



Chemical signalling: practice questions

8 questions • 26 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 / 26

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]

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