AQA - A-Level Biology - 2015

Topic	Learning Objective	1. Brain is the body's most complex organ. a	b	c	d	e	f	2. Neurons communicate using electrical and chemical signals. a	b	c	d	e	f	g	3. Genetically determined circuits are foundation of the nervous system. a	b	c	d	e	f	4. Life experiences change the nervous system. a	b	c	d	e	f	g	5. Intelligence arises as brain reasons, plans, solves problems. a	b	c	d	6. The brain makes it possible to communicate knowledge through language. a	b	7. Human brain endows us with a natural curiosity to understand how the world works. a	b	c	8. Fundamental discoveries promote healthy living and treatment of disease. a	b	c	d
3.1 Biological molecules																																										
3.1.1 Monomers and polymers																																										
3.1.2 Carbohydrates																																										
3.1.3 Lipids																																										
3.1.4 Proteins																																										
3.1.4.1 General properties of																																										
3.1.4.2 Many proteins are enzymes																																										
3.1.5 Nucleic acids are important information-carrying molecules																																										
3.1.5.1 Structure of DNA and RNA																																										
3.1.5.2 DNA replication																																										
3.1.6 ATP																																										
3.1.7 Water																																										
3.1.8 Inorganic ions																																										
3.2 Cells																																										
3.2.1 Cell structure	The structure of eukaryotic cells, restricted to the structure and function of: • cell-surface membrane • nucleus (containing chromosomes, consisting of protein-bound, linear DNA, and one or more nucleoli) • mitochondria • chloroplasts (in plants and algae) • Golgi apparatus and Golgi vesicles • lysosomes (a type of Golgi vesicle that releases lysozymes) • ribosomes • rough endoplasmic reticulum and smooth endoplasmic reticulum In complex multicellular organisms, eukaryotic cells become specialised for specific functions. Specialised cells are organised into tissues, tissues into organs and organs		•							•																																	
3.2.1.1 Structure of eukaryotic cells																																										
3.2.1.2 Structure of prokaryotic cells and of viruses																																										
3.2.1.3 Methods of studying cells	The principles and limitations of optical microscopes, transmission electron microscopes and scanning electron microscopes.		•							•																														•			
3.2.2 All cells arise from other cells																																										
3.2.3 Transport across cell membranes																																										
3.2.4 Cell recognition and the immune system																																										
3.3 Organisms exchange substances with their environment																																										
3.3.1 Surface area to volume ratio																																										
3.3.2 Gas exchange																																										
3.3.3 Digestion and absorption																																										
3.3.4 Mass transport																																										
3.3.4.1 Mass transport in animals																																										
3.3.4.2 Mass transport in plants																																										
3.4 Genetic information, variation and relationships between organisms																																										
3.4.1 DNA, genes and chromosomes																																										
3.4.2 DNA and protein synthesis																																										
3.4.3 Genetic diversity can arise as a result of mutation or during meiosis																																										
3.4.4 Genetic diversity and adaptation	Natural selection results in species that are better adapted to their environment. These adaptations may be anatomical, physiological or behavioural.					•									•							•																				
3.4.5 Species and taxonomy																																										
3.4.6 Biodiversity within a																																										
3.4.7 Investigating diversity																																										
3.5 Energy transfers in and between organisms (A-level only)																																										
3.5.1 Photosynthesis (A-level only)																																										
3.5.2 Respiration (A-level only)																																										
3.5.3 Energy and ecosystems (A-level only)																																										
3.5.4 Nutrient cycles (A-level only)																																										
3.6 Organisms respond to changes in their internal and external environments (A-level only)																																										
3.6.1 Stimuli, both internal and external, are detected and lead to a response (A-level only)																																										
3.6.1.1 Survival and response (A-level only)	Organisms increase their chance of survival by responding to changes in their environment.							•	•	•	•			•	•	•	•	•	•	•							•	•														
	The protective effect of a simple reflex, exemplified by a threeneurone simple reflex. Details of spinal cord and dorsal and ventral roots are not required.		•					•	•	•	•					•	•		•																							
3.6.1.2 Receptors (A-level only)	The Pacinian corpuscle should be used as an example of a receptor to illustrate that: • receptors respond only to specific stimuli • stimulation of a receptor leads to the establishment of a generator potential.		•					•	•	•						•	•		•																							
	The basic structure of a Pacinian corpuscle.		•					•	•	•						•	•		•																							
	Deformation of stretch-mediated sodium ion channels in a Pacinian corpuscle leads to the establishment of a generator potential.		•					•	•	•						•	•		•																							
	The human retina in sufficient detail to show how differences in sensitivity to light, sensitivity to colour and visual acuity are explained by differences in the optical pigments of rods and cones and the connections rods and cones make in the optic nerve.		•					•								•																										
3.6.1.3 Control of heart rate (A-level only)	Myogenic stimulation of the heart and transmission of a subsequent wave of electrical activity. The roles of the sinoatrial node (SAN), atrioventricular node (AVN) and Purkyne tissue in the bundle of His.		•	•	•				•	•	•																														
	The roles and locations of chemoreceptors and pressure receptors and the roles of the autonomic nervous system and effectors in controlling heart rate.		•	•	•				•	•	•																														
