4.5 Homeostasis and response

Cells in the body can only survive within narrow physical and chemical limits. They require a constant temperature and pH as well as a constant supply of dissolved food and water. In order to do this the body requires control systems that constantly monitor and adjust the composition of the blood and tissues. These control systems include receptors which sense changes and effectors that bring about changes. In this section we will explore the structure and function of the nervous system and how it can bring about fast responses. We will also explore the hormonal system which usually brings about much slower changes. Hormonal coordination is particularly important in reproduction since it controls the menstrual cycle. An understanding of the role of hormones in reproduction has allowed scientists to develop not only contraceptive drugs but also drugs which can increase fertility.

4.5.2 The human nervous system

4.5.2.4 Control of body temperature (biology only)

|  |  |
| --- | --- |
| **Content** | **Key opportunities for skills** |
|  | **development** |
|  |  |
| Body temperature is monitored and controlled by the |  |
| thermoregulatory centre in the brain. The thermoregulatory centre |  |
| contains receptors sensitive to the temperature of the blood. The |  |
| skin contains temperature receptors and sends nervous impulses to |  |
| the thermoregulatory centre. |  |
| If the body temperature is too high, blood vessels dilate |  |
| (vasodilation) and sweat is produced from the sweat glands. Both |  |
| these mechanisms cause a transfer of energy from the skin to the |  |
| environment. |  |
| If the body temperature is too low, blood vessels constrict |  |
| (vasoconstriction), sweating stops and skeletal muscles contract |  |
| (shiver). |  |
|  |  |
| (HT only) Students should be able to explain how these |  |
| mechanisms lower or raise body temperature in a given context. |  |

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4.5.3 Hormonal coordination in humans

4.5.3.1 Human endocrine system

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| --- | --- | --- |
| **Content** | | **Key opportunities for skills** |
|  |  | **development** |
|  | |  |
| Students should be able to describe the principles of hormonal | |  |
| coordination and control by the human endocrine system. | |  |
| The endocrine system is composed of glands which secrete | |  |
| chemicals called hormones directly into the bloodstream. The blood | |  |
| carries the hormone to a target organ where it produces an effect. | |  |
| Compared to the nervous system the effects are slower but act for | |  |
| longer. | |  |
| The pituitary gland in the brain is a ‘master gland’ which secretes | |  |
| several hormones into the blood in response to body conditions. | |  |
| These hormones in turn act on other glands to stimulate other | |  |
| hormones to be released to bring about effects. | |  |
| Students should be able to identify the position of the following on a | |  |
| diagram of the human body: | |  |
| • | pituitary gland |  |
| • | pancreas |  |
| • | thyroid |  |
| • | adrenal gland |  |
| • | ovary |  |
| • | testes. |  |
|  |  |  |

4.5.3.2 Control of blood glucose concentration

|  |  |  |
| --- | --- | --- |
| **Content** | **Key opportunities for skills** |  |
|  | **development** |  |
|  |  |  |
| Blood glucose concentration is monitored and controlled by the | WS 1.3 |  |
| pancreas. | Evaluate information around |  |
|  |  |
| If the blood glucose concentration is too high, the pancreas | the relationship between |  |
| produces the hormone insulin that causes glucose to move from the | obesity and diabetes, and |  |
| blood into the cells. In liver and muscle cells excess glucose is | make recommendations |  |
| converted to glycogen for storage. | taking into account social |  |
| Students should be able to explain how insulin controls blood | and ethical issues. |  |
|  |  |
| glucose (sugar) levels in the body. |  |  |
| Type 1 diabetes is a disorder in which the pancreas fails to produce |  |  |
| sufficient insulin. It is characterised by uncontrolled high blood |  |  |
| glucose levels and is normally treated with insulin injections. |  |  |
| In Type 2 diabetes the body cells no longer respond to insulin |  |  |
| produced by the pancreas. A carbohydrate controlled diet and an |  |  |
| exercise regime are common treatments. Obesity is a risk factor for |  |  |
| Type 2 diabetes. |  |  |
| Students should be able to compare Type 1 and Type 2 diabetes |  |  |
| and explain how they can be treated. |  |  |
|  |  |  |
| Students should be able to extract information and interpret data | MS 2c |  |
| from graphs that show the effect of insulin in blood glucose levels in |  |  |
| both people with diabetes and people without diabetes. |  |  |
|  |  |  |
| (HT only) If the blood glucose concentration is too low, the pancreas |  |  |
| produces the hormone glucagon that causes glycogen to be |  |  |
| converted into glucose and released into the blood. |  |  |
| (HT only) Students should be able to explain how glucagon |  |  |
| interacts with insulin in a negative feedback cycle to control blood |  |  |
| glucose (sugar) levels in the body. |  |  |
|  |  |  |

