**CFE Higher Biology Unit one**

1. Structure and Replication of DNA

Structure of DNA

Key Words: Nucleotide; bases; deoxyribose; hydrogen bond; sugar-phosphate backbone; base pairs; anti-parallel strands

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| Word/phrase  | Definition |
|  | Repeating unit of DNA composed of a deoxyribose joined to a phosphate group and a base. |
|  | Deoxyribose and phosphate of each nucleotide are joined together in a long permanent chain with the base pointing inward. |
|  | Sugar group present in DNA. |
|  | Type of bond formed between complementary bases on the parallel strands of DNA. |
|  | Two strands of DNA run in opposite directions. |
|  | Adenine pairing with thymine and guanine pairing with cytosine |
|  | General name for the 4 nitrogenous organic molecules which determine the DNA sequence. |

Organisation of DNA in prokaryotes and eukaryotes

Prokaryote; eukaryote; plasmids; mitochondria; chloroplasts; gel electrophoresis; restriction enzyme; chromosome

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| Word/Phrase | Definition |
|  | Organisms which contain linear chromosomal DNA wrapped in proteins inside a true nucleus. |
|  | Organelle present in green plant cells responsible for photosynthesis and carries small circular chromosomes. |
|  | Organelle present in the cells of all eukaryotes responsible for respiration and carries small circular chromosomes. |
|  | Organisms which contain circular chromosomal DNA and often contain plasmid DNA. |
|  | A technique used to separate out fragments of digested DNA based on their size and charge. |
|  | Enzyme required to cut DNA. |
|  | A DNA molecule carrying genetic information. |

Replication of DNA

Semi-conservative; DNA replication; leading strand; lagging strand; replication fork; ligase; primer; template; 5’ to 3’; 3’ to 5’; semi-conservative.

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| **Word or phrase** | **Definition** |
|  | Direction in which a strand of DNA is elongated |
|  | Strand of DNA which is copied to produce a new strand. |
|  | Small sequence of single stranded DNA required to start (prime) DNA replication. |
|  | Copying a molecule of DNA |
|  | Method used by a cell to replicate DNA to produce two daughter DNA molecules, each containing one original and one new strand of DNA. |
|  | Continuous replication of one strand of DNA from one primer. |
|  | Discontinuous replication of DNA as the double strand of DNA is unzipped to reveal more of the DNA read in the 3’ to 5’ direction. |
|  | Enzyme required to join newly replicated fragments of DNA formed by discontinuous DNA replication together. |
|  | Point at which the DNA strands are unzipped for DNA replication to take place. |
|  | Direction of DNA template for DNA replication. |

Polymerase chain reaction

Polymerase chain reaction; amplification of DNA; primers; specificity of primer; thermal cycling; heat-tolerant DNA polymerase;

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| **Word or phrase** | **Definition** |
|  | Repeated heating and cooling of a DNA template. |
|  | Producing a very large number of copies of a DNA fragment from possibly only one copy of DNA. |
|  | Method of amplifying DNA sequences by repeatedly copying the region between two primers. |
|  | Small sequence of single stranded DNA required to start (prime) DNA replication. |
|  | A type of DNA polymerase that is still active at relatively high temperatures. |
|  | Region of the DNA template which the primer is complementary to. |

1. **Gene expression**

Structure of proteins

Genotype; chromatography; Rf value; amino acids; polypeptide; peptide bond; bridges; three-dimensional structure; phenotype.

