NAME _____ CLASS _____ DATE _____

IB BIOLOGY · C2.1

Chemical signalling

Notes to fill in alongside the guide. Each numbered block matches a chapter of the guide, and of the lesson slides. Write in the gaps, answer the cues, annotate the figures, and sum up each section in your own words.

BY THE END YOU CAN

- [ ] Describe receptors as proteins with binding sites for specific ligands C2.1.1
- [ ] Explain quorum sensing in Vibrio fischeri C2.1.2
- [ ] Compare hormones, neurotransmitters, cytokines and calcium ions C2.1.3
- [ ] Give the chemical groups of hormones and neurotransmitters, and say why so many are used C2.1.4
- [ ] Contrast localized and distant effects of signalling chemicals C2.1.5
- [ ] Distinguish transmembrane receptors from intracellular receptors C2.1.6
- [ ] Explain how a receptor starts a signal transduction pathway C2.1.7
- [ ] Explain how the acetylcholine receptor changes the membrane potential C2.1.8
- [ ] Describe how receptors activate G proteins C2.1.9
- [ ] Outline the action of adrenaline, with the G protein and cAMP C2.1.10
- [ ] Explain how insulin acts through a tyrosine kinase receptor C2.1.11
- [ ] Explain how intracellular receptors change gene expression C2.1.12
- [ ] Describe the effects of oestradiol and progesterone on target cells C2.1.13
- [ ] Distinguish positive from negative feedback, with an example of each C2.1.14

01 A lock that only one key opens

C2.1.1 HL

CUES

Predict: Three ligands, a circle, a square and a triangle, are added to a receptor with a triangular binding site. Which one will switch the receptor on?

What is meant by receptors?

What is meant by binding site?

What is meant by ligand?

NOTES

1 Cells in a body are surrounded by thousands of different chemicals, and each cell has to respond to the right ones and ignore the rest. It does this with _____.

2 A receptor is a protein with a _____ whose shape and charge fit one particular signalling chemical, called a _____.

3 The cells that do are its _____.

4 A _____ is a signalling chemical; a _____ is a protein with a binding site that fits it.

5 Binding changes the receptor's _____ and starts a response.

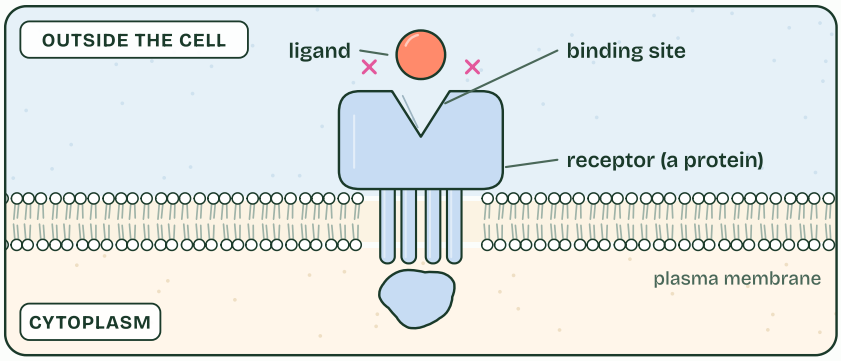
6 Only _____, with the right receptor, respond.

What is meant by target cells?

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Circle, Square and Triangle. Note what changes each time.



Circle: the shape does not fit the binding site,
so it does not bind and the receptor stays off.

SUMMARY

Sum up section 01 in two or three sentences of your own.

02 Bacteria that count each other

C2.1.2 HL

CUES

Predict: A single Vibrio fischeri cell in a large volume of seawater is given the genes for light. Will it glow?

What is meant by quorum sensing?

NOTES

1 Bacteria are single cells, but many act together once there are enough of them, and they work out when by releasing a signalling chemical and sensing how much of it there is. This is _____.

