Raedwald Trust KS4 Science Programme of Study - Biology

The three pathways below increase in difficulty and content from left to right. Baseline assessments are given to each student within the first science lessons at a site and the appropriate pathway is selected. This Programme of Study lists the Biology element of Entry Level Science and the foundation and higher AQA GCSE Biology content for comparison. Please see the Raedwald Trust KS4 Chemistry and Physics Programmes of Study for those parts of the full content. The full AQA Biology GCSE content taught at The Raedwald Trust, is listed below.

Working Scientifically

All of the below skills are taught throughout this Programme of Study, within the separate units. The lists below are for reference only and should only be taught explicitly if a significant difficulty with certain aspects are identified, to help a student to close any gaps in learning.

AQA Entry Level Certificate Science	Foundation AQA Biology GCSE	Higher AQA Biology GCSE – Extra content on top of Foundation content
AO1: Show knowledge and understanding of science, and how it works, and apply it where appropriate. Students should be able to: • recall scientific facts • apply scientific ideas. AO2: Demonstrate the ability to design an investigation, take measurements, present data and identify patterns and relationships. Students should be able to: • plan a simple investigation, identifying the techniques or equipment needed and the method to be followed • make a simple prediction about the outcome of the investigation • use equipment and materials safely to take simple measurements or observations that are meaningful and valid • record the results in an appropriate way • display the data using an appropriate method	**1 Development of Scientific Thinking** WS 1.3 Appreciate the power and limitations of science and consider any ethical issues which may arise. WS 1.4 Explain everyday and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decisions based on the evaluation of evidence and arguments. WS 1.5 Evaluate risks both in practical science and the wider societal context, including perception of risk in relation to data and consequences. WS 1.6 Recognise the importance of peer review of results and of communicating results to a range of audiences. **2 Experimental Skills and Strategies** WS 2.1 Use scientific theories and explanations to develop hypotheses. WS 2.2 Plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena. WS 2.3 Apply a knowledge of a range of techniques, instruments, apparatus, and materials to select those appropriate to the experiment. WS 2.4 Carry out experiments appropriately having due regard for the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations. WS 2.5 Recognise when to apply a knowledge of sampling techniques to ensure any samples collected are representative. WS 2.6 Make and record observations and measurements using a range of apparatus and methods. WS 2.7 Evaluate methods and suggest possible improvements and further investigations.	All aspects of working scientifically are in both the Foundation and Higher Assessments.

• state what has been found out during the investigation (drawing a conclusion) and describe simple relationships in the data • simply evaluate the investigation for its success in justifying the initial prediction.	**3 Analysis and Evaluation** WS 3.1 Presenting observations and other data using appropriate methods. WS 3.2 Translating data from one form to another. WS 3.3 Carrying out and represent mathematical and statistical analysis. WS 3.4 Representing distributions of results and make estimations of uncertainty. WS 3.5 Interpreting observations and other data (presented in verbal, diagrammatic, graphical, symbolic or numerical form), including identifying patterns and trends, making inferences and drawing conclusions. WS 3.6 Presenting reasoned explanations including relating data to hypotheses. WS 3.7 Being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error. WS 3.8 Communicating the scientific rationale for investigations, methods used, findings and reasoned conclusions through paper-based and electronic reports and presentations using verbal, diagrammatic, graphical, numerical and symbolic forms. **4 Scientific Vocabulary, quantities, units, symbols and nomenclature.** WS 4.1 Use scientific vocabulary, terminology and definitions. WS 4.2 Recognise the importance of scientific quantities and understand how they are determined. WS 4.3 Use SI units (eg kg, g, mg; km, m, mm; kJ, J) and IUPAC chemical nomenclature unless inappropriate. WS 4.4 Use prefixes and powers of ten for orders of magnitude (e.g. tera, giga, mega, kilo, centi, milli, micro and nano). WS 4.5 Interconvert units. WS 4.6 Use an appropriate number of significant figures in calculation.	

Cell Biology (same on NC)

AQA Entry Level Certificate Science	Foundation AQA Biology GCSE	Higher AQA Biology GCSE - Extra content on top of Foundation content
3.1 Component 1 – Biology: The Human Body 3.1.1 What is the body made of? Outcome 1 • Cells are the basic building blocks of all living organisms. • Most human cells are like most other animal cells and have the following parts: Nucleus, Cytoplasm, Cell Membrane. • Students should be able, when provided with appropriate information, explain how the structure of different types of cell relates to their function.	***4.1 Cell Biology*** **4.1.1 Cell Structure** 4.1.1.1 Eukarotes and Prokaryotes • Know similarities and differences between plant and animal cells (eukaryotic cells) • Understand that bacterial cells (prokaryotic cells) are much smaller in comparison. • 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. 4.1.1.2 Animal and Plant Cells • 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. • Know the parts of an animal cell (including mitochondria and ribosomes) • Know that plant cells often have chloroplasts and a permanent vacuole • Understand the purpose of cellulose in a cell wall 4.1.1.3 Cell Specialisation • 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. • Know that cells may be specialised to carry out a particular function. 4.1.1.4 Cell differentiation Explain the importance of cell differentiation. • 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. 4.1.1.5 Microscopy - Required Practical 1 • Understand how microscopy techniques have developed over time, comparing light and electron microscopes. • Explain how electron microscopy has increased understanding of sub-cellular structures. • Students should be able to carry out calculations involving magnification using the formula: magnification = size of image/size of real object. 4.1.1.6 Culturing Micro-organisms – Required Practical 2 • Bacteria multiply by simple cell division (binary fission) • 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. • Students should be able to describe how to prepare an uncontaminated culture using aseptic technique. • Students should be able to calculate cross-sectional areas of colonies or clear areas around colonies using πr^2. • Students should be able to calculate the number of bacteria in a population after a certain time if given the mean division time. **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 but do not need to know the different phases of mitosis. • Students should 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. • Students should be able to describe the function of stem cells in embryos, in adult animals and in the meristems in plants. • 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. • 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. **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 out 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. • Factors which affect the rate of diffusion. • Students should be able to calculate and compare surface area to volume ratios. • Students should be able to explain the need for exchange surfaces and a transport system in multicellular organisms in terms of surface area to	

	volume ratio. 4.1.3.2 Osmosis – Required Practical 3 • 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 percentages, calculate percentage gain and loss of mass of plant tissue. • Students should be able to plot, draw and interpret appropriate graphs. 4.1.3.3 Active Transport • Active transport moves substances from a more dilute solution to a more concentrated solution (against a concentration gradient). • This requires energy from respiration. • Students should be able to: describe how substances are transported into and out of cells by diffusion, osmosis and active transport and explain the differences between the three processes.	

