



Cells (Interaction and interdependence) practice questions

16 questions • 55 marks • mark scheme at the back

For IB Diploma Biology, Standard Level and Higher Level (first assessment 2025). **HL only** is additional higher level content, for HL students only.

Name

Total / 55

Chemical signalling **Spec C2.1** **HL only**

1 PAPER 1A STYLE [1 mark]
HL only

Which signalling chemical binds to a receptor in the cytoplasm or nucleus of its target cell?

- A. ☐ Insulin
- B. ☐ Epinephrine (adrenaline)
- C. ☐ Acetylcholine
- D. ☐ Testosterone

2 PAPER 1A STYLE [1 mark]
HL only

What acts as the second messenger when epinephrine binds to its receptor on a liver cell?

- A. ☐ GTP
- B. ☐ Cyclic AMP
- C. ☐ Phosphorylated tyrosine
- D. ☐ Calcium ions released from the blood

3 PAPER 1A STYLE [1 mark]
HL only

Which is an example of positive feedback in a cell signalling pathway?

- A. ☐ Rising oestradiol increases GnRH secretion, leading to more oestradiol secretion
- B. ☐ Insulin lowers blood glucose, so less insulin is secreted
- C. ☐ A G protein hydrolyses GTP to GDP and becomes inactive
- D. ☐ A steroid hormone binds an intracellular receptor that promotes transcription

PAPER 1B STYLE

HL only

Population density and bioluminescence of *Vibrio fischeri* in culture

[illegible]

PAPER 2A STYLE

HL only

[illegible]

PAPER 2A STYLE

HL only

[illegible]

PAPER 2A STYLE

HL only

[illegible]

PAPER 2B STYLE

HL only

[illegible]

Neural signalling Spec C2.2

9 PAPER 1A STYLE [1 mark]

How does the sodium-potassium pump contribute to the resting potential of a neuron?

- A. ☐ It pumps two Na^+ out and three K^+ in by facilitated diffusion
- B. ☐ It pumps three Na^+ out and two K^+ in using energy from ATP
- C. ☐ It pumps Na^+ and K^+ into the neuron using energy from ATP
- D. ☐ It opens voltage-gated channels so Na^+ diffuses out

10 PAPER 1A STYLE [1 mark]

Why can a signal pass in only one direction across a typical synapse?

- A. ☐ The synaptic cleft is too wide for ions to diffuse back
- B. ☐ The postsynaptic neuron has no sodium-potassium pumps
- C. ☐ Only the presynaptic neuron releases neurotransmitter and only the postsynaptic membrane has its receptors
- D. ☐ Voltage-gated calcium channels are found only in the postsynaptic membrane

11 PAPER 1A STYLE [1 mark]

HL only

How does cocaine affect synaptic transmission?

- A. ☐ It binds to acetylcholine receptors and blocks transmission
- B. ☐ It stimulates exocytosis of dopamine from the presynaptic neuron
- C. ☐ It opens chloride channels in the postsynaptic membrane
- D. ☐ It blocks reuptake of dopamine into the presynaptic neuron

Diameter and conduction speed of six nerve fibres			
Fibre	Myelinated	Diameter / μm	Conduction speed / m s^{-1}
A	No	0.5	0.6
B	No	1.0	1.2
C (squid giant axon)	No	500	25
D	Yes	4	24
E	Yes	10	60
F	Yes	20	120

[illegible][illegible]

HL only

An oscilloscope recorded the membrane potential at one point on an axon. The table gives readings from the trace during one action potential. (a) State the resting potential of this axon. [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 1.5 ms and 2.5 ms. [2] (d) Another trace from the same axon showed 24 action potentials in 0.40 s. Calculate the number of impulses per second. [1]

Membrane potential during one action potential

Time / ms	Membrane potential / mV
0.0	-70
0.5	-70
1.0	-55
1.5	+30
2.0	-20
2.5	-80
3.5	-70

Answer =

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HL only

A postsynaptic neuron receives synapses from several excitatory and inhibitory presynaptic neurons. Explain how these inputs determine whether it generates an action potential.

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[illegible]

Mark scheme

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

1. [1] **HL only**

D D [1]

2. [1] **HL only**

B B [1]

3. [1] **HL only**

A A [1]

4. [6] **HL only**

- (a) little or no light at low population density / up to 4 h [1]
- (a) light output rises steeply once density exceeds about $1.6-6 \times 10^7$ cells cm^{-3} / increase is not proportional to density [1]
- (a) positive correlation between density and light output overall [1]
- (a) max 2
- (b) $(900 - 50) \div 50 \times 100 = 1700\%$ [1]
- (c) bacteria release a signalling chemical / autoinducer [1]
- (c) its concentration rises as population density rises [1]
- (c) above a threshold concentration it binds to receptors (in the bacteria) [1]
- (c) activated receptor promotes transcription of genes for bioluminescence / luciferase [1]
- (c) positive feedback: more autoinducer is made once activated, so light output rises steeply [1]
- (c) max 3

5. [3] **HL only**

- transmembrane in plasma membrane, intracellular in cytoplasm / nucleus [1]
- transmembrane has hydrophobic amino acids in the region within the membrane / intracellular has hydrophilic amino acids on its surface / no hydrophobic membrane region [1]
- ligand of transmembrane receptor remains outside the cell, ligand of intracellular receptor enters the cell [1]
- transmembrane ligands are hydrophilic / proteins / amines, intracellular ligands are hydrophobic / steroids [1]
- intracellular receptors (when activated) bind DNA / affect gene expression directly [1]
- max 3
- Each mark needs both sides of the contrast. Accept a table.

