

Definitions and Concepts for OCR (A) Biology A-Level

Topic 6 - Genetics, Evolution & Ecosystems

Topic 6.1: Genetics and evolution

Allele: A version of a gene.

Allopatric speciation: A form of speciation that occurs when two populations become geographically isolated due to a physical barrier.

Apoptosis: Programmed cell death. This is important for pruning surplus cells and tissues in development.

Artificial selection: See 'selective breeding'.

Autosomal linkage: When two or more genes are positioned on the same autosome. They are unlikely to be separated by crossing over during meiosis so are often inherited together.

Autosome: A chromosome that is not an X or Y chromosome.

Bioinformatics: The development of the computer tools and software required to organise and analyse unprocessed biological data.

Chi-squared (χ^2) test: A statistical test used to determine whether a pattern of inheritance is statistically significant.

Chlorosis: A condition in which plant leaf cells produce insufficient chlorophyll, resulting in pale or yellow coloured leaves. This may be due to mineral deficiencies, lack of light, or viral infections.

Codominance: When both alleles for a gene in a heterozygous organism equally contribute to the phenotype.

Computational biology: The use of computational techniques to analyse large amounts of biodata and build theoretical models of biological systems.

Continuous variation: A type of variation that cannot be categorised e.g. skin colour, height. It produces a continuous range in which a characteristic can take any value. Multiple genes influence continuous variation.

Degrees of freedom (χ^2 test): The number of categories minus one.



Deletion: A form of gene mutation in which one or more nucleotide bases are removed from a DNA sequence. This may lead to a frameshift mutation, changing every successive codon.

Dihybrid inheritance: The determination of a trait by the inheritance of two genes.

Directional selection: A type of selection that favours one extreme phenotype and selects against all other phenotypes.

Discontinuous variation: A type of variation that can be categorised e.g. blood group. A characteristic can only appear in discrete values. One or two genes influence discontinuous variation.

Disruptive selection: A type of selection that favours individuals with extreme phenotypes and selects against those with phenotypes close to the mean.

DNA barcode: A short sequence of DNA that is used to identify a species. DNA barcodes are common to all species but vary between species.

DNA ligase: An enzyme that joins the sugar-phosphate backbone of two DNA segments.

DNA profiling: A technique used to determine the patterns in the non-coding DNA of an individual. It involves five main stages: DNA extraction; digestion; separation of DNA fragments; hybridisation; and observation.

DNA sequencing: Determining the entire DNA nucleotide base sequence of an organism.

Dominant: Describes an allele that is always expressed. Represented by a capital letter.

Electrophoresis: A type of chromatography that separates nucleic acid fragments or proteins by size using electric current.

Electroporation: A method of transformation in which a small electric current is used to transfer recombinant plasmids into bacterial cells or fragments of DNA into eukaryotic cells.

Epistasis: Describes a relationship between genes at different loci, where the allele of one gene affects the expression of a different gene.

Etiolation: A condition in plants characterised by weak stems and small, pale leaves, due to insufficient exposure to light.

Evolution: The gradual change in the allele frequencies within a population over time. Occurs due to natural selection.

Exon: A sequence of DNA that codes for an amino acid sequence.



Founder effect: A type of genetic drift in which a few individuals of a species break off from the population and form a new colony. This results in smaller gene pools and an increased frequency of rare alleles.

Gene mutation: A change to at least one nucleotide base in DNA or the arrangement of bases. Gene mutations can occur spontaneously during DNA replication and may be beneficial, damaging, or neutral.

Gene therapy: A therapeutic technique in which a faulty allele is replaced with a functional allele in order to treat or prevent disease.

Genetically modified organism (GMO): An organism that has had its genome altered.

Genetic bottleneck: A drastic reduction in population size leading to reduced genetic diversity within a population.

Genetic drift: Random variations in allele frequencies in small populations, due to mutations.

Genetic engineering: The modification of the genome of an organism by the insertion of a desired gene from another organism. This enables the formation of organisms with beneficial characteristics.

Genome: The complete genetic material of an organism.

Genotype: An organism's genetic composition. Describes all alleles.

