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**Knowledge Rich Curriculum Plan**

GCE Biology- Unit 3.4 Genetic Diversity



| **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** |
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| **Lesson 1:**  **Retrieval from 3.1 Biological molecules – nucleotides and polynucleotides** | *Consolidate work that was covered in the first term: structure and bonding within polynucleotides. Comparison of DNA and RNA structure and function.* | *Nucleotides have 3 components: phosphate, sugar and base. DNA: has deoxyribose and thymine; RNA has ribose and uracil substitutes for the Thymine.* | *Nucleotide*  *Pentose sugar; ribose/deoxyribose*  *Phosphodiester bond*  *Condensation reaction*  *Polynucleotide*  *Double helix*  *Purine*  *Pyrimidine*  *Adenine, thymine, cytosine, guanine* |
| **Lesson 2:**  **Genetic code** | Students will know that DNA stores the genetic code in a sequence of bases known as the triplet code. Each triplet is a codon and encodes for one amino acid within a specific polypeptide. Each gene codes for one polypeptide. The human genome codes for every gene involved in the human body – we call this the proteome. Some DNA has no associated protein: we call this DNA the introns. Exons are the coding sequences that need to be used to express genes. If there is a change in a single base within the proteome we call this a genetic mutation. Some genetic mutations result in no change to a gene because of the fact that the genetic code is degenerate (more than one triplet codes for some of the amino acids.) The genetic code is universal: all living things use the same triplet code. | As lesson 1  Proteins are polymers made of multiple amino acids joined by condensation reactions. Proteins have 4 levels of structure: the simplest is the primary sequence known as the primary structure. Other levels of structure arise from the difference in the R group attached to the central C unit of each amino acid. There are 20 different amino acids involved in proteins. | *Genome*  *Proteome*  *Intron*  *Exon*  *Degenerate*  *Universal*  *Mutation* |

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| **Lesson 3: Transcription** | *Transcription is the name of the first stage in protein synthesis. It involves making a temporary copy of a specific sequence of DNA known as a gene. The enzymes involved in this process are called helicase and RNA polymerase. Free nucleotides in the nucleus are joined together according to the sequence of bases on the template DNA strand. Only the region that encodes for the specific protein is unwound. This unwound section reconfigures as soon as the enzyme has completed its role and moved along the template strand. This preserves the original DNA molecule. The copy strand is known as a polynucleotide and specifically messenger RNA (mRNA). It is different to the DNA strand in that it has uracil instead of thymine and it is much shorter. It is small enough to leave the nucleus through pores in the nuclear membrane.* | *From Unit 1: enzymes; specifically those involved in Replication of DNA.*  *Unit 2: the structure of a nuclear membrane and ribosomes (KBH).* |  | *Polymerase*  *Helicase*  *Condensation reactions*  *Uracil*  *Thymine*  *Transcription loop*  *Helix*  *Template*  *Nuclear pore*  *Initiation*  *Elongation*  *Termination*  *Post-transcription modifications*  *Read: Transcription* | *Retrieval questions*  *Diagnostic questions*  *Exam questions* | *Knowledge Organiser: Unit 4* |
| **Lesson 4:**  **Translation** | Translation is the second stage of protein synthesis. It occurs in the cytoplasm at a location where a ribosome occurs. The mRNA that has left the nucleus attaches to a ribosome temporarily for the duration of the process. The mRNA is the transcript that codes for the gene being translated. The ribosome serves as a coordinator for the building process. A different molecule known as tRNA will bring an amino acid molecule to the ribosome and anchor it close to the mRNA. tRNA is a molecule of RNA that has a specific shape (clover leaf style). The molecule serves the function of binding to amino acids found in the cytoplasm – amino acid binding site. This tRNA has another region that will recognise mRNA molecule triplet codons and anchor: the anticodon.) Another tRNA molecule arrives bringing another amino acid molecule. The adjacent amino acids are bonded together using a condensation reaction. This is the beginning of a polypeptide molecule. The process repeats until the ribosome reaches a triplet called a STOP sequence. It detaches from the mRNA and no further tRNAs anchor. This is termination of the process. A polypeptide has been formed. | From Unit 1: amino acids join together with condensation reactions. The molecule is a polypeptide and the bond is a peptide bond.  The genetic code involves groups of 3 bases known as the triplet code. Some sequences do not code for an amino acid: specifically the start and stop sequences: these are instructions to aid protein synthesis. |  | *tRNA*  *amino acid binding site*  *anticodon*  *ribosome*  *Read: Translation and tRNA structure* | *Retrieval questions*  *Diagnostic questions*  *Exam questions* | *Knowledge Organiser: Unit 4* |

