enabled biologists to see and understand many more **sub-cellular structures**.			
<u>Students should be able to:</u> ★ **Understand** how microscopy **techniques** have developed over time.			
★ **Explain** how **electron microscopy** has increased understanding of sub-cellular structures. *Limited to the differences in magnification and resolution.*			
★ Carry out **calculations** involving **magnification**, real size and image size using the formula: $\text{magnification} = \frac{\text{size of image}}{\text{size of real object}}$			
★ Express answers in **standard form** if appropriate.			
WS 4.4 Use prefixes **centi**, **milli**, **micro** and **nano**.			
4.1.2 Cell division			
4.1.2.1 Chromosomes	☺	😐	☹
The nucleus of a cell contains **chromosomes** made of DNA molecules. Each chromosome carries a large number of **genes**.			
In body cells the chromosomes are normally **found in pairs**.			
4.1.2.2 Mitosis and the cell cycle	☺	😐	☹
Cells divide in a series of stages called the **cell cycle**. Students should be able to describe the stages of the cell cycle, including **mitosis**.			
During the cell cycle the **genetic material** is **doubled** and then divided into two identical cells.			
Before a cell can divide it needs to grow and increase the number of sub-cellular structures such as **ribosomes** and **mitochondria**. The DNA replicates to form two copies of each **chromosome**.			

In mitosis one set of chromosomes is pulled to each end of the cell and the **nucleus divides**.			
Finally, the cytoplasm and cell membranes divide to form **two identical cells**.			
Cell division by mitosis is important in the **growth** and **development** of multicellular organisms.			
Students should: ★ **Understand** the **three overall stages** of the cell cycle *but do not need to know the different phases of the mitosis stage.*			
★ Be able to recognise and describe situations in given contexts where mitosis is occurring.			
4.1.2.3 Stem cells	☺	😐	☹
A **stem cell** is an **undifferentiated** cell of an organism which is capable of giving rise to many more cells of the same type, and from which certain other cells can arise from differentiation.			
Stem cells from human **embryos** can be **cloned** and made to differentiate into most different types of human cells.			
Stem cells from **adult bone marrow** can form many types of cells including **blood cells**.			
Meristem tissue in plants can differentiate into any type of plant cell, throughout the life of the plant.			

Treatment with stem cells may be able to help conditions such as **diabetes** and **paralysis**.			
In **therapeutic cloning** an embryo is produced with the same genes as the patient. Stem cells from the embryo are not rejected by the patient's body so they may be used for **medical treatment**.			
The use of stem cells has potential risks such as transfer of **viral infection**, and some people have **ethical** or **religious objections**.			
Stem cells from **meristems** in **plants** can be used to produce clones of plants quickly and economically. • **Rare species** can be cloned to protect from **extinction**. • **Crop** plants with special features such as **disease resistance** can be cloned to produce large numbers of identical plants for **farmers**.			
Students should be able to: ★ **Describe** the **function** of stem cells in **embryos**, in **adult animals** and in the **meristems** in plants. *Knowledge and understanding of stem cell techniques are not required.*			
WS 1.3 Evaluate the practical risks and benefits, as well as social and ethical issues, of the use of stem cells in medical research and treatments.			

Year 9 AQA GCSE Science (TERM 1 CHEMISTRY)
Topic 2: Atomic Structure and Ionic Bonding