Germ line cell gene therapy: A type of gene therapy in which a faulty allele is replaced with a functional allele in germ cells or a very early embryo. The effects of this are permanent and can be inherited.

Hardy-Weinberg principle: A model that predicts that the ratio of dominant and recessive alleles in a population will remain constant between generations if the following five conditions are met: no new mutations; no natural selection; no migration; large population; and random mating. It provides a formula for calculating the frequencies of alleles:

$$p^2 + 2pq + q^2 = 1.0$$

where p is the frequency of the dominant allele, and q is the frequency of the recessive allele.

Heterozygous: When someone has two different alleles of a gene e.g. Ff.

High-throughput sequencing: More recent, large-scale approaches to DNA sequencing that use a flow cell. They enable many clusters of DNA fragments to be sequenced simultaneously, giving efficient and rapid sequencing. This has allowed whole-genome sequencing.



Homeobox genes: A group of regulatory genes that contain a homeobox, a DNA sequence that is highly conserved in animals, plants and fungi. Homeobox genes are responsible for the development of body plans in different organisms.

Homozygous: When someone has two identical alleles of a gene e.g. ff.

Hox gene: A type of homeobox gene that is present in animals only. The terms “Hox gene” and “homeobox gene” can be used interchangeably.

Inbreeding: The formation of offspring from the breeding of closely related individuals.

Insertion: A form of gene mutation in which one or more nucleotide bases are added to a DNA sequence. This may lead to a frameshift mutation, changing every successive codon.

Intron: A non-coding sequence of DNA.

Lac operon: A group of three structural genes, lacZ, lacY and lacA, that are required for the metabolism of lactose.

Mature mRNA: The final mRNA product that has had introns removed, as well as having undergone other post-transcriptional changes.

Mitosis: A form of cell division that produces two genetically identical diploid daughter cells. Mitosis is important for growth, increasing the number of cells.

Monogenic inheritance: The determination of a trait by the inheritance of a single gene.

Multiple alleles: When a gene has more than two potential alleles.

Mutagen: A chemical, biological or physical agent that increases the rate of gene mutations above normal level.

Operon: A group of genes that are expressed together and controlled by the same regulatory mechanism.

Phenotype: An organism’s observable characteristics. Due to interactions of the genotype and the environment.

Polymerase Chain Reaction (PCR): An *in vitro* technique used to rapidly amplify fragments of DNA.

Post-transcriptional control: The level of gene regulation in which primary mRNA can be modified, controlling translation.



Post-translational control: The level of gene regulation in which proteins can be modified post-synthesis.

Pre-mRNA: The product of transcription before any post-transcriptional regulation.

Recessive: Describes an allele that is only expressed in the absence of a dominant allele. Represented by a small letter.

Recombinant DNA: A combination of DNA from two different organisms.

Regulatory gene: A gene that codes for the production of proteins involved in DNA regulation. The expression of regulatory genes is influenced by internal and external stimuli.

Repressor protein: A protein that binds to the operator, altering the transcription rate.

Restriction endonucleases: Enzymes that cut DNA molecules at recognition sequences, creating sticky ends.

Sanger sequencing: The first method of DNA sequencing that involved the formation of DNA fragments of varying lengths. Fluorescent 'terminator' bases marked the final base of each fragment, allowing the overall DNA sequence to be determined.

Selection pressures: Factors that affect an organism's ability to survive in an environment e.g: disease, prey, competitors, water availability.

Selective breeding: The process by which humans artificially select organisms with desirable characteristics and breed them to produce offspring with desirable phenotypes. Selective breeding may also be referred to as 'artificial selection'.

Sex-linkage: The presence of a gene on an X or Y chromosome.

Sexual reproduction: A form of reproduction involving the random fusion of male and female gametes. This creates genetic variation.

Somatic cell gene therapy: A type of gene therapy in which a faulty allele is replaced with a functional allele in affected somatic cells. The effects of this are temporary and cannot be inherited.

Speciation: The formation of new species due to the evolution of two reproductively separated populations. Two forms: allopatric and sympatric speciation.

Stabilising selection: A type of selection that favours individuals with phenotypes close to the mean (average) and selects against extreme phenotypes.

Sticky ends: The staggered cut formed by restriction endonucleases in double-stranded DNA.