4.5.3.3 Maintaining water and nitrogen balance in the body (biology only)

|  |  |
| --- | --- |
| **Content** | **Key opportunities for skills** |
|  | **development** |
|  |  |
| Students should be able to explain the effect on cells of osmotic |  |
| changes in body fluids. |  |
| Water leaves the body via the lungs during exhalation. |  |
| Water, ions and urea are lost from the skin in sweat. |  |
| There is no control over water, ion or urea loss by the lungs or skin. |  |
| Excess water, ions and urea are removed via the kidneys in the |  |
| urine. |  |
| If body cells lose or gain too much water by osmosis they do not |  |
| function efficiently. |  |
|  |  |
| (HT only) The digestion of proteins from the diet results in excess |  |
| amino acids which need to be excreted safely. In the liver these |  |
| amino acids are deaminated to form ammonia. Ammonia is toxic |  |
| and so it is immediately converted to urea for safe excretion. |  |
|  |  |
| Students should be able to describe the function of kidneys in |  |
| maintaining the water balance of the body. |  |
| The kidneys produce urine by filtration of the blood and selective |  |
| reabsorption of useful substances such as glucose, some ions and |  |
| water. |  |
| Knowledge of other parts of the urinary system, the structure of the |  |
| kidney and the structure of a nephron is not required. |  |
|  |  |
| Students should be able to translate tables and bar charts of | MS 4a |
| glucose, ions and urea before and after filtration. |  |
|  |  |
| (HT only) Students should be able to describe the effect of ADH on |  |
| the permeability of the kidney tubules. |  |
| (HT only) The water level in the body is controlled by the hormone |  |
| ADH which acts on the kidney tubules. ADH is released by the |  |
| pituitary gland when the blood is too concentrated and it causes |  |
| more water to be reabsorbed back into the blood from the kidney |  |
| tubules. This is controlled by negative feedback. |  |
|  |  |





4.5.4 Plant hormones (biology only)

4.5.4.1 Control and coordination

|  |  |
| --- | --- |
| **Content** | **Key opportunities for skills** |
|  | **development** |
|  |  |
| Plants produce hormones to coordinate and control growth and |  |
| responses to light (phototropism) and gravity (gravitropism or |  |
| geotropism). Unequal distributions of auxin cause unequal growth |  |
| rates in plant roots and shoots. |  |
|  |  |
| (HT only) Gibberellins are important in initiating seed germination. |  |
| (HT only) Ethene controls cell division and ripening of fruits. |  |
| (HT only) The mechanisms of how gibberellins and ethene work are |  |
| not required. |  |
|  |  |

**Required practical activity 8:** investigate the effect of light or gravity on the growth of newlygerminated seedlings.

Record results as both length measurements and as careful, labelled biological drawings to show the effects.

4.6 Inheritance, variation and evolution

In this section we will discover how the number of chromosomes are halved during meiosis and then combined with new genes from the sexual partner to produce unique offspring. Gene mutations occur continuously and on rare occasions can affect the functioning of the animal or plant. These mutations may be damaging and lead to a number of genetic disorders or death. Very rarely a new mutation can be beneficial and consequently, lead to increased fitness in the individual. Variation generated by mutations and sexual reproduction is the basis for natural selection; this is how species evolve. An understanding of these processes has allowed scientists to intervene through selective breeding to produce livestock with favoured characteristics. Once new varieties of plants or animals have been produced it is possible to clone individuals to produce larger numbers of identical individuals all carrying the favourable characteristic. Scientists have now discovered how to take genes from one species and introduce them in to the genome of another by a process called genetic engineering. In spite of the huge potential benefits that this technology can offer, genetic modification still remains highly controversial.