2 Each bacterium makes a small signalling molecule, an _____, which diffuses out of the cell.

3 Each cell releases an _____. The more cells, the higher its concentration.

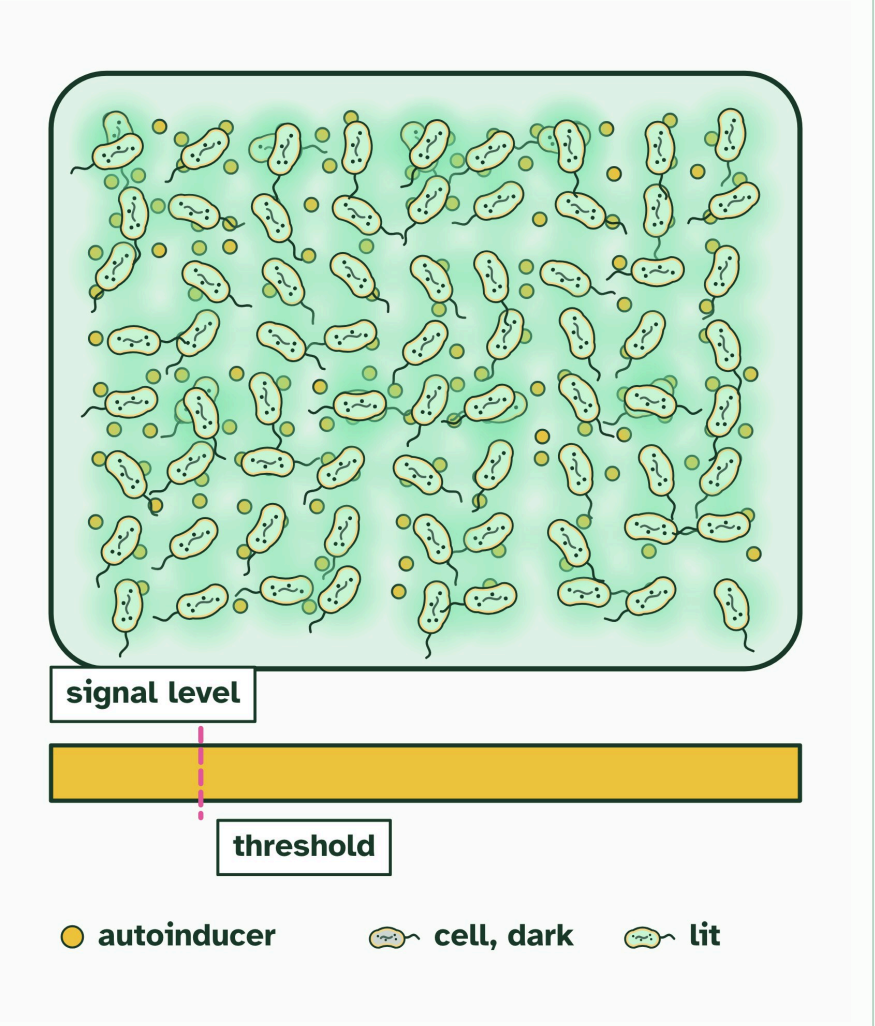
4 At a _____ it binds receptors and switches on genes, here for light.

5 It lets a population act together only when it is _____ to matter.

Your own notes

ANNOTATE THE FIGURE

Annotate this still from the animation (Bacteria counting each other): what is happening, and why?



SUMMARY

Sum up section 02 in two or three sentences of your own.

03 Four ways to send a message

C2.1.3 HL C2.1.5 HL

CUES

Predict: Which signalling chemical would be the best choice for a message that has to reach every muscle in the body, and last for several minutes?

NOTES

1 _____ are made by endocrine glands and carried by the blood to target cells anywhere in the body, so their effects are distant and slow, and often last for hours or longer. _____ are released by a neuron and diffuse across a synaptic gap, about 20 nm wide, to the next cell.

2 They act very locally, within milliseconds, and are quickly removed. _____ are small proteins released by immune and other cells that change the behaviour of nearby cells, and sometimes distant ones, to coordinate a defence. _____ are released from stores inside a cell into the cytoplasm and are a signal within and between cells.

3 Hormones: _____.

4 Neurotransmitters: _____.

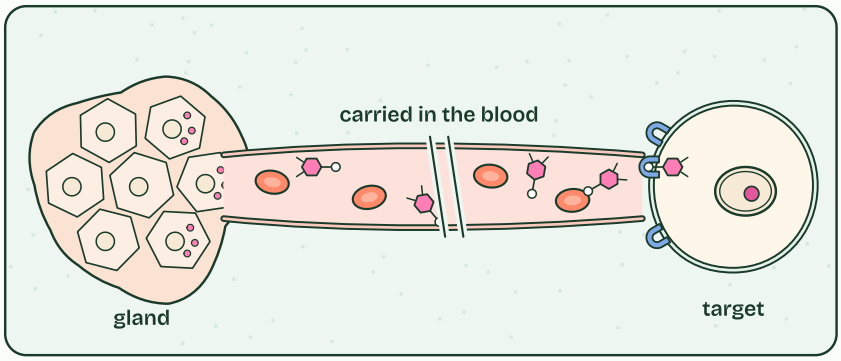
5 Cytokines: _____.

