



Coordination, Response and Gene Technology practice questions

38 questions • 135 marks • mark scheme at the back

For Pearson Edexcel International AS Biology XBI11 and International A Level Biology YBI11. **A Level only** is IA2 content (Units 4 to 6), not needed for the International AS.

Name

Total / 135

Neurones, reflexes and the nervous system

Spec 8.1-8.3, 8.10

A Level only

1 UNIT 5 STYLE [1 mark]

In a spinal reflex arc, where is the cell body of the motor neurone found?

- A. ☐ In the dorsal root ganglion
- B. ☐ In the grey matter of the spinal cord
- C. ☐ In the white matter of the spinal cord
- D. ☐ In the effector

2 UNIT 5 STYLE [3 marks]

Describe how the myelin sheath of a neurone is formed and state its function.

3 UNIT 5 STYLE [4 marks]

Compare and contrast the structure and function of a sensory neurone and a motor neurone.

4 UNIT 5 STYLE

[5 marks]

A person touches a hot plate and pulls their hand away. Describe the pathway taken by the nerve impulse through a spinal reflex arc, from stimulus to response.

[illegible]

5 UNIT 5 STYLE

[3 marks]

The person in question 4 pulled their hand away before they felt any pain. Explain why, and state the role of the white matter of the spinal cord in feeling the pain.

[illegible]

6 UNIT 5 STYLE

[4 marks]

(a) Name the two parts of the mammalian nervous system and state what makes up each. (2)
(b) State the roles of a receptor and an effector in a response to a stimulus. (2)

[illegible]

Impulses, synapses and receptors Spec 8.4-8.9 A Level only

7 UNIT 5 STYLE

[1 mark]

Which statement describes habituation?

- A. ☐ A permanent increase in sensitivity to a repeated stimulus
- B. ☐ A decrease in response to a repeated stimulus that is harmless
- C. ☐ A reflex response that is unaffected by repeated stimulation
- D. ☐ A decrease in response because muscles run out of ATP

The table shows the membrane potential of an axon measured at intervals after a stimulus was applied at 0.5 ms. (a) State the resting potential. (1) (b) Explain the change in membrane potential between 1.0 ms and 1.5 ms. (2) (c) Explain the change in membrane potential between 2.0 ms and 2.5 ms. (2)

Membrane potential of an axon after a stimulus	
Time / ms	Membrane potential / mV
0	-70
0.5	-70
1.0	-45
1.5	+30
2.0	-20
2.5	-75
3.0	-72
3.5	-70

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An impulse travels along a myelinated motor axon of length 0.60 m in 6.0 ms. Calculate the speed of conduction, in m s^{-1} .

Answer = ...

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Explain why an action potential is conducted faster along a myelinated axon than along an unmyelinated axon of the same diameter.

Describe how a nerve impulse is transmitted across a cholinergic synapse.

Explain how (a) lidocaine and (b) cobra venom alpha toxin prevent a response to a stimulus. (2 marks each)

13

[4 marks]

[illegible]

14

[5 marks]

[illegible]

Plant responses

Spec 8.11, 8.12

A Level only

15

[1 mark]

B. ☐ Pfr is converted to Pr and the seed does not germinate

C. ☐ Pr remains unchanged and the seed does not germinate

D. ☐ Pfr remains unchanged and the seed germinates

- A. ☐ Pr is converted to Pfr and the seed germinates
- B. ☐ Pfr is converted to Pr and the seed does not germinate
- C. ☐ Pr remains unchanged and the seed does not germinate
- D. ☐ Pfr remains unchanged and the seed germinates

16

[4 marks]

The table shows the results of an investigation into flowering in a short-day plant kept in a 16-hour night. Explain the results for treatments 2 and 3.

Flowering of a short-day plant after treatments during a long dark period		
Treatment	Light given in the night	Flowering
1	None (continuous darkness)	Yes
2	5-minute flash of red light	No
3	5-minute flash of red light, then 5-minute flash of far-red light	Yes

[illegible]

17

[4 marks]

Explain how auxin causes a shoot to grow towards the light.

