B1H+

AQA GCSE BIOLOGY (9-1)

Topic 1: Cell Biology

4.1.1 Cell structure			
4.1.1.1 Eukaryotes and prokaryotes	☺	😐	☹
Plant and animal cells (eukaryotic cells) have a **cell membrane**, **cytoplasm** and genetic material enclosed in a **nucleus**.			
Bacterial cells (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**.			
Students should be able to: ★ 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 animal cells 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, plant cells often have: • **chloroplasts**, which absorb light to make food by photosynthesis • a **permanent vacuole** filled with cell sap.			
Plant and algal cells also have a **cell wall** made of **cellulose**, which strengthens the cell.			
Students should be able to: ★ **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 sub-cellular 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.			
Students should be able to, when provided with appropriate information: ★ **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**.			
4.1.1.6 Culturing microorganisms – *GCSE Biology only*			
4.1.1.6 Culturing microorganisms	☺	😐	☹
Bacteria multiply by simple cell division (**binary fission**) as often as once every 20 minutes if they have enough **nutrients** and a suitable **temperature**.			
Bacteria can be grown in a **nutrient broth solution** or as colonies on an **agar gel plate**.			
Uncontaminated cultures of microorganisms are required for investigating the action of **disinfectants** and **antibiotics**.			
<u>Students should be able to:</u> ★ **Describe** how to prepare an **uncontaminated culture** using **aseptic technique**.			
★ **Explain** why petri dishes and culture media must be sterilised before use			
• **Explain** why inoculating loops used to transfer microorganisms to the media must be sterilised by passing them through a flame			
• **Explain** why the lid of the Petri dish should be secured with adhesive tape and stored upside down			
• **Explain** why in school and college laboratories, cultures should be incubated at a maximum temperature of 25°C.			
• **Calculate cross-sectional area**s of colonies or clear areas around colonies using πr^2.			
• **Calculate** the number of bacteria in a **population** after a certain **time** if given the mean division time.			
• (HT only) Express the answer in **standard form**.			
REQUIRED PRACTICAL – Microbiology. **AT 1, 3, 4 and 8. (Biology only)**			
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.			
4.1.3 Transport in cells			
4.1.3.1 Diffusion	☺	😐	☹
Substances may move into and out of cells across the **cell membranes** via **diffusion**.			
Diffusion is the spreading of the particles of any substance in solution, or particles of a gas, resulting in a net movement from an area of **higher concentration** to an area of **lower concentration**.			
Some of the substances transported in and out of cells by diffusion are **oxygen** and **carbon dioxide** in **gas exchange**, and of the waste product **urea** from cells into the **blood plasma** for **excretion** in the **kidney**.			

Factors which affect the **rate of diffusion** are: • the difference in concentrations (**concentration gradient**) • the **temperature** • the **surface area** of the membrane.			
A **single-celled organism** has a relatively **large surface area to volume ratio**. This allows sufficient transport of molecules into and out of the cell to meet the needs of the organism.			
In **multicellular organisms**, surfaces and organ systems are specialised for exchanging materials. This is to allow sufficient molecules to be transported into and out of cells for the organism's needs. The effectiveness of an exchange surface is increased by: • having a large surface area • a membrane that is thin, to provide a short diffusion path • (in animals) having an efficient blood supply • (in animals, for gaseous exchange) being ventilated.			
Students should be able to: ★ **Explain** how different **factors** affect the **rate** of diffusion.			
★ **Calculate** and compare **surface area to volume** ratios.			
★ **Explain** the need for **exchange surfaces** and a **transport system** in **multicellular** organisms in terms of surface area to volume ratio.			
★ **Explain** how the small intestine and lungs in **mammals**, gills in **fish**, and the roots and leaves in **plants**, are **adapted** for exchanging materials.			
WS 1.2 Recognise, draw and interpret diagrams that model diffusion.			
WS 1.5 Use of **isotonic drinks** and **high energy drinks** in sport.			
4.1.3.2 Osmosis	☺	😐	☹
Water may move across cell membranes via **osmosis**. Osmosis is the diffusion of **water** from a dilute solution to a concentrated solution through a **partially permeable membrane**.			
Students should be able to: ★ Use simple compound measures of **rate** of water uptake.			
★ Use **percentiles**.			
★ **Calculate** percentage gain and loss of mass of plant tissues.			
★ Plot, draw and interpret appropriate **graphs**.			
WS 1.2 Recognise, draw and interpret diagrams that model osmosis.			
REQUIRED PRACTICAL – Osmosis. **AT 1, 3 and 5.**			
4.1.3.2 Active Transport – *Links with 'Cell specialisation'.*	☺	😐	☹
Active transport moves substances from a more dilute solution to a more concentrated solution (against a concentration gradient). This **requires energy** from **respiration**.			
Active transport allows **mineral ions** to be absorbed into **plant root hairs** from very dilute solutions in the soil. Plants require ions for **healthy growth**.			
It also allows **sugar molecules** to be absorbed from lower concentrations in the **gut** into the blood which has a higher sugar concentration. Sugar molecules are used for **cell respiration**.			
Students should be able to: ★ **Describe** how substances are transported into and out of cells by **diffusion**, **osmosis** and **active transport**.			
★ **Explain** the **differences** between **diffusion**, **osmosis** and **active transport**.			