6 Calcium ions: _____.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Hormone, Neurotransmitter, Cytokine and Calcium ions. Note what changes each time.



Hormones: made by endocrine glands and carried by the blood,
so they reach target cells anywhere in the body. Slow, and long-lasting.

SUMMARY

Sum up section 03 in two or three sentences of your own.

04 Why so many kinds of chemical?

C2.1.4 HL

CUES

NOTES

1 Hormones and neurotransmitters are not one family of molecule.

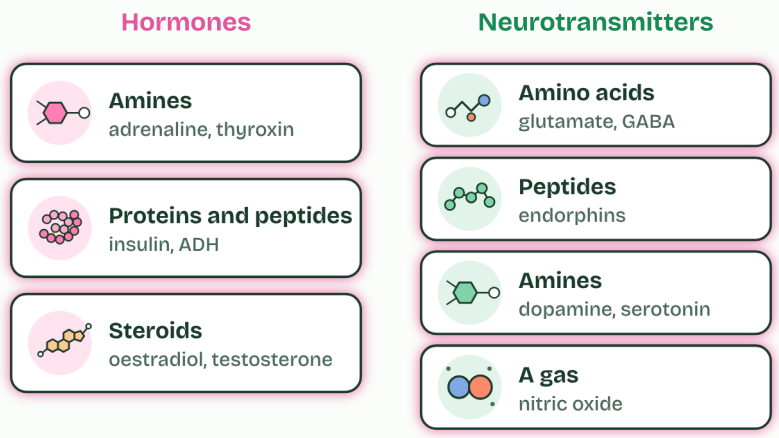
_____ include _____ such as adrenaline and thyroxin, _____ such as insulin and ADH, and _____ such as oestradiol and testosterone.

_____ include _____ such as glutamate and GABA, _____ such as endorphins, _____ such as dopamine and serotonin, and even a gas, nitric oxide.

Your own notes

ANNOTATE THE FIGURE

Label each part and say what it does: amines, proteins and peptides, steroids, amino acids, peptides, amines, nitric oxide (NO).



SPOT THE MISTAKE

What do students often get wrong about chemical diversity of hormones and neurotransmitters? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 04 in two or three sentences of your own.

05 Receptor at the door or inside the house

C2.1.6 HL

CUES

Predict: Which sentence correctly describes the part of a transmembrane receptor that lies in the lipid bilayer?

NOTES

1 A ligand that is _____, such as a peptide hormone or adrenaline, cannot enter, so it binds a _____: a protein that spans the membrane.

2 The part that crosses the bilayer is made of _____ amino acids, which are at home in the lipid core.

3 A ligand that is _____, such as a steroid hormone, diffuses through the bilayer and binds an _____ in the cytoplasm or nucleus.

4 _____ cannot cross the membrane: it binds a _____.

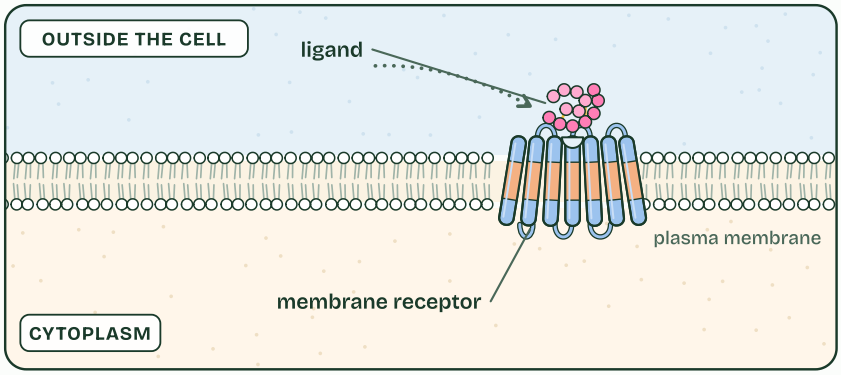
5 The receptor has _____ parts in the water and a _____ part in the bilayer.