[illegible]

18

[3 marks]

Explain how gibberellin affects transcription in a germinating barley grain.

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Explain how a root grows downwards in response to gravity.

The brain and hormonal control

Spec 8.13–8.16

A Level only

Damage to which part of the brain would be most likely to stop breathing and heart rate being controlled?

- A. ☐ Cerebellum
- B. ☐ Hypothalamus
- C. ☐ Medulla oblongata
- D. ☐ Cerebral hemispheres

Compare and contrast nervous and hormonal coordination in animals.

Describe the roles of the hypothalamus and the pituitary gland in coordination.

26 UNIT 5 STYLE**[4 marks]**

Suggest which scanning technique would be most suitable for each of the following, giving a reason in each case. (a) Finding bleeding in the brain of a patient after a head injury. (2) (b) Finding which regions of the brain are active when a patient is reading aloud. (2)

27 UNIT 5 STYLE**[5 marks]**

Evaluate the use of MRI rather than CT to investigate a suspected brain tumour.

28 UNIT 5 STYLE**[4 marks]**

Explain how a lack of dopamine causes the symptoms of Parkinson's disease and how L-DOPA helps to relieve them.

29 UNIT 5 STYLE

[3 marks]

A drug used to treat depression stops serotonin being taken back into the presynaptic neurone. Explain how this may reduce the symptoms of depression.

30 UNIT 5 STYLE

[3 marks]

A person with damage to the cerebellum has normal muscle strength and can understand speech, but their movements are jerky and they cannot keep their balance. Explain these symptoms.

Gene technology

Spec 8.17-8.22

A Level only

31 UNIT 5 STYLE

[1 mark]

Which statement correctly describes the roles of the enzymes used to make recombinant DNA?

- A. ☐ Restriction endonuclease joins DNA fragments; DNA ligase cuts DNA at a recognition site
- B. ☐ Restriction endonuclease cuts DNA at a recognition site; DNA ligase forms phosphodiester bonds between fragments
- C. ☐ Restriction endonuclease forms hydrogen bonds between sticky ends; DNA ligase cuts the plasmid
- D. ☐ Restriction endonuclease makes cDNA from mRNA; DNA ligase breaks phosphodiester bonds

32 UNIT 5 STYLE

[5 marks]

Describe how a gene can be inserted into a plasmid to form recombinant DNA.

33 UNIT 5 STYLE**[3 marks]**

Scientists made the human insulin gene by extracting mRNA from beta cells of the pancreas rather than cutting the gene from human DNA. Explain this approach.

34 UNIT 5 STYLE**[4 marks]**

Describe how bacteria that have taken up a recombinant plasmid can be identified and separated from those that have not. The plasmid contains a gene for antibiotic resistance.

35 UNIT 5 STYLE**[4 marks]**

Explain the advantages of using genetically modified bacteria, rather than animals, to produce human insulin.

36 UNIT 5 STYLE**[4 marks]**

(a) Describe how a microarray is used to find out which genes are active in a sample of cells. (3) (b) State what is meant by bioinformatics. (1)

Describe how a gene can be transferred into (a) plant cells and (b) an animal. (Accept any one method for each.)

Golden rice has been genetically modified to produce beta-carotene, which the body converts to vitamin A. Evaluate the risks and benefits of growing GM crops such as this.

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

B B (1) Cell bodies of relay and motor neurones are in the grey matter.

2. [3]

- Schwann cells wrap around the axon (1)
- many times / many layers of (lipid-rich) plasma membrane form the sheath (1)
- acts as an electrical insulator / ions cannot cross it, except at nodes of Ranvier (1)
- so impulses are conducted faster (1)
- Max 3

3. [4]

- similarity: both have a cell body / axon / are myelinated / conduct action potentials (1)
- sensory carries impulses from receptor to CNS; motor carries impulses from CNS to effector (1)
- sensory cell body is in the dorsal root ganglion / outside the spinal cord; motor cell body is in the grey matter of the CNS (1)
- sensory has a long dendron (and short axon); motor has many short dendrites and a long axon (1)
- Max 4. Accept any other valid difference of structure or position