Topic 2: Organisation

4.2.1 Principles of organisation			
4.2.1 Principles of organisation	☺	😐	☹
Cells are the basic building blocks of all living organisms.			
A **tissue** is a group of cells with a **similar** structure and function.			
Organs are aggregations of tissues performing **specific functions**.			
Organs are organised into **organ systems**, which **work together** to form organisms.			
Students should be able to: ★ Develop an understanding of size and scale in relation to cells, tissues, organs and systems.			
4.2.2 Animal tissues, organs and organ systems			
4.2.2.1 The human digestive system	☺	😐	☹
This section assumes knowledge of the digestive system studied in Key Stage 3 science.			
The **digestive system** is an example of an **organ system** in which several organs work together to **digest** and **absorb food**.			
Enzymes catalyse specific reactions in living organisms due to the shape of their active site.			
Enzymes: • are **biological catalysts** that speed up chemical reactions in living organisms • are **large proteins** • catalyse a **specific reaction** due to the **shape** of the **active site** • are **denatured** by **high temperature** and **extremes of pH** due to changes in the shape of the active site • have an **optimum temperature** • have an **optimum pH**.			
Digestive enzymes convert food into **small soluble molecules** that can be **absorbed** into the **bloodstream**.			
Carbohydrases break down **carbohydrates** to **simple sugars**.			
Amylase is a carbohydrase which breaks down **starch**.			
Proteases break down **proteins** to **amino acids**.			
Lipases break down **lipids** (fats) to **glycerol** and **fatty acids**.			
The products of digestion are used to build new carbohydrates, lipids and proteins. Some glucose is used in **respiration**.			
Bile is made in the **liver** and stored in the **gall bladder**. It is **alkaline** to **neutralise** hydrochloric acid from the stomach. It also emulsifies fat to form small droplets which increases the **surface area**. The alkaline conditions and large surface area increase the rate of fat breakdown by **lipase**.			
Students should be able to: ★ Relate knowledge of enzymes to 'Metabolism' (Bioenergetics topic).			
★ **Describe** the nature of enzyme molecules and relate their activity to temperature and pH changes.			
★ Carry out rate **calculations** for chemical reactions.			
★ Use the **'lock and key theory'** as a simplified model to explain enzyme action.			
★ Use other models to explain enzyme action.			
★ **Recall** the sites of production and the action of **amylase**, **proteases** and **lipases**.			
★ Understand simple **word equations** but no chemical symbol equations are required.			

