A cell that carries a signal

60 minutes • C2.2.1, C2.2.2 • Chapters 1, 2

What a neuron is and what its parts do, and how pumping sodium and potassium ions makes and keeps a resting potential, negative inside

BY THE END, STUDENTS CAN

- [ ] Describe a neuron and say what its cell body, axon and dendrites are for C2.2.1
- [ ] Explain how pumping sodium and potassium ions across the membrane makes the resting potential, and why the inside is negative C2.2.2

TIMING

0–5	5 min	Do now: draw a neuron	
5–15	10 min	One cell, one metre long	
15–25	10 min	Paper-clip test	
25–45	20 min	A battery before any signal	
45–55	10 min	Exam question	
55–60	5 min	Exit	
	60 min	One lesson	

STARTER

5 min

Do now: draw a neuron

From memory, in four minutes: a neuron with as many of seven parts labelled as students can (cell body, nucleus, dendrites, axon, myelin sheath, node, axon terminals). Pairs compare and add what the other has.

ON THE BOARD, FROM THE GUIDE

Open the guide on the projector at each chapter (the links work in this PDF). Every figure plays from its own buttons, and the lesson's slides have the same figures, step by step, in the order of this plan.

01 One cell, built to signal

CHAPTER 01 IN THE SLIDES

Tap the parts of the figure in turn: Dendrites, Axon, Cell body, Nucleus, Myelin sheath and Axon terminals.

> **Predict box:** The motor neuron that moves a toe muscle has its cell body in the lower spinal cord. Where is its axon? Hands up or mini whiteboards first.
>
> **Answer C: Running all the way from the cord to the toe muscle, one thread about a metre long in a tall adult**

02 A battery before any signal

CHAPTER 02 IN THE SLIDES

Step through the figure (5 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. A resting neuron's membrane, much enlarged: **sodium** ions crowd the fluid outside, **potassium** ions the cytoplasm inside, and the dial reads about −70 mV.
2. The **sodium-potassium pump** uses one ATP to move three Na^+ out and two K^+ in, both against their gradients. It never stops.
3. Potassium **leaks** back out through channels that are always open; sodium can barely leak in. Each K^+ that leaves takes a positive charge out.
4. Large **negative ions**, mostly proteins, are trapped inside: they are far too big to cross the membrane.
5. The result: more positive charge outside, more negative inside. The membrane is **polarized**, at about −70 mV: the resting potential.

Play the animation, A battery before any signal. It loops; pause it on each moment below and ask what is happening (in the lesson slides it is a video).

1. A patch of an axon's membrane, zoomed in. Suppose Na^+ and K^+ were spread the same on both sides: ions cross both ways, and there is no voltage across it.
2. The **sodium-potassium pump** uses one ATP to move 3 Na^+ out and 2 K^+ in, against their gradients. Each turn moves more positive charge out than in.
3. K^+ leaks back out through open **leak channels** far more easily than Na^+ leaks in. The large anions inside cannot follow, so the inside is left negative.
4. About **−70 mV** inside: the **resting potential**. The membrane is **polarized**, and only a tiny share of the ions had to cross to make it.
5. At rest a little Na^+ still leaks in and K^+ leaks out, so the pump keeps working, using ATP, and the resting potential holds.

> **Predict box:** A neuron's pumps are all switched off and it is left alone. What happens to the voltage across its membrane over a long time? Hands up or mini whiteboards first.
>
> **Answer D: It runs slowly down towards zero, as the ions leak across and the gradients fade away**

THE LESSON

10 min — One cell, one metre long

Chapter 1's predict box on the toe muscle's neuron first, then its figure: tap each part and check the Do now drawings against it. Name the three kinds of neuron (sensory, relay, motor) in one line each; their roles in a reflex are C3.1's.

10 min — Paper-clip test

The practical below: one point or two, on the fingertip, the back of the hand and the forearm. Pool the smallest gap each place can tell apart. Ask why the fingertip wins: more sensory endings packed closer, a lead into signals from the skin.

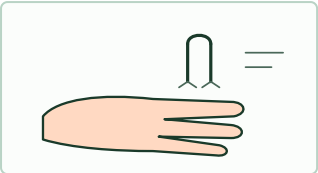
20 min — A battery before any signal

Chapter 2's predict box (the pumps switched off) before the figure. Then the five-step figure, and the film under it: turn the Pump off and watch the voltage run down, then the Leak. Students write the resting potential in one sentence that names the pump, the two ions, the leak and the negative inside.

10 min — Exam question

Explain how a neuron establishes and maintains its resting potential (4 marks). Mark in pairs: ATP drives the pump; three sodium out for two potassium in; more potassium than sodium leaks across; so there is more positive charge outside, and the inside is negative.

ACTIVITIES



PRACTICAL

Paper-clip test

Bend a paper clip so its two ends are a set distance apart, starting at 2 cm. With the partner's eyes closed, touch the skin lightly with one end or both, at random, ten times, and record how often they say the right number. Close the gap a few millimetres at a time and find the smallest they can still tell as two, on the fingertip, the back of the hand and the forearm. Compare places and partners. Safety: a touch only, never a press or a scratch; partners agree before they start and either can stop; blunt dividers are better than a clip with sharp ends.

Needs: a paper clip or blunt dividers and a ruler for each pair.

PLENARY

5 min

Exit

Why is the inside of a resting neuron negative? One sentence, no more than twenty words.

WHAT STUDENTS GET WRONG

"The pump makes the impulse." The pump makes and keeps the gradients at rest; the impulse is ions flowing through channels, down those gradients. A neuron fires many times before its pumps are needed to catch up.

"The inside is negative because it has no positive ions." It is full of potassium. It is negative because there is slightly less positive charge inside than out, and many negatively charged proteins stay inside.

STRETCH AND SUPPORT

Support: a labelled neuron to colour, the cell body, axon and dendrites in three colours, before drawing one from memory.

Stretch: the pump moves three sodium out for two potassium in. Why does that alone make the inside slightly more negative, and why is it only a small part of the resting potential?

IN THE GUIDE

1 One cell, built to signal

2 A battery before any signal

All The whole guide, with the figures that play

PPTX This lesson's slides, in the order of this plan

EXAM PRACTICE

Check yourself

Set it for homework: a fresh paper of exam-bank questions on C2.2 at standard level each time, marked as students go and saved to their Exam practice when they are signed in.

biologybybradford.com/exam-maker/sit?topics=C2.2&level=SL&paper=quiz&marks=15&src=ep

PRACTISE AND REVISE

BUILD FOR YOUR CLASS

- Tarsia puzzle, dominoes and picture reveal on C2.2, built from its key terms and ready to print
- A pub quiz with rounds on C2.2, to present or run with no projector
- An escape room built from the question bank on C2.2

ALREADY ON THE SITE FOR C2.2

- Lesson: Synaptic Transmission
- Lesson: Action Potentials
- Summary doodle: Neural Signalling
- Quiz: Neural Signalling
- Revision map: C2.2 Neural signalling, to fill in
- Exam questions: C2.2 in the exam maker, a paper with its markscheme

CARD SETS ON SPLYCR

Open a set to host it as a class game, or make a copy to edit.

- C2.2–C3.2 Neural Signalling, Body Systems & Defence
- B3.2–C2.2 Plant Transport, Respiration & Neural Signalling

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.