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**Knowledge Rich Curriculum Plan**

Biology 3.7

Genetics, populations and environment

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| **Lesson/Learning Sequence** | **Intended Knowledge:**  *Students will know that…* | **Prior Knowledge:**  *In order to know this, students need to already know that…* | **Tiered Vocabulary and Reading Activity** |
| **L1**  **GCSE recap: genetic diagrams and key terms** | Retrieval of key terms and mechanisms for completing genetic cross diagrams.  Gene, allele, genotype, phenotype, dominant, recessive, locus, homozygous, heterozygous, carrier, expressed, diploid, haploid.  Revisit how to complete Punnet Squares, pedigree charts and genetic cross diagrams.  Explicitly state that these are monohybrid crosses.  Somatic cells have two copies of each gene: maternal and paternal.  Gametes have only one copy. Each gene may have multiple alleles. Monohybrid crosses consider inheritance where a single gene with different alleles is involved. The diagram represents the possible genotypes that offspring could inherit. Capital letters represent the alleles that are dominant and lower case represents the alleles that are recessive. (These alleles are only expressed when a zygote is homozygous) An example using a typical A level scenario will be used to scaffold experience of typical A level alleles ie fruit fly and vestigial wings. | Topic B6 from GCSE | GCSE language in intended knowledge  Monohybrid cross  Vestigial wings  F1 generation |
| **L2**  **Codominance *with ‘multiple alleles’ as a special case of codominance*** | Occasionally both alleles are expressed in the phenotype because neither one is recessive. Sickle-cell anaemia is an example from humans. Possible genotypes:  a. homozygous for normal haemoglobin = HN HN  b. heterozygous have in-between phenotype called ‘trait’ = HNHS  c. homozygous for sickle cell anaemia HSHS  Practice drawing genetic crosses will be required to predict probabilities for offspring from different combinations of parents.  Occasionally there are phenotypes that can be controlled by more than 2 alleles eg., blood groups. The system used is called the ABO system. The 3 alleles involved are A, B and O. I is the letter used to describe the immunoglobulin and a suffix is used to assign the allele eg., Io, IA, IB  Recessive allele = Io  Alleles IA and IB are co-dominant. The homozygous recessive trait should be rare but in Britain the frequency is relatively high at 11% because of similar descendents.  Blood groups are known as type A, type B, type AB and type O. Type AB are codominant. | Unit 1&3 from AS/Y12. *Reference will be made to cell surface proteins and immunoglobulins.*  Y10 simple genetic crosses and the fact that some inherited conditions were covered including sickle-cell disease. | Immunoglobulin  Antigen  Gene expression |
| **L3**  **Dihybrid crosses** | Genetic diagrams can also be used to work out chances of offspring inheriting combinations of characteristics. The diagram is then called a dihybrid cross. The specific example to be used to model how a dihybrid cross work is the Mendel experiment with colour and texture of coat on pea seeds.  The resulting combinations are recorded in a grid that is 4 x 4 ie 16 possible combinations. The combinations that result in a similar phenotype are grouped and characteristic ratios are to be learned eg., 9:3:3:1 when each parent is heterozygous for both alleles. The charts can be used for codominance … different ratios are produced (1:2:1).  \*when sex-linkage, autosomal linkage and epistasis are involved, the ratios differ from those predicted. | Genetic crosses are used to estimate the probability of offspring inheriting certain characteristics. The diagrams called punnet squares are typically 2 x 2 with four possible outcome combinations. | Monohybrid cross  Dihybrid cross  F1 generation  F2 generation |
| **L4**  **Linkage** | A characteristic is called sex-linked if the allele is found on the sex chromosomes. Y chromosomes have less genetic material ie fewer genes. This means that the sex-linked genes tend to be on the X chromosome. (Males only have one of these alleles and therefore are more likely to experience a phenotype caused by a recessive allele – females are likely to have a dominant version on the other chromosome and hence not express the recessive allele.)  Genetic conditions inherited in this manner include: colour blindness and haemophilia. The sex-linked allele is denoted by XN and Xn  Example: in colour blindness, the Y has no suffix as it does not carry the allele for colour blindness. It is the mothers chromosome that determines the type of vision since the father does not pass on any allele for colur vision.  