REQUIRED PRACTICAL – Food tests. **AT 2 and 8.**			
REQUIRED PRACTICAL – Enzymes. **AT 1, 2, 5 and 8.**			
4.2.2.2 The heart and blood vessels	☺	😐	☹
The **heart** is an organ that **pumps blood** around the body in a **double circulatory system**.			
The **right ventricle** pumps blood to the **lungs** where gas exchange takes place.			
The **left ventricle** pumps blood around the rest of the **body**.			
Knowledge of the blood vessels associated with the heart is limited to the **aorta**, **vena cava**, **pulmonary artery**, **pulmonary vein** and **coronary arteries**. *Knowledge of the names of the heart valves is not required.*			
Knowledge of the lungs is restricted to the **trachea**, **bronchi**, **alveoli** and the **capillary network** surrounding the **alveoli**.			
The natural resting heart rate is controlled by a group of cells located in the right atrium that act as a **pacemaker**.			
Artificial pacemakers are electrical devices used to correct irregularities in the heart rate.			
The body contains three different types of blood vessel: • **arteries** • **veins** • **capillaries**.			
Students should be able to: ★ **Describe** the **structure** and **functioning** of the **human heart** and **lungs**, including how lungs are adapted for gaseous exchange.			
★ **Explain** how the **structure** of the blood vessels relates to their **functions**.			
★ Use simple compound measures such as **rate** and carry out rate calculations for blood flow.			
4.2.2.3 Blood	☺	😐	☹
Blood is a **tissue** consisting of **plasma**, in which the **red blood cells**, **white blood cells** and **platelets** are suspended.			
• **Plasma** transports **proteins** and other chemical substances around the body.			
• **Red blood cells** contain **haemoglobin** which binds to **oxygen** to transport it from the lungs to the tissues.			
• **White blood cells** help to **protect** the body against infection.			
• **Platelets** are fragments of cells which initiate the **clotting** process at wound sites.			
Students should be able to: ★ **Recall** the **functions** of each of the **blood components**.			
★ Recognise different types of blood cells in a **photograph** or **diagram**, and explain how they are **adapted** to their functions.			
WS 1.5 Evaluate risks related to use of blood products.			
4.2.2.4 Coronary heart disease: a non-communicable disease	☺	😐	☹
In **coronary heart disease** layers of **fatty material** build up inside the **coronary arteries**, narrowing them. This reduces the flow of blood through the coronary arteries, resulting in a lack of **oxygen** for the heart muscle.			
Stents are used to keep the coronary arteries open.			
Statins are widely used to reduce blood cholesterol levels which slow down the rate of fatty material deposit.			

In some people heart valves may become **faulty**, preventing the valve from opening fully, or the heart valve might develop a leak. Faulty heart valves can be replaced using **biological** or **mechanical valves**.			
In the case of heart failure, a **donor** heart, or heart and lungs can be transplanted. **Artificial hearts** are occasionally used to keep patients alive whilst waiting for a heart transplant, or to allow the heart to rest as an aid to recovery.			
Students should be able to: ★ **Evaluate** the advantages and disadvantages of treating cardiovascular diseases by **drugs**, **mechanical devices** or **transplant**.			
★ **Understand** the **consequences** of faulty heart valves.			
WS 1.3 Evaluate methods of treatment bearing in mind the benefits and risks associated with the treatment.			
4.2.2.5 Health issues	☺	😐	☹
Health is the state of **physical** and **mental** wellbeing.			
Diseases, both **communicable** and **non-communicable**, are major causes of ill health. Other factors including **diet**, **stress** and **life situations** may have a profound effect on both **physical** and **mental** health.			
Different types of disease may interact: • Defects in the **immune system** mean that an individual is more likely to suffer from infectious diseases. • **Viruses** living in cells can be the trigger for **cancers**. • Immune reactions initially caused by a pathogen can trigger **allergies** such as **skin rashes** and **asthma**. • Severe physical ill health can lead to **depression** and other mental illness.			
Students should be able to: ★ **Describe** the **relationship** between **health** and **disease** and the interactions between different types of disease.			
★ Translate information between graphical and numerical forms, construct and interpret frequency tables and diagrams, bar charts and histograms, and use a scatter diagram to identify a correlation between two variables.			
★ **Understand** the principles of sampling as applied to scientific data, including epidemiological data.			
4.2.2.6 The effect of lifestyle on some non-communicable diseases	☺	😐	☹
Risk factors are linked to an increased rate of a disease. They can be: • aspects of a person's **lifestyle** • **substances** in the person's body or environment.			
A **causal mechanism** has been proven for some risk factors, but not in others. • The effects of **diet**, **smoking** and **exercise** on **cardiovascular disease**. • **Obesity** as a risk factor for **Type 2 diabetes**. • The effect of **alcohol** on the **liver** and **brain** function. • The effect of **smoking** on **lung disease** and **lung cancer**. • The effects of **smoking** and **alcohol** on **unborn babies**. • **Carcinogens**, including **ionising radiation**, as risk factors in **cancer.**			
Many diseases are caused by the **interaction of a number of factors** (e.g. cardiovascular disease, some lung and liver diseases and diseases influences by nutrition, including Type 2 diabetes).			
Students should be able to: ★ **Discuss** the **human** and **financial cost** of these non-communicable diseases to an individual, a local community, a nation or globally.			

