AQA Biology GCSE - **Student Progress Sheet**

Name: **Target:**

Unit 4.6 – Inheritance, Variation and Evolution

4.6.1. Reproduction

4.6.1.1. Sexual and Asexual Reproduction

a	I know that that meiosis leads to non-identical cells being formed and that these cells are called gametes.			
b	I know that sexual reproduction involves the joining (fusion) of male and female gametes: • sperm and egg cells in animals; • pollen and egg cells in flowering plants.			
c	I know that, in sexual reproduction, there is mixing of genetic information which leads to variety in the offspring.			
d	I know that mitosis leads to identical cells being formed.			
e	I know that asexual reproduction involves mitosis and only one parent (there is no fusion of gametes and so no mixing of genetic information) and that it leads to the production of genetically identical offspring (clones).			

4.6.1.2. Meiosis

a	I know that cells in reproductive organs divide by meiosis to form gametes.			
b	I can explain how meiosis halves the number of chromosomes in gametes, including: • copies of the genetic information are made; • the cell divides twice to form four gametes, each with a single set of chromosomes; • all gametes are genetically different from each other.			
c	I can explain how gametes join at fertilisation to restore the normal number of chromosomes.			
d	I can describe how, after fertilisation, the new cell divides by mitosis, the number of cells increases and as the embryo develops, cells differentiate (become specialised).			

4.6.1.3. Advantages and Disadvantages of Sexual and Asexual Reproduction (Biology Only)

a	I can describe the advantages of sexual reproduction: • variation in the offspring; • if the environment changes variation gives a survival advantage by natural selection; • natural selection can be speeded up by humans in selective			
b	I can describe the advantages of asexual reproduction: • only one parent needed; • more time and energy efficient as do not need to find a mate; • faster than sexual reproduction; • many identical offspring can be produced when conditions are favourable.			
c	I know that some organisms reproduce by both methods depending on the circumstances. • malarial parasites reproduce asexually in the human host, but sexually in the mosquito; • many fungi reproduce asexually by spores but also reproduce sexually to give variation; • many plants produce seeds sexually, but also reproduce asexually by runners such as strawberry plants, or bulb division such as daffodils.			
d	I can explain the advantages and disadvantages of asexual and sexual reproduction for any organism if given appropriate information.			
e	I can discuss the historical developments related to our understanding of the causes and prevention of malaria.			

4.6.1.4. DNA and the Genome

a	I know that the genetic material in the nucleus of a cell is composed of a chemical called DNA.			
b	I know that DNA is a polymer made up of two strands forming a double helix and that the DNA is contained in structures called chromosomes.			
c	I know that a gene is a small section of DNA on a chromosome and that each gene codes for a particular sequence of amino acids, to make a specific protein.			
d	I know that the genome of an organism is the entire genetic material of that organism.			
e	I know that the whole human genome has now been studied and I can explain the importance of this for medicine in the future, limited to: • search for genes linked to different types of disease; • understanding and treatment of inherited disorders; • use in tracing human migration patterns from the past.			

4.6.1.5. DNA Structure (Biology Only)

a	I know that DNA as a polymer made from four different nucleotides and that the DNA polymer is made up of repeating nucleotide units.			
b	I know that each nucleotide consists of a common sugar and phosphate group with one of four different bases attached to the sugar.			
c	I know that the long strands of DNA consist of alternating sugar and phosphate sections. Attached to each sugar is one of the four bases.			
d	I know that DNA contains four bases, A, C, G and T.			
e	I know that in the complementary strands a C is always linked to a G on the opposite strand and a T to an A. (HT only)			
f	I can interpret a diagram of DNA structure.			
g	I know that a sequence of three bases is the code for a particular amino acid and that the order of bases controls the order in which amino acids are assembled to produce a particular protein.			
h	I can recall a simple description of protein synthesis. (HT only)			
i	I know that proteins are synthesised on ribosomes, according to a template and that carrier molecules bring specific amino acids to add to the growing protein chain in the correct order. (HT only)			
j	I know that when the protein chain is complete it folds up to form a unique shape and that this unique shape enables the proteins to do their job as enzymes, hormones or forming structures in the body such as collagen. (HT only)			
k	I can explain how a change in DNA structure may result in a change in the protein synthesised by a gene. (HT only)			
l	I know that mutations occur continuously and that most do not alter the protein, or only alter it slightly so that its appearance or function is not changed. (HT only)			
m	I know that a few mutations code for an altered protein with a different shape and that this means that an enzyme may no longer fit the substrate binding site or a structural protein may lose its strength. (HT only)			
n	I can describe how genetic variants may influence phenotype: a) in coding DNA by altering the activity of a protein: and b) in non-coding DNA by altering how genes are expressed. (HT only)			
o	I know that not all parts of DNA code for proteins and that non-coding parts of DNA can switch genes on and off, so variations in these areas of DNA may affect how genes are expressed. (HT only)			

4.6.1.6. Genetic Inheritance

a	I know that some characteristics are controlled by a single gene, such as: fur colour in mice; and red-green colour blindness in humans.			
b	I know that most characteristics are a result of multiple genes interacting, rather than a single gene.			
c	I know that each gene may have different forms and that these are called alleles.			
d	I know that the alleles present (the genotype), operate at a molecular level to develop characteristics that can be expressed as a phenotype.			
e	I know that a dominant allele is always expressed, even if only one copy is present, whereas, a recessive allele is only expressed if two copies are present (therefore no dominant allele present).			
f	I know that if the two alleles present are the same the organism is homozygous for that trait, but if the alleles are different they are heterozygous.			
g	I can complete a Punnett square diagram and extract and interpret information from genetic crosses and family trees.			
h	I can construct a Punnett square diagram and use it to make predictions about a genetic cross using the theory of probability (HT only).			