Organisation (NC Transport Systems)

AQA Entry Level Certificate Science	Foundation AQA Biology GCSE	Higher AQA Biology GCSE
3.1 Component 1 – Biology: The Human Body **3.1.1 What is the body made of?** Outcome 2 • A tissue is a group of cells with a similar structure and function. • Students should develop some understanding of size and scale in relation to cells, tissues, organs and systems. • Organs are aggregations of tissues performing similar functions. • Organs are organised into organ systems which work together. Outcome 3 • The human digestive system contains a variety of organs. • Students should be able to identify the position of these organs on a diagram of the digestive system. • Enzymes are used to convert food into soluble substances that can be absorbed into the bloodstream.	***4.2 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. **4.2.2 Animal tissues, organs and organ systems** 4.2.2.1 The Human Digestive System – Required Practical 4 and 5 *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. • Students should be able to relate knowledge of enzymes to Metabolism. • Students should be able to carry out rate calculations for chemical reactions. • Students should be able to use the 'lock and key theory' as a simplified model to explain enzyme action. • Students should be able to recall the sites of production and the action of amylase, proteases and lipases. • Students should be able to understand simple word equations but no chemical symbol equations are required. • Digestive enzymes convert food into small soluble molecules that can be absorbed into the bloodstream.	

• The human circulatory system consists of the heart, which pumps blood around the body (in a dual circulatory system) and blood, which transports oxygen, proteins and other chemical substances around the body. • Students should be able to recognise the different types of blood cell from a photograph or diagram.	• Bile is made in the liver and stored in the gall bladder. 4.2.2.2 The Heart and Blood Vessels • Students should know the structure and functioning of the human heart and lungs, including how lungs are adapted for gaseous exchange. • The heart is an organ that pumps blood around the body in a double circulatory system. • 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 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. • Students should be able to 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. • Students should be able to recognise different types of blood cells in a photograph or diagram, and explain how they are adapted to their functions. 4.2.2.4 Coronary Heart Disease; A non-communicable disease • Students should be able to evaluate the advantages and disadvantages of treating cardiovascular diseases by drugs, mechanical devices or transplant • Stents are used to keep the coronary arteries open. • Statins are widely used to reduce blood cholesterol levels which slows down the rate of fatty material	

3.1.2 How the body works Outcome 4 • Lifestyle can have an effect on people's health e.g. diet and exercise are linked to obesity; smoking to cancer; alcohol to liver and brain function. A healthy diet contains the right balance of the different food groups you need and the right amount of energy. • People who exercise regularly are usually fitter than people who take little exercise.	deposit. • In some people heart valves may become faulty. Students should understand the consequences of faulty valves and how they are replace. • 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. 4.2.2.5 Health Issues • Students should be able to describe the relationship between health and disease and the interactions between different types of disease. • Health is the state of physical and mental well-being. • Defects in the immune system. • Severe physical ill health can lead to depression and other mental illness. • Students should be able to translate disease incidence 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. • Students should 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. • 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 and the effects of these on the wider community. • Students should be able to understand the principles of sampling as applied to scientific data in terms of risk factors.	

	• Students should be able to translate information between graphical and numerical forms; and extract and interpret information from charts, graphs and tables in terms of risk factors. • Students should be able to use a scatter diagram to identify a correlation between two variables in terms of risk factors. 4.2.2.7 Cancer • Students should be able to describe cancer as the result of changes in cells that lead to uncontrolled growth and division. • Benign tumours. • Malignant tumours. • Scientists have identified lifestyle risk factors for various types of cancer. There are also genetic risk factors for some cancers. **4.2.3 Plant tissues, organs and systems – taught in Bioenergetics topic to keep plant topics together which has historically aided understanding and progress.** 4.2.3.1 Plant Tissues • Students should be able to explain how the structures of plant tissues are related to their functions. • Knowledge limited to epidermis, palisade and spongy mesophyll, xylem and phloem, and guard cells surrounding stomata. 4.2.3.2 Plant Organ System • Students should be able to explain how the structure of root hair cells, xylem and phloem and guard cells/stomata are adapted to their functions. • Students should be able to explain the effect of changing temperature, humidity, air movement and light intensity on the rate of transpiration. • Students should be able to understand and use simple compound measures such as the rate of transpiration. • The roots, stem and leaves form a plant organ system for transport of substances around the plant.	

	• Students should be able to describe the process of transpiration and translocation.	

