IBDP Biology SL/HL

Topic 3: Genetics

Revision List - Syllabus Topics

3.1: Genes

1. A gene is a heritable factor that consists of a length of DNA and influences a specific characteristic.
2. A gene occupies a specific position on a chromosome (loci).
3. The various specific forms of a gene are alleles.
4. Alleles differ from each other by one or only a few bases.
5. New alleles are formed by mutation.
6. The genome is the whole of the genetic information of an organism.
7. The entire base sequence of human genes was sequenced in the Human Genome Project.
8. The causes of sickle cell anemia, including a base substitution mutation, a change to the base sequence of mRNA transcribed from it and a change to the sequence of a polypeptide in hemoglobin.
    a. Recall one specific base substitution that causes glutamic acid to be substituted by valine as the sixth amino acid in the hemoglobin polypeptide.
9. Comparison of the number of genes in humans with other species.
    a. The number of genes in a species should not be referred to as genome size as this term is used for the total amount of DNA.

3.2: Chromosomes

1. Prokaryotes have one chromosome consisting of a circular DNA molecule.
2. Some prokaryotes also have plasmids but eukaryotes do not.
3. Eukaryote chromosomes are linear DNA molecules associated with histone proteins.
4. In a eukaryote species there are different chromosomes that carry different genes.
5. Homologous chromosomes carry the same sequence of genes but not necessarily the same alleles of those genes.
6. Diploid nuclei have pairs of homologous chromosomes.
7. Haploid nuclei have one chromosome of each pair.
8. The number of chromosomes is a characteristic feature of members of a species.
    a. Comparison of diploid chromosome numbers of Homo sapiens, Pan troglodytes, Canis familiaris, Oryza sativa, Parascaris equorum.
    b. Comparison of genome size in T2 phage, E. coli, Drosophila melanogaster, Homo sapiens and Paris japonica.
        i. Genome size is the total length of DNA in an organism.
9. A karyogram (karyotype) shows the chromosomes of an organism in homologous pairs of decreasing length.
    a. Use a karyogram to deduce sex and diagnose Down syndrome in humans.
    b. Describe methods used to obtain cells for a karyotype, including chorionic villus sampling and amniocentesis, and the associated risks.
10. Sex is determined by sex chromosomes and autosomes are chromosomes that do not determine sex.

3.3: Meiosis

1. One diploid nucleus divides by meiosis to produce four haploid nuclei.
    a. Draw a diagram to show the stages of meiosis.
2. The halving of the chromosome number allows a sexual life cycle with fusion of gametes.
3. DNA is replicated before meiosis so that all chromosomes consist of two sister chromatids.
4. The early stages of meiosis involve pairing of homologous chromosomes and crossing over followed by condensation.
5. Orientation of pairs of homologous chromosomes prior to separation is random.

6. Separation of pairs of homologous chromosomes in the first division of meiosis halves the chromosome number.
    a. Non-disjunction can cause Down's syndrome and other chromosome abnormalities.
    b. Studies show that age of parents can influence the chances of non-disjunction.
7. Crossing over and random orientation promotes genetic variation.
8. Fusion of gametes from different parents promotes genetic variation.

3.4: Inheritance

1. Mendel discovered the principles of inheritance with experiments in which large numbers of pea plants were crossed.
    a. Construct Punnett grids (Punnett squares) for predicting the outcomes of monohybrid genetic crosses.
    b. Comparison of predicted and actual outcomes of genetic crosses.
2. Gametes are haploid so contain only one allele of each gene.
3. The two alleles of each gene separate into different haploid daughter nuclei during meiosis.
4. Fusion of gametes results in diploid zygotes with two alleles of each gene that may be the same allele or different alleles.
5. Dominant alleles mask the effects of recessive alleles, but co-dominant alleles have joint effects.
    a. Inheritance of ABO blood groups (use proper notation for genotype and phenotype)
6. Many genetic diseases in humans are due to recessive alleles of autosomal genes, although some genetic diseases are due to dominant or co-dominant alleles.
    a. Inheritance of cystic fibrosis and Huntington's disease.
7. Some genetic diseases are sex-linked. The pattern of inheritance is different with sex-linked genes due to their location on sex chromosomes.
    a. Red-green color blindness and hemophilia are examples of sex-linked inheritance.
8. Many genetic diseases have been identified in humans but most are very rare.
9. Radiation and mutagenic chemicals increase the mutation rate and can cause genetic diseases and cancer.
10. Analysis of pedigree charts to deduce the pattern of inheritance of genetic diseases.

3.5: Genetic modification and biotechnology

1. Gel electrophoresis is used to separate proteins or fragments of DNA according to size.
2. PCR can be used to amplify small amounts of DNA.
3. DNA profiling involved comparison of DNA.
    a. Use of DNA profiling in paternity and forensic investigations.
4. Genetic modification is carried out by gene transfer between species.
    a. Gene transfer to bacteria using plasmids makes use of restriction endonuclease and DNA ligase.
5. Clones are groups of genetically identical organisms, derived from a single original parent cell.
6. Many plant species and some animal species have natural methods of cloning.
7. Animals can be cloned at the embryo stage by breaking up the embryo into more than one group of cells.
8. Methods have been developed for cloning adult animals using differentiated cells.
9. Production of cloned embryos produced by somatic-cell nuclear transfer. (Dolly the sheep example.)