6. [4] **HL only**

- both bind to specific receptors on/in target cells [1]
- both trigger a response / signal transduction in the target cell [1]
- hormones secreted by endocrine glands, neurotransmitters released by neurons [1]
- hormones transported in the blood, neurotransmitters diffuse across a synaptic gap / cleft [1]
- hormones have distant / widespread effects, neurotransmitters localized effects / one cell [1]
- hormone effects slower and longer lasting, neurotransmitter effects rapid and brief [1]
- max 4
- Award at least one mark for a similarity for full marks.

7. [3] HL only

- insulin binds to a (transmembrane) receptor in the plasma membrane / insulin does not enter the cell [1]
- receptor has tyrosine kinase activity / tyrosine (inside the cell) is phosphorylated [1]
- sequence of reactions / signal transduction follows [1]
- vesicles containing glucose transporters move to / fuse with the plasma membrane [1]
- more glucose enters by facilitated diffusion [1]
- max 3

8. [7] HL only

- ligand binds to a specific binding site on the receptor (outside the cell) [1]
- binding causes a conformational change in the receptor [1]
- starts a signal transduction pathway / sequence of responses inside the cell [1]
- acetylcholine receptor contains an ion channel that opens when acetylcholine binds [1]
- positively charged ions / Na^+ diffuse into the cell [1]
- membrane potential changes / membrane depolarized / may trigger an action potential or muscle contraction [1]
- epinephrine receptor is a G protein-coupled receptor [1]
- G protein activated / binds GTP (in place of GDP) [1]
- G protein activates adenylyl cyclase [1]
- ATP converted to cAMP [1]
- cAMP is the second messenger / activates protein kinase [1]
- cascade amplifies the signal / leads to glycogen breakdown (in liver cells) [1]
- epinephrine does not enter the cell [1]
- max 7

9. [1]

B B [1]

10. [1]

C C [1]

11. [1] HL only

D D [1]

12. [6]

- (a) speeds similar / C 25 m s^{-1} and D 24 m s^{-1} [1]
- (a) D achieves this with a much smaller diameter / C is non-myelinated and D is myelinated [1]
- (b) $500 \div 4 = 125$ times [1]
- (c) (strong) positive correlation [1]
- (c) $R^2 = 0.95^2 = 0.90$ [1] Accept 0.9025.
- (d) fast conduction with narrow fibres, so many fibres fit in a small space / nerve OWTTE [1]
- Accept: rapid responses without needing giant axons.

13. [4]

- depolarization of presynaptic membrane opens (voltage-gated) calcium channels [1]
- Ca^{2+} diffuses into presynaptic neuron [1]
- Ca^{2+} acts as a signal causing vesicles to fuse with presynaptic membrane / exocytosis [1]
- acetylcholine diffuses across the synaptic cleft [1]
- acetylcholine binds to (transmembrane) receptors on postsynaptic membrane [1]
- ion channels open and positive ions / Na^+ diffuse into the postsynaptic cell [1]
- postsynaptic membrane depolarized [1]
- max 4

14. [6] HL only

- (a) -70 mV [1]
- (b) threshold potential reached (at -55 mV) [1]
- (b) voltage-gated sodium channels open [1]
- (b) Na^+ diffuses in, depolarizing the membrane / inside becomes positive [1]
- (b) max 2
- (c) sodium channels close [1]
- (c) voltage-gated potassium channels open [1]
- (c) K^+ diffuses out, repolarizing the membrane / overshoot below resting potential (hyperpolarization) [1]
- (c) max 2
- (d) $24 \div 0.40 = 60$ impulses per second [1]

15. [3] HL only

- excitatory neurotransmitters cause depolarization / EPSPs [1]
- inhibitory neurotransmitters cause hyperpolarization / IPSPs [1]
- effects are summed / added together [1]
- action potential only if the summed depolarization reaches the threshold potential [1]
- all-or-nothing response [1]
- max 3

16. [7] HL only

- resting potential about -70 mV / maintained by sodium-potassium pumps [1]
- threshold potential must be reached for an action potential [1]
- voltage-gated sodium channels open and Na^+ diffuses in [1]
- depolarization / inside becomes positive [1]
- voltage-gated potassium channels open and K^+ diffuses out [1]
- repolarization [1]
- local currents: Na^+ diffuses along inside (and outside) of the axon to the next region [1]
- this brings the next region / node to threshold [1]
- myelin sheath insulates the axon [1]
- ion pumps and channels clustered at nodes of Ranvier [1]
- action potential propagated / jumps from node to node: saltatory conduction [1]
- faster than in non-myelinated fibres [1]
- max 7