AQA - GCSE Biology - 2016

Topic	Learning Objective	Nervous System Controls & Responds to Body Functions & Directs Behavior														Nervous System Structure & Function Are Determined By Both Genes & Environment Throughout Life														The Brain is the Foundation of the Mind						Research Leads to Essential Understanding for Therapies							
		1. Brain is the body's most complex organ.						2. Neurons communicate using electrical and chemical signals.								3. Genetically determined circuits are foundation of the nervous system.							4. Life experiences change the nervous system.							5. Intelligence arises as brain reasons, plans, solves problems.				6. The brain makes it possible to communicate knowledge through language.		7. Human brain endows us with a natural curiosity to understand how the world works.			8. Fundamental discoveries promote healthy living and treatment of disease.			
		a	b	c	d	e	f	a	b	c	d	e	f	g	a	b	c	d	e	f	a	b	c	d	e	f	g	a	b	c	d	a	b	a	b	c	a	b	c	d
4.1 Cell biology																																									
4.1.1 Cell structure																																									
4.1.1.1 Eukaryotes and prokaryotes																																									
4.1.1.2 Animal and plant cells	Students should be able to explain how the main sub-cellular structures, including the nucleus, cell membranes, mitochondria, chloroplasts in plant cells and plasmids in bacterial cells are related to their									•																															
4.1.1.3 Cell specialisation	Students should be able to, when provided with appropriate information, explain how the structure of different types of cell relate to their function in a tissue, an organ or organ system, or the whole organism.	•	•	•						•																															
	Cells may be specialised to carry out a particular function.	•													•							•					•													
4.1.1.4 Cell differentiation	As an organism develops, cells differentiate to form different types of cells.	•													•							•					•													
	• Most types of animal cell differentiate at an early																																								
4.1.1.5 Microscopy	Students should be able to: • understand how microscopy techniques have developed over time • explain how electron microscopy has increased understanding of sub-cellular structures.									•																															
4.1.1.6 Culturing microorganisms (biology only)																																									
4.1.2 Cell division																																									
4.1.2.1 Chromosomes																																									
4.1.2.2 Mitosis and the cell cycle																																									
4.1.2.3 Stem cells	A stem cell is an undifferentiated cell of an organism which is capable of giving rise to many more cells of the same type, and from which certain other cells can arise from differentiation	•					•								•							•					•							•				•	•	•	•
	Students should be able to describe the function of stem cells in embryos, in adult animals and in the meristems.	•					•								•							•					•							•				•	•	•	•
	Stem cells from human embryos can be cloned and made to differentiate into most different types of human cells.	•					•								•							•					•							•				•	•	•	•
	Treatment with stem cells may be able to help conditions such as diabetes and paralysis.	•					•								•							•					•							•				•	•	•	•
	In therapeutic cloning an embryo is produced with the same genes as the patient. Stem cells from the embryo are not rejected by the patient's body so they may be used for medical treatment.	•					•								•							•					•							•				•	•	•	•
	The use of stem cells has potential risks such as transfer of viral infection, and some people have ethical or religious objections.	•					•								•							•					•											•	•	•	•
4.1.3 Transport in cells																																									
4.1.3.1 Diffusion																																									
4.1.3.2 Osmosis																																									
4.1.3.3 Active transport																																									
4.2 Organisation																																									
4.2.1 Principles of organisation	Organs are aggregations of tissues performing specific functions.	•	•	•																																					
4.2.2 Animal tissues, organs and organ systems																																									
4.2.2.1 The human digestive system																																									
4.2.2.2 The heart and blood vessels																																									
4.2.2.3 Blood																																									
4.2.2.4 Coronary heart disease: a non-communicable disease																																									
4.2.2.5 Health issues	Students should be able to describe the relationship between health and disease and the interactions between different types of disease.				•		•																																		
	Diseases, both communicable and non-communicable, are major causes of ill health. Other factors including diet, stress and life situations may have a profound effect on both physical and mental health.				•		•																																		
	Different types of disease may interact. • Severe physical ill health can lead to depression and other mental illness.				•		•																																		
4.2.2.6 The effect of lifestyle on some non-communicable diseases	Students should be able to: • discuss the human and financial cost of these non-communicable diseases to an individual, a local community, a nation or globally • explain the effect of lifestyle factors including diet, alcohol and smoking on the incidence of non-communicable diseases at local, national and global				•		•																																		
	Risk factors are linked to an increased rate of a disease. They can be: • aspects of a person's lifestyle • substances in the person's body or environment				•		•																																		
	A causal mechanism has been proven for some risk factors, but not in others. • The effect of alcohol on the liver and brain function.				•		•																																		
4.2.2.7 Cancer																																									
4.2.3 Plant tissues, organs and systems																																									
4.2.3.1 Plant tissues																																									
4.2.3.2 Plant organ system																																									
4.3 Infection and response																																									