★ **Explain** the effect of **lifestyle factors** including diet, alcohol and smoking on the incidence of non-communicable diseases at local, national and global levels.			
★ **Understand** the principles of sampling as applied to scientific data in terms of risk factors.			
★ Translate information between graphical and numerical forms; and extract and interpret information from charts, graphs and tables in terms of risk factors.			
★ Use a scatter diagram to identify a correlation between two variables in terms of risk factors.			
WS 1.5 Interpret data about risk factors for specified diseases.			
4.2.2.7 Cancer	☺	😐	☹
Benign tumours are growths of abnormal cells which are **contained in one area**, usually within a membrane. They do not invade other parts of the body.			
Malignant tumour cells are **cancers**. They invade neighbouring tissues and spread to different parts of the body in the blood where they form **secondary tumours**.			
Scientists have identified **lifestyle risk factors** for various types of cancer (including **smoking**, **obesity**, common **viruses** and **UV** exposure). There are also **genetic** risk factors for some cancers.			
Students should be able to: ★ **Describe cancer** as the result of changes in **cells** that lead to **uncontrolled growth** and **division**.			
4.2.3 Plant tissues, organs and systems			
4.2.3.1 Plant tissues	☺	😐	☹
Plant tissues include: • **epidermal tissues**, which cover the plant • **palisade mesophyll**, which carries out **photosynthesis** • **spongy mesophyll**, which has air spaces for **diffusion of gases** • **xylem** and **phloem**, which **transport** substances around the plant • **meristem tissue** found at the growing tips of shoots and roots which will **differentiate** into different plant cells.			
The **leaf** is a plant **organ**. Knowledge limited to **epidermis**, **palisade** and **spongy mesophyll**, **xylem** and **phloem**, and **guard cells** surrounding stomata.			
Students should be able to: ★ **Explain** how the **structures** of plant tissues are related to their **functions**.			
4.2.3.2 Plant organ systems	☺	😐	☹
The roots, stem and leaves form a plant **organ system** for transport of substances around the plant.			
Root hair cells are adapted for the efficient **uptake of water** by **osmosis** and **mineral ions** by **active transport**.			
Xylem tissue transports **water** and **mineral ions** from the roots to the stems and leaves.			
Xylem tissue is composed of **hollow tubes** strengthened by **lignin** adapted for the transport of water in the transpiration stream.			
The role of **stomata** and **guard cells** are to control **gas exchange** and **water loss**.			
Phloem tissue transports dissolved **sugars** from the leaves to the rest of the plant for immediate use or storage. The movement of food through phloem tissue is called **translocation**.			
Phloem is composed of tubes of **elongated cells**. Cell sap can move from one phloem cell to the next through **pores** in the end walls. *Detailed structure of phloem tissue or the mechanism of transport is not required.*			
Students should be able to: ★ **Explain** how the structure of **root hair cells**, **xylem** and **phloem** are **adapted** to their functions.			

★ **Describe** the process of **transpiration** and **translocation**, including the structure and functions of the **stomata**.			
★ **Explain** the effect of changing **temperature**, **humidity**, **air flow** and **light intensity** on the **rate of transpiration**.			
★ **Understand** and use simple compound measures such as the rate of transpiration.			
★ Translate information between graphical and numerical form			
★ Plot and draw appropriate **graphs**, selecting appropriate scales for axes			
★ Extract and interpret information from graphs, charts and tables.			
MS 2a, 2d, 5c Process data from investigations involving stomata and transpiration rates to find arithmetic means, understand the principles of sampling and calculate surface areas and volumes.			

