5.6 The Biological Approach: Genes, Neurochemistry and Evolutionary Explanations

AQA 7182 · about 50 minutes · Write-in edition

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions.

1 Definition of natural selection and example behaviour

(Total for Question 1 is 4 marks)

2 Neuron structure parts and functions

(Total for Question 2 is 3 marks)

3 Function of myelin sheath and nodes of Ranvier in neural transmission

(Total for Question 3 is 3 marks)

4 Definition and basic sequence of synaptic transmission

(Total for Question 4 is 2 marks)

5 Role of serotonin in behaviour

(Total for Question 5 is 3 marks)

6 Definition and example of genotype and phenotype

(Total for Question 6 is 2 marks)

7 Use of twin and adoption studies to estimate heritability

(Total for Question 7 is 3 marks)

8 Detailed explanation of neurotransmitter action and termination at a chemical synapse

(Total for Question 8 is 6 marks)

9 Evaluate strengths and limitations of the biological approach

(Total for Question 9 is 12 marks)

Mark scheme · 5.6 The Biological Approach: Genes, Neurochemistry and Evolutionary Explanations

Question 1

defines natural selection as the process by which heritable traits that increase survival and reproductive success become more common in a population over generations oe — **M1**

states that this operates through differential survival and reproduction of individuals with advantageous traits oe — **A1**

gives a clear behavioural example, e.g. fear of snakes aiding survival by avoiding danger oe — **A1**

links example to survival or reproduction in a sentence oe — **A1**

Answer: Natural selection is the process where heritable traits that improve survival and reproductive success become more common across generations because individuals with those traits leave more offspring. For example, a fear of snakes could have aided survival by reducing dangerous encounters, increasing the chance of living to reproduce.

Question 2

identifies and states function of one part, e.g. dendrites receive signals from other neurons oe — **B1**

identifies and states function of a second part, e.g. cell body / soma contains nucleus and integrates incoming signals oe — **B1**

identifies and states function of a third part, e.g. axon/axon terminal conducts impulses away from the cell body and transmits to the next neuron oe — **B1**

Answer: Dendrites receive incoming signals; the cell body or soma contains the nucleus and integrates inputs; the axon conducts impulses away from the cell body and axon terminals release neurotransmitter to the next neuron.

Question 3

identifies the myelin sheath as an insulating layer around some axons oe — **M1**

explains that myelin increases conduction speed by allowing electrical impulses to jump between nodes of Ranvier, called saltatory conduction oe — **A1**

explains that nodes of Ranvier are gaps in the myelin where action potentials are regenerated, enabling faster transmission along the axon oe — **A1**

Answer: The myelin sheath insulates parts of the axon and enables faster transmission by causing action potentials to jump from one node of Ranvier to the next, while nodes of Ranvier are gaps where the impulse is regenerated.

Question 4

defines synaptic transmission as the process by which a signal is passed from one neuron to another across a synapse oe — **B1**

states sequence: action potential arrives, neurotransmitter released from presynaptic vesicles, diffuses across cleft, binds to postsynaptic receptors oe — **B1**

Answer: Synaptic transmission is the process where an electrical impulse triggers release of neurotransmitter from the presynaptic neuron; the chemical crosses the synaptic cleft and binds to receptors on the postsynaptic neuron, causing a response.

Question 5

states that serotonin is a neurotransmitter involved in mood regulation oe — **M1**

links low serotonin function to behaviours/conditions such as low mood or depression oe — **A1**

gives an example, e.g. selective serotonin reuptake inhibitors increase serotonin at synapses and are used to treat depression oe — **A1**

Answer: Serotonin is a neurotransmitter involved in regulating mood. Low serotonin activity is associated with low mood and depression; for example, antidepressant drugs such as SSRIs act to increase serotonin levels at synapses to reduce depressive symptoms.

Question 6

defines genotype as the genetic makeup or alleles an individual possesses oe — **B1**

defines phenotype as the observable characteristics or traits resulting from genes interacting with environment, and gives an example oe — **B1**

Answer: Genotype is an individual's genetic makeup, the alleles they carry. Phenotype is the observable characteristics produced by genes interacting with the environment, for example genetic tendency for high activity level (genotype) may result in an outgoing behaviour (phenotype) depending on upbringing.