Infection and Response (NC Health, Disease and the Development of Medicines)

AQA Entry Level Certificate Science	Foundation AQA Biology GCSE	Higher AQA Biology GCSE
3.1.3 How the body fights disease Outcome 5 • Infectious (communicable) diseases are caused by microorganisms called pathogens. • These may reproduce rapidly inside the body and may produce poisons (toxins) that make us feel ill. Viruses damage cells in which they reproduce.	***4.3 Infection and Response*** **4.3.1 Communicable diseases** 4.3.1.1 Communicable (Infectious) diseases • Students should be able to explain how diseases caused by viruses, bacteria, protists and fungi are spread in animals and plants. • Students should be able to explain how the spread of diseases can be reduced or prevented. • Pathogens are microorganisms that cause infectious disease 4.3.1.2 Viral Diseases • Symptoms, complications, mode of transmission and treatment of the viral diseases below; - Measles - HIV - Tobacco mosaic virus (TMV) • Late stage HIV infection, or AIDS, occurs when the body's immune system becomes so badly damaged it can no longer deal with other infections or cancers. 4.3.1.3 Bacterial diseases • Symptoms, complications, mode of transmission and treatment of the bacterial diseases below; - Salmonella - Gonorrhoea 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	

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Outcome 6

- White blood cells help to defend against bacteria by ingesting them.
- 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 so that if the same pathogen re-enters the body, antibodies can be produced rapidly.
- Students should be able to explain the use of vaccination in the prevention of disease.

Outcome 7

- Antibiotics, including penicillin, are medicines that help to cure bacterial disease by killing infective bacteria inside the body, but cannot be used to kill viruses.
- Medical drugs are developed

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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.
- The symptoms and prevention of malaria.

4.3.1.6 Human defence systems

- Students should be able to describe the non-specific defence systems of the human body (skin, nose hairs etc).
- Students should be able to explain the role of the immune system in the defence against disease.
- 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 and antitoxin production.

4.3.1.7 Vaccination

- Students should be able to 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.

4.3.1.8 Antibiotics and Painkillers

- Students should be able to explain the use of antibiotics and other medicines in treating disease.
- 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.

4.3.1.9 Discovery and development of drugs

- Students should be able to describe the process of discovery and development of potential new medicines, including preclinical and clinical testing.

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4.3.2 Monoclonal antibodies (Higher Tier only)

4.3.2.1 Producing monoclonal antibodies

- Students should be able to describe how monoclonal antibodies are produced.

4.3.2.2 Uses of monoclonal antibodies

- Students should be able to describe some of the ways in which monoclonal antibodies can be used.
- Some examples include: for diagnosis such as in pregnancy tests, in laboratories to measure the levels of hormones and other chemicals in blood. or to detect pathogens
- Monoclonal antibodies create more side effects than expected. They are not yet as widely used as everyone hoped when they were first developed

4.3.3 Plant diseases

4.3.3.1 Detection and identification of plant diseases

- (HT only) Plant diseases can be detected by:

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and tested before being used to relieve illness or disease. • Drugs change the chemical processes in people's bodies. People may become dependent or addicted to the drugs and suffer withdrawal symptoms without them.	• Traditionally drugs were extracted from plants and microorganisms. • 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. **4.3.3 Plant diseases** 4.3.3.1 Detection and identification of plant diseases • Plants can be infected by a range of viral, bacterial and fungal pathogens as well as by insects. Knowledge of plant diseases is 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. 4.3.3.2 Plant defence responses • Students should be able to describe physical and chemical plant defence responses.	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.

Bioenergetics (NC Photosynthesis)

AQA Entry Level Certificate Science	Foundation AQA Biology GCSE	Higher AQA Biology GCSE
3.2 Component 2 – Biology; Environment, Evolution and Inheritance **3.2.1 What are the feeding relationships between living organisms?** Outcome 1 • Radiation from the Sun is the source of energy for living organisms • Green plants and algae absorb a small amount of the light that reaches them and make glucose by photosynthesis. These organisms are called producers. Carbon dioxide + water → glucose + oxygen Students should know the word equation for photosynthesis. ***3.1.2 How the body works*** Outcome 4 • Respiration releases the energy needed for living processes and is represnted by the equation: glucose + oxygen → carbon dioxide + water (+ energy) Students should know the word	***4.4 Bioenergetics*** **4.4.1 Photosynthesis** 4.4.1.1 Photosynthetic reaction • Students should know the word equation for photosynthesis and recognise the chemical symbols. • Students should be able to describe photosynthesis as an endothermic reaction. 4.4.1.2 Rate of Photosynthesis – Required Practical 6 • 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. • Students should be able to: measure and calculate rates of photosynthesis, extract and interpret graphs of photosynthesis rate involving one limiting factor, plot and draw appropriate graphs selecting appropriate scale for axes, translate information between graphical and numeric form. 4.4.1.3 Use of glucose from photosynthesis • List the main uses for the glucose produced in photosynthesis. Such as: in respiration, starch, to produce fat or oil for storage, to produce cellulose and to produce amino acids for protein synthesis. **4.4.2 Respiration** 4.4.2.1 Aerobic and anaerobic respiration • Students should be able to describe cellular respiration as an exothermic reaction which is continuously occurring in living cells. • Respiration in cells can take place aerobically (using oxygen) or anaerobically (without oxygen), to transfer energy. • Students should be able to compare the processes of aerobic and anaerobic respiration with regard to the need for oxygen, the differing products and the	4.4.1.2 Rate of Photosynthesis – Required Practical 6 • (HT only) These factors interact and any one of them may be the factor that limits photosynthesis. • (HT only) Students should be able to explain graphs of photosynthesis rate involving two or three factors and decide which is the limiting factor • (HT only) Students should understand and use inverse proportion – the inverse square law and light intensity in the context of 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. 4.4.2.2 Response to exercise

equation for respiration. • Students should know that glucose is derived from the diet and that carbon dioxide and oxygen gases are exchanged through the lungs.	relative amounts of energy transferred. • Students should know the word equation and recognise the symbols for aerobic respiration and anaerobic respiration in muscles (lactic acid build up) and yeast cells (ethanol, fermentation with economic importance in the manufacture of bread and alcoholic drinks). 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. • If insufficient oxygen is supplied anaerobic respiration takes place in muscles. 4.4.2.3 Metabolism • Students should be able to explain the importance of sugars, amino acids, fatty acids and glycerol in the synthesis and breakdown of carbohydrates, proteins and lipids. • 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 synthesise new molecules.	• (HT only) Blood flowing through the muscles transports the lactic acid to the liver where it is converted back into glucose. 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.