4. [5]

- pain / temperature receptor in the skin detects the stimulus and generates an impulse (1)
- impulse travels along a sensory neurone to the spinal cord, entering through the dorsal root (1)
- sensory neurone synapses with a relay neurone in the grey matter (1)
- relay neurone synapses with a motor neurone (1)
- motor neurone carries the impulse out through the ventral root to the effector / muscle (1)
- muscle (in arm) contracts and hand is withdrawn (1)
- Max 5

5. [3]

- reflex arc is short / has few synapses, so the response is fast (1)
- the reflex does not involve the brain / conscious thought, so the response occurs before the brain is aware (1)
- white matter (axons) carries impulses up the spinal cord to the brain, so pain is felt later (1)

6. [4]

- central nervous system, made up of the brain and spinal cord (1)
- peripheral nervous system, made up of the neurones / nerves outside the brain and spinal cord (1)
- receptor detects a stimulus / converts energy of stimulus into an electrical impulse (1)
- effector (muscle or gland) responds / contracts or secretes (1)

7. [1]

B B (1) Habituation is a decrease in response to a repeated, harmless stimulus; D describes fatigue.

8. [5]

- (a) -70 mV (1) units required
- (b) voltage-gated Na^+ channels open / permeability to Na^+ increases (1)
- (b) Na^+ diffuse into the axon down the electrochemical gradient, so the membrane depolarises / inside becomes positive (1)
- (c) Na^+ channels close and voltage-gated K^+ channels open / permeability to K^+ increases (1)
- (c) K^+ diffuse out of the axon (repolarisation); K^+ channels slow to close so the potential falls below the resting level / hyperpolarisation (1)

9. [2]

- $6.0 \text{ ms} = 6.0 \times 10^{-3} \text{ s}$, speed = $0.60 \div 6.0 \times 10^{-3}$ (1)
- 100 m s^{-1} (1) (credit the second mark for the correct answer with units, or by error carried forward from a wrong conversion)

10. [4]

- myelin acts as an insulator / prevents ions crossing the membrane except at nodes of Ranvier (1)
- depolarisation (Na^+ entry) only at nodes (1)
- local circuits carry the depolarisation from node to node / action potential jumps (saltatory conduction) (1)
- so fewer places have to depolarise and repolarise, which is quicker (than regenerating at every point) (1)
- Max 4. Accept less ATP is needed as fewer ions move (not a speed mark)

11. [5]

- action potential arrives at the presynaptic knob and opens voltage-gated Ca^{2+} channels / Ca^{2+} enter the knob (1)
- vesicles containing acetylcholine fuse with the presynaptic membrane and release ACh by exocytosis (1)
- ACh diffuses across the synaptic cleft (1)
- ACh binds to receptors on the postsynaptic membrane, opening Na^+ channels (1)
- Na^+ enter and depolarise the postsynaptic membrane, producing an action potential if threshold is reached (1)
- acetylcholinesterase breaks down ACh, so the response is not continuous (1)
- Max 5

12. [4]

- lidocaine blocks voltage-gated Na^+ channels in the axon membrane (1)
- so no depolarisation / action potentials are not conducted to the brain, so pain is not felt (1)
- alpha toxin binds to the acetylcholine receptors on the postsynaptic membrane (1)
- so ACh cannot bind / Na^+ channels do not open and the muscle is not depolarised, giving paralysis (1)

13. [4]

- receptors in the retina detect the light and send impulses (along the optic nerve) to the brain (1)
- impulses are sent along motor (parasympathetic) neurones to the iris (1)
- circular muscles contract and radial muscles relax / antagonistic muscles (1)
- pupil constricts, reducing the light that reaches the retina, protecting it from damage (1)
- Max 4

14. [5]

- light changes retinal from the cis to the trans form (1)
- rhodopsin splits / is bleached into opsin and retinal (1)
- cation channels / Na^+ channels in the rod membrane close (1)
- less Na^+ enters the rod, so the rod cell becomes hyperpolarised (1)
- less (inhibitory) transmitter released onto the bipolar neurone (1)
- bipolar neurone depolarised and releases transmitter, which depolarises the optic neurone to threshold, so action potentials form (1)
- Max 5

15. [1]

B B (1) The last flash was far-red, which converts Pfr to Pr.