6 _____ (a steroid) crosses the membrane: it binds an _____.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Peptide or amine and Steroid. Note what changes each time.



Water-soluble ligand: cannot cross the bilayer.

It binds the outside of a transmembrane receptor.

hydrophilic amino acids

hydrophobic amino acids

SUMMARY

Sum up section 05 in two or three sentences of your own.

06 One ligand, a chain of events

C2.1.7 HL

CUES

Predict: A single molecule of a hormone binds to a single receptor, yet the cell makes millions of glucose molecules. What best explains this?

What is meant by signal transduction pathway?

NOTES

1 Instead, the binding switches the receptor on, and the receptor starts a _____: a series of steps in which one molecule activates the next, until the cell does something.

2 Each step can switch on many molecules of the next, so the pathway _____ the signal: one ligand molecule can lead to thousands of enzyme molecules at work.

3 Binding _____, which starts a _____ of steps inside the cell.

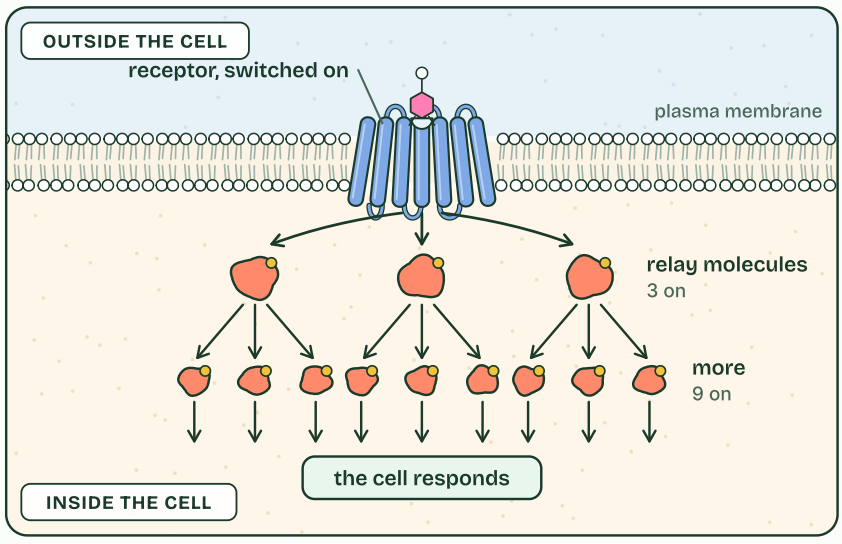
4 Each step activates _____ of the next: the signal is _____.

5 The pathway ends in a _____: an enzyme, a channel or a gene.

Your own notes

ANNOTATE THE FIGURE

Number the 5 steps on the figure and note what happens at each: 1 ligand; 2 switched on; 3 relay molecules; 4 amplified; 5 response.



SUMMARY

Sum up section 06 in two or three sentences of your own.

07 A receptor that is also a gate

C2.1.8 HL

CUES

Predict: Acetylcholine binds a receptor and positively charged ions flow into the cell. What happens to the membrane potential?

What is meant by depolarizes?

NOTES

1 The _____ in the membrane of a muscle fibre or a neuron is a protein with a central pore that is closed at rest.

2 With the channel open, _____, mostly sodium, diffuse into the cell down their concentration gradient.

3 The inside of the cell, which was negative (about −70 mV at rest), becomes less negative: the membrane _____.

4 If the change reaches the threshold in a neuron, an _____ starts and travels along the axon (see the C2.2 guide, and its films of the synapse and the action potential).