4.6.1.7. Inherited Disorders

a	I know that some disorders are inherited and that they are caused by the inheritance of certain alleles, for instance: • polydactyly (having extra fingers or toes) is caused by a dominant allele; • cystic fibrosis (a disorder of cell membranes) is caused by a recessive allele.			
b	I can explain how embryo screening and gene therapy may alleviate suffering.			
c	I can discuss the economic, social and ethical issues concerning embryo screening.			

4.6.2. Variation and Evolution

4.6.2.1. Variation

a	I know that 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); • a combination of genes and the environment.			
b	I know that there is usually extensive genetic variation within a population of a species.			
c	I know that all variants arise from mutations and that: most have no effect on the phenotype; some influence phenotype; very few determine phenotype.			
d	I can explain that mutations occur continuously and 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

a	I can describe evolution as a 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.			
b	I can explain how evolution occurs through natural selection of variants that give rise to phenotypes best suited to their environment.			
c	I know that, if two populations of one species become so different in phenotype that they can no longer interbreed to produce fertile offspring, they have formed two new species.			

4.6.2.3. Selective Breeding

a	Students should be able to explain the impact of selective breeding of food plants and domesticated animals. I can describe selective breeding (artificial selection) as the process by which humans breed plants and animals for particular genetic characteristics. Humans have been doing this for thousands of years since they first bred food crops from wild plants and domesticated animals.			
b	I know that selective breeding involves choosing parents with the desired characteristic from a mixed population which are then bred together. From the offspring those with the desired characteristic are bred together. This is repeated over many generations until all the offspring show the desired characteristic.			
c	I know that the characteristic can be chosen for usefulness or appearance, for instance: • disease resistance in food crops; • animals which produce more meat or milk; • domestic dogs with a gentle nature; • large or unusual flowers.			
d	I can explain how selective breeding can lead to 'inbreeding' where some breeds are particularly prone to disease or inherited defects.			
e	I can discuss the benefits and risks of selective breeding and consider related ethical issues.			

4.6.2.4. Genetic Engineering

a	I can 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.			
b	I know that, in genetic engineering, genes from the chromosomes of humans and other organisms can be 'cut out' and transferred to cells of other organisms.			
c	I can describe the main steps in the process of genetic engineering (HT only): • 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.			
d	I can describe how plant crops have been genetically engineered to be resistant to diseases or to produce bigger better fruits.			
e	I know that crops that have had their genes modified in this way are called genetically modified (GM) crops.			
f	I know that GM crops include ones that are resistant to insect attack or to herbicides and that they generally show increased yields.			
g	I can discuss the potential benefits and risks of genetic engineering in agriculture and in medicine and that some people have objections, such as, the effect of GM crops on populations of wild flowers and insects and the effects of eating GM crops on human health.			
h	I can describe how bacterial cells have been genetically engineered to produce useful substances such as human insulin to treat diabetes.			
i	I can describe how modern medical research is exploring the possibility of genetic modification to overcome some inherited disorders.			
j	I can interpret information about genetic engineering techniques and make informed judgements about issues concerning cloning and genetic engineering (including GM crops).			

4.6.2.5. Cloning (Biology Only)

a	I know that tissue culture involves using small groups of cells from part of a plant to grow identical new plants. Explain the potential benefits and risks of cloning in agriculture and in medicine and that some people have ethical objections.			
b	I know that tissue culture is important for preserving rare plant species or commercially in nurseries.			
c	I know that taking 'cuttings' is an older, but simpler, method used by gardeners to produce many identical new plants from a parent plant.			
d	I know that embryo transplantation involves splitting apart cells from a developing animal embryo before they become specialised, to create many identical embryos, then transplanting these embryos into host mothers.			
e	I can describe the process of adult cell cloning: • the nucleus is removed from an unfertilised egg cell; • the nucleus from an adult body cell, such as a skin cell, is inserted into the egg cell; • an electric shock stimulates the egg cell to divide to form an embryo; • these embryo cells contain the same genetic information as the adult skin cell; • when the embryo has developed into a ball of cells, it is inserted into the womb of an adult female to continue its development.			