4.3.1 Communicable diseases																																									
4.3.1.1 Communicable (infectious) diseases																																									
4.3.1.2 Viral diseases																																									
4.3.1.3 Bacterial diseases																																									
4.3.1.4 Fungal diseases																																									
4.3.1.5 Protist diseases																																									
4.3.1.6 Human defence systems																																									
4.3.1.7 Vaccination																																									
4.3.1.8 Antibiotics and painkillers																																									
4.3.1.9 Discovery and development of drugs	Students should be able to describe the process of discovery and development of potential new medicines, including preclinical and clinical testing.						•																																•	•	•
	New medical drugs have to be tested and trialled before being used to check that they are safe and effective.						•																																•	•	•
	New drugs are extensively tested for toxicity, efficacy and dose.						•																																•	•	•
	Preclinical testing is done in a laboratory using cells, tissues and live animals.						•																																•	•	•
	Clinical trials use healthy volunteers and patients. • Very low doses of the drug are given at the start of the clinical trial. • If the drug is found to be safe, further clinical trials are carried out to find the optimum dose for the drug. • In double-blind trials, some patients are given a						•																																•	•	•
4.3.2 Monoclonal antibodies (biology only) (HT only)																																									
4.3.2.1 Producing monoclonal antibodies																																									
4.3.2.2 Uses of monoclonal antibodies																																									
4.3.3 Plant disease (biology only)																																									
4.3.3.1 Detection and identification of plant diseases																																									
4.3.3.2 Plant defence responses																																									
4.4 Bioenergetics																																									
4.4.1 Photosynthesis																																									
4.4.1.1 Photosynthetic reaction																																									
4.4.1.2 Rate of photosynthesis																																									
4.4.1.3 Uses of glucose from photosynthesis																																									
4.4.2 Respiration																																									
4.4.2.1 Aerobic and anaerobic respiration																																									
4.4.2.2 Response to exercise																																									
4.4.2.3 Metabolism																																									
4.5 Homeostasis and response																																									
4.5.1 Homeostasis	These automatic control systems may involve nervous responses or chemical responses.				•																																				
	All control systems include: • cells called receptors, which detect stimuli (changes in the environment) • coordination centres (such as the brain, spinal cord and pancreas) that receive and process information from receptors • effectors, muscles or glands, which bring about responses which restore optimum levels				•																																				
4.5.2 The human nervous system																																									
4.5.2.1 Structure and function	Students should be able to explain how the structure of the nervous system is adapted to its functions.		•	•				•	•	•			•	•	•	•	•	•		•			•	•																	
	The nervous system enables humans to react to their surroundings and to coordinate their behaviour.		•	•				•	•	•			•	•	•	•	•	•		•			•	•																	
	Information from receptors passes along cells (neurones) as electrical impulses to the central nervous system (CNS). The CNS is the brain and spinal cord. The CNS coordinates the response of effectors which may be muscles contracting or glands secreting hormones.		•	•				•	•	•			•	•	•	•	•	•		•			•	•																	
	Students should be able to explain how the various structures in a reflex arc – including the sensory neurone, synapse, relay neurone and motor neurone – relate to their function. Students should understand why reflex actions are important.		•					•	•	•	•				•	•		•																							
	Reflex actions are automatic and rapid; they do not involve the conscious part of the brain.		•					•	•	•	•				•	•		•																							
4.5.2.2 The brain (biology only)	The brain controls complex behaviour. It is made of billions of interconnected neurones and has different regions that carry out different functions.	•	•	•				•	•	•			•		•		•		•				•				•			•										
	Students should be able to identify the cerebral cortex, cerebellum and medulla on a diagram of the brain, and describe their functions.	•	•	•				•	•	•			•		•		•		•				•				•			•										
	(HT only) Students should be able to explain some of the difficulties of investigating brain function and treating brain damage and disease.	•	•											•				•	•																	•			•	•	
	(HT only) Neuroscientists have been able to map the regions of the brain to particular functions by studying patients with brain damage, electrically stimulating different parts of the brain and using MRI scanning techniques. The complexity and delicacy of the brain makes investigating and treating brain disorders very	•	•											•				•	•																	•			•	•	
4.5.2.3 The eye (biology only)	Students should be able to relate the structures of the eye to their functions. This includes: • accommodation to focus on near or distant objects • adaptations in dim light		•					•							•																										
	The eye is a sense organ containing receptors sensitive to light intensity and colour.		•					•							•																										
	Students should be able to identify the following structures on a diagram of the eye and explain how their structure is related to their function: • retina • optic nerve • sclera • cornea • iris • ciliary muscles • suspensory ligaments		•					•							•																										
	Two common defects of the eyes are myopia (short sightedness) and hyperopia (long sightedness) in which rays of light do not focus on the retina. • Generally these defects are treated with spectacle lenses which refract the light rays so that they do focus on the retina. • New technologies now include hard and soft contact lenses, laser surgery to change the shape of the cornea and, sometimes, lens implants.						•																																		