4.1.1 Atoms, elements and compounds			
4.1.1.1 Atoms, elements and compounds	☺	😐	☹
All substances are made of **atoms**. An atom is the smallest part of an **element** that can exist.			
Atoms of each element are represented by a **chemical symbol**, eg O represents an atom of oxygen, Na represents an atom of sodium.			
There are about **100 different elements**. Elements are shown in the **periodic table**.			
Compounds are formed from elements by **chemical reactions**. Chemical reactions always involve the formation of one or more **new substances**, and often involve a detectable **energy change**.			
Compounds contain two or more elements **chemically combined** in fixed proportions and can be represented by formulae using the symbols of the atoms from which they were formed. Compounds can only be **separated** into elements by **chemical reactions**.			
Chemical reactions can be represented by **word equations** or equations using **symbols** and **formulae**.			
Students will be supplied with a periodic table for the exam and should be able to: ★ Use the names and symbols of the **first 20 elements** in the periodic table, the elements in **Groups 1 and 7**, and other elements in this specification.			
★ Name **compounds** of these elements from given formulae or symbol equations.			
★ Write **word equations** for the reactions in this specification.			
★ Write **formulae** and **balanced chemical equations** for the reactions in this specification.			
★ (HT only) Write balanced **half equations** and **ionic equations** where appropriate.			
4.1.1.2 Mixtures	☺	😐	☹
A **mixture** consists of two or more elements or compounds **not chemically combined** together. The **chemical properties** of each substance in the mixture are unchanged.			
Mixtures can be **separated** by **physical processes** such as **filtration**, **crystallisation**, **simple distillation**, **fractional distillation** and **chromatography**. These physical processes do not involve chemical reactions.			
Students should be able to: ★ **Describe**, explain and give examples of the specified processes of separation.			
★ **Suggest** suitable separation and purification techniques for mixtures when given appropriate information.			
4.1.1.3 Scientific models of the atom (*common content with physics*)	☺	😐	☹
New experimental evidence may lead to a **scientific model** being changed or replaced.			

Before the discovery of the electron, **atoms** were thought to be tiny spheres that could not be divided.			
The discovery of the electron led to the **plum pudding model** of the atom. The plum pudding model suggested that the atom was a ball of positive charge with negative electrons embedded in it.			
The results from the **alpha particle scattering experiment** led to the conclusion that the mass of an atom was concentrated at the centre (nucleus) and that the nucleus was charged. This **nuclear model** replaced the plum pudding model.			
Niels Bohr adapted the nuclear model by suggesting that **electrons orbit** the nucleus at specific distances. The theoretical calculations of Bohr agreed with experimental observations.			
Later experiments led to the idea that the **positive charge** of any nucleus could be subdivided into a whole number of smaller particles, each particle having the same amount of positive charge. The name **proton** was given to these particles.			
The experimental work of **James Chadwick** provided the evidence to show the existence of **neutrons** within the nucleus. This was about 20 years after the nucleus became an accepted scientific idea.			
Students should be able to: ★ **Describe** the **difference** between the **plum pudding model** of the atom and the **nuclear model** of the atom.			
★ **Describe** why the **new evidence** from the scattering experiment led to a **change** in the atomic model. *Details of experimental work supporting the Bohr model are not required. Details of these experiments are not required. Details of Chadwick's experimental work are not required.*			
4.1.1.4 Relative electrical charges of subatomic particles	☺	😐	☹
The **relative electrical charges** of the particles in atoms are: (see table below)			
In an atom, the number of electrons is equal to the number of protons in the nucleus. Atoms have no overall electrical charge (they are neutral).			
The number of **protons** in an atom of an element is its **atomic number**. All atoms of a particular element have the same number of protons. Atoms of different elements have different numbers of protons.			
Students should be able to: ★ Use the atomic model to describe atoms.			
4.1.1.5 Size and mass of atoms	☺	😐	☹
Atoms are **very small**, having a radius of **about 0.1 nm** (1×10^{-10} m).			
The radius of a nucleus is less than 1/10 000 of that of the atom (about 1×10^{-14} m).			
Almost all the **mass** of an atom is the **nucleus**.			

Name of particle	Relative charge
Proton	+1
Neutron	0
Electron	–1

The **relative masses** of protons, neutrons and electrons are:

Name of particle	Relative mass
Proton	1
Neutron	1
Electron	Very small

The sum of the protons and neutrons in an atom is its **mass number**

Atoms of the same element can have different numbers of neutrons; these atoms are called **isotopes** of that element.