Autosomes are all the other chromosome pairs from 1 – 22 (23rd pair = sex chromosomes). Genes on the same chromosome are said to be linked. (They stay together during chromosome segregation in meiosis i) Alleles are passed on together UNLESS crossing over happens during meiosis. NB if the genes are in loci that are close together, it is more likely that the genes will be linked as it is less likely that crossing over will occur to separate them. Phenotypic ratio indicate when genes are linked as the ratio is not what is expected. Example: dihybrid cross between two heterozygous parents results in 9:3:3:1 ratio but in linkage, the dihybrid cross would yield similar patterns to a monohybrid cross ie 3:1 since the pair of genes do not separate. Specifically, the ratio can tell us if autosomal genes are linked by this data. | Gender is inherited on a pair of chromosomes called X and Y. Females have 2 x X whilst males have X and Y. Y chromosomes are smaller. Phenotype = appearance/expression of a gene. Typical ratios for monohybrid and dihybrid crosses.  Crossing over occurs when homologues line up at the equator and bits of genetic material swaps between the different chromosomes resulting in new combinations of alleles. | Sex-linkage  Autosome  segregation |
| **L5**  **Epistasis** | Many different genes can be involved in a particular characteristic: epistasis is when a phenotype is controlled by interacting genes – one gene masks the expression of another  Examples: widows peak hairline and flower pigments.  Widows peak hairline: one gene controls widows peak; other genes control baldness. If you have the bald gene and the widows peak gene, you will still be bald! The gene for baldness is epistatic to the widows peak gene.  Flower pigments: two genes control colour. Yellow pigment is controlled by one gene whilst a separate gene codes for an enzyme that changes the yellow pigment to orange. The yellow gene must be present in order for flowers to appear coloured. The gene for the enzyme relies on the gene for yellow to be present to have any effect. The yellow gene is epistatic to the enzyme gene. In other words flowers can be white, yellow or orange. The phenotypic ratios are not what is expected if epistasis is involved. The ratios can be predicted.  a. recessive epistasis 9:3:4 (2 copies of the recessive epistatic gene blocks expression of the other gene)  b. dominant epistatic gene 12:3:1 (one copy of the dominant epistatic gene will block the expression of the other gene) | Typical phenotypic ratios: monohybrid cross = 3:1; dihybrid cross = 9:3:3:1  Alleles are either dominant or recessive or codominant  Homozygous and heterozygous indicate whether two identical or two different alleles for a specific gene are involved. | epistasis |
| **Hardy Weinberg Principle** | Students will learn that this is a mathematical model used to predict the frequency of alleles in a population and states that this doesn’t change from one generation to the next providing certain assumptions are made.  The assumptions are that no selection, no mutations, no migration has occurred, the population is large and mating is random.  Students will learn how to use the equations:  p+q=1  p 2 + 2pq + q 2 = 1 | New content | Species  Population  Allele  Gene pool  Genotype  Phenotype |
| **Variation and Selection** | Students will learn that stabilizing selection is where individuals with alleles towards the middle of the range are more likely to survive and pass on genes to offspring. It occurs when the environment isn’t changing and It reduces the range of possible phenotypes.  Directional selection is where individuals with alleles for a single extreme phenotype are more likely to survive and reproduce. This could be a response to environmental change.  Disruptive selection is where individuals with alleles for extreme phenotypes at either range are more likely to survive and reproduce. It is the opposite of stabilising selection because characteristics towards the middle of the range are lost. It occurs when the environment favours more than one phenotype. | Students will already know that variation is cause by genetic, the environment or both. Variation is differences between individuals. Evolution is a gradual change over a long period of time. Students will already know how to describe Charles Darwin’s theory of Natural selection known a s survival of the fittest. | Variation  Differential levels  Selection pressure  Adaptation  Beneficial |
| **Speciation and genetic drift** | **Evolution**causes **speciation**: the formation of **new species** from pre-existing species over time, as a result of **changes to gene pools** from generation to generation. **Genetic isolation**between the new population and the pre-existing species population is necessary for speciation. There are two different situations when speciation can take place: Two populations of a species are separated by a**geographical** **barrier** and become genetically isolated from each other. Two populations of species are living in the **same area** (experiencing similar environmental selection pressures) but still become genetically isolated from each other. Allopatric speciation occurs as a result of **geographical isolation**. It is the most common type of speciation. Allopatric speciation occurs when populations of a species become **separated** from each other by **geographical** **barriers** The barrier could be **natural** like a body of water, or a mountain range It can also be **man-made**, like a motorway. This creates two populations of the same species who are **reproductively separated** from each