OCR (B) Biology A-level

Topic 3.1 - Cell Division and Development

Definitions and Concepts

3.1.1 The developing cell: cell division and cell differentiation

Anaphase - The third stage in mitosis where the chromosomes are pulled apart to the poles of the cell by the spindle fibres.

Apoptosis - Programmed cell death.

Blebs - Bulges on the plasma membrane.

Bone marrow - Tissue within some bones which consists of hematopoietic stem cells, adipose tissue and stromal cells.

Cell cycle - The periodic cycle of cell growth and division, divided into interphase, mitosis and cytokinesis.

Cell plate - A structure that forms between the two groups of chromosomes during cell division in plants.

Cell shrinkage - Occurs due to pyknosis during apoptosis.

Centrioles - Structures found in the cytoplasm made of microtubules that produce the spindle fibres during mitosis.

Centromere - A structure on a chromosome that holds the sister chromatids together.

Chromatid - One strand of a replicated chromosome.

Chromosome - A structure consisting of a long, coiled molecule of DNA and its associated proteins, by which genetic information is passed from generation to generation.

Cytokinesis - The division of the cytoplasm at the end of mitosis to produce two new daughter cells.

Differentiation - The process where a cell develops certain features so that it is specialised to carry out a certain function.

G_1 (Gap 1) phase - The first growth phase in interphase during which the cell synthesises proteins and RNA, duplicates its organelles and increases in size before DNA replication in S phase.

G_2 (Gap 2) phase - The second growth phase of interphase during which the cell continues to increase in size and synthesize biomolecules.

Histone proteins - Proteins that, together with DNA, form chromosomes in the nuclei of eukaryotic cells.

Homologous chromosomes - Two chromosomes with the same gene loci but different alleles, one inherited from each parent.

Interphase - The longest stage of the eukaryotic cell cycle. It consists of G_1 phase, S phase and G_2 phase and occurs before mitosis.

Karyorrhexis - The nucleus breaks into fragments during apoptosis.

Macrophage - A phagocytic white blood cell.

Metaphase - The second stage of mitosis in which replicated chromosomes align at the equator of the cell.

Mitosis - The division of a cell to produce two genetically identical daughter cells.

Mitotic spindle - A structure mainly consisting of microtubules that is formed by the cytoskeleton between centrioles. Chromosomes attach to the spindle via the kinetochore at their centrosome.

Multipotent - A type of stem cell which has the ability to differentiate into any cell type within a certain tissue in the body.

Nuclear envelope - The double plasma membrane surrounding the nucleus.

Nucleus - An organelle which stores genetic information.

Phosphatidylserine - A cell membrane phospholipid which acts as a signal for apoptosis.

Pluripotent - A type of stem cell which has the ability to differentiate into any cell type in the body.

Prophase - The first stage in mitosis where the nuclear envelope breaks down, the centrosomes move to opposite poles of the cell, the mitotic spindle begins to form and the chromosomes condense.

Pyknosis - The nucleus shrinks during apoptosis.

Specialised cell - A cell which expresses genes that enable it to perform a specific function.

S (Synthesis) phase - The second phase in the cell cycle where the DNA in the cell is replicated.

Stem cell - A type of undifferentiated cell which has the ability to divide many times and differentiate into many different cell types.

Telophase - The final stage of mitosis in which new nuclear envelopes begin to form around the separated sets of chromosomes.

Totipotent - A type of stem cell which has the ability to differentiate into any type of cell in the body or in the placenta.

Amniocentesis - A cell sample from the amniotic fluid can be screened for genetic conditions.

Anaphase 1 - The third stage of meiosis where the chromosomes that make up the bivalent are pulled apart to the poles of the cell by the spindle fibres.

Anaphase 2 - The seventh stage of meiosis where the chromatids are pulled apart to opposite poles of the cell.

Antenatal care - Healthcare provision during pregnancy before childbirth.

Biparietal diameter - A measurement of a fetus' cranial diameter performed using ultrasound.

Chiasma - The point of linkage between two non-sister chromatids from homologous chromosomes where crossing over occurs.

Chorionic villus sampling - A cell sample from the placenta can be screened for genetic conditions.

Chromosomal mutation - A change in the number or structure of chromosomes.

Crossing over - The exchange of genetic material between two chromosomes in a bivalent.

Crown-rump length - The length of a fetus from the top of the head to the bottom of the buttocks measured using ultrasound.

Dietary reference value (DRV) - An estimate of the energy and nutrient intake required by different groups of people.

Diploid cell - Cells with two copies of each chromosome.

Down's syndrome - A condition associated with physical and intellectual disability caused by a chromosomal non-disjunction mutation in which three copies of chromosome 21 are inherited.

Essential vitamin - A vitamin that cannot be produced by the body and must be obtained from food.

Folic acid - An essential B vitamin used for DNA and RNA production. It is used to treat anaemia and is given as a supplement during pregnancy to reduce the risk of neural tube defects in the fetus.

Fertilisation - The fusion of gametes.

Fetal growth chart - A graph which shows expected crown-rump length and biparietal cranium diameter at different stages of pregnancy.

Fetus - Unborn offspring which develops from an embryo.

Gametes - Sex cells that have a haploid nucleus and are produced through meioisis.

Genetic variation - The differences in DNA base sequence between organisms, including members of the same species.

Haploid cell - Cells with only one copy of each chromosome.

Independent assortment of chromatids - Separated chromosomes move to either pole of the cell with equal probability.

Independent assortment of chromosomes - Homologous chromosomes can line up at the equator of the cell in any order. During meiosis I, they move to either pole of the cell with equal probability.

Karyotypes - A photomicrograph of an individual's chromosomes.