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| ***L7***  ***Meiosis and variation*** | *Before meiosis begins, the DNA must unravel and replicate. The two copies of the DNA strand are called chromatids and are held together by a centromere. This has the classic X shape seen as a chromosome. When the DNA condenses, the X shape is visible with a microscope. The process involves two cycles of the PMAT sequence: meiosis I and meiosis II. In meiosis I the pairs of homologous chromosomes are separated which halves the chromosome number.*  *In meiosis II the pairs of chromatids are separated when the centromere is divided.*  *Each new cell is haploid. 4 different haploid cells are produced.*  *\*\* critical idea: the reduction division occurs in stage I.*  *Crossing over may occur in stage 1. This involves the lengths of DNA in a pair of chromatids getting tangled and subsequently exchanging genetic sequences. As there is an exchange, genes are not lost/gained – it is simply an exchange of alleles. This is a key cause of variation.*  *During stage I, independent segregation of homologous pairs also occurs. This means that gametes have unique combinations of parental chromosomes.* | *Replication is a process that involves copying the DNA to prepare for cell division.*  *Gametes are the haploid cells that are produced to carry genetic information from parents to offspring. The genetic material from each parent is combined to give rise to different combinations of genes. When a sperm and egg cell join together we say that the nuclei have fused. This restores the diploid number. This process is called fertilisation. When two individuals are involved in reproduction it is described as sexual reproduction. Fertilisation of gametes is random and therefore the combination of alleles that are inherited is random and produces a unique individual. Mixing of genetic material is one source of genetic variation and results in diversity in a species.*  *Mitosis and meiosis are cell division processes but have different daughter cells. Mitosis produces clones of the parent cell following a sequence abbreviated to PMATI. Meiosis produces haploid cells by having more stages in the process.* |  | *Homologous pairs*  *Homologues*  *Reduction division*  *Crossing over*  *Independent segregation* | *Specific exam questions linked to examples of organisms that have not been considered.* | *Knowledge Organiser: Unit 4* |
| **L8**  **Types of mutation: chromosome and base sequence** | a. Chromosome mutations: this type of mutation arises during cell division is non-dysjunction. Down’s Syndrome is a genetic condition based on extra chromosome in the nucleus. This arises during meiosis II, as the chromatids separate, the centromere doesn’t divide and this results in two chromatids going together into one of the daughter cells, whilst the other daughter cell doesn’t receive one at all. This is called non-dysjunction. In Downs Syndrome it is chromosome pair 21 that are involved. The resulting zygote has three copies of chromosome 21. A cell that has three copies of a chromosome is termed trisomy.  b. Base sequence mutations: these can be useful or a nuisance. The order of bases determines the nature of polypeptide/protein that is expressed by a cell. If that sequence changes, we say there has been a mutation and a different polypeptide/no polypeptide will be produced. Types of mutation: deletion, substitution, inversion, duplication, translocation. The degenerate nature of the genetic code means that not all changes in base sequence give rise to a different polypeptide. Deletion mutations will always cause a frameshift.  Mutations can arise spontaneously during meiosis or they can be promoted through exposure to mutagenic agents eg., UV, ionising radiation, chemicals and viruses. | Meiosis is the cell division that results in genetic variation. Cells with the haploid number of chromosomes are produced. |  | *Zygote*  *Non-dysjunction*  *Trisomy*  *Frameshift*  *Substitution*  *Inversion*  *Duplication*  *Deletion*  *Degenerate*  *mutagen* |  | *Knowledge Organiser: Unit 4* |
| **L9**  **Genetic Diversity and Natural Selection** | The gene pool is the term used to describe all the alleles of a gene represented in a population. Genetic Diversity describes the number of different alleles in a species or population.  Natural selection is a process that acts to increase the proportion of advantageous alleles. Genetic diversity is increased by gene mutations giving rise to new alleles or gene flow (population changes resulting from migration of individuals). Without genetic diversity, natural selection would not be possible.  Events that cause a dramatic reduction in the number of members of a population are called genetic bottlenecks. The number of different alleles is reduced. As survivors reproduce, the gene pool is limited to the alleles found among the survivors.  An example of bottleneck is the Founder effect: a few members of a population start a completely new population (colony) elsewhere. The initial gene pool is limited in alleles. Offspring will have a narrow range of alleles and the gene frequency in the isolated group will be very different to that within the original group. Specifically, a genetic disease may have a higher frequency in the new colony g., the Amish people  Natural Selection arises when a genetic mutation gives an advantage to the offspring that make it more likely to withstand selection pressures: competition, disease, predators. These advantages are called adaptations and can be grouped into behavioural, anatomiical and functional.  Adaptation and selection are processes that underpin evolution over long periods of time. Evolution is described as gradual changes in members of a species over time. | Populations show variation in phenotype. Where more phenotypes occur, we describe that as diversity. Natural Selection is a process that explains why the fittest organisms survive. In Y11 they learn to use an acronym to explain the process at GCSE standard: VASRI.  Whilst all members of a population in a species will have the same set of genes, they will have different alleles for those genes. (Alleles are different versions of a gene) |  | *Genetic Diversity*  *Gene flow*  *Bottleneck*  *Founder effect*  *Gene pool*  *colony* |  | *Knowledge organiser: Unit 4* |