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| **Word or phrase** | **Definition** |
|  | A chain of amino acids linked together by peptide bonds |
|  | Bonds that join different parts of a polypeptide chain together to help create the three dimensional structure of the protein |
|  | Distance migrated by small molecules such as amino acids, peptides, photosynthetic pigments divided by the distance travelled by the solvent. This gives a consistent value that can be used to identify the chemical. |
|  | The complete genetic information contained in a cell. |
|  | The 20 subunits that make up a polypeptide. |
|  | The bond that joins two amino acids together. |
|  | The final overall shape that a protein takes based on how it is folded and how the polypeptide chains in it interact. |
|  | The physical characteristics of an organism. |

Functions of proteins

Enzymes; structural protein; hormones; antibodies; insulin; anti-diuretic hormone; human growth hormone; glycoprotein; haemoglobin

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| **Word or phrase** | **definition** |
|  | Protein completed by the attachment of carbohydrate groups. |
|  | Y-shaped proteins involved in the immune response which bind specifically to particular antigens. |
|  | Hormone produced by the pituitary gland which controls the permeability of kidney tubules to water |
|  | Oxygen transporting protein contained in red blood cells. |
|  | Hormone produced by the pituitary gland which promotes the growth of long bones. |
|  | Chemical messengers produced by the endocrine glands and sent in the blood stream to ‘target’ tissues where they elicit a particular response. |
|  | Protein molecules which catalyse specific chemical reactions. |
|  | Proteins that form the shape of all organelles and cells in the body. |

Structure of RNA, transcription and translation

Ribose; uracil; transcription; translation; sequence of amino acids; ribosomes; mRNA; tRNA; RNA polymerase; primary transcript; mature transcript; introns; exons; splicing; codons; anti-codon; attachment site; start codon; stop codon; binding sites; polyribosome; multiple translation.

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| **Word or phrase** | **Definition** |
|  | Enzyme required for transcription |
|  | First RNA transcript made before processing |
|  | Section of RNA removed to create the mature RNA transcript. |
|  | Triplet of bases on a tRNA molecule which determine the particular amino acid joined onto the extending polypeptide chain. |
|  | RNA–protein complex in two sub units which carry out translation. |
|  | Fragments of RNA which join together to form the mature transcript. |
|  | Procedure to remove introns from an RNA transcript leaving the mature transcript. |
|  | Triplets of bases on mRNA each of which codes for an amino acid. |
|  | Final RNA molecule ready for translation. |
|  | Type of RNA molecule that is joined to a specific amino acid. |
|  | Many ribosomes attached to an mRNA molecule to carry out multiple translations of the one mRNA. |
|  | Several of the same polypeptide being translated from the one mRNA transcript. |
|  | Codon that initiates translation from this point on. |
|  | Sugar molecule present on RNA |
|  | Type of base present in RNA rather than thymine in DNA. |
|  | Synthesis of the primary RNA molecule from a DNA template. |
|  | Place on a tRNA where the correct amino acid is joined. |
|  | Sites on a ribosome where the tRNA and mRNA molecules bind. |
|  | Codon that terminates translation at this point and does not code for an amino acid. |
|  | Synthesis of a polypeptide chain from a mRNA. |

One gene but many proteins

Alternative RNA splicing; post-translational modification; cleavage; molecular addition

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| Word or phrase | Definition |
|  | Processing of a polypeptide chain to create the active mature protein. |
|  | Modification of the protein by another molecule such as a carbohydrate or phosphate group |
|  | More than one possible pathway to create different mRNA molecules from the original primary transcript. |

1. **Differentiation in multicellular organisms**

Differentiation; meristems; apical meristem; gene activity; annual plant; perennial plant; lateral meristem; cambium; tissue-culturing; specialised; stem cells; blastocyst; embryonic stem cell; adult stem cells; ethical issues.