4.5.2.4 Control of body temperature (biology only)	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						•								•																										
	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).						•								•																										
4.5.3 Hormonal coordination in humans																																									
4.5.3.1 Human endocrine system	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	Students should be able to explain how insulin controls blood glucose (sugar) levels in the body.				•																																			
	(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)	(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.				•																																			
4.5.3.4 Hormones in human reproduction																																									
4.5.3.5 Contraception																																									
4.5.3.6 The use of hormones to treat infertility (HT only)																																									
4.5.3.7 Negative feedback (HT only)	Students should be able to explain the roles of thyroxine and adrenaline in the body.				•																																			
	Adrenaline is produced by the adrenal glands in times of fear or stress. It increases the heart rate and boosts the delivery of oxygen and glucose to the brain and muscles, preparing the body for 'flight or fight'.				•																																			
	Thyroxine from the thyroid gland stimulates the basal metabolic rate. It plays an important role in growth and development.				•																																			
	Thyroxine levels are controlled by negative feedback.				•																																			
4.5.4 Plant hormones (biology only)																																									
4.5.4.1 Control and coordination																																									
4.5.4.2 Use of plant hormones (HT only)																																									
4.6 Inheritance, variation and evolution																																									
4.6.1 Reproduction																																									
4.6.1.1 Sexual and asexual reproduction																																									
4.6.1.2 Meiosis																																									
4.6.1.3 Advantages and disadvantages of sexual and asexual reproduction (biology only)																																									
4.6.1.4 DNA and the genome																																									
4.6.1.5 DNA structure (biology only)																																									
4.6.1.6 Genetic inheritance																																									
4.6.1.7 Inherited disorders																																									
4.6.1.8 Sex determination																																									
4.6.2 Variation and evolution																																									
4.6.2.1 Variation																																									
4.6.2.2 Evolution																																									
4.6.2.3 Selective breeding																																									
4.6.2.4 Genetic engineering	Students should be able to explain the potential benefits and risks of genetic engineering in agriculture and in medicine and that some people have objections.						•								•							•													•			•	•	•	•
	Modern medical research is exploring the possibility of genetic modification to overcome some inherited						•								•							•													•			•	•	•	•
4.6.2.5 Cloning (biology only)																																									
4.6.3 The development of understanding of genetics and evolution																																									
4.6.3.1 Theory of evolution (biology only)																																									
4.6.3.2 Speciation (biology only)																																									
4.6.3.3 The understanding of genetics (biology only)																																									
4.6.3.4 Evidence for evolution																																									
4.6.3.5 Fossils																																									
4.6.3.6 Extinction																																									
4.6.3.7 Resistant bacteria																																									
4.6.4 Classification of living																																									
4.7 Ecology																																									
4.7.1 Adaptations, interdependence and competition																																									
4.7.1.1 Communities																																									
4.7.1.2 Abiotic factors																																									
4.7.1.3 Biotic factors																																									
4.7.1.4 Adaptations																																									
4.7.2 Organisation of an ecosystem																																									
4.7.2.1 Levels of organisation																																									
4.7.2.2 How materials are cycled																																									
4.7.2.3 Decomposition (biology only)																																									
4.7.2.4 Impact of environmental change (biology only) (HT only)																																									
4.7.3 Biodiversity and the effect of human interaction on ecosystems																																									
4.7.3.1 Biodiversity																																									
4.7.3.2 Waste management																																									
4.7.3.3 Land use																																									
4.7.3.4 Deforestation																																									
4.7.3.5 Global warming																																									
4.7.3.6 Maintaining biodiversity																																									
4.7.4 Trophic levels in an ecosystem (biology only)																																									
4.7.4.1 Trophic levels																																									
4.7.4.2 Pyramids of biomass																																									
4.7.4.3 Transfer of biomass																																									
4.7.5 Food production (biology only)																																									
4.7.5.1 Factors affecting food																																									
4.7.5.2 Farming techniques																																									
4.7.5.3 Sustainable fisheries																																									
4.7.5.4 Role of biotechnology																																									

KEY			Description
Nervous System Controls and Responds to Body Functions and Directs Behavior	1. The brain is the body's most complex organ.	a	There are a hundred billion neurons in the human brain, all of which are in use.
