

Ingenious Genes Curriculum Links for AQA GCSE Biology (8461)

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4.1.2.1 Chromosomes

The nucleus of a cell contains chromosomes made of DNA molecules. Each chromosome carries a large number of genes.

In body cells the chromosomes are normally found in pairs.

4.6.1.1 Sexual and asexual reproduction

Students should understand that meiosis leads to non-identical cells being formed while mitosis leads to identical cells being formed.

Sexual reproduction involves the joining (fusion) of male and female gametes:

- sperm and egg cells in animals

In sexual reproduction there is mixing of genetic information which leads to variety in the offspring. The formation of gametes involves meiosis

4.6.1.2 Meiosis

Students should be able to explain how meiosis halves the number of chromosomes in gametes and fertilisation restores the full number of chromosomes.

Cells in reproductive organs divide by meiosis to form gametes.

When a cell divides to form gametes:

- copies of the genetic information are made
- the cell divides twice to form four gametes, each with a single set of chromosomes
- all gametes are genetically different from each other.

Gametes join at fertilisation to restore the normal number of chromosomes. The new cell divides by mitosis. The number of cells increases. As the embryo develops cells differentiate.

4.6.1.4 DNA and the genome

Students should be able to describe the structure of DNA and define genome.

The genetic material in the nucleus of a cell is composed of a chemical called DNA. DNA is a polymer made up of two strands forming a double helix. The DNA is contained in structures called chromosomes.

A gene is a small section of DNA on a chromosome. Each gene codes for a particular sequence of amino acids, to make a specific protein.

The genome of an organism is the entire genetic material of that organism. The whole human genome has now been studied and this will have great importance for medicine in the future.

Students should be able to discuss the importance of understanding the human genome. This is limited to the:

- search for genes linked to different types of disease
- understanding and treatment of inherited disorders

4.6.1.5 DNA structure (biology only)

Students should be able to describe DNA as a polymer made from four different nucleotides. Each nucleotide consists of a common sugar and phosphate group with one of four different bases attached to the sugar.

DNA contains four bases, A, C, G and T.

A sequence of three bases is the code for a particular amino acid. The order of bases controls the order in which amino acids are assembled to produce a particular protein.

The long strands of DNA consist of alternating sugar and phosphate sections. Attached to each sugar is one of the four bases.

The DNA polymer is made up of repeating nucleotide units.

(HT only) Students should be able to:

- recall a simple description of protein synthesis
- explain simply how the structure of DNA affects the protein made
- describe how genetic variants may influence phenotype:

a) in coding DNA by altering the activity of a protein and

b) in non-coding DNA by altering how genes are expressed.

(HT only) In the complementary strands a C is always linked to a G on the opposite strand and a T to an A.

(HT only) Students should be able to explain how a change in DNA structure may result in a change in the protein synthesised by a gene.

(HT only) Proteins are synthesised on ribosomes, according to a template. Carrier molecules bring specific amino acids to add to the growing protein chain in the correct order.

(HT only) When the protein chain is complete it folds up to form a unique shape. This unique shape enables the proteins to do their job as enzymes, hormones or forming structures in the body such as collagen.

(HT only) Mutations occur continuously. Most do not alter the protein, or only alter it slightly so that its appearance or function is not changed.

(HT only) A few mutations code for an altered protein with a different shape. An enzyme may no longer fit the substrate binding site or a structural protein may lose its strength.

(HT only) Not all parts of DNA code for proteins. Non-coding parts of DNA can switch genes on and off, so variations in these areas of DNA may affect how genes are expressed.

4.6.1.6 Genetic inheritance

Students should be able to explain the terms:

- gamete
- chromosome
- gene
- allele

- dominant
- recessive
- homozygous
- heterozygous
- genotype
- phenotype

Some characteristics are controlled by a single gene, such as: fur colour in mice; and red-green colour blindness in humans. Each gene may have different forms called alleles.

The alleles present, or genotype, operate at a molecular level to develop characteristics that can be expressed as a phenotype.

A dominant allele is always expressed, even if only one copy is present. A recessive allele is only expressed if two copies are present (therefore no dominant allele present).

If the two alleles present are the same the organism is homozygous for that trait, but if the alleles are different they are heterozygous.

Most characteristics are a result of multiple genes interacting, rather than a single gene.

Students should be able to understand the concept of probability in predicting the results of a single gene cross, but recall that most phenotype features are the result of multiple genes rather than single gene inheritance.

Students should be able to use direct proportion and simple ratios to express the outcome of a genetic cross.

4.6.1.7 Inherited disorders

Some disorders are inherited. These disorders are caused by the inheritance of certain alleles.

4.6.1.8 Sex determination

Ordinary human body cells contain 23 pairs of chromosomes.

22 pairs control characteristics only, but one of the pairs carries the genes that determine sex.

- In females the sex chromosomes are the same (XX).
- In males the chromosomes are different (XY).

Students should be able to carry out a genetic cross to show sex inheritance.

Students should understand and use direct proportion and simple ratios in genetic crosses.

4.6.2.1 Variation

Students should be able to describe simply how the genome and its interaction with the environment influence the development of the phenotype of an organism.

Differences in the characteristics of individuals in a population is called variation and may be due to differences in:

- the genes they have inherited (genetic causes)
- the conditions in which they have developed (environmental causes)
- a combination of genes and the environment.

Students should be able to:

- state that there is usually extensive genetic variation within a population of a species
- recall that all variants arise from mutations and that: most have no effect on the phenotype; some influence phenotype; very few determine phenotype.

Mutations occur continuously. Very rarely a mutation will lead to a new phenotype. If the new phenotype is suited to an environmental change it can lead to a relatively rapid change in the species.

4.6.2.2 Evolution

Students should be able to explain how evolution occurs through natural selection of variants that give rise to phenotypes best suited to their environment.

4.6.3.1 Theory of evolution (biology only)

- Individual organisms within a particular species show a wide range of variation for a characteristic.
- Individuals with characteristics most suited to the environment are more likely to survive to breed successfully.
- The characteristics that have enabled these individuals to survive are then passed on to the next generation.

4.7.1.4 Adaptations

Students should be able to explain how organisms are adapted to live in their natural environment, given appropriate information.

Organisms have features (adaptations) that enable them to survive in the conditions in which they normally live. These adaptations may be structural, behavioural or functional.