5 The _____ is a _____: binding opens the pore.

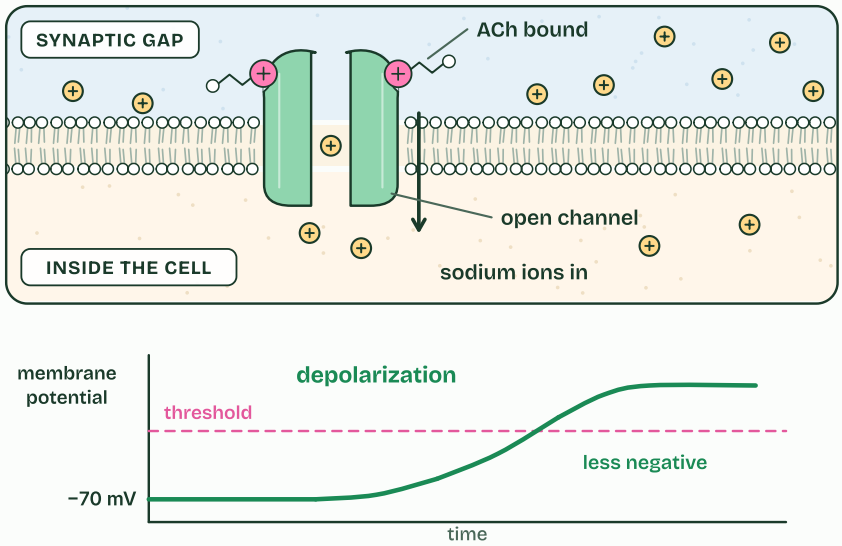
6 _____ (sodium) diffuse in, and the membrane _____.

7 It may then trigger an _____ or a contraction.

Your own notes

ANNOTATE THE FIGURE

Number the 5 steps on the figure and note what happens at each: 1 closed, −70 mV; 2 Acetylcholine; 3 channel opens; 4 Positive ions; 5 less negative, depolarized.



SUMMARY

Sum up section 07 in two or three sentences of your own.

08 A receptor that wakes a second protein

C2.1.9 HL

CUES

Predict: What switches a G protein on?

What is meant by g protein?

What is meant by second messenger?

NOTES

1 Instead they pass the signal to a _____ on the inside of the membrane.

2 The human genome has hundreds of these _____, and they respond to hormones, neurotransmitters, light and smells.

3 The G protein sits next to the receptor holding a molecule of _____, and it is off.

4 When a ligand binds the receptor, the receptor changes shape and switches the G protein on: it lets go of GDP and takes up _____.

5 That molecule is a _____: the ligand is the first messenger, and this is the second.

6 A _____ is off with _____ and on with _____.

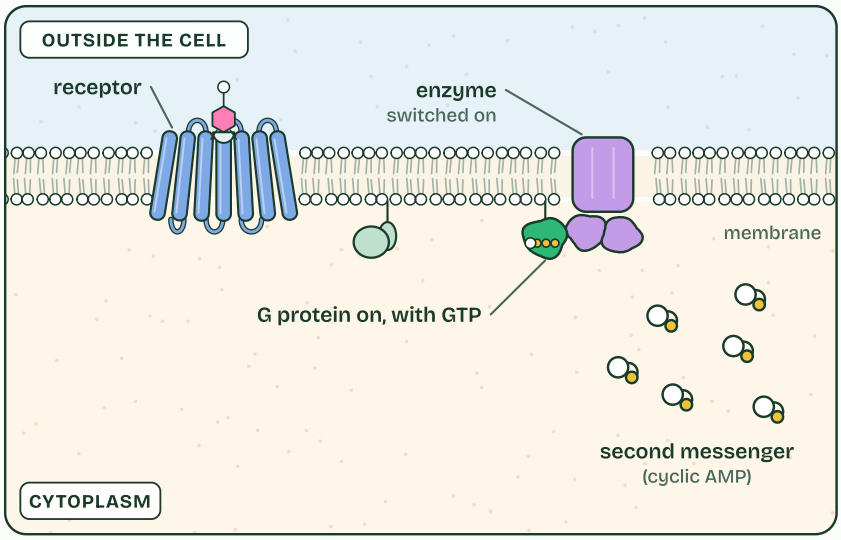
7 The ligand switches on the _____; the receptor switches on the _____.

8 The G protein switches on an _____ that makes a _____.

Your own notes

ANNOTATE THE FIGURE

Number the 4 steps on the figure and note what happens at each: 1 ligand, G protein, GDP; 2 on; 3 swaps GDP for GTP, on; 4 enzyme, second messenger.



SUMMARY

Sum up section 08 in two or three sentences of your own.

09 Adrenaline: from receptor to glucose

C2.1.10 HL

CUES

Predict: A drug binds the adrenaline receptor but does not change its shape. What will happen when adrenaline is also present?

What is meant by adrenaline?