4.6.1 Reproduction

4.6.1.1 Sexual and asexual reproduction

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Content** |  | **Key opportunities for skills** | | | |  |
|  |  | **development** | | | |  |
|  |  |  |  |  |  |  |
| Students should understand that meiosis leads to non-identical cells |  | There are links with this | | | |  |
| being formed while mitosis leads to identical cells being formed. |  | content to [Mitosis and the](#page22) | | | |  |
|  |  |  |  |  |  |  |
| Sexual reproduction involves the joining (fusion) of male and female |  | [cell cycle](#page22) | (page 22). | | |  |
|  |  |  |
| gametes: |  |  |  |  |  |  |
| • sperm and egg cells in animals |  |  |  |  |  |  |
| • pollen and egg cells in flowering plants. |  |  |  |  |  |  |
| In sexual reproduction there is mixing of genetic information which |  |  |  |  |  |  |
| leads to variety in the offspring. The formation of gametes involves |  |  |  |  |  |  |
| meiosis. |  |  |  |  |  |  |
| Asexual reproduction involves only one parent and no fusion of |  |  |  |  |  |  |
| gametes. There is no mixing of genetic information. This leads to |  |  |  |  |  |  |
| genetically identical offspring (clones). Only mitosis is involved. |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

4.6.1.2 Meiosis

|  |  |  |
| --- | --- | --- |
| **Content** | **Key opportunities for skills** |  |
|  | **development** |  |
|  |  |  |
| Students should be able to explain how meiosis halves the number | WS 1.2 |  |
| of chromosomes in gametes and fertilisation restores the full | Modelling behaviour of |  |
| number of chromosomes. |  |
| chromosomes during |  |
|  |  |
| Cells in reproductive organs divide by meiosis to form gametes. | meiosis. |  |
| 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

|  |  |
| --- | --- |
| **Content** | **Key opportunities for skills** |
|  | **development** |
|  |  |
| 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 | WS 1.1, 1.4 |
| understanding the human genome. |  |
| This is limited to the: |  |
| • search for genes linked to different types of disease |  |
| • understanding and treatment of inherited disorders |  |
| • use in tracing human migration patterns from the past. |  |
|  |  |

4.6.1.5 DNA structure (biology only)

|  |  |  |
| --- | --- | --- |
| **Content** | **Key opportunities for skills** |  |
|  | **development** |  |
|  |  |  |
| 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 | WS 1.2 |  |
| sections. Attached to each sugar is one of the four bases. | Interpret a diagram of DNA |  |
|  |  |
| The DNA polymer is made up of repeating nucleotide units. | structure but will not be |  |
|  | required to reproduce it. |  |
|  |  |  |

|  |  |  |
| --- | --- | --- |
| **Content** |  | **Key opportunities for skills** |
|  |  | **development** |
|  |  |  |

(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 are not expected to know or understand the |  |  |
| structure of mRNA, tRNA, or the detailed structure of amino acids |  |  |
| or proteins. |  |  |
| (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 | WS 1.2 |  |
| protein, or only alter it slightly so that its appearance or function is | Modelling insertions and |  |
| not changed. |  |
| deletions in chromososmes |  |
|  |  |
| (HT only) A few mutations code for an altered protein with a | to illustrate mutations. |  |
| 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



|  |  |  |
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| **Content** |  | **Key opportunities for skills** |
|  |  | **development** |
|  |  |  |

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 | | MS 2e |
| 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 | | MS 1c, 3a |
| to express the outcome of a genetic cross. | |  |
|  | |  |
| Students should be able to complete a Punnett square diagram and | | MS 2c, 4a |
| extract and interpret information from genetic crosses and family | |  |
| trees. | |  |
|  | |  |
| (HT only) Students should be able to construct a genetic cross by | | MS 2e, WS 1.2 |
| Punnett square diagram and use it to make predictions using the | |  |
| theory of probability. | |  |

4.6.1.7 Inherited disorders

|  |  |  |
| --- | --- | --- |
| **Content** | **Key opportunities for skills** |  |
|  | **development** |  |
|  |  |  |
| Some disorders are inherited. These disorders are caused by the | WS 1.3 |  |
| inheritance of certain alleles. | Appreciate that embryo |  |
|  |  |
| • Polydactyly (having extra fingers or toes) is caused by a | screening and gene therapy |  |
| dominant allele. | may alleviate suffering but |  |
| • Cystic fibrosis (a disorder of cell membranes) is caused by a | consider the ethical issues |  |
| recessive allele. | which arise. |  |
| Students should make informed judgements about the economic, |  |  |
| social and ethical issues concerning embryo screening, given |  |  |
| appropriate information. |  |  |
|  |  |  |
|  |  |