		b	Each neuron communicates with many other neurons to form circuits and share information.
		c	Proper nervous system function involves coordinated action of neurons in many brain regions.
		d	The nervous system influences and is influenced by all other body systems (e.g., cardiovascular, endocrine, gastrointestinal and immune systems).
		e	Humans have a complex nervous system that evolved from a simpler one.
		f	This complex organ can malfunction in many ways, leading to disorders that have an enormous social and economic
	2. Neurons communicate using electrical and chemical signals.	a	Sensory stimuli are converted to electrical signals.
		b	Action potentials are electrical signals carried along neurons.
		c	Synapses are chemical or electrical junctions that allow electrical signals to pass from neurons to other cells.
		d	Electrical signals in muscles cause contraction and movement.
		e	Changes in the amount of activity at a synapses can enhance or reduce its function.
		f	Communication between neurons is strengthened or weakened by an individual's activities, such as exercise, stress, and drug use.
		g	All perceptions, thoughts, and behaviors result from combinations of signals among neurons.
Nervous System Structure and Function are Determined by Both Genes and Environment Throughout Life	3. Genetically determined circuits are foundation of the nervous system.	a	Neuronal circuits are formed by genetic programs during embryonic development and modified through interactions with the internal and external environment.
		b	Sensory circuits (sight, touch, hearing, smell, taste) bring information to the nervous system, whereas motor circuits send information to muscles and glands.
		c	The simplest circuit is a reflex, in which sensory stimulus directly triggers an immediate motor response.
		d	Complex responses occur when the brain integrates information from many brain circuits to generate a response.
		e	Simple and complex interactions among neurons take place on time scales ranging from milliseconds to months.
		f	The brain is organized to recognize sensations, initiate behaviors, and store and access memories that can last a lifetime.
	4. Life experiences change the nervous system.	a	Differences in genes and environments make the brain of each animal unique.
		b	Most neurons are generated early in development and survive for life.
		c	Some injuries harm nerve cells, but the brain often recovers from stress, damage, or disease.
		d	Continuously challenging the brain with physical and mental activity helps maintain its structure and function - "use it or lose it."
		e	Peripheral neurons have greater ability to regrow after injury than neurons in the brain and spinal cord.
		f	Neuronal death is a natural part of development and aging.
		g	Some neurons continue to be generated throughout life and their production is regulated by hormones and experience.
The Brain is the Foundation of the Mind	5. Intelligence arises as brain reasons, plans, and solves problems.	a	The brain makes sense of the world by using all available information, including senses, emotions, instincts, and remembered experiences.
		b	Emotions are based on value judgments made by our brains and are manifested by feelings as basic as love and anger and as complex as empathy and hate.
		c	The brain learns from experiences and makes predictions about best actions in response to present and future challenges.
		d	Consciousness depends on normal activity of the brain.
	6. The brain makes it possible to communicate knowledge through language.	a	Languages are acquired early in development and facilitate information exchange and creative thought.
		b	Communication can create and solve many of the most pressing problems humankind faces.
Research Leads to Essential Understanding for Therapies	7. The human brain endows us with a natural curiosity to understand how the world works.	a	The nervous system can be studied at many levels, from complex behaviors such as speech or learning, to the interactions among individual molecules.
		b	Research can ultimately inform us about mind, intelligence, imagination, and consciousness.
		c	Curiosity leads us to unexpected but surprising discoveries that can benefit humanity.
	8. Fundamental discoveries promote healthy living and treatment of disease.	a	Experiments on animals play a central role in providing insights about the human brain and in helping to make healthy lifestyle choices, prevent disease, and find cures for disorders.
		b	Research on humans is an essential final step before new treatments are introduced to prevent or cure disorders.
		c	Neuroscience research has formed the basis for significant progress in treating a large number of disorders.
		d	Finding cures for disorders of the nervous system is a social imperative.