NOTES

1 When you are frightened, the adrenal glands release _____ (epinephrine) into the blood.

2 Slide _____, and see what a _____, which fits the receptor and does not switch it on, does.

3 Adrenaline → _____ → _____ → _____ → _____ → _____ → glucose.

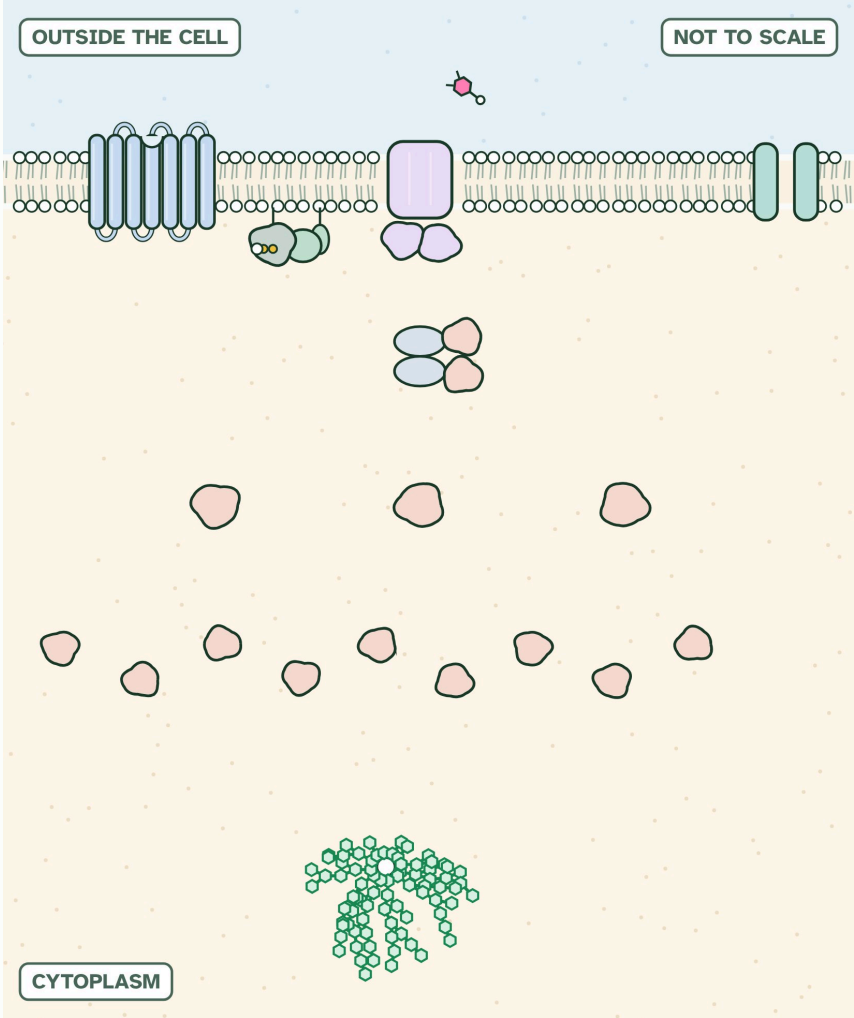
4 _____ is the _____.

5 The pathway _____, so the response is fast and large.

Your own notes

ANNOTATE THE FIGURE

Annotate this still from the animation (Adrenaline, receptor to response): what is happening, and why?



REMEMBER IT

R G A C K: rack up the glucose

R	G	A	C	K
R	G	A	C	K

SUMMARY

Sum up section 09 in two or three sentences of your own.

10 Insulin: move the transporters

C2.1.11 HL

CUES

Predict: A muscle cell is given insulin. What is the direct effect on the plasma membrane?

What is meant by tyrosine kinase receptor?

NOTES

1 The insulin receptor is a _____: the part inside the cell is an enzyme.

2 When insulin binds, the receptor changes shape, and the enzyme part adds phosphate groups to _____ amino acids on the receptor (_____).

3 The phosphorylated tyrosines are docking sites that switch on relay proteins, and a sequence of reactions follows. It ends with _____ that carry _____ (GLUT4) moving to the plasma membrane and fusing with it.