| **L10**  **Investigating selection** | Different types of selection result in different frequency patterns.  a. directional selection occurs when the environment is changing: individuals with alleles that represent extreme versions of the phenotype are more likely to survive and reproduce. A graph showing normal distribution will have a shift to the extremes.  Example: antibiotic resistance.  b. stabilising selection: individuals with alleles that represent more extreme phenotypes will not be likely to survive and reproduce, this stabilises the mean characteristic and reduces the range of characteristics in the gene pool. Example: human birth weight. (\* Deliberate practice with interpreting data for unfamiliar species is essential using past paper questions) | Natural selection alters the frequency of alleles in a population/species. |  | *Stabilising selection*  *Directional selection* |  | *Knowledge Organiser Unit 4* |
| **L11**  **Required Practical**  **CPAC skills** | Bacteria are grown in the laboratory using agar plates filled with nutrient broth, distilled water and kept warm/incubated).  Aseptic techniques are required: disinfect the surfaces to prevent unwanted microbes from accessing the utensils. Work close to a Bunsen to ensure that airborne particles are carried up with the convection currents. Flaming us used on the neck of the McCartney bottle will force hot air to carry microbes away from the opening. Sterile apparatus is used throughout to prevent contamination. The area where no bacteria can be seen after incubation is called the Zone of Inhibition. Tape is used to fix the lid of the agar plate but the edges must not be sealed : air is required to prevent potentially dangerous anaerobic bacteria from growing. All materials are placed in disinfectant after use to prevent any cross-contamination. | Triple science students will have done a similar practical without the detailed techniques. Recall of agar plate/antibiotic effect/zone of inhibition/using maths to determine the size of effects/antibiotics kill pathogens | *CPAC skills* | *McCartney bottle*  *Sterile*  *Aseptic technique*  *Flaming*  *Bacterial lawn*  *Culture*  *Broth*  *Agar*  *Multodisc*  *Invert*  *Zone of inhibition* |  |  |
| **L12**  **Classification** | Classification is about grouping related organisms. The science is called Taxonomy. We do this to make organisms easier to study and identify. Modern approaches to grouping include the use of phylogenetic trees. These represent evolutionary relationships between organisms. The branching trees highlight the close relationships and also when these differences emerged. Each node represents an ancestor that is extinct and the new species that evolved at that time. If species diverged recently, the space between their branches will be small.  Classification has 8 levels (taxa) Each taxon is a level in a hierarchy. The largest grups are at the top and the smallest group (individual species) is at the bottom. Species = a group of similar organisms that can reproduce to give rise to fertile offspring. The system for naming organisms is called the Binomial System. It is latin. Two parts: genus and species written in italics or underlines.  In the absence of a classification key, courtship behaviour can be used to identify members of a species.  New techniques are clarifying connections between species. Genome sequencing, comparing amino acid sequences, immunological comparisons. (Unit 8) Gene technologies can be used to measure genetic diversity too. | KPCOFGS acronym to recall the different levels in the classification system. |  |  |  |  |
| **L13**  **Measuring biodiversity** | Biodiversity reflects how well an ecosystem functions. High diversity correlates to a stable ecosystem that is less affected by changes in climate. Extreme environments have low species diversity and therefore it is classed as unstable as small changes will not be tolerated well by the occupants. (Converse is true: in these examples, changes in population are independent of climate and are more likely to be affected by other organisms. Species richness tells us the number of different populations in the community. Index of diversity is a better measure of biodiversity as it takes account of population size as well. Students will be confident to use the formula  **d = N( N – 1 )**  **Σn( n – 1 )**  N=total number of all species  N = total number of one species.  The higher the value of d, the more rich the biodiversity is.  Absence of diversity (ie one type of living thing) gives d=1  Index is more useful because it takes account of species that are only present in small numbers | Y11 work on populations (number of organisms), ecosystems (living and non-living things in an environment) and sampling techniques (quadrat and line transect | *Mathematical process involved in data-handling and interpretation of symbols/conventions for working with formula* | *Biodiversity*  *Genetic diversity*  *Community*  *Species richness*  *Index of diversity* | *Retrieval questions*  *Diagnostic questions:*  ***Which habitat has the greatest diversity?***  *\* Use ‘stop & jot’ to capture initial ideas & redraft answers based on shared understanding*  *Exam questions* |
| **L14**  **Investigating variation** | Sampling is the approach rather than studying the entire population which would be costly, time consuming and impractical. The sample is a model of the system studied. The sample must accurately represent the entire system. Remove bias and variation is due to chance. Use of mean values demands that standard deviations are considered to avoid over generalisation. Std devn will give a snapshot of range and statistical significance particularly if error bars are viewed: if they overlap, the difference is by chance. If not overlapping, statistically significant outcome. | GCSE Population study methods: line transect and quadrat sampling.  GCSE maths: mean, mode and median. |  | *Significant*  *Mean*  *Range*  *Standard deviation* |  |  |