Structural gene: A gene that codes for the production of proteins or enzymes that are not involved in DNA regulation.

Substitution: A form of gene mutation in which one nucleotide base is exchanged for another. This may change an amino acid or produce the same amino acid (due to the degeneracy of the genetic code).

Sympatric speciation: A form of speciation that occurs when two populations within the same area become reproductively isolated.

Synthetic biology: The design and construction of new biological entities, as well as the reconstruction of pre-existing natural biological systems.

Thermocycler: A machine controlled by a computer that varies temperatures at predetermined time intervals.

Transcriptional control: The level of gene regulation in which genes are switched 'on' or 'off'.

Transcription factors: Proteins that help to switch genes 'on' or 'off' by controlling the binding of RNA polymerase to DNA.

Transgenic organism: An organism that contains recombinant DNA.

Translational control: The level of gene regulation in which translation can be initiated or stopped.

Vector: A carrier used to transfer a gene from one organism to another e.g. plasmid.

Topic 6.2: Cloning and biotechnology

Artificial twinning: The artificial production of monozygotic twins from the manual splitting of the early embryo.

Aseptic techniques: A range of techniques used to culture microorganisms under sterile conditions in order to minimise contamination.

Batch fermentation: An industrial method of fermentation that runs for a set period of time. The culture broth is not removed until the fermentation is complete.

Bioremediation: The use of microorganisms to remove soil and water pollution.

Biotechnology: The field of biology involving the use of living systems to produce or transform materials. Applications include agriculture, medicine and food science.



Brewing: The production of beer from the steeping of barley in water, and the fermentation of the resulting product with yeast.

Clones: The genetically identical offspring produced as a result of cloning.

Cloning: A method of producing genetically identical offspring by asexual reproduction.

Continuous fermentation: An industrial method of fermentation in which culture broth is continuously removed and extra nutrient medium is added. The fermentation conditions remain relatively constant.

Culture: The growth of living matter *in vitro* in suitable conditions.

Cutting: A small section of the root or stem of an adult plant that is used in horticulture to produce natural clones.

Enucleation: The removal of the nucleus.

Fermentation: A type of anaerobic respiration that does not involve an electron transport chain.

Immobilised aminoacylase: An immobilised enzyme that is used to produce pure samples of L-amino acids.

Immobilised enzymes: Enzymes which are attached to an inert, insoluble material over which the substrate passes and the reaction takes place.

Immobilised glucoamylase: An immobilised enzyme that can be used to breakdown dextrans into glucose.

Immobilised glucose isomerase: An immobilised enzyme that is used to convert glucose to fructose.

Immobilised lactase: An immobilised enzyme that hydrolyses lactose to glucose and galactose in the production of lactose-free milk.

Immobilised penicillin acylase: An immobilised enzyme that is used to produce semi-synthetic penicillins from natural penicillins.

Micropropagation: The production of large numbers of clones from one parent plant using tissue culture.

Monozygotic twins: Identical twins formed from one fertilised egg that splits to form two embryos.



Natural cloning: A form of asexual reproduction that takes place in plants in which a new genetically identical plant grows from a structure (stem, leaf, bud or root) of the parent plant. Also known as vegetative propagation.

Penicillin: The first conventional, effective and safe antibiotic derived from the mould *Penicillium chrysogenum*.

Somatic cell nuclear transfer (SCNT): The production of an embryo (clone) from the transfer of the nucleus of an adult animal cell to an enucleated egg cell in the laboratory. The nucleus and egg are fused and stimulated to divide.

Tissue culture: The growth of cells or tissues outside of an organism in an artificial culture medium.

Topic 6.3: Ecosystems

Abiotic factors: The non-living aspects of an ecosystem e.g. light, temperature, water availability, oxygen availability and soil pH.

Abundance: The number of individuals per species in a specific area at any given time.

Ammonification: The production of ammonium compounds when decomposers feed on organic nitrogen-containing molecules.

Azotobacter: A type of nitrogen-fixing bacteria that lives freely in the soil.

Belt transect: A line along a sampled area upon which quadrats are placed at intervals to determine the abundance and distribution of organisms in an ecosystem.