Question 7

for twin studies: compares concordance rates for a trait between monozygotic (MZ) twins and dizygotic (DZ) twins oe — **M1**

explains that higher concordance in MZ than DZ suggests genetic influence because MZ share 100% genes while DZ share about 50% oe — **A1**

for adoption studies: compares similarity between adopted child and biological parents versus adopted child and adoptive parents, to separate genetic and environmental influences oe — **A1**

Answer: Twin studies compare concordance rates for a trait between monozygotic twins, who share 100% of genes, and dizygotic twins, who share about 50% of genes; higher concordance in MZ twins suggests genetic influence. Adoption studies compare similarity between an adopted child and their biological parents versus their adoptive parents to separate genetic from environmental contributions.

Question 8

states that an action potential arriving at the presynaptic terminal causes calcium ion influx and triggers vesicle fusion oe	**M1**
explains that neurotransmitter is released from synaptic vesicles into the synaptic cleft by exocytosis oe	**A1**
explains that neurotransmitter diffuses across the cleft and binds to specific receptors on the postsynaptic membrane causing excitatory or inhibitory post-synaptic potentials oe	**A1**
states that termination of the signal occurs by reuptake into the presynaptic neuron or enzymatic breakdown in the cleft oe	**M1**
explains reuptake mechanism, e.g. transporter proteins return neurotransmitter to presynaptic neuron for recycling oe	**A1**
or explains enzymatic breakdown, e.g. enzymes in the synaptic cleft break down neurotransmitter into inactive components, preventing continuous stimulation oe	**A1**

Answer: When an action potential reaches the presynaptic terminal it causes calcium ions to enter, triggering synaptic vesicles to fuse with the membrane and release neurotransmitter into the synaptic cleft. The neurotransmitter diffuses across, binds to specific receptors on the postsynaptic membrane and elicits excitatory or inhibitory effects. The signal is then terminated either by reuptake via transporter proteins into the presynaptic neuron for recycling, or by enzymatic breakdown in the cleft which renders the neurotransmitter inactive.

Question 9

Level 4 Knowledge of the biological approach is accurate and detailed. Evaluation is thorough and well balanced, addressing strengths and limitations with developed reasoning and relevant evidence. Discussion is applied and coherent, showing understanding of implications. Specialist terminology is used effectively.	**10-12**
Level 3 Knowledge is clear and mostly accurate. Evaluation considers strengths and limitations with some development and supporting examples. Argument is generally coherent with appropriate terminology.	**7-9**
Level 2 Knowledge is present but limited in depth. Evaluation is basic or one-sided, with limited development or examples. Response may lack clarity in places and use limited specialist terms.	**4-6**
Level 1 Very limited knowledge and evaluation. Points are brief, undeveloped or largely descriptive. Little specialist vocabulary is used and argument lacks organisation.	**1-3**
Level 0 No creditable content.	**0**

Indicative content:

- AO1 strengths: the biological approach uses objective scientific methods such as brain imaging, PET and fMRI, biochemical analysis and genetic studies, producing reliable, quantifiable data.
- AO1 strengths: twin and adoption studies provide systematic approaches to estimate genetic influences, and pharmacological research links neurotransmitters to behaviour providing mechanistic explanations and treatments.
- AO1 applications: findings have led to real-world applications such as drug treatments for mental disorders, and biological markers that inform interventions.
- AO3 limitations: biological determinism claims behaviour is governed by biology which can underplay the role of choice and social factors; this raises ethical implications about responsibility and stigma.
- AO3 limitations: difficulty separating nature and nurture, since biological research such as twin studies can be confounded by shared environment and gene-environment interaction, complicating simple genetic explanations.
- AO3 limitations: reductionism, explaining complex behaviours in terms of genes or neurotransmitters can ignore psychological and social levels of explanation, limiting understanding and treatment approaches.
- AO3 methodological critique: some biological measures such as brain scans show correlation not causation; small or unrepresentative samples in genetic studies can limit generalisability.
- AO3 strengths: scientific rigour enables replication and cumulative knowledge, and biological explanations have predictive power and clear practical outcomes, such as development of SSRIs for depression.
- AO3 balanced conclusion: the biological approach contributes important, testable explanations and effective interventions, but must be integrated with psychological and social perspectives to avoid deterministic or reductionist conclusions and to acknowledge complexity.