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| **Word or phrase** | **Definition** |
|  | Unspecialised animal cell from an adult which can divide repeatedly but has limited potential to differentiate into some types of specialised cells in the body. |
|  |  A type of cell that can divide repeatedly and has the potential to differentiate into specialised cells.  |
|  | The changing of a non-specialised cell to one with a specialised function. |
|  | The switching on of particular genes (normally to enable the creation of a specialised cell or function). |
|  | Taking a small section from a plant to grow on an agar or liquid culture medium containing nutrients. |
|  | Discussion about the moral values that should be in place to regulate society. |
|  | A group of unspecialised cells capable of dividing repeatedly throughout the life cycle of the plant |
|  | A plant which continues to grow year after year |
|  | Unspecialised animal cell from an embryo which can divide repeatedly and has the potential to differentiate into any type of cell in the body. |
|  | A plant which grows from a seed, flowers and dies within a year. |
|  | An embryonic ball of unspecialised stem cells |

1. **Genome and Mutation**

Structure of the genome

Genome; non-protein coding sequences; transcription factors; regulator sequences; telomere; tRNA; rRNA; RNA fragments.

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|  | Family of RNA molecules which carry particular amino acids to the ribosome for translation. |
|  | The complete DNA sequence of an organism |
|  | Specific sequences of DNA that act as binding sites for transcription factors to control the transcription of a gene. |
|  | Intervening sections of DNA that do not code for a polypeptide. |
|  | Proteins that bind to DNA and stimulate or repress the transcription of a gene. |
|  | RNA molecules that from part of the ribosome |
|  | Small nuclear RNA molecules that take part in the splicing process. |
|  | The end sequences of a chromosome composed of repetitive sequences. |

Point mutations

Mutation; mutant; frequency of mutation; mutagenic agents; induced mutations; point mutations; substitution; insertion; deletion; frameshift mutation; splice site mutation; missense mutation; nonsense mutation; nucleotide sequence repeat.

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|  | A mutation causing an insertion or deletion which changes the coding sequence and hence the reading frame downstream to produce a protein with a different amino acid sequence, from this point on, to the original protein sequence therefore creating a protein which is almost certainly non-functional or no protein at all. |
|  | The number of times a mutation occurs in a particular gene per one million gametes. |
|  | Mutations which only change one base pair in a DNA sequence. |
|  | Changing one base pair for another. |
|  | A change in the DNA sequence of an organism. |
|  | Mutations generated artificially by mutagenic agents. |
|  | An organism whose phenotype is altered by a mutation. |
|  | Factors that cause an increase in the frequency of mutation. |
|  | Removing a base pair from a DNA sequence. |
|  | Adding a base pair to a DNA sequence. |
|  |  An insertion or deletion mutation in the DNA sequence that abolishes a splice junction rendering the splice site non-functional and creating a non-functional protein from the altered mRNA transcript. |
|  | A mutation caused by a nucleotide substitution which changes an amino acid and is likely to affect the function of the protein negatively. |
|  | A substitution mutation which causes the codon to become a stop codon and hence translation would stop at this point giving rise to a truncated (shortened) protein. |
|  | A series of short DNA sequences which are repeated in a tandem order. |

Chromosome structure mutations

Deletion; duplication; translocation; multi-gene families; polyploidy; triploid; tetraploid; diploid; haploid; increase in vigour.

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| **Word or phrase** | **definition** |
|  | Cells containing two sets of chromosomes. |
|  | An exchange of chromosomal DNA between two non-homologous chromosomes. |
|  | An organism’s (normally a plant) ability to grow better, be more resistant to disease and produce larger crops. |
|  | Removal of a large piece of chromosomal DNA creating an organism lacking in certain genes. |
|  | A set of related genes that have arisen from a single common ancestral gene by duplication and mutation. |
|  | Cells containing three sets of chromosomes |
|  | Insertion of a repeated sequence of genes into a chromosome. |
|  | Cells containing four sets of chromosomes. |
|  | A cell containing one or more **extra** sets of chromosomes. |
|  | Cells containing one set of chromosomes. |

1. **Evolution**

Inheritance

Evolution; frequency of genetic sequences; inheritance; vertical transfer; horizontal transfer;

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|  | The transfer of particular genetic characteristics from one organism to another |
|  | The transfer of particular genetic characteristics from one organism to another |
|  |  The gradual changes in the characteristics of a population of organisms which takes place over many generations due to changes in the gene pool of that population. |
|  | The exchange of genetic material from one organism to another which is not the offspring but can also be a member of a different species. |
|  | The proportion of a population containing a particular type of allele. |

Selection

Natural selection/survival of the fittest; sexual selection; variation; male to male competition; polygenic; normal distribution curve; directional selection; artificial selection; disruptive selection.

