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.)