4 Insulin binds a _____ receptor; the receptor _____ inside the cell.

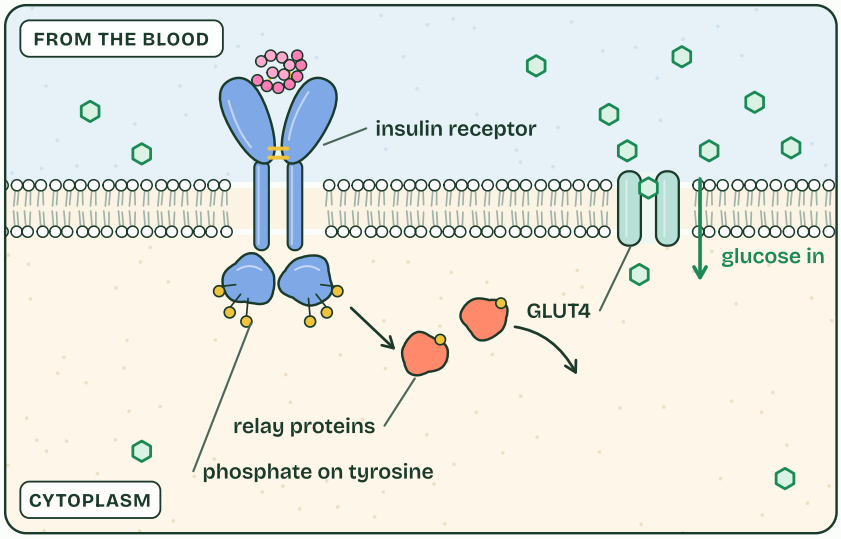
5 A sequence of reactions moves _____ to the plasma membrane.

6 More transporters: _____, less in the blood.

Your own notes

ANNOTATE THE FIGURE

Number the 6 steps on the figure and note what happens at each.



SUMMARY

Sum up section 10 in two or three sentences of your own.

11 A hormone that switches on a gene

C2.1.12 HL

CUES

Predict: Why does a steroid hormone take longer to act on a cell than adrenaline does?

NOTES

1 Steroid hormones, such as _____, _____ and _____, are lipids made from cholesterol.

2 They pass straight through the phospholipid bilayer and bind a receptor _____, so they need no pathway of relay molecules at the membrane.

3 The ligand binds a site on the receptor and _____ it.

4 The activated receptor moves into the nucleus (some start there), where it binds to _____ next to a gene and _____ of that gene.

5 Because the cell has to make mRNA and then protein, the response is _____ (hours) but it _____, compared with the seconds of a G protein pathway.

6 A steroid is _____, so it crosses the membrane and binds an _____.

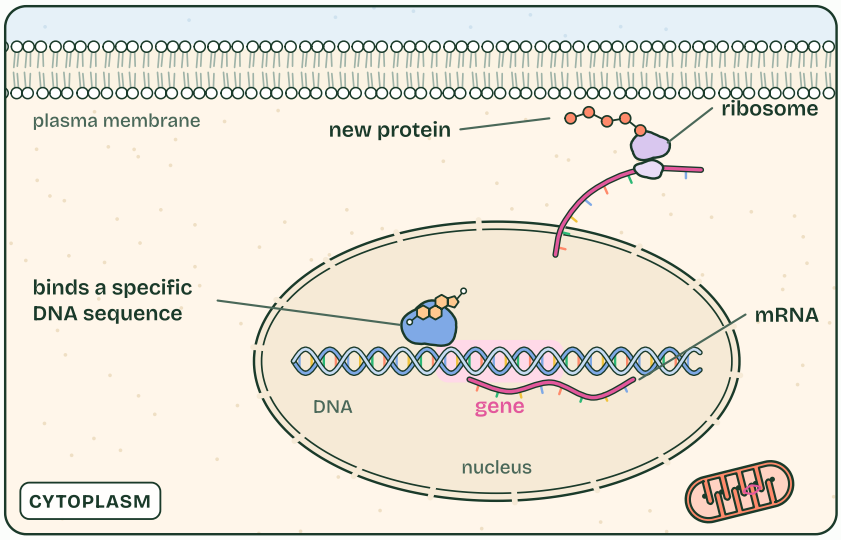
7 The active receptor binds _____ and _____.

8 It changes _____ a cell makes: slower, longer-lasting.

Your own notes

ANNOTATE THE FIGURE

Number the 6 steps on the figure and note what happens at each: 1 steroid hormone; 2 diffuses through; 3 intracellular receptor; 4 nucleus; 5 specific DNA sequence, promotes transcription; 6 translated.