Biomass: The total mass of organic material, measured in a specific area over a set time period. This can be calculated in terms of dry mass.

Biotic factors: The living components of an ecosystem e.g. food availability, pathogens, predators and other species.

Carbon cycle: The cycle through which carbon (in the form of carbon dioxide) moves between living organisms and the environment, involving respiration, photosynthesis and combustion.

Carrying capacity: The maximum population size that can be indefinitely supported by an environment.

Climax community: The stable community of organisms that exists at the final stage of ecological succession.



Conservation: The maintenance of ecosystems and biodiversity by humans in order to preserve the Earth's resources.

Consumers: Organisms that feed on other organisms to obtain energy.

Decomposers: Organisms that release enzymes which catalyse the breakdown of dead plant and animal material into simpler organic matter.

Deflected succession: Changes to the natural flow of succession due to human activity that result in a stable community known as a plagioclimax.

Denitrification: The conversion of nitrate ions to nitrogen gas by denitrifying bacteria.

Denitrifying bacteria: Anaerobic microorganisms, found in waterlogged soils, responsible for the reduction of nitrate ions to nitrogen gas.

Distribution: The spread of living organisms in an ecosystem.

Ecological efficiency: The efficiency of energy or biomass transfer between trophic levels is calculated using:

$$\text{ecological efficiency} = \frac{\text{energy or biomass available after transfer}}{\text{energy or biomass available before transfer}} \times 100$$

Ecosystem: The community of organisms (biotic) and non-living (abiotic) components of an area and their interactions.

Food chain: Describes the feeding relationships between organisms and the resulting stages of biomass transfer. It takes the form:

producer → primary consumer → secondary consumer → tertiary consumer

Interspecific competition: A type of competition that takes place between members of different species.

Intraspecific competition: A type of competition that takes place between members of the same species.

Limiting factor: A variable that limits the rate of a particular process.

Line transect: A line along a sampled area. The species touching the transect at regular intervals are recorded to determine the abundance and distribution of organisms in an ecosystem.



Nitrification: The conversion of ammonium ions to nitrate ions by nitrifying bacteria. This takes place in two stages: ammonium ions are oxidised to nitrite ions; nitrite ions are oxidised to nitrate ions.

Nitrifying bacteria: Aerobic microorganisms found in the soil responsible for the oxidation of ammonium ions to nitrate ions.

Nitrobacter: A genus of nitrifying bacteria that oxidises nitrites into nitrates.

Nitrogen cycle: The cycle through which nitrogen moves between living organisms and the environment, involving ammonification, nitrification, nitrogen fixation and denitrification.

Nitrogen fixation: The conversion of atmospheric nitrogen gas into ammonia by nitrogen-fixing bacteria in the soil or root nodules of legumes.

Nitrogen-fixing bacteria: Microorganisms responsible for the conversion of atmospheric nitrogen gas into nitrogen-containing compounds. They can be free-living or mutualistic.

Nitrosomonas: A genus of nitrifying bacteria that oxidises ammonium compounds into nitrites.

Peat bogs: Areas of peat soil in wetland habitats formed by the accumulation of partially decayed organic matter. They store carbon and are commonly referred to as 'carbon sinks'.

Pioneer species: Species that can survive in hostile environments and colonise bare rock or sand e.g. lichens.

Plagioclimax: A stage in succession in which artificial factors prevent the formation of a natural climax community.

Population: All organisms of the same species living with one another in a habitat at the same time.

Predator: An organism that eats other organisms.

Preservation: The restriction of human interference in an area in order to protect and maintain the ecosystem.

Prey: An organism that is eaten by predators.

Primary succession: A type of succession in which pioneer species colonise a newly formed or exposed area of land.

Producers: Photosynthetic organisms at the start of the food chain that manufacture biomass for all living things.



Quadrat: A square grid of known area used in sampling to determine the abundance of organisms in a habitat.

Rhizobium: A type of nitrogen-fixing bacteria that lives inside the root nodules of leguminous plants.

Succession: Describes changes in the community of organisms occupying a certain area over time.

Sustainable: The ability to maintain something for future generations.

Sustainable resource: A resource that can be continuously renewed; it will not diminish or run out.

Trophic level: The position of an organism in a food chain.