16. [4]

- red light converts Pr to Pfr (1)
- Pfr is the active form that inhibits flowering in a short-day plant / prevents flowering (1)
- far-red light converts Pfr to Pr, so Pr is dominant and flowering occurs (1)
- the last light flash determines the form / the effect of red is reversed by far-red (1)
- Max 4. Accept a reference to changes in transcription of flowering genes

17. [4]

- auxin (IAA) is moved to the shaded side of the shoot (1)
- auxin stimulates proton pumps / H^+ pumped into the cell wall, lowering pH (1)
- wall becomes more extensible / cellulose microfibrils loosened (1)
- cells on the shaded side elongate more (than on the lit side), so the shoot bends towards the light (1)
- Max 4. Accept effect on transcription of genes for elongation

18. [3]

- embryo releases gibberellin, which diffuses to the aleurone layer (1)
- gibberellin binds to a receptor and causes breakdown of a repressor protein (1)
- so transcription factors can bind and switch on the amylase gene / transcription of amylase mRNA increases (1)
- so amylase is made and hydrolyses starch to sugars used by the embryo (1)
- Max 3

19. [5]

- surface-sterilise the grains / use aseptic technique, as microorganisms also make amylase (1)
- cut grains in half so that one half has the embryo and one half does not (1)
- place the halves cut-side down on starch agar plates (1)
- control: boiled embryo halves / agar without a grain (1)
- keep temperature, time of incubation, grain age and mass constant / incubate for 24–48 hours at the same temperature (1)
- flood plates with iodine solution and measure the diameter of the clear zone around each half (1)
- repeat for each treatment and calculate the mean (1)
- Max 5

20. [3]

- radius = diameter ÷ 2, so radii are 5.0, 6.0 and 7.0 mm (1)
- areas (πr^2) = 78.5, 113 and 154 mm² (1)
- mean area = 115 mm² (1) (correct answer with no working gains 3 marks; accept 115.2 mm²; 113 mm², the area of the mean diameter, gains 2 marks)

21. [3]

- to show that the clear zone is caused by amylase made by living / active tissue (1)
- boiling denatures enzymes / amylase / gibberellin (1)
- no clear zone (starch not digested; agar stays blue-black with iodine) (1)

22. [4]

- auxin (IAA) accumulates on the lower side of the root (1)
- high concentration of auxin inhibits elongation in roots (1)
- cells on the upper side elongate more than those on the lower side (1)
- so the root bends downwards (positive gravitropism) (1)

23. [1]

C C (1) The medulla oblongata controls heart rate and breathing.

24. [4]

- similarity: both involve chemicals / act on effectors / target specific cells (1)
- nervous is fast, hormonal is slower (1)
- nervous transmitted by neurones (impulses), hormonal transmitted in the blood (1)
- nervous effects short-lived, hormonal effects longer-lasting (1)
- nervous acts on specific effectors, hormones act on any target cells with receptors (1)
- Max 4

25. [4]

- hypothalamus monitors blood / body conditions such as temperature or water content (1)
- hypothalamus produces releasing hormones / controls the anterior pituitary (1)
- hypothalamus makes ADH, which is released from the posterior pituitary (1)
- pituitary secretes hormones that act on target glands / tissues (1)
- so links the nervous and endocrine systems (1)
- Max 4

26. [4]

- (a) CT (1)
- quick / shows bleeding and bone / widely available in emergencies (1)
- (b) fMRI (1)
- detects changes in blood flow / oxygen use in active areas, as the patient performs the task (1)

27. [5]