SUMMARY

Sum up section 11 in two or three sentences of your own.

12 Two steroids, two targets

C2.1.13 HL

CUES

Predict: A target cell has no receptor for progesterone. What is its response to a high concentration of progesterone?

NOTES

1 _____, made by the growing follicle, acts on _____.

2 _____, made by the corpus luteum after ovulation, acts on the cells of the _____, the lining of the uterus.

3 **Oestradiol:** acts on _____ in the hypothalamus.

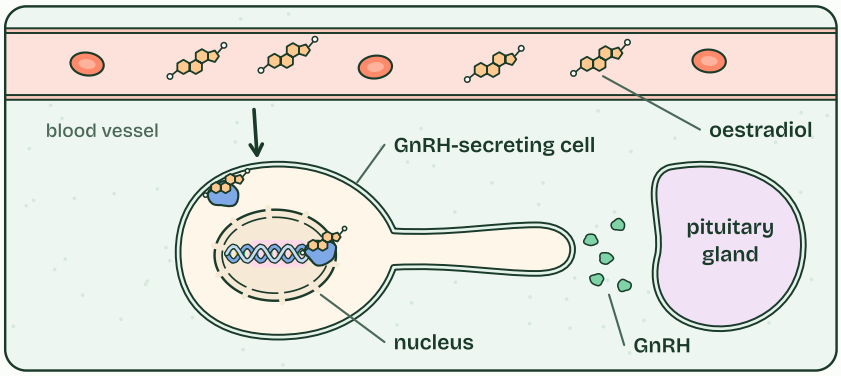
4 **Progesterone:** acts on the _____, to prepare it for implantation.

5 Both are _____: they enter cells and change _____.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Oestradiol and Progesterone. Note what changes each time.



Oestradiol enters and acts on the GnRH gene.
Low levels reduce GnRH; high levels raise it (LH surge).

SUMMARY

Sum up section 12 in two or three sentences of your own.

13 Switching a signal off, or up

C2.1.14 HL

CUES

Predict: Which is an example of positive feedback?

NOTES

1 In _____ the result _____ the change that started it.

2 In _____ the result _____ the change.

3 In labour, the baby's head presses on the cervix, which sends a signal to the hypothalamus, so the pituitary gland releases _____.

4 **Negative:** the result _____ the change. Stable. Example: insulin and glucose.

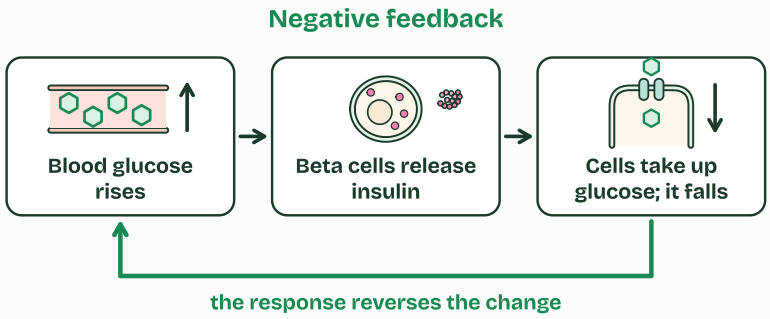
5 **Positive:** the result _____ the change. Example: oxytocin in labour.

6 Positive feedback needs an _____: the birth, or the supply running out.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Negative feedback and Positive feedback. Note what changes each time.



Negative: the output of the pathway switches the pathway off.

Stable. Most signals in the body are controlled this way.

SUMMARY

Sum up section 13 in two or three sentences of your own.

Check yourself

The check for this guide is online: a fresh paper of past-paper style questions from the exam bank on C2.1 each time, marked as you go, and saved to your Exam practice progress when you are signed in. Scan the code, or type the link.

biologybybradford.com/exam-maker/sit?topics=C2.1&level=HL&paper=quiz&marks=15&src=ep

How this was made. The course structure, the activities and the teaching choices come from my own classroom, my presentations and my years of teaching IB and AP Biology. I use Claude, an AI, to help write and build the interactive guides, lesson plans, slides and practice questions, and to draw the diagrams and code the interactives. I direct the work and review it against the IB and AP specifications before it goes live.