Topic 3: Infection and Response

4.3.1 Communicable diseases			
4.3.1.1 Communicable (infectious) diseases	☺	😐	☹
Pathogens are **microorganisms** that cause **infectious disease**.			
Pathogens may be **viruses**, **bacteria**, **protists** or **fungi**.			
They may infect **plants** or **animals** and can be spread by **direct contact**, by **water** or by **air**.			
Bacteria and viruses may reproduce rapidly inside the body.			
Bacteria may produce **poisons** (toxins) that damage tissues and make us feel ill.			
Viruses live and reproduce **inside cells**, causing cell damage.			
The spread of diseases can be reduced or prevented by: • simple **hygiene** measures • destroying **vectors** • **isolation** of infected individuals • **vaccination**.			
<u>Students should be able to:</u> ★ **Explain** how diseases caused by **viruses**, **bacteria**, **protists** and **fungi** are spread in animals and plants.			
★ **Explain** how the spread of diseases can be **reduced** or **prevented**.			
4.3.1.2 Viral diseases	☺	😐	☹
Measles is a viral disease showing symptoms of **fever** and a **red skin rash**. Measles is a serious illness that can be fatal if complications arise. For this reason most **young children** are **vaccinated** against measles. The measles virus is spread by **inhalation** of droplets from sneezes and coughs.			
HIV initially causes a **flu-like illness**. Unless successfully controlled with **antiretroviral drugs** the virus enters the **lymph nodes** and attacks the body's immune cells. Late stage HIV, or **AIDS**, occurs when the body's **immune system** is no longer able to deal with other infections or cancers. HIV is spread by **sexual contact** or exchange of **body fluids** such as blood which occurs when **drug users** share needles.			
Tobacco mosaic virus (TMV) is a widespread **plant pathogen** affecting many species of plants including **tomatoes**. It gives a distinctive 'mosaic' pattern of **discolouration** on the leaves which affects the growth of the plant due to lack of **photosynthesis**.			

4.3.1.3 Bacterial diseases	☺	😐	☹
***Salmonella* food poisoning** is spread by **bacteria** ingested in **food**, or on food prepared in unhygienic conditions. In the UK, poultry are **vaccinated** against *Salmonella* to control the spread. **Fever**, **abdominal cramps**, **vomiting** and **diarrhoea** are caused by the bacteria and the **toxins** they secrete.			
Gonorrhoea is a **sexually transmitted** disease (STD) with symptoms of a thick yellow or green **discharge** from the vagina or penis and pain on urinating. It is caused by a **bacterium** and was easily treated with the **antibiotic penicillin** until many **resistant strains** appeared. Gonorrhoea is spread by **sexual contact**. The spread can be controlled by treatment with **antibiotics** or the use of a barrier method of contraception such as a **condom**.			
4.3.1.4 Fungal diseases	☺	😐	☹
Rose black spot is a **fungal** disease where purple or black spots develop on leaves, which often turn yellow and drop early. It affects the growth of the plant as **photosynthesis** is reduced. It is spread in the environment by **water** or **wind**. Rose black spot can be treated by using **fungicides** and/or removing and destroying the affected leaves.			
4.3.1.5 Protist diseases	☺	😐	☹
The pathogens that cause **malaria** are **protists**. The malarial protist has a life cycle that includes the **mosquito**. Malaria causes recurrent episodes of **fever** and can be **fatal**. The spread of malaria is controlled by **preventing the vectors**, mosquitos, from breeding and by using **mosquito nets** to avoid being bitten.			
4.3.1.6 Human defence systems	☺	😐	☹
The **human body** defends itself against the entry of pathogens. • The **skin** (a **barrier** and produces **antimicrobial secretions**) • The **nose** (traps **particles** which may contain pathogens) • The **trachea** and **bronchi** (secrete **mucus** which traps pathogens and **cilia** waft the mucus to the back of the throat where it is swallowed) • The **stomach** (produces **acid** which kills the majority of pathogens which enter via the mouth)			
If a pathogen enters the body the **immune system** tries to **destroy** the pathogen.			
White blood cells help to defend against pathogens by: • phagocytosis • antibody production • antitoxin production.			
<u>Students should be able to:</u> ★ **Explain** the **non-specific defence systems** of the **human body** against pathogens (skin, nose, trachea and bronchi, stomach).			
★ **Explain** the role of the **immune system** in the defence against disease.			
4.3.1.7 Vaccination	☺	😐	☹
Vaccination involves introducing small quantities of **dead** or **inactive forms** of a pathogen into the body to stimulate the **white blood cells** to produce **antibodies**. If the same pathogen re-enters the body the white blood cells **respond quickly** to produce the correct **antibodies**, preventing infection.			
<u>Students should be able to:</u> ★ **Explain** how vaccination will prevent illness in an individual, and how the spread of pathogens can be reduced by immunising a large proportion of the population. *Students do <u>not</u> need to know details of vaccination schedules and side effects associated with specific vaccines.*			