4.7.1 Adaptations, interdependence and competition

4.7.1.1 Communities

|  |  |  |
| --- | --- | --- |
| **Content** | **Key opportunities for skills** |  |
|  | **development** |  |
|  |  |  |
| Students should be able to describe: | WS 2.6 |  |
| • different levels of organisation in an ecosystem from individual | Recording first-hand |  |
| organisms to the whole ecosystem | observations of organisms. |  |
| • the importance of interdependence and competition in a |  |  |
| community. |  |  |
| Students should be able to, when provided with appropriate |  |  |
| information: |  |  |
| • suggest the factors for which organisms are competing in a |  |  |
| given habitat |  |  |
| • suggest how organisms are adapted to the conditions in which |  |  |
| they live. |  |  |
| An ecosystem is the interaction of a community of living organisms |  |  |
| (biotic) with the non-living (abiotic) parts of their environment. |  |  |
| To survive and reproduce, organisms require a supply of materials |  |  |
| from their surroundings and from the other living organisms there. |  |  |
| Plants in a community or habitat often compete with each other for |  |  |
| light and space, and for water and mineral ions from the soil. |  |  |
| Animals often compete with each other for food, mates and territory. |  |  |
| Within a community each species depends on other species for |  |  |
| food, shelter, pollination, seed dispersal etc. If one species is |  |  |
| removed it can affect the whole community. This is called |  |  |
| interdependence. A stable community is one where all the species |  |  |
| and environmental factors are in balance so that population sizes |  |  |
| remain fairly constant. |  |  |
|  |  |  |
| Students should be able to extract and interpret information from | MS 2c, 4a |  |
| charts, graphs and tables relating to the interaction of organisms | Extract and interpret |  |
| within a community. |  |

4.7.1.2 Abiotic factors

|  |  |  |  |
| --- | --- | --- | --- |
| **Content** | | **Key opportunities for skills** |  |
|  |  | **development** |  |
|  | |  |  |
| Students should be able to explain how a change in an abiotic | | WS 1.2 |  |
| factor would affect a given community given appropriate data or | |  |  |
| context. | |  |  |
| Abiotic (non-living) factors which can affect a community are: | |  |  |
| • | light intensity |  |  |
| • | temperature |  |  |
| • | moisture levels |  |  |
| • soil pH and mineral content | |  |  |
| • wind intensity and direction | |  |  |
| • carbon dioxide levels for plants | |  |  |
| • oxygen levels for aquatic animals. | |  |  |
|  | |  |  |
| Students should be able to extract and interpret information from | | MS 2c, 4a |  |
| charts, graphs and tables relating to the effect of abiotic factors on | | Extract and interpret |  |
| organisms within a community. | |  |
|  |  | information from charts, |  |
|  |  | graphs and tables. |  |
|  |  |  |  |

4.7.1.3 Biotic factors

|  |  |  |  |
| --- | --- | --- | --- |
| **Content** | | **Key opportunities for skills** |  |
|  |  | **development** |  |
|  | |  |  |
| Students should be able to explain how a change in a biotic factor | | WS 1.2 |  |
| might affect a given community given appropriate data or context. | |  |  |
| Biotic (living) factors which can affect a community are: | |  |  |
| • | availability of food |  |  |
| • | new predators arriving |  |  |
| • | new pathogens |  |  |
| • one species outcompeting another so the numbers are no longer | |  |  |
|  | sufficient to breed. |  |  |
|  | |  |  |
| Students should be able to extract and interpret information from | | MS 2c, 4a |  |
| charts, graphs and tables relating to the effect of biotic factors on | | Extract and interpret |  |
| organisms within a community. | |  |
|  |  | information from charts, |  |
|  |

4.7.2.1 Levels of organisation

|  |  |  |
| --- | --- | --- |
| **Content** | **Key opportunities for skills** |  |
|  | **development** |  |
|  |  |  |
| Students should understand that photosynthetic organisms are the |  |  |
| producers of biomass for life on Earth. |  |  |
| Feeding relationships within a community can be represented by |  |  |
| food chains. All food chains begin with a producer which |  |  |
| synthesises molecules. This is usually a green plant or alga which |  |  |
| makes glucose by photosynthesis. |  |  |
| A range of experimental methods using transects and quadrats are |  |  |
| used by ecologists to determine the distribution and abundance of |  |  |
| species in an ecosystem. |  |  |
|  |  |  |
| In relation to abundance of organisms students should be able to: | MS 2b, 2f, 4a, 4c |  |
| • understand the terms mean, mode and median |  |  |
| • calculate arithmetic means |  |  |
| • plot and draw appropriate graphs selecting appropriate scales |  |  |
| for the axes. |  |  |
|  |  |  |
| Producers are eaten by primary consumers, which in turn may be |  |  |
| eaten by secondary consumers and then tertiary consumers. |  |  |
|  |  |  |
| Consumers that kill and eat other animals are predators, and those | WS 1.2 |  |
| eaten are prey. In a stable community the numbers of predators and | Interpret graphs used to |  |
| prey rise and fall in cycles. | model predator-prey cycles. |  |
|  |  |
|  |  |  |
| Students should be able to interpret graphs used to model these | MS 4a |  |
| cycles. |  |  |
|  |  |  |