Homeostasis and Response (NC Coordination and Control)

AQA Entry Level Certificate Science	Foundation AQA Biology GCSE	Higher AQA Biology GCSE
3.1.4 How the body is co-ordinated Outcome 8 • The human body has automatic control systems, which may involve nervous responses or chemical responses coordinated by hormones. • Reflex actions are automatic and rapid. Examples include the response of the pupil in the eyes to bright light, and the knee jerk reaction.	***4.5 Homeostasis and Response*** **4.5.1 Homeostasis** • Students should be able to explain that homeostasis is the regulation of the internal conditions of a cell or organism to maintain optimum conditions for function in response to internal and external changes. • These automatic control systems may involve nervous responses or chemical responses. • Receptors detect stimuli. • Coordination centres (such as the brain, spinal cord and pancreas) receive and process information from receptors. • Effectors (muscles or glands) bring about responses which restore optimum levels. **4.5.2 The Human Nervous System** 4.5.2.1 Structure and function – Required Practical 7 • Students should be able to explain how the structure of the nervous system is adapted to its functions. • Information from receptors passes along cells (neurones) as electrical impulses to the central nervous system (CNS). • Students should be able to explain how the various structures in a reflex arc – including the sensory neurone, synapse, relay neurone and motor neurone – relate to their function. • Students should understand why reflex actions are important. Reflex actions are automatic and rapid; they do not involve the conscious part of the brain. • Students should be able to translate information about reaction times between numerical and graphical forms. 4.5.2.2 The Brain • The brain controls complex behaviour. It is made of billions of interconnected neurones and has different	4.5.2.2 The Brain • (HT only) Students should be able to explain some of the difficulties of investigating brain function and treating brain damage and disease. • (HT only) Neuroscientists have been able to map the regions of the brain to particular functions by studying patients with brain damage, electrically stimulating different parts of the brain and using MRI scanning techniques. The complexity and delicacy of the brain makes investigating and treating brain disorders very difficult.

	regions that carry out different functions. • Students should be able to identify the cerebral cortex, cerebellum and medulla on a diagram of the brain, and describe their functions. 4.5.2.3 The Eye • Students should be able to relate the structures of the eye to their functions. This includes: focussing on near or distant objects and adaptation to dim light. • The eye is a sense organ containing receptors sensitive to light intensity and colour. • Students should be able to identify the following structures on a diagram of the eye: retina, optic nerve, sclera, cornea , iris, ciliary muscles and suspensory ligaments. • Two common defects of the eyes are myopia (short sightedness) and hyperopia (long sightedness) in which rays of light do not focus on the retina. • Generally these defects are treated with spectacle lenses which refract the light rays so that they do focus on the retina. New technologies now include hard and soft contact lenses, laser surgery to change the shape of the cornea and a replacement lens in the eye. 4.5.2.4 Control of body temperature • Body temperature is monitored and controlled by the thermoregulatory centre in the brain. • The thermoregulatory centre contains receptors sensitive to the temperature of the blood. • The skin contains temperature receptors and sends nervous impulses to the thermoregulatory centre. • Vasoconstriction and vasodilation. **4.5.3 Hormonal coordination in humans** 4.5.3.1 Human endocrine system • The endocrine system is composed of glands which	4.5.2.4 Control of body temperature • (HT only) Students should be able to explain how these mechanisms lower or raise body temperature in a given context. 4.5.3.2 Control of blood glucose concentration • (HT only) If the blood glucose concentration is too low, the pancreas produces the hormone glucagon that causes glycogen to be converted into glucose and released into the blood. • (HT only) Students should be able to explain how glucagon interacts with insulin in a negative feedback cycle to control blood glucose (sugar) levels in the body. 4.5.3.3 Maintaining water and nitrogen balance in the
Outcome 9		

• Hormones are secreted by glands and are transported to their target organs by the bloodstream. • Several hormones are involved in the menstrual cycle of a woman, including some that are involved in promoting the release of an egg. Students should be familiar with a diagram of the menstrual cycle. Outcome 10 • The uses of hormones in controlling fertility include giving oral contraceptives that contain hormones to inhibit eggs from maturing and giving 'fertility drugs' to stimulate eggs to mature. • Students should be able to evaluate the benefits of, and the problems that may arise from, the use of hormones to control fertility.	secrete chemicals called hormones directly into the bloodstream. • Compared to the nervous system the effects are slower but act for longer. • The pituitary gland in the brain is a 'master gland' which secretes several hormones into the blood in response to body conditions. • Students should be able to identify the position of the following on a diagram of the human body: pituitary gland, pancreas, thyroid, adrenal gland, ovary and testes. 4.5.3.2 Control of blood glucose concentration • Blood glucose concentration is monitored and controlled by the pancreas. • If the blood glucose concentration is too high, the pancreas produces the hormone insulin. • Students should be able to explain how insulin controls blood glucose (sugar) levels in the body. • Type 1 diabetes and Type 2 diabetes – what they are, treatments and risk factors. • Students should be able to compare Type 1 and Type 2 • Students should be able to extract information and interpret data from graphs that show the effect of insulin in blood glucose levels in both people with diabetes and people without diabetes. 4.5.3.3 Maintaining water and nitrogen balance in the body • There is no control over water, ion or urea loss by the lungs (through exhalation) or skin (through sweating). • If body cells lose or gain too much water by osmosis they do not function efficiently. • Excess water, ions and urea are removed via the kidneys in the urine. • Students should be able to describe the function of kidneys in maintaining the water balance of the body. The structure of the kidney is not required. • Students should be able to translate tables and bar charts of glucose, ions and urea before and after	body • (HT only) The digestion of proteins from the diet results in excess amino acids which need to be excreted safely. • (HT only) Students should be able to describe the effect of ADH on the permeability of the kidney tubules. • (HT only) The water level in the body is controlled by the hormone ADH which acts on the kidney tubules. ADH is released by the pituitary gland when the blood is too concentrated and it causes more water to be reabsorbed back into the blood from the kidney tubules. This is controlled by negative feedback. 4.5.3.4 Hormones in Human reproduction • (HT only) Students should be able to explain the interactions of FSH, oestrogen, LH and progesterone, in the control of the menstrual cycle. • (HT only) Students should be able to extract and interpret data from graphs showing hormone levels during the menstrual cycle. 4.5.3.6 The use of hormones to treat infertility (HT Only) • Students should be able to explain the use of hormones in modern reproductive technologies to treat infertility. This includes giving FSH and LH in a 'fertility drug' to a woman. She may then become pregnant in the normal way. • In Vitro Fertilisation (IVF) treatment. • Although fertility treatment gives a woman the chance to have a baby of her own: it is very emotionally and physically stressful, the success rates are not high, it can lead to multiple births which are a risk to both the babies and the mother.