Atoms can be represented as shown in this example:

(Mass number) 23
(Atomic number) 11 Na

$^{23}_{11}Na$

Students should be able to:

★ **Calculate** the numbers of protons, neutrons and electrons in an atom or ion, given its atomic number and mass number.

★ Relate size and scale of atoms to objects in the physical world. [MS 1d]

WS 4.3 Use SI units and the prefix **nano**.

MS 1b Recognise expressions in **standard form**.

4.1.1.6 Relative atomic mass	☺	😐	☹

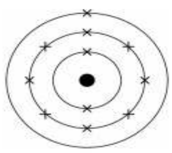
The relative atomic mass of an element is an average value that takes account of the abundance of the isotopes of the element.

Students should be able to:

★ **Calculate** the relative atomic mass of an element given the percentage abundance of its isotopes.

4.1.1.7 Electronic structure	☺	😐	☹

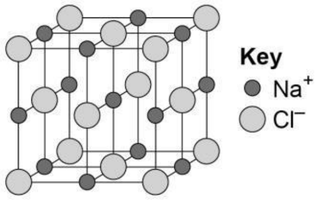
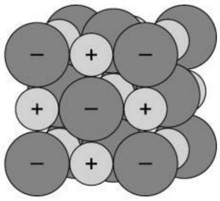
The electrons in an atom occupy the lowest available **energy levels** (innermost available **shells**). The electronic structure of an atom can be represented by numbers or by a diagram. For example, the electronic structure of **sodium** is **2,8,1** or



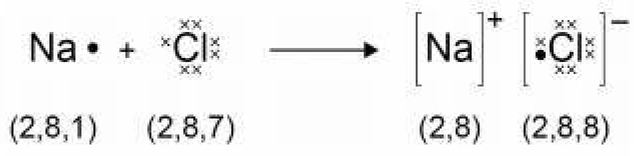
showing two electrons in the lowest energy level, eight in the second energy level and one in the third energy level. *Students may answer questions in terms of either energy levels or shells.*

Students should be able to:

★ Represent the electronic structures of the **first twenty elements** of the periodic table in both forms.

4.2.1.3 Ionic compounds	☺	😐	☹
An ionic compound is a **giant structure** of ions. Ionic compounds are held together by **strong electrostatic forces** of attraction between **oppositely charged ions**. These forces act in all directions in the lattice and this is called **ionic bonding**.			
The structure of **sodium chloride** can be represented in the following forms:   *Students should be familiar with the structure of **sodium chloride** but do not need to know the structures of other ionic compounds.*			
<u>Students should be able to:</u> ★ **Deduce** that a **compound is ionic** from a diagram of its structure in one of the specified forms			
★ **Describe** the **limitations** of using dot and cross, ball and stick, two and three dimensional diagrams to represent a **giant ionic structure**			

4.2.1.2 Ionic bonding	☺	😐

When a metal atom reacts with a non-metal atom, **electrons** in the outer shell of the metal atom are **transferred**. **Metal atoms lose electrons** to become **positively charged ions**. **Non-metal atoms gain electrons** to become **negatively charged ions**. The ions produced by metals in Groups 1 and 2 and by non-metals in Groups 6 and 7 have the electronic structure of a **noble gas** (Group 0).			
The electron transfer during the formation of an ionic compound can be represented by a **dot and cross** diagram e.g. for sodium chloride:  			
The **charge** on the ions produced by metals in Groups 1 and 2 and by non-metals in Groups 6 and 7 relates to the **group number** of the element in the periodic table.			
<u>Students should be able to:</u> ★ Draw **dot and cross diagrams** for ionic compounds formed by metals in Groups 1 and 2 with non-metals in Groups 6 and 7.			
★ Work out the **charge** on the ions of metals and non-metals from the group number of the element, limited to the metals in Groups 1 and 2, and non-metals in Groups 6 and 7.			