**Required practical activity 9:** measure the population size of a common species in a habitat. Usesampling techniques to investigate the effect of a factor on the distribution of this species

4.7.2.2 How materials are cycled

|  |  |  |
| --- | --- | --- |
| **Content** | **Key opportunities for skills** |  |
|  | **development** |  |
|  |  |  |
| Students should: | WS 1.2 |  |
| • recall that many different materials cycle through the abiotic and | Interpret and explain the |  |
| biotic components of an ecosystem | processes in diagrams of |  |
| • explain the importance of the carbon and water cycles to living | the carbon cycle, the water |  |
| organisms. | cycle. |  |
| All materials in the living world are recycled to provide the building | There are links with the |  |
| blocks for future organisms. | water cycle to GCSE |  |
| The carbon cycle returns carbon from organisms to the atmosphere | Chemistry The Earth's early |  |
| atmosphere. |  |
| as carbon dioxide to be used by plants in photosynthesis. | WS 1.2 |  |
| The water cycle provides fresh water for plants and animals on land |  |
| before draining into the seas. Water is continuously evaporated and |  |  |
| precipitated. |  |  |
| Students are not expected to study the nitrogen cycle. |  |  |
| Students should be able to explain the role of microorganisms in |  |  |
| cycling materials through an ecosystem by returning carbon to the |  |  |
| atmosphere as carbon dioxide and mineral ions to the soil. |  |  |
|  |  |  |

4.7.2.3 Decomposition (biology only)

|  |  |
| --- | --- |
| **Content** | **Key opportunities for skills** |
|  | **development** |
|  |  |
| Students should be able to explain how temperature, water and |  |
| availability of oxygen affect the rate of decay of biological material. |  |
|  |  |
| Students should be able to: | MS 1c, 4a, 4c |
| • calculate rate changes in the decay of biological material |  |
| • translate information between numerical and graphical form |  |
| • plot and draw appropriate graphs selecting appropriate scales |  |
| for the axes. |  |
|  |  |
| Gardeners and farmers try to provide optimum conditions for rapid |  |
| decay of waste biological material. The compost produced is used |  |
| as a natural fertiliser for growing garden plants or crops. |  |
| Anaerobic decay produces methane gas. Biogas generators can be |  |
| used to produce methane gas as a fuel. |  |

4.7.3.2 Waste management

|  |  |
| --- | --- |
| **Content** | **Key opportunities for skills** |
|  | **development** |
|  |  |
| Rapid growth in the human population and an increase in the | There are links with this |
| standard of living mean that increasingly more resources are used | content to GCSE Chemistry |
| and more waste is produced. Unless waste and chemical materials | 4.9.3.1 Atmospheric |
| are properly handled, more pollution will be caused. | pollutants from fuels. |
| Pollution can occur: |  |
| • in water, from sewage, fertiliser or toxic chemicals |  |
| • in air, from smoke and acidic gases |  |
| • on land, from landfill and from toxic chemicals. |  |
| Pollution kills plants and animals which can reduce biodiversity. |  |