	filtration. • People who suffer from kidney failure may be treated by organ transplant or by using kidney dialysis. Students should know the basic principles of dialysis. 4.5.3.4 Hormones in Human reproduction • Students should be able to describe the roles of hormones in human reproduction, including the menstrual cycle. • During puberty reproductive hormones cause secondary sex characteristics to develop. • Follicle stimulating hormone (FSH) causes maturation of an egg in the ovary. Luteinising hormone (LH) stimulates the release of the egg. Oestrogen and progesterone are involved in maintaining the uterus lining. 4.5.3.5 Contraception • Students should be able to evaluate the different hormonal and non-hormonal methods of contraception. • Fertility can be controlled by a variety of hormonal and non-hormonal methods of contraception.	4.5.3.7 Negative feedback (HT Only) • Students should be able to explain the roles of thyroxine and adrenaline in the body. • Thyroxine levels are controlled by negative feedback. 4.5.4.1 Control and coordination – Required Practical 8 • (HT only) Gibberellins are important in initiating seed germination. • (HT only) Ethene controls cell division and ripening of fruits. • (HT only) The mechanisms of how gibberellins and ethene work are not required. 4.5.4.2 Use of plant hormones (HT Only) • Students should be able to describe the effects of some plant hormones and the different ways people use them to control plant growth. • Plant growth hormones (Auxin, Ethene and Gibberellins) are used in agriculture and horticulture.

	4.5.4 Plant hormones 4.5.4.1 Control and coordination – Required Practical 8 • Plants produce hormones to coordinate and control growth and responses to light (phototropism) and gravity (gravitropism or geotropism). • Unequal distributions of auxin cause unequal growth rates in plant roots and shoots.	

Inheritance, Variation and Evolution (same on NC)

AQA Entry Level Certificate Science	Foundation AQA Biology GCSE	Higher AQA Biology GCSE
3.2.3 How life has developed on Earth Outcome 9 • There are two types of reproduction: 1. sexual reproduction, which involves the joining of male and female sex cells. There is a mixing of genetic information, which leads to variety in the offspring. 2. asexual reproduction, where only one individual is needed as a parent. There is no mixing of genetic information, which leads to	***4.6 Inheritance, variation and evolution*** **4.6.1 Reproduction** 4.6.1.1 Sexual and asexual reproduction • Students should understand that meiosis leads to non-identical cells being formed while mitosis leads to identical cells being formed. • Sexual reproduction involves the joining (fusion) of male and female gametes: • In sexual reproduction there is mixing of genetic information which leads to variety in the offspring. • The formation of gametes involves meiosis. • Asexual reproduction involves only one parent and no fusion of gametes. There is no mixing of genetic information. This leads to genetically identical offspring (clones). Only mitosis is involved. 4.6.1.2 Meiosis • Students should be able to explain how meiosis halves	

identical offspring (clones). Outcome 10 • The genetic material in the nucleus of a cell is made of a chemical called DNA, which is contained in structures called chromosomes. Students should know that a cell consists of a nucleus that controls the actions of the cell, and cytoplasm.	the number of chromosomes in gametes and fertilisation restores the full number of chromosomes. • All gametes are genetically different from each other. • The new cell divides by mitosis. The number of cells increases. As the embryo develops cells differentiate. • Knowledge of the stages of meiosis is not required. 4.6.1.3 Advantages and disadvantages of sexual and asexual reproduction • Advantages of sexual reproduction: produces variation in the offspring (survival advantage), natural selection can be speeded up by humans in selective breeding to increase food production. • Advantages of asexual reproduction: only one parent needed, more time and energy efficient, faster than sexual reproduction, many identical offspring can be produced when conditions are favourable. • Some organisms reproduce by both methods depending on the circumstances (malarial parasites, fungi). • Many plants produce seeds sexually, but also reproduce asexually by runners such as strawberry plants. • Students are expected to be able to explain the advantages and disadvantages of asexual and sexual reproduction for any organism if given appropriate information. 4.6.1.4 DNA and the Genome • Students should be able to describe the structure of DNA and define genome. • The genetic material in the nucleus of a cell is composed of a chemical called DNA. • The DNA is contained in structures called chromosomes. • A gene is a small section of DNA on a chromosome. • Each gene codes for a particular sequence of amino acids, to make a specific protein. • The whole human genome has now been studied and this will have great importance for medicine in the future. • Students should be able to discuss the importance of	4.6.1.5 DNA Structure • (HT only) In the complementary strands a C is always linked to a G on the opposite strand and a T to an A. • (HT only) Students are not expected to know or understand the structure of mRNA, tRNA, or the detailed structure of amino acids or proteins. • (HT only) Students should be able to explain how a change in DNA structure may result in a change in the protein synthesised by a gene. • (HT only) Proteins are synthesised on ribosomes, according to a template. Carrier molecules bring specific amino acids to add to the growing protein chain in the correct order. • (HT only) When the protein chain is complete it folds up to form a unique shape. This unique shape enables the proteins to do their job as enzymes, hormones or forming structures in the body such as collagen. • (HT only) Mutations occur continuously. Most do not alter the protein. • (HT only) A few mutations code for an altered