WS 1.4 Evaluate the global use of vaccination in the prevention of disease.			
4.3.1.8 Antibiotics and painkillers	☺	😐	☹
Antibiotics, such as **penicillin**, are medicines that help to **cure bacterial disease** by killing infective bacteria inside the body. It is important that **specific bacteria** should be treated by **specific antibiotics**.			
The use of antibiotics has greatly reduced deaths from infectious bacterial diseases. However, the emergence of strains **resistant** to antibiotics is of great concern.			
Antibiotics cannot kill viral pathogens.			
Painkillers and other medicines are used to treat the **symptoms** of disease but do not kill pathogens.			
It is difficult to develop drugs that kill viruses without also damaging the body's tissues.			
Students should be able to: ★ **Explain** the use of antibiotics and other medicines in treating disease.			
4.3.1.9 Discovery and development of drugs	☺	😐	☹
Traditionally drugs were extracted from **plants** and **microorganisms**. • The heart drug **digitalis** originates from **foxgloves**. • The painkiller **aspirin** originates from **willow**. • **Penicillin** was discovered by **Alexander Fleming** from the ***Penicillium* mould**.			
Most new drugs are **synthesised** by chemists in the pharmaceutical industry. However, the starting point may still be a chemical extracted from a plant.			
New medical drugs have to be **tested** and **trialled** before being used to check that they are safe and effective.			
New drugs are extensively **tested** for **toxicity**, **efficacy** and **dose**.			
Preclinical **testing** is done in a laboratory using **cells**, **tissues** and **live animals**.			
Clinical **trials** use healthy volunteers and patients. • Very **low doses** of the drug are given at the start of the clinical trial. • If the drug is found to be safe, further clinical trials are carried out to find the **optimum dose** for the drug. • In **double blind trials**, some patients are given a **placebo**, which does not contain the drug. • Patients are allocated **randomly** to groups so that neither the doctors nor the patients know who has received a placebo and who has received the drug until the trial is complete.			
Students should be able to: ★ **Describe** the process of **discovery** and **development** of potential new medicines, including **preclinical** and **clinical testing**.			
WS 1.6 Understand that the results of testing and trials are published only after scrutiny by **peer review**. This helps to prevent false claims.			
4.3.2 Monoclonal antibodies – *GCSE Biology only*			
4.3.2.1 Producing monoclonial antibodies (HT only)	☺	😐	☹
Monoclonal antibodies are produced from a single **clone** of cells. The antibodies are **specific** to one **binding site** on one protein **antigen** and so are able to target a specific chemical or specific cells in the body.			
They are produced by stimulating **mouse lymphocytes** to make a particular antibody. The lymphocytes are combined with a particular kind of tumour cell to make a cell called a **hybridoma cell**. The hybridoma cell can both divide and make the antibody. Single hybridoma cells are cloned to produce many identical cells that all produce the same antibody. A large amount of the antibody can be collected and purified.			