Klinefelter's syndrome - A condition associated with infertility in males caused by a chromosomal mutation in which males inherit two copies of the X chromosome and one copy of the Y chromosome.

Meiosis - A type of cell division used to produce gametes that produces four genetically different haploid daughter cells from one parent cell.

Metaphase 1 - The second stage of meiosis where the bivalent chromosomes align along the metaphase plate and independent assortment occurs.

Metaphase 2 - The sixth stage of meiosis where the recombinant chromosomes align on the metaphase plate.

Neural tube - The precursor to the CNS in the embryo.

Neural tube defect - Any condition that arises when the neural tube fails to close around the fourth week of pregnancy.

Nondisjunction (mutation) - A chromosomal mutation in which homologous chromosomes or sister chromatids do not separate properly.

Post-conceptual care - Healthcare provided from the onset of pregnancy.

Pre-conceptual care - Advice on improving health provided before trying to become pregnant.

Prophase 1 - The first stage of meiosis where the nuclear envelope breaks down, the spindle fibres form and the chromosomes condense and form bivalents. This is the stage of meiosis where crossing over occurs.

Prophase 2 - The fifth stage of meiosis where the nuclear envelope breaks down, the spindle fibres form and the chromosomes condense.

Recombinant chromosomes - The chromosomes produced by the crossing over and exchange of genes during metaphase 1.

Telophase 1 - The fourth stage of meiosis where the nuclear envelopes reform around the separated chromosomes and they uncoil.

Telophase 2 - The final stage in meiosis where the nuclear envelopes reform around the separated chromatids (now called chromosomes) and they uncoil.

Translocation mutation - A chromosomal mutation in which part of a chromosome is moved to another locus.

Turner's syndrome - A condition associated with underdeveloped ovaries in females caused by a chromosomal mutation in which only one healthy X chromosome is inherited and the other is partially or completely missing.

Ultrasonography/ ultrasound - A technique that uses the reflection of ultrasound waves at borders between tissues to form images.

Vitamin A (retinol) - A vitamin required for normal function of the immune system and eyes.

Vitamin C (ascorbic acid) - A vitamin required for the production of collagen, an important component of blood vessels, skin, cartilage and bone.

3.1.3 The development of species: evolution and classification

Adaptation - A feature of an organism that increases its chance of survival in its environment. An adaptation may be anatomical, physiological or behavioural.

Alleles - Different versions of the same gene.

Anatomical adaptation - A favourable change in the structure of an organism which makes it better suited to its environment.

Behavioural adaptation - A favourable change in the actions of an organism which increases its chance of survival.

Biodiversity - The variety of genes, species and habitats within ecosystems or habitats.

Biological species - A group of organisms descended from common ancestors which can reproduce to form fertile offspring with one another.

Bipedalism - The ability to walk on two legs.

Classification - The process of grouping organisms based on their phylogenetic characteristics or evolutionary heritage.

Chloroplast genes - Chloroplasts contain some of their own DNA which codes for some of the proteins involved in photosynthesis.

Cytochrome c oxidase 1 - A mitochondrial gene in vertebrates which codes for a respiratory protein that reduces oxygen.

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

DNA barcoding - A short section of DNA from a standard part of the genome is compared to a reference database to identify an unknown specimen.

Hominid classification - A taxonomic family which consists of four genera of primates, including *Homo*. The classification has been revised many times.

Homo sapiens - The binomial nomenclatures for modern humans.

Hylobatid - Members of the Hylobatidae family of lesser apes, e.g. gibbons.

Ecosystem - The interactions between living organisms and the environment in a given area.

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

Extant species - A species that still exists.

Extinct species - The population of a species may decrease until it no longer exists due to habitat loss, hunting by humans, competition with other species or climate change.

Fossil - A preserved trace or remnant of an organism from a past geological age found in rock.

Genome - All of the genetic information within an organism.

Gossip hypothesis - The theory that language arose from vocal signals during social grooming. It suggests that vocal signals evolved to allow storytelling.

Lactose - A disaccharide formed by a condensation reaction between glucose and galactose.

Locus - The location of a gene on a chromosome.

Melanin - A biological pigment produced by melanocytes which provides the skin with some protection from damage by sun radiation.

Mitochondrial genes - Mitochondria contain some of their own DNA which codes for some of the proteins involved in aerobic respiration.

Mother tongue hypothesis - The theory that all languages developed from a single 'mother tongue' spoken prehistorically in Africa.

Natural selection - The process which leads to evolution by which organisms with favourable adaptations have a selective advantage and survive to pass on their genes.

Phylogenetic species - A group of organisms with similar characteristics that arose from the same series of common ancestors.

Phylogenetic tree - A diagram used to show the evolutionary relationships between organisms.

Physiological adaptation - A favourable change in the bodily/metabolic functions of an organism which makes it better suited to its environment.

Polymorphic gene loci - A measure of genetic biodiversity. Calculated using:

$$\text{proportion of polymorphic gene loci} = \frac{\text{number of polymorphic gene loci}}{\text{total number of loci}}$$

Selection pressures - Environmental factors that drive evolution by natural selection and limit population sizes e.g. competition, predation and disease.

Simpson's Index of Diversity *(D)* - A measurement of diversity that considers both species richness and evenness. Calculated using the formula:

$$D = 1 - \sum \left(\frac{n}{N}\right)^2$$

Species evenness - The number of individuals of each species living together in a community.

Species richness - The number of different species found within an area.

Stabilising selection - A type of selection which selects against extreme phenotypes and produces a population with average phenotypes.

Taxonomic hierarchy - A hierarchy used to group and classify living organisms which typically contains 8 levels - Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species.

Taxonomy - The classification of organisms into groups.

Xerophytes - Plants that are adapted to live and reproduce in dry habitats where water availability is low, e.g. cacti and marram grass.