4.7.3.3 Land use

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Content** |  | **Key opportunities for skills** | | | | |  |
|  |  | **development** | | | | |  |
|  |  |  |  |  |  |  |  |
| Humans reduce the amount of land available for other animals and |  |  |  |  |  |  |  |
| plants by building, quarrying, farming and dumping waste. |  |  |  |  |  |  |  |
|  |  |  | | | | |  |
| The destruction of peat bogs, and other areas of peat to produce |  | WS 1.4, 1.5 | | | | |  |
| garden compost, reduces the area of this habitat and thus the |  | Understand the conflict | | | | |  |
| variety of different plant, animal and microorganism species that live |  |  |
|  | between the need for cheap | | | | |  |
| there (biodiversity). |  | available compost to | | | | |  |
|  |  |  |
| The decay or burning of the peat releases carbon dioxide into the |  | increase food production | | | | |  |
| atmosphere. |  | and the need to conserve | | | | |  |
|  |  | peat bogs and peatlands as | | | | |  |
|  |  | habitats for biodiversity and | | | | |  |
|  |  | to reduce carbon dioxide | | | | |  |
|  |  | emissions. | | | | |  |
|  |  | There are links within this | | | | |  |
|  |  | section to [Global warming](#page77) | | | | |  |
|  |  | (page 77). |  | |  | |  |
|  |  | There are links within this | | | | |  |
|  |  | section to [Factors affecting](#page80) | | | | |  |
|  |  |  |  |  | |  |  |
|  |  | [food security](#page80) (page 80). | | | | |  |
|  |  |  |  |  |  |  |  |

4.7.3.5 Global warming

|  |  |  |
| --- | --- | --- |
| **Content** | **Key opportunities for skills** |  |
|  | **development** |  |
|  |  |  |
| Students should be able to describe some of the biological | WS 1.6 |  |
| consequences of global warming. | Understand that the |  |
|  |  |
| Levels of carbon dioxide and methane in the atmosphere are | scientific consensus about |  |
| increasing, and contribute to ‘global warming’. | global warming and climate |  |
|  | change is based on |  |
|  | systematic reviews of |  |
|  | thousands of peer reviewed |  |
|  | publications. |  |
|  | WS 1.3 |  |
|  | Explain why evidence is |  |
|  | uncertain or incomplete in a |  |
|  | complex context. |  |
|  |  |  |

4.7.4.3 Transfer of biomass



|  |  |  |
| --- | --- | --- |
| **Content** |  | **Key opportunities for skills** |
|  |  | **development** |
|  |  |  |

Students should be able to:

* describe pyramids of biomass
* explain how biomass is lost between the different trophic levels.

Producers are mostly plants and algae which transfer about 1% of the incident energy from light for photosynthesis.



|  |  |  |
| --- | --- | --- |
| Only approximately 10% of the biomass from each trophic level is | MS 1c |  |
| transferred to the level above it. | Calculate the efficiency of |  |
|  |  |
| Losses of biomass are due to: | biomass transfer between |  |
| • not all the ingested material is absorbed, some is egested as | trophic levels. |  |
|  |  |
| faeces |  |  |

* some absorbed material is lost as waste, such as carbon dioxide and water in respiration and water and urea in urine.

Large amounts of glucose are used in respiration.



|  |  |
| --- | --- |
| Students should be able to calculate the efficiency of biomass | MS 1c |
| transfers between trophic levels by percentages or fractions of |  |
| mass. |  |
| Students should be able to explain how this affects the number of |  |
| organisms at each trophic level. |  |



4.7.5 Food production (biology only)

4.7.5.1 Factors affecting food security



|  |  |  |  |
| --- | --- | --- | --- |
| **Content** |  | **Key opportunities for skills** |  |
|  |  | **development** |  |
|  |  |  |  |
| Students should be able to describe some of the biological factors |  | WS 1.4 |  |
| affecting levels of food security. |  | Interpret population and |  |
|  |  |  |
| Food security is having enough food to feed a population. |  | food production statistics to |  |
| Biological factors which are threatening food security include: |  | evaluate food security. |  |
|  |  |  |

* the increasing birth rate has threatened food security in some countries
* changing diets in developed countries means scarce food resources are transported around the world
* new pests and pathogens that affect farming
* environmental changes that affect food production, such as widespread famine occurring in some countries if rains fail
* the cost of agricultural inputs
* conflicts that have arisen in some parts of the world which affect the availability of water or food.

Sustainable methods must be found to feed all people on Earth.

4.7.5.2 Farming techniques

|  |  |  |
| --- | --- | --- |
| **Content** | **Key opportunities for skills** |  |
|  | **development** |  |
|  |  |  |
| The efficiency of food production can be improved by restricting | WS 1.3 |  |
| energy transfer from food animals to the environment. This can be | Understand that some |  |
| done by limiting their movement and by controlling the temperature |  |
| people have ethical |  |
| of their surroundings. |  |
| objections to some modern |  |
|  |  |
| Some animals are fed high protein foods to increase growth. | intensive farming methods. |  |
|  | WS 1.4 |  |
|  | Evaluate the advantages |  |
|  | and disadvantages of |  |
|  | modern farming techniques. |  |
|  |  |  |