Students should be able to: ★ **Describe** how monoclonal antibodies are produced.			
4.3.2.2 Uses of monoclonial antibodies (HT only)	☺	😐	☹
Examples of how monoclonial antibodies are used include: • For **diagnoses** such as **pregnancy tests** (a monoclonal antibody binds to the **hormone HCG** found in the urine during early pregnancy).			
• In **laboratories** to measure the levels of **hormones** and **other chemicals** in blood, or to detect **pathogens**.			
• In research to **locate** or **identify** specific molecules in a cell or tissue by binding to them with a **fluorescent dye**.			
• To **treat** some diseases: for **cancer** the monoclonal antibody can be bound to a **radioactive substance**, a **toxic drug** or a **chemical** which stops cells growing and dividing. It delivers the substance to the cancer cells without harming other cells in the body.			
Monoclonal antibodies create more **side effects** than expected. They are not yet as widely used as everyone hoped when they were first developed.			
Students should be able to: ★ **Describe** some of the ways in which monoclonal antibodies can be used.			
★ **Explain** how specific test work, given appropriate information. *They are not expected to recall any specific tests.*			
WS 1.3 Appreciate the power of monoclonal antibodies and consider any ethical issues.			
WS 1.5 Evaluate the advantages and disadvantages of monoclonal antibodies.			
4.3.3 Plant disease – *GCSE Biology only*			
4.3.3.1 Detection and identification of plant diseases	☺	😐	☹
(HT only) **Plant diseases** can be **detected** by: • stunted growth • spots on leaves • areas of decay (rot) • growths • malformed stems or leaves • discolouration • the presence of pests.			
(HT only) **Identification** can be made by: • reference to a gardening manual or website • taking infected plants to a laboratory to identify the pathogen • using testing kits that contain monoclonal antibodies.			
Plants can be infected by a range of **viral**, **bacterial** and **fungal** pathogens as well as by **insects**.			
Knowledge of plant diseases restricted to **tobacco mosaic virus** as a viral disease, **black spot** as a fungal disease and **aphids** as insects.			
Plants can be damaged by a range of **ion deficiency** conditions: • **stunted growth** caused by **nitrate** deficiency • **chlorosis** caused by **magnesium** deficiency.			
Knowledge of ions is limited to **nitrate** ions needed for **protein synthesis** and therefore **growth** and **magnesium ions** needed to make **chlorophyll**.			
WS 1.4 The everyday application of scientific knowledge to detect and identify plant disease.			
WS 1.4 The understanding of ion deficiencies allows horticulturists to provide optimum conditions for plants.			

4.3.3.2 Plant defence responses	☺	😐	☹
Physical defence responses to resist invasion of microorganisms. • Cellulose cell walls. • Tough waxy cuticle on leaves. • Layers of dead cells around stems (bark on trees) which fall off taking pathogens with them.			
Chemical plant defence responses. • Produce **antibacterial chemicals**, such as mint and witch hazel. • Produce **poisons** to deter herbivores, such as tobacco plants, foxgloves and deadly nightshade.			
Mechanical adaptations. • Thorns and hairs deter animals from eating or touching them. • Leaves which droop or curl when touched. • Mimicry to trick animals into not eating them or not laying eggs on the leaves.			
Students should be able to: ★ **Describe physical** and **chemical** plant defence responses.			

Topic 4: Bioenergetics

4.4.1 Photosynthesis			
4.4.1.1 Photosynthesis reaction	☺	😐	☹
Photosynthesis is represented by the equation: $\text{carbon dioxide} + \text{water} \xrightarrow{\text{light}} \text{glucose} + \text{oxygen}$			
The chemical symbols: $6CO_2 + 6H_2O \xrightarrow{\text{light}} C_6H_{12}O_6 + 6O_2$			
Students should be able to: ★ **Describe** photosynthesis as an **endothermic** reaction in which energy is transferred from the environment to the **chloroplast** by light. *Links with 'Plant tissues' in Topic 2: Organisation.*			
4.4.1.2 Rate of photosynthesis	☺	😐	☹
Factors that affect the rate of photosynthesis include: • Temperature • Light intensity • Carbon dioxide concentration • The amount of chlorophyll			
(HT only) These factors **interact** and any one of them may be the factor that limits photosynthesis.			
(HT only) Limiting factors are important in the economics of enhancing the conditions in **greenhouses** to gain the **maximum rate** of photosynthesis while still maintaining **profit**.			
Students should be able to: ★ **Explain** the effects of **temperature**, **light intensity**, **carbon dioxide concentration**; and the **amount of chlorophyll** on the rate of photosynthesis.			
★ Measure and calculate rates of photosynthesis			
★ Extract and interpret **graphs** of photosynthesis rate involving one limiting factor			