	understanding the human genome. 4.6.1.5 DNA Structure • Students should be able to describe DNA as a polymer made from four different nucleotides. Each nucleotide consists of a common sugar and phosphate group with one of four different bases attached to the sugar. • DNA contains four bases, A, C, G and T. • A sequence of three bases is the code for a particular amino acid. • The long strands of DNA consist of alternating sugar and phosphate sections. Attached to each sugar is one of the four bases. 4.6.1.6 Genetic Inheritance • Students should be able to explain the terms gamete, chromosome, gene, allele, dominant, recessive, homozygous, heterozygous, genotype and phenotype. • Some characteristics are controlled by a single gene, such as: fur colour in mice; and red-green colour blindness in humans. • When dominant and recessive alleles are expressed. • Most characteristics are a result of multiple genes interacting, rather than a single gene. • Students should be able to understand the concept of probability in predicting the results of a single gene cross, but recall that most phenotype features are the result of multiple genes rather than single gene inheritance. • Students should be able to use direct proportion and simple ratios to express the outcome of a genetic cross. • Students should be able to complete a Punnett square diagram and extract and interpret information from	protein with a different shape. An enzyme may no longer fit the substrate binding site or a structural protein may lose its strength. • (HT only) Not all parts of DNA code for proteins. Non-coding parts of DNA can switch genes on and off, so variations in these areas of DNA may affect how genes are expressed. 4.6.1.6 Genetic Inheritance • (HT only) Students should be able to construct a genetic cross by Punnett square diagram and use it to make predictions using the theory of probability.

• Chromosomes carry genes that control the characteristics of the body. Humans have 23 pairs of chromosomes. Only one pair carries the genes that determine sex: females have the same sex chromosomes (XX); in males the chromosomes are different (XY).	genetic crosses and family trees. 4.6.1.7 Inherited disorders • Some disorders are inherited. These disorders are caused by the inheritance of certain alleles. • Polydactyly is caused by a dominant allele. • Cystic fibrosis is caused by a recessive allele. • Students should make informed judgements about the economic, social and ethical issues concerning embryo screening, given appropriate information. 4.6.1.8 Sex determination • Ordinary human body cells contain 23 pairs of chromosomes. 22 pairs control characteristics only, but one of the pairs carries the genes that determine sex. • In females the sex chromosomes are the same (XX). In males the chromosomes are different (XY). • Students should be able to carry out a genetic cross to show sex inheritance. Students should understand and use direct proportion and simple ratios in genetic crosses. **4.6.2 Variation and Evolution** 4.6.2.1 Variation • Differences in the characteristics of individuals in a population is called variation and may be due to differences in: the genes they have inherited (genetic causes), the conditions in which they have developed (environmental causes) or a combination of the two. • Students should be able to: state that there is usually extensive genetic variation within a population of a species. • Very rarely a mutation will lead to a new phenotype. If the new phenotype is suited to an environmental change it can lead to a relatively rapid change in the species. 4.6.2.2 Evolution • Students should be able to describe evolution as a	

• In genetic engineering, genes from chromosomes of humans and other organisms can be 'cut out' and transferred to the cells of other organisms. Students should be aware of the potential benefits and risks of genetic engineering.	change in the inherited characteristics of a population over time through a process of natural selection which may result in the formation of a new species. • The theory of evolution by natural selection states that all species of living things have evolved from simple life forms that first developed more than three billion years ago. • Students should be able to explain how evolution occurs through natural selection. 4.6.2.3 Selective Breeding • Students should be able to explain the impact of selective breeding of food plants and domesticated animals. • Selective breeding (artificial selection) is the process by which humans breed plants and animals for particular genetic characteristics. • The characteristic can be chosen for usefulness or appearance: disease resistance in food crops, animals which produce more meat or milk, domestic dogs with a gentle nature, large or unusual flowers. • Selective breeding can lead to 'inbreeding' where some breeds are particularly prone to disease or inherited defects. 4.6.2.4 Genetic Engineering • Students should be able to describe genetic engineering as a process which involves modifying the genome of an organism by introducing a gene from another organism to give a desired characteristic. • Plant crops have been genetically engineered to be resistant to diseases or to produce bigger better fruits. • Bacterial cells have been genetically engineered to produce useful substances such as human insulin to treat diabetes. • Students should be able to explain the potential benefits and risks of genetic engineering in agriculture and in medicine and that some people have objections. 4.6.2.5 Cloning	4.6.2.4 Genetic Engineering • (HT only) Students should be able to describe the main steps in the process of genetic engineering. • (HT only) In genetic engineering: enzymes are used to isolate the required gene; this gene is inserted into a vector, usually a bacterial plasmid or a virus; the vector is used to insert the gene into the required cells; genes are transferred to the cells of animals, plants or microorganisms at an early stage in their development so that they develop with desired characteristics.