Year 9 AQA GCSE Science (TERM 1 PHYSICS)
Topic 3: Particle model of matter

4.3.1 Changes of state and the particle model			
4.3.1.1 Density of materials	☺	😐	☹
The **density** of a material is defined by the equation: $\text{density} = \frac{\text{mass}}{\text{volume}}$ $\quad \rho = \frac{m}{V}$			
• density, ρ, in kilograms per metre cubed, **kg/m³** • mass, *m*, in kilograms, **kg** • volume, *V*, in metres cubed, **m³**			
The **particle model** can be used to explain • the different states of matter • differences in density			
<u>Students should be able to:</u> ★ **Recall** and apply the equation for **density**.			

★ **Recognise/draw** simple diagrams to model the difference between **solids**, **liquids** and **gases** [*links with chemistry*].			
★ **Explain** the differences in **density** between the different states of matter in terms of the arrangement of atoms or molecules.			
REQUIRED PRACTICAL – Density. **AT 1.**			
4.3.1.2 Changes of state	☺	😐	☹
Changes of state are **physical changes**: the change does not produce a new substance. If the change is reversed the substance recovers its original properties.			
Students should be able to: ★ **Describe** how when substances **change state** (melt, freeze, boil, evaporate, condense or sublimate), mass is conserved.			

4.3.3 Particle model and pressure			
4.3.3.1 Particle motion in gases	☺	😐	☹
The molecules of a gas are in **constant random motion**. The **temperature** of the gas is related to the **average kinetic energy** of the molecules. The higher the temperature the greater the average kinetic energy and so the faster the average speed of the molecules.			
When the molecules **collide** with the wall of their container they exert a **force** on the wall. The total force exerted by all of the molecules inside the container on a **unit area** of the walls is the gas **pressure**.			
Changing the **temperature** of a gas, held at constant volume, changes the **pressure** exerted by the gas.			
Students should be able to: ★ **Explain** how the motion of the molecules in a gas is related to both its **temperature** and its **pressure**.			
★ **Explain** qualitatively the relationship between **temperature** of a gas and its **pressure** at constant **volume**.			

Part 2 Physics: Energy stores and changes

4.1.1 Energy changes in a system, and the ways energy is stored before and after such changes			
4.1.1.1 Energy stores and systems	☺	😐	☹
A **system** is an object or group of objects.			
There are **changes** in the way energy is **stored** when a system changes.			
For example: • an object projected upwards • a moving object hitting an obstacle • an object accelerated by a constant force • a vehicle slowing down • bringing water to a boil in an electric kettle.			
Students should be able to: ★ Describe all the changes involved in the way energy is stored when a system changes, for common situations (including the examples above).			
★ Throughout this Energy topic, calculate the changes in energy involved when a system is changed by: **heating, work done** by **forces, work done** when a **current flows.**			
★ Use calculations to show on a common scale how the overall energy in a system is redistributed when the system is changed.			
4.1.1.2 Changes in energy	☺	😐	☹
The **kinetic energy** of a **moving object** can be calculated using the equation: kinetic energy = 0.5 × mass × (speed)^2 | $E_k = \frac{1}{2} m v^2$			
• kinetic energy, E_k, in joules, **J** • mass, m, in kilograms, **kg** • speed, v, in metres per second, **m/s**			
The amount of **elastic potential energ**y stored in a **stretched spring** can be calculated using the equation: elastic potential energy = 0.5 × spring constant × (extension)^2 | $E_e = \frac{1}{2} k e^2$ (assuming the limit of proportionality has not been exceeded)			
• elastic potential energy, E_e, in joules, **J** • spring constant, k, in newtons per metre, **N/m** • extension, e, in metres, **m**			
The amount of **gravitational potential energy** gained by an **object raised** above ground level can be calculated using the equation: gravitational potential energy = mass × gravitational field strength (g) × height | $E_p = m g h$			

