Summary

Unit 3 - Genetics Current

Subject	Year	Start date	Duration
Biology	IB1	Week 1, May	4 weeks 15 hours

Course Part

Core

Curriculum

Aims

Appreciate scientific study and creativity within a global context through stimulating and challenging opportunities

Acquire a body of knowledge, methods and techniques that characterize science and technology

Apply and use a body of knowledge, methods and techniques that characterize science and technology

Develop an ability to analyse, evaluate and synthesize scientific information

Develop a critical awareness of the need for, and the value of, effective collaboration and communication during scientific activities

Develop experimental and investigative scientific skills including the use of current technologies

Develop and apply 21st century communication skills in the study of science

Become critically aware, as global citizens, of the ethical implications of using science and technology

Develop an appreciation of the possibilities and limitations of science and technology

Develop an understanding of the relationships between scientific disciplines and their influence on other areas of knowledge

Objectives

Demonstrate knowledge and understanding of

- facts, concepts, and terminology
- methodologies and techniques
- communicating scientific information

Apply

- facts, concepts, and terminology
- methodologies and techniques
- methods of communicating scientific information

Syllabus Content

Core

3. Genetics

3.1 Genes

Nature of science:

Developments in scientific research follow improvements in technology - gene sequencers are used for the sequencing of genes.

Understandings:

A gene is a heritable factor that consists of a length of DNA and influences a specific characteristic.

A gene occupies a specific position on a chromosome.

The various specific forms of a gene are alleles.

Alleles differ from each other by one or only a few bases.

New alleles are formed by mutation.

The genome is the whole of the genetic information of an organism.

The entire base sequence of human genes was sequenced in the Human Genome Project.

Applications and skills:

Application: 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.

Application: Comparison of the number of genes in humans with other species.

Skill: Use of a database to determine differences in the base sequence of a gene in two species.

3.2 Chromosomes

Nature of science:

Developments in research follow improvements in techniques - autoradiography was used to establish the length of DNA molecules in chromosomes.

Understandings:

Prokaryotes have one chromosome consisting of a circular DNA molecule.

Some prokaryotes also have plasmids but eukaryotes do not.

Eukaryote chromosomes are linear DNA molecules associated with histone proteins.

In a eukaryote species there are different chromosomes that carry different genes.

Homologous chromosomes carry the same sequence of genes but not necessarily the same alleles of those genes.

Diploid nuclei have pairs of homologous chromosomes.

Haploid nuclei have one chromosome of each pair.

The number of chromosomes is a characteristic feature of members of a species.

A karyogram shows the chromosomes of an organism in homologous pairs of decreasing length.

Sex is determined by sex chromosomes and autosomes are chromosomes that do not determine sex.

Applications and skills:

Application: Cairns' technique for measuring the length of DNA molecules by autoradiography.

Application: Comparison of genome size in T2 phage, Escherichia coli, Drosophila melanogaster, Homo sapiens and Paris japonica.

Application: Comparison of diploid chromosome numbers of Homo sapiens, Pan troglodytes, Canis familiaris, Oryza sativa, Parascaris equorum.

Application: Use of karyograms to deduce sex and diagnose Down syndrome in humans.

Skill: Use of databases to identify the locus of a human gene and its polypeptide product.

3.3 Meiosis

Nature of science:

Making careful observations - meiosis was discovered by microscope examination of dividing germ-line cells.

Understandings:

One diploid nucleus divides by meiosis to produce four haploid nuclei.

The halving of the chromosome number allows a sexual life cycle with fusion of gametes.

DNA is replicated before meiosis so that all chromosomes consist of two sister chromatids.

The early stages of meiosis involve pairing of homologous chromosomes and crossing over followed by condensation.

Orientation of pairs of homologous chromosomes prior to separation is random.

Separation of pairs of homologous chromosomes in the first division of meiosis halves the chromosome number.

Crossing over and random orientation promotes genetic variation.

Fusion of gametes from different parents promotes genetic variation.

Applications and skills:

Application: Non-disjunction can cause Down syndrome and other chromosome abnormalities.

Application: Studies showing age of parents influences chances of non-disjunction.