other, and as a result, **no genetic exchange**can occur between them. If there are sufficient **selection pressures**acting to change the **gene pools** (and allele frequencies) within both populations then eventually these populations will**diverge**and form**separate species**. The changes in the alleles/genes of each population will affect the **phenotypes** present in both populations. Over time, the two populations may begin to differ **physiologically**, **behaviourally**  and **morphologically** (structurally) Sympatric speciation takes place with **no geographical barrier**  A group of the same species could be living in the **same place** but in order for speciation to take place there must exist **two populations** within that group and **no gene flow** occurs between them Something has to happen that **splits** or **separates** the two populations: | Triple science students will already know that speciation is the where a new species evolves from an existing one | Speciation  Isolation |
| **Biotic, abiotic factors and competition** | Students will learn that the maximum population size of a species that an ecosystem can support is called the carrying capacity. Biotic and abiotic conditions can affect this.  When organisms of different species compete with each other (interspecific) this might be for food, habitats etc  When individuals within the same species compete with each other, this is called intraspecific competition. (space, food, mate)  Students will learn about predator prey cycles which show how population sizes of predator and prey are interlinked- when one changes the other changes. | Students will already know that biotic factors are living factors that affect survival (pathogens, predators, food,) and abiotic factors are non living factors that affect survival (water, pH, temperature, sunlight, wind, oxygen, CO2) | Biotic  Abiotic  Niche  Population size  Interspecific competition  Intraspecific competition  Carrying capacity |
| **Sampling techniques** | Students will learn that quadrats can be used to estimate population size in a particular area.  Students will be able to follow and describe the method as:  Use a tape measure to measure the area of the field you want to sample. Record this area.  Using a tape measure, create a **transect line** along the area  Carefully throw the quadrat **randomly** at various points along each side of the transect line. This will **avoid bias and improve the validity of data**  Count the number of plants in each quadrat and record the results. **Repeat** at least 10 different distances along the transect. Collecting a **large sample of data** increases the **accuracy** of the sampling  Calculate the mean number of plants per quadrat  Multiply this figure by the total area of the field  A good idea is to take a running mean so keep calculating mean each time to take a new sample. Once the mean no longer changes by a large amount, this should mean data is realistic | Students will have used quadrats previously during GCSE required practical. | Quadrat  Transect  Bias  Accuracy |
| **Succession** | Students will learn that Succession is the gradual change in a community over time.  During succession the organisms within an ecosystem change its abiotic conditions.  This allows better adapted organisms to colonize the area, replacing its current inhabitants.  Primary succession occurs when organisms colonize a lifeless habitat. Secondary succession occurs when organisms re-colonize  a devastated  ecosystem. Primary succession begins in barren areas, such as on bare rock exposed by a retreating glacier.  The first inhabitants are lichens or plants—those that can survive in such an environment.  Over hundreds of years these “pioneer species” convert the rock into soil that can support simple plants such as grasses.  These grasses further modify the soil, which is then colonized by other types of plants. Each successive stage modifies the habitat by altering the amount of shade and the composition of the soil.  The final stage of succession is a climax community, which is a very stable stage that can endure for hundreds of years. |  | Pioneer species  Seral stage  Species richness  Barren landscape  Primary succession  Secondary succession  Climax community |
| **Conservation Methods** | Students will learn about several different conservation methods including:  Seedbanks- seeds are stored from plant species that are at risk of becoming extinct in the wild.  Fishing quotas- limits on the number of certain fish that can be caught and killed.  Protected areas- National parks and nature reserves to protect habitats. Restricting urban development, industrial development and farming.  Captive breeding programmes- Animals can be bred in captivity then released into their natural habitats.  Students will learn to describe data, draw conclusion and evaluate evidence for and against conservation issues | Students will already know that a zoo is an example of a place where conservation of animals occurs.  Students will already know that there is sometimes conflict between human needs and conservation but conservation methods are necessary to protect endangered species. | Conservation |