SQA - Advanced Highers - 2015				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					
				. Brain is the body's most complex organ.			iplex 2	2. Neurons communicate using electrical and chemical signals.				trical	3. Genetically determined circuits are foundation of the nervous system.							vous	5. Intelligence arises as brain reasons, plans, solves problems. 6. The brain makes it possible to communicate knowledge through language.				endows us with a natural curiosity to		8. Fundamental discoveries promote healthy living and treatment of disease.				
Topic Cells and Proteins	Learning Objective	Detail	а	b	c d	е	f	a b	С	d	e f	g	a l	С	d	e f	а	b c	d	e f	g	a b	С	d	а	b	а	b c	а	b	c d
1 Laboratory techniques for biologists	(e) Microscopy. Use of bright field to examine whole organisms, parts of organisms or thin sections of dissected tissue. Fluorescence microscopy allows particular protein			•			T	Т	•								П														
2 Proteins	structures to be visualised.																														
3 Membrane proteins	(a) Movement of molecules across membranes The phospholipid bilayer as a barrier to ions and most uncharged polar molecules. Some small molecules such as oxygen and carbon dioxide pass through. Specific transmembrane proteins, which act as channels or transporters, control ion concentrations and concentration gradients. To perform specialised functions, different cell types and different cell compartments have different channel and transporter proteins. Passage of molecules through channel proteins is passive, eg aquaporin. Some channel proteins are gated and change conformation to allow or prevent diffusion, eg sodium channels, potassium channels. 'Gated' channels can be controlled by signal molecules (ligand-gated channels) or								•																						
	<u>Changes in ion concentrations (voltage-gated channels).</u> <u>Transporter proteins change conformation to transport molecules across a membrane. Transport can be facilitated, eg glucose symport or active eg Na/KATPase.</u> <u>Conformational change in active transport requires energy from hydrolysis of ATP.</u>								•																						
	(b) Signal transduction. Some cell surface receptor proteins convert an extracellular chemical signal to a specific intracellular response through a signal transduction pathway. This may result in the activation of an enzyme or G protein, a change in uptake or secretion of molecules, rearrangement of the cytoskeleton or activation of proteins that regulate gene transcription.							•	•																						
	(c) Ion transport pumps and generation of ion gradients. The sodium potassium pump transports ions against a steep concentration gradient using energy directly from ATP. The transporter protein has high affinity for sodium ions inside the cell; binding occurs; phosphorylation by ATP; conformation changes; affinity for ions changes; sodium ions released outside of the cell, potassium ions bind outside the cell; dephosphorylation; conformation changes; potassium ions taken into cell; affinity returns to start.	or a significant part of basal metabolic rate (up to 25% in						•																							
	Functions of Na/KATPase include the following examples: maintaining the osmotic balance in animal cells; generation of the ion gradient for glucose symport in small intestine; generation and long-term maintenance of ion gradient for resting potential in neurons; generation of ion gradient in kidney tubules.							•																							
	(d) Ion channels and nerve transmission. Nerve transmission is a wave of depolarisation of the resting potential of a neuron. This can be stimulated when an appropriate signal molecule, such as a neurotransmitter, triggers the opening of ligand-gated ion channels at a synapse. If sufficient ion movement occurs, then voltagegated ion channels will open and the effect travels along the length of the nerve. Once the wave of depolarisation has passed, these channel proteins close and others open to allow the movement of ions in the opposite direction to							•	•																						
4 Detecting and amplifying an environmental stimulus 5 Communication within multicellular organisms																															
6 Protein control of cell division Organisms and Evolution																															
1 Field techniques for biologists2 Organisms3 Variation and sexual reproduction4 Sex and behaviour																															
5 Parasitism Investigative Biology 1 Scientific principles and process 2 Experimentation 3 Critical evaluation of biological research																															

KEY			Description							
Nervous System Controls 1. The brain is the body's most		a	There are a hundred billion neurons in the human brain, all of which are in use.							
	complex organ.	b	Each neuron communicates with many other neurons to form circuits and share information.							
and Responds to Body	oempren ergann	C	Proper nervous system function involves coordinated action of neurons in many brain regions.							
Functions and Directs Behavior		d	The nervous system influences and is influenced by all other body systems (e.g., cardiovascular, endocrine, gastrointestinal							
		0	and immune systems). 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	2	Sensory stimuli are converted to electrical signals.							
	electrical and chemical signals.		Action potentials are electrical signals carried along neurons.							
	ciccurcar and circumcar signals.	C	Synapses are chemical or electrical junctions that allow electrical signals to pass from neurons to other cells.							
		<u>с</u>	Electrical signals in muscles cause contraction and movement.							
		<u> </u>	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	3. Genetically determined circuits are foundation of the	a	Neuronal circuits are formed by genetic programs during embryonic development and modified through interactions with the internal and external environment.							
and Function are Determined by Both	nervous system.	b	Sensory circuits (sight, touch, hearing, smell, taste) bring information to the nervous system, whereas motor circuits send information to muscles and glands.							
Genes and Environment		С	The simplest circuit is a reflex, in which sensory stimulus directly triggers an immediate motor response.							
Throughout Life		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	a	Differences in genes and environments make the brain of each animal unique.							
	nervous system.	b	Most neurons are generated early in development and survive for life.							
		С	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	5. Intelligence arises as brain reasons, plans, and solves	а	The brain makes sense of the world by using all available information, including senses, emotions, instincts, and remembered experiences.							
Foundation of the Mind	problems.	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.							
		С	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	a	Languages are acquired early in development and facilitate information exchange and creative thought.							
	to communicate knowledge through language.	b	Communication can create and solve many of the most pressing problems humankind faces.							
Research Leads to	7. The human brain endows us	a	The nervous system can be studied at many levels, from complex behaviors such as speech or learning, to the interactions							
Essential Understanding			among individual molecules. Research can ultimately inform us about mind, intelligence, imagination, and consciousness.							
for Therapies	understand how the world works.	C C	Curiosity leads us to unexpected but surprising discoveries that can benefit humanity.							
	8. Fundamental discoveries	a	Experiments on animals play a central role in providing insights about the human brain and in helping to make healthy							
	promote healthy living and		lifestyle choices, prevent disease, and find cures for disorders.							
	treatment of disease.	D	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.							