4.6.3. The Development and Understanding of Genetics and Evolution

4.6.3.1. Theory of Evolution (Biology Only)

a	I know that Charles Darwin proposed the theory of evolution by natural selection as a result of observations on a round the world expedition and that this was backed by years of experimentation and discussion and linked to developing knowledge of geology and fossils.			
b	I know that the theory of evolution by natural selection states: • individual organisms within a particular species show a wide range of variation for a characteristic; • 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.			
c	I know that Darwin published his ideas in On the Origin of Species (1859) and that there was much controversy surrounding these revolutionary new ideas.			
d	I know that the theory of evolution by natural selection was not accepted immediately 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 the theory was published to convince many scientists; • the mechanism of inheritance and variation was not known until 50 years after the theory was published.			
e	I know that 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 and we now know that in the vast majority of cases this type of inheritance cannot occur.			
f	I know that the theory of evolution by natural selection developed over time and from information gathered by many scientists.			

4.6.3.2. Speciation (Biology Only)

a	I can describe the work of Darwin and Wallace in the development of the theory of evolution by natural selection.			
b	I can explain the impact of the ideas of Darwin and Wallace on biology.			
c	I know that Alfred Russel Wallace independently proposed the theory of evolution by natural selection and that he published joint writings with Darwin in 1858 which prompted Darwin to publish On the Origin of Species (1859) the following year.			
d	I know that Wallace worked worldwide gathering evidence for evolutionary theory.			
e	I know that Wallace is best known for his work on warning colouration in animals and his theory of speciation.			
f	I know that Alfred Wallace did much pioneering work on speciation but more evidence over time has led to our current understanding of the theory of speciation.			
g	I can describe the steps which give rise to new species.			

4.6.3.3. Understanding of Genetics (Biology Only)

a	I can describe the development of our understanding of genetics including the work of Mendel.			
b	I can explain why the importance of Mendel's discovery was not recognised until after his death.			
c	I know that in the mid-19th century Gregor Mendel carried out breeding experiments on plants and that one of his observations was that the inheritance of each characteristic is determined by 'units' that are passed on to descendants unchanged.			
d	I know that in the late 19th century, the behaviour of chromosomes during cell division was observed.			
e	I know that in the early 20th century it was observed that chromosomes and Mendel's 'units' behaved in similar ways and that this led to the idea that the 'units', now called genes, were located on chromosomes.			
f	I know that in the mid-20th century the structure of DNA was determined and the mechanism of gene function worked out.			
g	I know that this scientific work by many scientists, over time, led to the gene theory being developed.			

4.6.3.4. Evidence for Evolution

a	I know that Darwin's theory of evolution by natural selection is now widely accepted, as evidence for is now available.			
b	I can describe the evidence for the theory of evolution by natural selection as: • it has been shown that characteristics are passed on to offspring in genes; • the fossil record; • the development of antibiotic resistance in bacteria.			

4.6.3.5. Fossils

a	I know that fossils are the 'remains' of organisms from millions of years ago, which are found in rocks.			
e	I can describe how 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; • as preserved traces of organisms, such as footprints, burrows and rootlet traces.			
c	I know that fossils can inform us how different organisms have changed as life developed on Earth.			
d	I can explain that the fossil record is incomplete because many early forms of life were soft-bodied, which means that they have left few traces behind. Also, that what traces there were have been mainly destroyed by geological activity and that this is why scientists cannot be certain about how life began on Earth.			
e	I can extract and interpret information from charts, graphs and tables such as evolutionary trees.			

4.6.3.6. Extinction

a	I know that extinctions occur when there are no remaining individuals of a species still alive.			
b	I can describe factors which may contribute to the extinction of a species.			

4.6.3.7. Resistant Bacteria

a	I know that bacteria can evolve rapidly because they reproduce at a fast rate.			
b	I can explain how 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.			
c	I know that MRSA is a strain of bacteria that is resistant to antibiotics.			
d	I can describe ways to reduce the rate of development of antibiotic resistant strains: • doctors should not prescribe antibiotics inappropriately, such as treating non-serious or viral infections; • patients should complete their course of antibiotics so all bacteria are killed and none survive to mutate and form resistant strains; • the agricultural use of antibiotics should be restricted.			
e	I can describe how the development of new antibiotics is costly and slow and that it is unlikely to keep up with the emergence of new resistant strains.			

4.6.4. Classification of Living Organisms

a	I know that, traditionally, living things have been classified into groups depending on their structure and characteristics in a system developed by Carl Linnaeus.			
b	I know that Linnaeus classified living things into kingdom, phylum, class, order, family, genus and species and that organisms are named by the binomial system of genus and species.			
c	I can use information given to show understanding of the Linnaean system.			
d	I know that, as evidence of internal structures of cells became more developed due to improvements in microscopes, and the understanding of biochemical processes progressed, new models of classification were proposed.			
e	I can explain that, as evidence became available from chemical analysis, a new 'three-domain system' was developed by Carl Woese. In this system organisms are divided into: • archaea (primitive bacteria usually living in extreme environments); • bacteria (true bacteria); • eukaryota (which includes protists, fungi, plants and animals).			
f	I can describe how evolutionary trees are 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.			
g	I can interpret evolutionary trees.			