3.2.3 How life has developed on Earth Outcome 8 • Darwin's theory of evolution states that all species of living things have evolved from simple life forms that first developed more than three billion years ago. • In natural selection, individuals with characteristics most suited to their environment are most likely to survive to breed successfully. • Artificial selection (selective breeding) is the process by which humans breed plants and animals for particular genetic traits.	• Tissue culture: using small groups of cells from part of a plant to grow identical new plants. • This is important for preserving rare plant species or commercially in nurseries. • Cuttings: an older, but simple, method • Embryo transplants – making multiple embryos from one. • Adult cell cloning. **4.6.2 The development of understanding of Genetics and Evolution** 4.6.3.1 Theory of evolution • Charles Darwin proposed the theory of evolution by natural selection. • Individuals with characteristics most suited to the environment are more likely to survive to breed successfully. The characteristics that have enabled these individuals to survive are then passed on to the next generation. • Darwin published his ideas in On the Origin of Species (1859). There was much controversy surrounding these revolutionary new ideas because the theory challenged the idea that God made all the animals and plants that live on Earth, there was insufficient evidence at the time and the mechanism of inheritance and variation was not known until 50 years after the theory was published. • Other theories, including that of Jean-Baptiste Lamarck, are based mainly on the idea that changes that occur in an organism during its lifetime can be inherited. We now know that in the vast majority of cases this type of inheritance cannot occur. A study of creationism is not required. 4.6.3.2 Speciation • Students should be able to: describe the work of Darwin and Wallace in the development of the theory of evolution by natural selection and explain the impact of these ideas on biology.	

	4.6.3.3 The understanding of genetics • Students should be able to describe the development of our understanding of genetics including the work of Mendel, understand why the importance of Mendel's discovery was not recognised until after his death. • In the early 20th century it was observed that chromosomes and Mendel's 'units' behaved in similar ways. This led to the idea that the 'units', now called genes, were located on chromosomes. • In the mid-20th century the structure of DNA was determined and the mechanism of gene function worked out. This scientific work by many scientists led to the gene theory being developed. 4.6.3.4 Evidence for evolution • Students should be able to describe the evidence for evolution including fossils and antibiotic resistance in bacteria. 4.6.3.5 Fossils • Fossils are the 'remains' of organisms from millions of years ago, which are found in rocks. Fossils may be formed from parts of organisms that have not decayed because one or more of the conditions needed for decay are absent, when parts of the organism are replaced by minerals as they decay or as preserved traces of organisms, such as footprints, burrows and rootlet traces. • Many early forms of life were soft-bodied, which means that they have left few traces behind. What traces there were have been mainly destroyed by geological activity. This is why scientists cannot be certain about how life began on Earth. • Students should be able to extract and interpret information from charts, graphs and tables such as evolutionary trees. 4.6.3.6 Extinction	

	• Extinctions occur when there are no remaining individuals of a species still alive. • Students should be able to describe factors which may contribute to the extinction of a species. 4.6.3.7 Resistant Bacteria • Bacteria can evolve rapidly because they reproduce at a fast rate. Mutations of bacterial pathogens produce new strains. Some strains might be resistant to antibiotics, and so are not killed. They survive and reproduce, so the population of the resistant strain rises. The resistant strain will then spread because people are not immune to it and there is no effective treatment. • MRSA is resistant to antibiotics. Students should be able to explain how this occurs. • The development of new antibiotics is costly and slow. It is unlikely to keep up with the emergence of new resistant strains. **4.6.3 Classification of living organisms** • Traditionally living things have been classified into groups depending on their structure and characteristics in a system developed by Carl Linnaeus. • Linnaeus classified living things into kingdom, phylum, class, order, family, genus and species. Organisms are named by the binomial system of genus and species. • Students should be able to describe the impact of developments in biology on classification systems. • Due to evidence available from chemical analysis there is now a 'three domain system' developed by Carl Woese. In this system organisms are divided into: archaea (primitive bacteria usually living in extreme environments), bacteria (true bacteria) and eukaryota (which includes protists, fungi, plants and animals). • Evolutionary trees are a method used by scientists to show how they believe organisms are related. They use current classification data for living organisms and fossil data for extinct organisms.	

Ecology (NC Ecosystems)

AQA Entry Level Certificate Science	Foundation AQA Biology GCSE	Higher AQA Biology GCSE
3.2.2 What determines where particular species live? Outcome 5 • Plants often compete with each other for light and space, and for water and nutrients from the soil. • Animals often compete with each other for food, mates and territory.	***4.7 Ecology*** **4.7.1 Adaptations, Interdependence and Competition** **4.7.1.1 Communities** • Students should be able to describe different levels of organisation in an ecosystem from individual organisms to the whole ecosystem and the importance of interdependence and competition in a community. • Students should be able to, when provided with appropriate information, suggest the factors for which organisms are competing in a given habitat and suggest how organisms are adapted to the conditions in which they live. • Living organisms (biotic) with the non-living (abiotic) parts of the environment. • Students should be able to extract and interpret information from charts, graphs and tables relating to the interaction of organisms within a community. 4.7.1.2 Abiotic factors • Students should be able to explain how a change in an abiotic factor would affect a given community given appropriate data or context. • Examples are light intensity, temperature amd moisture levels. 4.7.1.3 Biotic factors • Students should be able to explain how a change in a biotic factor might affect a given community given appropriate data or context. • Examples are availability of food, new predators arriving and new pathogens. • Students should be able to extract and interpret	

3.2 Component 2 – Biology; Environment, Evolution and Inheritance **3.2.1 What are the feeding relationships between living organisms?** Outcome 2 • Animals and plants may be adapted for survival in the conditions where they normally live. Outcome 3 • Feeding relationships within a community can be represented by a food chain. All food chains begin with a producer. A food web can be used to understand the interdependence of species within an ecosystem in terms of food resources. Outcome 4 • All materials in the living world are recycled to provide the building blocks for future organisms.	information from charts, graphs and tables relating to the effect of abiotic and biotic factors on organisms within a community. 4.7.1.4 Adaptations • Students should be able to explain how organisms are adapted to live in their natural environment, given appropriate information. • These adaptations may be structural, behavioural or functional. • Extremophiles, such as bacteria living in deep sea vents. **4.7.2 Organisation of an Ecosystem** 4.7.2.1 Levels of organisation – Required Practical 9 • Students should understand that photosynthetic organisms are the producers of biomass for life on Earth. • Feeding relationships within a community can be represented by food chains. • All food chains begin with a producer. • A range of experimental methods using transects and quadrats are used by ecologists to determine the distribution and abundance of species in an ecosystem. • Producers are eaten by primary consumers, which in turn may be eaten by secondary consumers and then tertiary consumers. • Consumers that kill and eat other animals are predators, and those eaten are prey. In a stable community the numbers of predators and prey rise and fall in cycles. • Students should be able to interpret graphs used to model these cycles. • Students should be able to understand the terms mean, mode and median, calculate arithmetic means and plot and draw appropriate graphs selecting appropriate scales for the axes. 4.7.2.2 How materials are recycled • Students should recall that many different materials	