- MRI gives more detailed images of soft tissue (1)
- so smaller tumours / their boundaries are seen more clearly (1)
- MRI uses no ionising radiation, so can be repeated safely; CT uses X-rays (1)
- MRI is slower, more expensive and less widely available than CT (1)
- MRI cannot be used for patients with a pacemaker / metal implants (1)
- reasoned conclusion, e.g. MRI is better for diagnosing and locating the tumour, but CT may be used when MRI is unavailable or unsafe for the patient (1)
- Max 5

28. [4]

- neurones that make dopamine (in the brain) are lost / die (1)
- so less dopamine is released at synapses / less transmission in the regions that control movement, causing tremor and rigidity (1)
- L-DOPA crosses the blood-brain barrier (dopamine cannot) (1)
- L-DOPA is converted to dopamine in the brain, restoring transmission (1)

29. [3]

- serotonin stays in the synaptic cleft for longer / concentration of serotonin in the cleft increases (1)
- serotonin binds to receptors on the postsynaptic membrane more often / for longer (1)
- so synaptic transmission is increased, which counteracts the low serotonin activity linked to depression (1)

30. [3]

- the cerebellum coordinates movement (1)
- and balance / posture, using information from muscles, joints and the ear (1)
- the motor areas of the cerebral hemispheres and the muscles are undamaged / muscles can still contract, so muscle strength is normal (1)

31. [1]

B B (1) Restriction enzymes cut; ligase joins by phosphodiester bonds.

32. [5]

- cut the gene and plasmid with the same restriction endonuclease (1)
- at its recognition site / specific base sequence (1)
- staggered cut leaves complementary sticky ends (1)
- gene and plasmid mixed so sticky ends join by complementary base pairing / hydrogen bonds (1)
- DNA ligase joins the sugar-phosphate backbones / forms phosphodiester bonds (1)
- Max 5

33. [3]

- beta cells make large amounts of insulin mRNA (1)
- reverse transcriptase makes a cDNA copy of the mRNA (1)
- cDNA has no introns, which bacteria cannot remove, so the gene can be expressed in bacteria (1)

34. [4]

- bacteria spread on agar containing the antibiotic (1)
- bacteria with the plasmid have (and express) the resistance gene (1)
- so they survive and grow into colonies (1)
- bacteria without the plasmid are killed / do not grow (1)
- colonies are picked off / subcultured to grow a culture of transformed bacteria (1)
- Max 4. Ignore description of how the plasmid was inserted (calcium chloride, heat shock)

35. [4]

- insulin is identical to human insulin / gene is the human gene, so less chance of an immune response (1)
- bacteria reproduce quickly / large amounts can be made in fermenters (1)
- cheaper / reliable supply (1)
- fewer ethical objections as animals are not killed (1)
- Max 4

36. [4]

- mRNA extracted from the cells and converted to labelled (fluorescent) cDNA (1)
- cDNA binds to complementary DNA probes on the array (1)
- spots that fluoresce show the gene is active / brighter spot means more mRNA (1)
- (b) use of computer science / software to store, analyse and interpret biological data (e.g. DNA sequences) (1)

37. [3]

- (a) gene inserted into the Ti plasmid of Agrobacterium / DNA coated onto gold or tungsten particles (1)
- (a) Agrobacterium infects plant cells and transfers the gene into the plant genome / particles fired into plant cells with a gene gun (1)
- (b) gene microinjected into the nucleus of a fertilised egg (1)
- (b) embryo implanted into a surrogate mother, which gives birth to a transgenic animal (1)
- Max 3. At least one mark from each part for full marks

38. [6]

- benefit: reduces vitamin A deficiency / improves nutrition in people with a rice-based diet (1)
- benefit: higher yield / pest-resistant crops / less pesticide, so greater food security (1)
- risk: gene transfer by pollen to wild relatives / weeds (1)
- risk: harm to non-target organisms / reduced biodiversity (1)
- risk: unforeseen health effects / allergies; long-term effects not fully known (1)
- economic / ethical: seeds patented and costly for farmers; some object to modifying organisms (1)
- reasoned judgement that weighs benefits against risks / suggests monitoring and testing (1)
- Max 6