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|  | Selecting for traits (characteristics) that increase successful sexual reproduction. |
|  | Male animals such as stags which vie with each other for females and for territory. |
|  | A phenotype dependent on the interactions of several genes. |
|  | The type of curve generated with quantitative data from a polygenic trait within a large population. |
|  | The survival of some organisms in a population that are best suited to survive under the present environmental conditions or to a change in their environment and pass their favourable characteristics to their offspring leading to a non-random increase in the frequency of these favourable genes within the population. |
|  | The differences that exist between individuals within a population based on differences in their respective genotypes. |
|  |  A progressive shift in a populations mean value for a trait giving a non-random change in the frequency of alleles due to some environmental change. |
|  | A change in the frequency of an allele(s) due to selective breeding by humans. |
|  | Extreme versions of a trait are produced as a result of two distinct habitats becoming available. |

 **Genetic drift**

Genetic drift; gene pool; sampling error; evolutionary change; founder effect; bottleneck effect; neutral mutation; uniformity.

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|  TERM |  MEANING |
|   | Occurs when a small group of organisms, with an *unrepresentative frequency*  of alleles, becomes detached form the larger gene pool; the descendants of these organisms will have an allele frequency determined (influenced) by that of the original *splinter group* |
|  | A change in the genome at the molecular level which *does not* affect how well an individual is adapted to their environment. |
|  | Changes that occur in the gene pool due to *chance* as only a *sample* of genes is passed on from one generation to the next. |
|  | A situation in which genetic diversity (i.e. the total number of different kinds of allele in the gene pool) is *reduced.* |
|  | changes that occur in the gene pool over generations that may lead to *new* populations or even species. |
|  | the *total* of all the different alleles and genes in a population at any one time. |
|  | when due to chance an event, such as a meteor impact, acts in an *unselective* way to destroy many members of a gene pool; the survivors have a gene pool with *less* genetic variation (reduced frequency of certain alleles) as so many may have been destroyed in the event |
|  | the creation of a sample which is *not* representative of the population it is taken from, especially if the sample is *small* |

 **Species and speciation**

Species; stable relationship; speciation; allopatric speciation; geographical barrier; sympatric speciation; ecological barrier; behavioural barrier; hybrid zones;

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| TERM  |  MEANING  |
|  | where two genetically similar populations are genetically *isolated* even though they may be in close proximity, as they are found in different parts of the ecosystem, e.g. one population of molluscs may be found in deep water, the other in shallow water  |
|  | the formation of *new* biological species. |
|  | a group of organisms *able* to interbreed and produce fertile offspring. |
|  | an obstruction which separates two populations which are still *potentially* capable of interbreeding, e.g. a sea, a mountain range, or a desert. |
|  | the area shared between two populations which show *some* genetic difference (such a hooded crows and carrion crows) but can still interbreed and produce fertile offspring. |
|  | this describes the interaction between a species and its environment when that species is *not* moving towards extinction or undergoing changes leading to *speciation*  |
|  | where gene flow between two populations (which may be in *close* proximity) is prevented by an ecological or behavioural barrier |
|  | where gene flow between two populations, which are *potentially* still capable of interbreeding, is prevented by a geographical barrier |
|  | where two populations are genetically isolated, even though in *close* proximity, as they become sexually active at different times or have different courtship rituals, e.g. Herring Gulls and Lesser-Black Backed Gulls |

 **Genomics and genomic sequencing**

Genomics; genomic sequencing; bioinformatics; restriction site; genome shotgun method; model organisms; comparative genomics; single nucleotide polymorphisms; conservation; highly conserved genetic sequences.

