

Ingenious Genes Curriculum Links for AQA AS (7401) and A-Level Biology (7402)

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3.1.1 Monomers and polymers

Monomers are the smaller units from which larger molecules are made

Polymers are molecules made from a large number of monomers joined together

Monosaccharides, amino acids and nucleotides are examples of monomers

3.1.4 Proteins

Amino acids are the monomers from which proteins are made

A condensation reaction between two amino acids forms a peptide bond

- Polypeptides are formed by the condensation of many amino acids

Proteins have a variety of functions within all living organisms

3.1.5 Nucleic acids are important information-carrying molecules

Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are important information-carrying molecules. In all living cells, DNA holds genetic information and RNA transfers genetic information from DNA to the ribosomes

Both DNA and RNA are polymers of nucleotides. Each nucleotide is formed from a pentose, a nitrogen-containing organic base and a phosphate group.

- The components of a DNA nucleotide are deoxyribose, a phosphate group and one of the organic bases adenine, cytosine, guanine or thymine

A DNA molecule is a double helix with two polynucleotide chains held together by hydrogen bonds between specific complementary base pairs.

3.2.1 Cell structure

The structure of eukaryotic cells, restricted to the structure and function of:

- nucleus (containing chromosomes, consisting of protein-bound, linear DNA, and one or more nucleoli)

3.4.1 DNA, genes and chromosomes

In the nucleus of eukaryotic cells, DNA molecules are very long, linear and associated with proteins, called histones. Together a DNA molecule and its associated proteins form a chromosome.

A gene is a base sequence of DNA that codes for:

- the amino acid sequence of a polypeptide
- a functional RNA (including ribosomal RNA and tRNAs).

A gene occupies a fixed position, called a locus, on a particular DNA molecule.

A sequence of three DNA bases, called a triplet, codes for a specific amino acid. The genetic code is universal, non-overlapping and degenerate.

In eukaryotes, much of the nuclear DNA does not code for polypeptides. There are, for example, non-coding multiple repeats of base sequences between genes. Even within a gene only some sequences, called exons, code for amino acid sequences. Within the gene, these exons are separated by one or more non-coding sequences, called introns.

3.4.2 DNA and protein synthesis

Transcription as the production of mRNA from DNA. The role of RNA polymerase in joining mRNA nucleotides.

- In prokaryotes, transcription results directly in the production of mRNA from DNA.
- In eukaryotes, transcription results in the production of pre-mRNA; this is then spliced to form mRNA.

Translation as the production of polypeptides from the sequence of codons carried by mRNA. The roles of ribosomes, tRNA and ATP.

Students should be able to:

- relate the base sequence of nucleic acids to the amino acid sequence of polypeptides, when provided with suitable data about the genetic code

3.4.3 Genetic diversity can arise as a result of mutation or during meiosis

Gene mutations involve a change in the base sequence of chromosomes. They can arise spontaneously during DNA replication and include base deletion and base substitution. Due to the degenerate nature of the genetic code, not all base substitutions cause a change in the sequence of encoded amino acids. Mutagenic agents can increase the rate of gene mutation.

Meiosis produces daughter cells that are genetically different from each other.

The process of meiosis only in sufficient detail to show how:

- two nuclear divisions result usually in the formation of four haploid daughter cells from a single diploid parent cell
- genetically different daughter cells result from the independent segregation of homologous chromosomes
- crossing over between homologous chromosomes results in further genetic variation among daughter cells.

Students should be able to:

- explain how random fertilisation of haploid gametes further increases genetic variation within a species.

3.4.4 Genetic diversity and adaptation

Genetic diversity as the number of different alleles of genes in a population.

Genetic diversity is a factor enabling natural selection to occur.

The principles of natural selection in the evolution of populations.

- Random mutation can result in new alleles of a gene.
- Many mutations are harmful but, in certain environments, the new allele of a gene might benefit its possessor, leading to increased reproductive success.
- The advantageous allele is inherited by members of the next generation.
- As a result, over many generations, the new allele increases in frequency in the population.

3.7.1 Inheritance (A-level only)

The genotype is the genetic constitution of an organism.

The phenotype is the expression of this genetic constitution and its interaction with the environment.

There may be many alleles of a single gene.

Alleles may be dominant, recessive or codominant.

In a diploid organism, the alleles at a specific locus may be either homozygous or heterozygous.

The use of fully labelled genetic diagrams to interpret, or predict, the results of:

- monohybrid and dihybrid crosses involving dominant, recessive and codominant alleles
- crosses involving sex-linkage

3.7.3 Evolution may lead to speciation (A-level only)

Individuals within a population of a species may show a wide range of variation in phenotype. This is due to genetic and environmental factors. The primary source of genetic variation is mutation. Meiosis and the random fertilisation of gametes during sexual reproduction produce further genetic variation.

Evolution as a change in the allele frequencies in a population.

3.8.1 Alteration of the sequence of bases in DNA can alter the structure of proteins (A-level only)

Gene mutations might arise during DNA replication. They include addition, deletion, substitution, inversion, duplication and translocation of bases.

Gene mutations occur spontaneously. The mutation rate is increased by mutagenic agents. Mutations can result in a different amino acid sequence in the encoded polypeptide.

- Some gene mutations change only one triplet code. Due to the degenerate nature of the genetic code, not all such mutations result in a change to the encoded amino acid.
- Some gene mutations change the nature of all base triplets downstream from the mutation, ie result in a frame shift.

Students should be able to relate the nature of a gene mutation to its effect on the encoded polypeptide.

