9.3 Blueprint of Life

Contextual Outline

Because all living things have a finite life span, the survival of each species depends on the ability of individual organisms to reproduce. The continuity of life is assured when the chemical information that defines it is passed on from one generation to the next on the chromosomes.

Modern molecular biology is providing opportunities to alter the information transferred from one generation to the next in technologies such as cloning and in the production of transgenic species.

The segregation and independent assortment of the genetic information within a species provides the variation necessary to produce some individuals with characteristics that better suit them to surviving and reproducing in their environment. Changes in the environment may act on these variations. The identification of mutations and their causes becomes important in preventing mutations and in identifying and potentially nullifying the effects of mutations in living organisms.

This module increases students' understanding of the history, nature and practice of biology, the applications and uses of biology, the implications of biology for society and the environment and current issues, research and developments in biology.

	Students learn to:	*Students:*
1. Evidence of evolution suggests that the mechanisms of inheritance, accompanied by selection, allow change over many generations	▪ outline the impact on the evolution of plants and animals of: – changes in physical conditions in the environment – changes in chemical conditions in the environment – competition for resources ▪ describe, using specific examples, how the theory of evolution is supported by the following areas of study: – palaeontology, including fossils that have been considered as transitional forms – biogeography – comparative embryology – comparative anatomy – biochemistry ▪ explain how Darwin/Wallace's theory of evolution by natural selection and isolation accounts for divergent evolution and convergent evolution	▪ plan, choose equipment or resources and perform a first-hand investigation to model natural selection ▪ analyse information from secondary sources to prepare a case study to show how an environmental change can lead to changes in a species ▪ perform a first-hand investigation or gather information from secondary sources (including photographs/ diagrams/models) to observe, analyse and compare the structure of a range of vertebrate forelimbs ▪ use available evidence to analyse, using a named example, how advances in technology have changed scientific thinking about evolutionary relationships ▪ analyse information from secondary sources on the historical development of theories of evolution and use available evidence to assess social and political influences on these developments

	Students learn to:	*Students:*
2. Gregor Mendel's experiments helped advance our knowledge of the inheritance of characteristics	▪ outline the experiments carried out by Gregor Mendel ▪ describe the aspects of the experimental techniques used by Mendel that led to his success ▪ describe outcomes of monohybrid crosses involving simple dominance using Mendel's explanations ▪ distinguish between homozygous and heterozygous genotypes in monohybrid crosses ▪ distinguish between the terms allele and gene, using examples ▪ explain the relationship between dominant and recessive alleles and phenotype using examples ▪ outline the reasons why the importance of Mendel's work was not recognised until some time after it was published	▪ perform an investigation to construct pedigrees or family trees, trace the inheritance of selected characteristics and discuss their current use ▪ solve problems involving monohybrid crosses using Punnett squares or other appropriate techniques ▪ process information from secondary sources to describe an example of hybridisation within a species and explain the purpose of this hybridisation

	Students learn to:	*Students:*
3. Chromosomal structure provides the key to inheritance	▪ outline the roles of Sutton and Boveri in identifying the importance of chromosomes ▪ describe the chemical nature of chromosomes and genes ▪ identify that DNA is a double-stranded molecule twisted into a helix with each strand comprised of a sugar-phosphate backbone and attached bases – adenine (A), thymine (T), cytosine (C) and guanine (G) – connected to a complementary strand by pairing the bases, A-T and G-C ▪ explain the relationship between the structure and behaviour of chromosomes during meiosis and the inheritance of genes ▪ explain the role of gamete formation and sexual reproduction in variability of offspring ▪ describe the inheritance of sex-linked genes, and alleles that exhibit co-dominance and explain why these do not produce simple Mendelian ratios ▪ describe the work of Morgan that led to the understanding of sex linkage ▪ explain the relationship between homozygous and heterozygous genotypes and the resulting phenotypes in examples of co-dominance ▪ outline ways in which the environment may affect the expression of a gene in an individual	▪ process information from secondary sources to construct a model that demonstrates meiosis and the processes of crossing over, segregation of chromosomes and the production of haploid gametes ▪ solve problems involving co-dominance and sex linkage ▪ identify data sources and perform a first-hand investigation to demonstrate the effect of environment on phenotype

	Students learn to:	*Students:*
4. The structure of DNA can be changed and such changes may be reflected in the phenotype of the affected organism	▪ describe the process of DNA replication and explain its significance ▪ outline, using a simple model, the process by which DNA controls the production of polypeptides ▪ explain the relationship between proteins and polypeptides ▪ explain how mutations in DNA may lead to the generation of new alleles ▪ discuss evidence for the mutagenic nature of radiation ▪ explain how an understanding of the source of variation in organisms has provided support for Darwin's theory of evolution by natural selection ▪ describe the concept of punctuated equilibrium in evolution and how it differs from the gradual process proposed by Darwin	▪ perform a first-hand investigation or process information from secondary sources to develop a simple model for polypeptide synthesis ▪ analyse information from secondary sources to outline the evidence that led to Beadle and Tatum's 'one gene – one protein' hypothesis and to explain why this was altered to the 'one gene – one polypeptide' hypothesis ▪ process information to construct a flow chart that shows that changes in DNA sequences can result in changes in cell activity ▪ process and analyse information from secondary sources to explain a modern example of 'natural' selection ▪ process information from secondary sources to describe and analyse the relative importance of the work of: – James Watson – Francis Crick – Rosalind Franklin – Maurice Wilkins in determining the structure of DNA and the impact of the quality of collaboration and communication on their scientific research
5. Current reproductive technologies and genetic engineering have the potential to alter the path of evolution	▪ identify how the following current reproductive techniques may alter the genetic composition of a population: – artificial insemination – artificial pollination – cloning ▪ outline the processes used to produce transgenic species and include examples of this process and reasons for its use ▪ discuss the potential impact of the use of reproduction technologies on the genetic diversity of species using a named plant and animal example that have been genetically altered	▪ process information from secondary sources to describe a methodology used in cloning ▪ analyse information from secondary sources to identify examples of the use of transgenic species and use available evidence to debate the ethical issues arising from the development and use of transgenic species