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|  TERM |  MEANING |
|  | a term used *similarities* found between the genomes of different species which have been separated over *long* periods of evolutionary time |
|  | where genetic sequences of different species, different phenotypes of the same species, or even different cells within the one organism are studied for *similarities or differences* |
|  | the cutting of a genome into fragments and then using a computer to recognise and reassemble the fragments to *determine the sequence* of the complete genome |
|  | the *study* of the *complete* set of an organism’s DNA (i.e. genes and genetic information) and the relating of this genetic information to the *function* of the genes  |
|  | the sequence of DNA that codes for *fundamental* activities which have been selected *for* over a long period of time and are common to many different species, e.g. the enzymes which control respiration |
|  | the use of a computer to *map and statistically analyse* DNA (i.e. genetic) sequences |
|  | term used for non-human species that possess genes *nearly equal* to those which cause genetic diseases and malfunctions in humans |
|  | the determination of the *order* of bases along an organisms’s DNA  |
|  | type of variation that affects an *individual* base pair in a DNA sequence |
|  | *specific* sequence of DNA bases which is cut by a restriction endonuclease. |

**Phylogenetics**

Phylogenetics; divergence; molecular phylogenetics; common ancestor; evolutionary distance; phylogenetic tree; molecular clocks; three domains of living things.

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| TERM |  MEANING |
|  | a diagram which shows how a common ancestor has *evolved* into a group of *species* and which shows the *sequence* of divergences that have brought this about |
|  | the *original* species or population from which two or more distinct groups have evolved |
|  | the main groups that living things can be placed into on the basis of *comparison*  of theirribosomal RNA |
|  | the degree of genetic difference (usually counted as *differences* in base sequence per unit length of DNA) between two groups |
|  | a *tool* used to *date* how closely or distantly two groups are by comparing the number of nucleotide substitutions by which they differ |
|  | the examination of how closely related, in *evolutionary* terms, different populations are . |
|  | the examination of *base sequences* in the genes of two groups to try and ascertain how closely each group is related to the other |
|  | term used to describe how a *single* group develops into *two or more* groups with genomes which differ from each other. |

**Sequence of evolutionary events**

Fossils; combined evidence; fossilisation; modifications; complex.

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| TERM  |  MEANING |
|  | the *changes* that living things seem to have undergone through evolutionary time as they as they have become better and better adapted |
|  | the term that describes the more recent products of evolution, with *many different* parts, compared with earlier simpler forms |
|  | the use of fossil evidence and the genomic sequences to determine the *sequence of events* in evolution |
|  | the *conversion* of hard body parts (and plant remnants) into rock |
|  | *preserved* remnants or impressions left by organisms that have lived in the past |

**Personal genomics**

Personal genomics; DNA sequencing; genetic disorder; causal link; molecularly characterised; personalised medicine; risk prediction; ethical issues; predisposition; genetic discrimination.

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| TERM | MEANING |
|  | what a disease is said to be when it is *causally linked* with a particular genomic sequence |
|  | the *likelihood or chance* of an individual developing a particular disease or disorder |
|  | subjects which generate questions and debate on ‘right or wrong’ with ‘answers’ which vary from society to society or individual to individual often depending on *moral or religious* *viewpoints.* |
|  | the order of nucleotide bases found on an *individual’s* DNA |
|  | what may result if *information* on an individual’s is widely known to such bodies as employers, medical insurers, and so on |
|  | the determining of the *probability* (high or low) of an individual developing a particular disease or disorder after scanning their genome |
|  | a disease *resulting* from a *variation* in a genomic DNA sequence |
|  | the *customising* of treatments, and making them more effective, on the basis of knowledge of an individual’s DNA profile |
|  | when a *connection* is established between a variation (usually the result of a mutation) in a genomic sequence and a *particular* disease or disorder |
|  | the mechanism of determining the *order* of nucleotide bases along the chromosomes. |