• gravitational potential energy, E_p, in joules, **J** • mass, *m*, in kilograms, **kg** • gravitational field strength, *g*, in newtons per kilogram, **N/kg** (*In any calculation the value of the gravitational field strength (g) will be given*) • height, *h*, in metres, **m**			
<u>Students should be able to:</u> ★ Calculate the amount of energy associated with a **moving object**, a **stretched spring** and an **object raised** above ground level.			
★ **Recall** and apply the equation for **kinetic energy**			
★ Apply the equation for **elastic potential energy**, which is given on the **Physics equation sheet**			
★ **Recall** and apply the equation for **gravitational potential energy**			
4.1.1.3 Energy changes in systems	☺	😐	☹
The amount of energy stored in or released from a system as its **temperature changes** can be calculated using the equation: change in thermal energy = mass × specific heat capacity × temperature change $\Delta E = m\, c\, \Delta\theta$			
• change in thermal energy, Δ*E*, in joules, **J** • mass, *m*, in kilograms, **kg** • specific heat capacity, *c*, in joules per kilogram per degree Celsius, **J/kg °C** □ temperature change, Δθ, in degrees Celsius, **°C**			
The **specific heat capacity of a substance** is the amount of **energy** required to raise the **temperature** of **one kilogram** of the substance by **one degree Celsius**.			
<u>Students should be expected to:</u> ★ Apply the equation for **specific heat capacity**, which is given on the **Physics equation sheet**.			
REQUIRED PRACTICAL: Specific Heat Capacity. **AT 1 and 5.**			
4.1.1.4 Power	☺	😐	☹
Power is defined as the **rate** at which **energy is transferred** or the rate at which **work is done**.			
power = $\frac{\text{energy transferred}}{\text{time}}$ $P = \frac{E}{t}$			
power = $\frac{\text{work done}}{\text{time}}$ $P = \frac{W}{t}$			
• power, *P*, in watts, **W** • energy transferred, *E*, in joules, **J** • work done, *W*, in joules, **J** • time, *t*, in seconds, **s**			
An energy transfer of **1 joule per second** is equal to a power of **1 watt**.			
<u>Students should be able to:</u> ★ **Recall** and apply both of the equations for **power**.			

★ Give **examples** that illustrate the definition of power e.g. comparing two electric motors that both lift the same weight through the same height but one does it faster than the other.			
4.1.2 Conservation and dissipation of energy			
4.1.2.1 Energy transfers in a system	☺	😐	☹
Energy can be **transferred** usefully, stored or dissipated, but **cannot** be **created** or **destroyed**.			
Whenever there are energy transfers in a system only part of the energy is **usefully transferred**. The rest of the energy is **dissipated** so that it is stored in less useful ways. This energy is often described as being '**wasted**'.			
Unwanted energy transfers can be reduced in a number of ways, for example through **lubrication** and the use of **thermal insulation**.			
The higher the **thermal conductivity** of a material the higher the **rate of energy transfer** by conduction across the material.			
<u>Students should be able to:</u> ★ Describe, with examples, where there are energy transfers in a closed system, that there is no net change to the total energy.			
★ Describe, with examples, how in all system changes energy is dissipated, so that it is stored in less useful ways. The energy is often described as being 'wasted'.			
★ Explain ways of reducing unwanted energy transfers, for example, through lubrication and the use of thermal insulation.			
★ Describe how the rate of cooling of a building is affected by the thickness and thermal conductivity of its walls. *Students do not need to know the definition of thermal conductivity.*			
4.1.2.2 Efficiency	☺	😐	☹
The **energy efficiency** for any energy transfer can be calculated using the equation: $\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$			
Efficiency may also be calculated using the equation: $\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$			
<u>Students should be able to:</u> ★ **Recall** and apply both equations for **efficiency**.			
★ Calculate or use efficiency values as a **decimal** or as a **percentage**.			
★ (HT only) Describe ways to **increase** the **efficiency** of an intended energy transfer.			