3.6.2 Nervous coordination (A-level only)																																										
3.6.2.1 Nerve impulses (A-level	The structure of a myelinated motor neurone.		•					•	•	•	•					•	•		•																							
	The establishment of a resting potential in terms of differential membrane permeability, electrochemical gradients and the movement of sodium ions and potassium ions.		•					•	•	•	•					•	•		•																							
	Changes in membrane permeability lead to depolarisation and the generation of an action potential. The all-or-nothing principle.		•					•	•	•	•					•	•		•																							
	The passage of an action potential along non-myelinated and myelinated axons, resulting in nerve impulses.		•					•	•	•	•					•	•		•																							
	The nature and importance of the refractory period in producing discrete impulses and in limiting the frequency of impulse transmission.		•					•	•	•	•					•	•		•																							
	Factors affecting the speed of conductance: myelination and saltatory conduction; axon diameter; temperature.		•					•	•	•	•					•	•		•																							
3.6.2.2 Synaptic transmission (A-level only)	The detailed structure of a synapse and of a neuromuscular junction.		•							•		•	•							•			•					•										•			
	The sequence of events involved in transmission across a cholinergic synapse in sufficient detail to explain: • unidirectionality • temporal and spatial summation • inhibition by inhibitory synapses.		•							•		•	•							•			•					•										•			
	A comparison of transmission across a cholinergic synapse and across a neuromuscular junction.		•							•		•	•							•			•					•										•			
	Students should be able to use information provided to predict and explain the effects of specific drugs on a		•							•		•	•							•			•					•										•			
3.6.3 Skeletal muscles are stimulated to contract by nerves and act as effectors (A-level only)	The roles of actin, myosin, calcium ions and ATP in myofibril contraction.										•					•																										
	The structure, location and general properties of slow and fast skeletal muscle fibres.										•					•																										
3.6.4 Homeostasis is the maintenance of a stable internal environment (A-level only)																																									
3.6.4.1 Principles of homeostasis and negative feedback (A-level only)	Homeostasis in mammals involves physiological control systems that maintain the internal environment within restricted limits.		•	•	•				•	•	•					•																										
	Negative feedback restores systems to their original level.		•	•	•				•	•	•					•																										
	The possession of separate mechanisms involving negative feedback controls departures in different directions from the original state, giving a greater degree		•	•	•				•	•	•					•																										
3.6.4.2 Control of blood glucose concentration (A-level only)	The action of insulin by: • attaching to receptors on the surfaces of target cells • controlling the uptake of glucose by regulating the inclusion of channel proteins in the surface membranes of target cells • activating enzymes involved in the conversion of glucose to glycogen		•	•	•				•	•	•																														
	The action of glucagon by: • attaching to receptors on the surfaces of target cells • activating enzymes involved in the conversion of glycogen to glucose • activating enzymes involved in the conversion of glycerol and amino acids into glucose.		•	•	•				•	•	•																														
	The role of adrenaline by: • attaching to receptors on the surfaces of target cells • activating enzymes involved in the conversion of glycogen to glucose.		•	•	•				•	•	•																														
	The second messenger model of adrenaline and glucagon action, involving adenylate cyclase, cyclic AMP (cAMP) and protein kinase.		•	•	•				•	•	•																														
3.6.4.3 Control of blood water potential (A-level only)	The roles of the hypothalamus, posterior pituitary and antidiuretic hormone (ADH) in osmoregulation.		•	•	•				•	•	•																														
3.7 Genetics, populations, evolution and ecosystems (A-level only)																																									
3.7.1 Inheritance (A-level only)																																									
3.7.2 Populations (A-level only)																																									
3.7.3 Evolution may lead to speciation (A-level only)																																									
3.7.4 Populations in ecosystems (A-level only)																																									
3.8 The control of gene expression (A-level only)																																									
3.8.1 Alteration of the sequence of bases in DNA can alter the structure of proteins (A-level only)																																									
3.8.2 Gene expression is controlled by a number of features (A-level																																									
3.8.2.1 Most of a cell's DNA is not translated (A-level only)	Pluripotent cells are found in embryos; multipotent and unipotent cells are found in mature mammals and can divide to form a limited number of different cell types. • Pluripotent stem cells can divide in unlimited numbers and can be used in treating human disorders. • Unipotent cells, exemplified by the formation of cardiomyocytes. • Induced pluripotent stem cells (iPS cells) can be produced from adult somatic cells using appropriate protein transcription factors. Students should be able to evaluate the use of stem cells in treating human disorders.	•					•							•						•										•			•	•	•	•
3.8.2.2 Regulation of transcription and translation (A-level only)																																									
3.8.2.3 Gene expression and cancer (A-level only)																																									
3.8.3 Using genome projects (A-level only)																																									
3.8.4 Gene technologies allow the study and alteration of gene function allowing a better understanding of organism function and the design of new industrial and medical processes (A-level only)																																									
3.8.4.1 Recombinant DNA technology (A-level only)																																									
3.8.4.2 Differences in DNA between individuals of the same species can be exploited for identification and diagnosis of heritable conditions (A-level only)																																									
3.8.4.3 Genetic fingerprinting (A-level only)																																									

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.