★ Plot and draw appropriate **graphs** selecting appropriate scales for axes			
★ Translate information between graphical and numerical form			
★ (HT only) **Explain** graphs of photosynthesis rate involving two or three factors and decide which is the limiting factor.			
★ (HT only) **Understand** and use **inverse proportion** – the **inverse square law** and **light intensity** in the context of photosynthesis.			
WS 1.4 (HT only) Use data to relate limiting factors to the cost effectiveness of adding heat, light or carbon dioxide to greenhouses.			
REQUIRED PRACTICAL – Photosynthesis. **AT 1, 2, 3, 4 and 5.**			
4.4.1.3 Uses of glucose from photosynthesis	☺	😐	☹
The **glucose** produced in photosynthesis may be: • used for **respiration** • converted into insoluble **starch** for storage • used to produce **fat** or **oil** for storage • used to produce **cellulose**, which strengthens the cell wall • used to produce **amino acids** for protein synthesis.			
To produce **proteins**, plants also use **nitrate ions** that are absorbed from the soil.			
4.4.2 Respiration			
4.4.2.1 Aerobic and anaerobic respiration	☺	😐	☹
The energy transferred supplies all the energy needed for **living processes**.			
Organisms need energy for: • chemical reactions to build larger molecules • movement • keeping warm.			
Respiration in cells can take place **aerobically** (using oxygen) or **anaerobically** (without oxygen), to transfer energy.			
<u>Aerobic</u> respiration is represented by the equations: glucose + oxygen → carbon dioxide + water			
The chemical symbols: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$			
Reactions which transfer energy to the environment are **exothermic** reactions.			
<u>Anaerobic</u> respiration in muscles is represented by the equation: glucose → lactic acid			
As the oxidation of glucose is incomplete in **anaerobic respiration** much **less energy** is transferred than in aerobic respiration.			
<u>Anaerobic</u> respiration in **plant** and **yeast** cells is represented by the equations: glucose → ethanol + carbon dioxide			
(HT only) $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$			
Anaerobic respiration in **yeast** cells is called **fermentation** and has economic importance in the manufacture of **bread** and **alcoholic drinks**.			
<u>Students should be able to:</u> ★ **Describe** cellular **respiration** as an **exothermic** reaction which is continuously occurring in living cells.			

★ **Compare** the processes of **aerobic** and **anaerobic respiration** with regard to the need for **oxygen**, the differing **products** and the relative amounts of energy transferred.			
4.4.2.2 Response to exercise	☺	😐	☹
During exercise the human body reacts to the increased demand for energy.			
The **heart rate**, **breathing rate** and **breath volume** increase during exercise to supply the muscles with more oxygenated blood. This is needed for the increased cellular respiration to transfer more energy to meet the demand.			
If **insufficient oxygen** is supplied **anaerobic respiration** takes place in muscles. The incomplete oxidation of glucose causes a build-up of **lactic acid** and creates an **oxygen debt**.			
During long periods of vigorous activity muscles become fatigued and stop contracting efficiently. One cause of **muscle fatigue** is the **build-up of acid** in the muscles. The oxygen debt must be 'repaid' once exercise stops, causing deep breathing for some time.			
(HT only) Blood flowing through the muscles transports the **lactic acid** to the **liver** where it is converted back into **glucose**.			
(HT only) **Oxygen debt** is the amount of **extra oxygen** the body needs after exercise to react with the accumulated **lactic acid** and remove it from the cells.			
4.4.2.3 Metabolism	☺	😐	☹
Metabolism is the **sum** of all the **reactions** in a cell or the body.			
The energy transferred by respiration in cells is used by the organism for the continual **enzyme** controlled processes of metabolism that **synthesises** new molecules.			
Metabolism includes: • conversion of glucose to starch, glycogen and cellulose • the formation of lipid molecules from a molecule of glycerol and three molecules of fatty acids • the use of glucose and nitrate ions to form amino acids which in turn are used to synthesise proteins • respiration • breakdown of excess proteins to form urea for excretion. *All of these aspects are covered in more detail in the relevant specification section but are linked together here.*			
<u>Students should be able to:</u> ★ **Explain** the importance of sugars, amino acids, fatty acids and glycerol in the synthesis and breakdown of carbohydrates, proteins and lipids.			