Application: Description of methods used to obtain cells for karyotype analysis e.g. chorionic villus sampling and amniocentesis and the associated risks.

Skill: Drawing diagrams to show the stages of meiosis resulting in the formation of four haploid cells.

3.4 Inheritance

Nature of science:

Making quantitative measurements with replicates to ensure reliability. Mendel's genetic crosses with pea plants generated numerical data.

Understandings:

Mendel discovered the principles of inheritance with experiments in which large numbers of pea plants were crossed.

Gametes are haploid so contain only one allele of each gene.

The two alleles of each gene separate into different haploid daughter nuclei during meiosis.

Fusion of gametes results in diploid zygotes with two alleles of each gene that may be the same allele or different alleles.

Dominant alleles mask the effects of recessive alleles but co-dominant alleles have joint effects.

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.

Some genetic diseases are sex-linked. The pattern of inheritance is different with sex-linked genes due to their location on sex chromosomes.

Many genetic diseases have been identified in humans but most are very rare.

Radiation and mutagenic chemicals increase the mutation rate and can cause genetic diseases and cancer.

Applications and skills:

Application: Inheritance of ABO blood groups.

Application: Red-green colour blindness and hemophilia as examples of sex-linked inheritance.

Application: Inheritance of cystic fibrosis and Huntington's disease.

Application: Consequences of radiation after nuclear bombing of Hiroshima and accident at Chernobyl.

Skill: Construction of Punnett grids for predicting the outcomes of monohybrid genetic crosses.

Skill: Comparison of predicted and actual outcomes of genetic crosses using real data.

Skill: Analysis of pedigree charts to deduce the pattern of inheritance of genetic diseases.

3.5 Genetic modification and biotechnology

Nature of science:

Assessing risks associated with scientific research - scientists attempt to assess the risks associated with genetically modified crops or livestock.

Understandings:

Gel electrophoresis is used to separate proteins or fragments of DNA according to size.

PCR can be used to amplify small amounts of DNA.

DNA profiling involves comparison of DNA.

Genetic modification is carried out by gene transfer between species.

Clones are groups of genetically identical organisms, derived from a single original parent cell.

Many plant species and some animal species have natural methods of cloning.

Animals can be cloned at the embryo stage by breaking up the embryo into more than one group of cells.

Methods have been developed for cloning adult animals using differentiated cells.

Applications and skills:

Application: Use of DNA profiling in paternity and forensic investigations.

Application: Gene transfer to bacteria using plasmids makes use of restriction endonucleases and DNA ligase.

Application: Assessment of the potential risks and benefits associated with genetic modification of crops.

Application: Production of cloned embryos produced by somatic-cell nuclear transfer.

Skill: Design of an experiment to assess one factor affecting the rooting of stem-cuttings.

Skill: Analysis of examples of DNA profiles.

Skill: Analysis of data on risks to monarch butterflies of Bt crops.

ATL Skills

Approaches to Learning

Thinking

- In this unit, we will

ask students to formulate a reasoned argument to support their opinion or conclusion

give students time to think through their answers before asking them for a response

reward a new personal understanding, solution or approach to an issue

ask open questions

set students a task which required higher-order thinking skills (such as analysis or evaluation)

build on a specific prior task

help students to make their thinking more visible (for example, by using a strategy such as a thinking routine)

require students to take an unfamiliar viewpoint into account when formulating arguments

ask questions that required the use of knowledge from a different subject from the one you are teaching

include a reflection activity

make a link to TOK

Social

- In this unit, we will

  have students work in small groups

  allocate, or ask students to allocate among themselves, different roles in a classroom discussion or activity

  have students peer assess their group performance or process

  support students in resolving a conflict in a team

  give a group assessment task

  give students feedback on how they worked as a group

  have students discuss their understanding of a text or idea among themselves and come up with a shared understanding

  provide an opportunity for students to analyse the impact of their behaviour on the class or on a group performance

  encourage students to consider alternative points of view or to take the perspective of others

  provide opportunities for students to make decisions

Developing IB Learners

Learner Profile

Inquirers

Knowledgeable

Thinkers

Reflective