• Decay of dead plants and animals by microorganisms returns carbon to the atmosphere as carbon dioxide to be used by plants in photosynthesis. **3.2.2 What determines where particular species live?** Outcome 6 • Animals and plants are subjected to environmental changes. Such changes may be caused by non-living or living factors.	cycle through the abiotic and biotic components of an ecosystem. • Explain the importance of the carbon and water cycles to living organisms. • All materials in the living world are recycled to provide the building blocks for future organisms. • Students are not expected to study the nitrogen cycle. • Students should be able to explain the role of microorganisms in cycling materials through an ecosystem by returning carbon to the atmosphere as carbon dioxide and mineral ions to the soil. 4.7.2.3 Decomposition – Required Practical 10 • Students should be able to explain how temperature, water and availability of oxygen affect the rate of decay of biological material. • Students should be able to calculate rate changes in the decay of biological material, translate information between numerical and graphical form and plot and draw appropriate graphs selecting appropriate scales for the axes. • Anaerobic decay produces methane gas. Biogas generators can be used to produce methane gas as a fuel. 4.7.2.4 Impact of environmental change • Students should be able to evaluate the impact of environmental changes on the distribution of species in an ecosystem given appropriate information. • These changes include temperature, availability of water and the composition of atmospheric gases. • The changes may be seasonal, geographic or caused by human interaction. **4.7.3 Biodiversity** 4.7.3.1 Biodiversity • Biodiversity is the variety of all the different species of organisms on earth, or within an ecosystem. • A great biodiversity ensures the stability of ecosystems	

Outcome 7 • Pollution of the environment can occur in water, in air and on land. • Students should recognise that rapid growth in human population means that more resources are used and more waste is produced.	by reducing the dependence of one species on another for food, shelter and the maintenance of the physical environment. • The future of the human species on Earth relies on us maintaining a good level of biodiversity. Many human activities are reducing biodiversity and only recently have measures been taken to try to stop this reduction. 4.7.3.2 Waste Management • Rapid growth in the human population and an increase in the standard of living mean that increasingly more resources are used and more waste is produced. • Unless waste and chemical materials are properly handled, more pollution will be caused. 4.7.3.3 Land use • Humans reduce the amount of land available for other animals and plants by building, quarrying, farming and dumping waste. • The destruction of peat bogs, and other areas of peat to produce garden compost, reduces the area of this habitat and thus the variety of different plant, animal and microorganism species that live there (biodiversity). The decay or burning of the peat releases carbon dioxide into the atmosphere. 4.7.3.4 Deforestation • Large-scale deforestation in tropical areas has occurred to provide land for cattle and rice fields and grow crops for biofuels. 4.7.3.5 Global warming • Students should be able to describe some of the biological consequences of global warming. Levels of carbon dioxide and methane in the atmosphere are increasing, and contribute to 'global warming'. 4.7.3.6 Maintaining Biodiversity • Students should be able to describe both positive and	

	negative human interactions in an ecosystem and explain their impact on biodiversity. • Scientists and concerned citizens have put in place programmes to reduce the negative effects of humans on ecosystems and biodiversity. **4.7.4 Trophic levels in an ecosystem** 4.7.4.1 Trophic levels • Students should be able to describe the differences between the trophic levels of organisms within an ecosystem. • Trophic levels can be represented by numbers, starting at level 1 with plants and algae. Further trophic levels are numbered subsequently according to how far the organism is along the food chain. 4.7.4.2 Pyramids of biomass • Pyramids of biomass can be constructed to represent the relative amount of biomass in each level of a food chain. Trophic level 1 is at the bottom of the pyramid. • Students should be able to construct accurate pyramids of biomass from appropriate data. 4.7.4.3 Transfer of biomass • Students should be able to describe pyramids of biomass and explain how biomass is lost between the different trophic levels. • Producers are mostly plants and algae which transfer about 1% of the incident energy from light for photosynthesis. • Only approximately 10% of the biomass from each trophic level is transferred to the level above it. • Students should be able to calculate the efficiency of biomass transfers between trophic levels by percentages or fractions of mass. Students should be able to explain how this affects the number of organisms at each trophic level. **4.7.5 Food Production** 4.7.5.1 Factors affecting food security	

	• Food security is having enough food to feed a population. • Biological factors which are threatening food security include, the increasing birth rate in some countries, new pests and pathogens that affect farming and environmental changes that affect food production. • Sustainable methods must be found to feed all people on Earth. 4.7.5.2 Farming techniques • The efficiency of food production can be improved by restricting energy transfer from food animals to the environment. 4.7.4.3 Sustainable fisheries • Fish stocks in the oceans are declining. • Control of net size and the introduction of fishing quotas play important roles in conservation of fish stocks at a sustainable level. 4.7.5.4 Role of biotechnology • Students should be able to describe and explain some possible biotechnical and agricultural solutions, including genetic modification, to the demands of the growing human population. • Modern biotechnology techniques enable large quantities of microorganisms to be cultured for food. • The fungus Fusarium is useful for producing mycoprotein, a protein-rich food suitable for vegetarians. • A genetically modified bacterium produces human insulin. • GM crops could provide more food or food with an improved nutritional value such as golden rice.	