Downhill

60 minutes • 2.5.A, 2.6.A • Chapters 1, 2, 3, 4 • The dry lab

Diffusion and passive transport, facilitated diffusion through channels and carriers, aquaporins, gated ion channels and membrane potential, with the dialysis tubing lab

BY THE END, STUDENTS CAN

- [ ] Describe diffusion and passive transport down a concentration gradient, and their role in taking in materials and getting rid of wastes 2.5.A
- [ ] Explain why charged and large polar molecules need channel or carrier proteins, including aquaporins for water and channels for Na+ and K+ 2.6.A
- [ ] Explain how gated ion channels and the movement of ions polarize a membrane 2.6.A
- [ ] Describe active transport and the sodium-potassium pump, and explain why it needs ATP 2.5.A

TIMING

0–5	5 min	**Do now: the smell spreads**	
5–12	7 min	**Down the gradient**	
12–21	9 min	**Doors in the wall**	
21–52	31 min	**What gets out of the bag**	
52–60	8 min	**Exit**	
	60 min	**One lesson**	

STARTER

5 min

Do now: the smell spreads

Spray a little air freshener at the front of the room. Students raise a hand when they smell it. Pairs write why the back row smells it last, and whether the molecules "know" where to go.

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 Downhill, for free

CHAPTER 01 IN THE SLIDES

Play the animation, Who smelled it first?. It loops; pause it on each moment below and ask what is happening (in the lesson slides it is a video).

1. A quiet classroom. Nobody has noticed anything yet.
2. Somebody lets one go. The gas particles start crowded together in one place: a **high concentration**.
3. Each particle moves at **random**, yet more wander out of the crowd than back into it. That net movement from high to low concentration is **diffusion**.
4. The nearest nose smells it first, because the concentration is still highest close to the source. Whoever smelled it first is probably sitting beside whoever dealt it.
5. Given time the particles spread through the whole room. Nobody pushed them: diffusion needs no energy, only random motion and a **concentration gradient**.

Play the animation, Diffusion across a membrane. It loops; pause it on each moment below and ask what is happening (in the lesson slides it is a video).

1. Every particle moves at **random**, bumping into the others and the walls.
2. **Net movement** down the concentration gradient: more cross from the left.
3. **Dynamic equilibrium**: still crossing both ways, at about the same rate.

> **Predict box:** Oxygen is at a higher concentration inside a leaf cell in sunlight than in the air spaces around it. Which way does it move, and what does it cost the cell? Hands up or mini whiteboards first.
>
> **Answer B: Out of the cell, down its gradient, and the cell spends nothing on it because diffusion is passive**

02 A door through the bilayer

CHAPTER 02 IN THE SLIDES

Switch the figure through Channel shut, Channel open and Pump, and have the class say what will change before each.

> **Predict box:** Glucose enters a red blood cell through a carrier protein. What happens to the rate of entry as the glucose outside rises higher and higher? Hands up or mini whiteboards first.
>
> **Answer B: It rises, then levels off, because every carrier protein is busy and none is left to carry more**

03 Water in single file

CHAPTER 03 IN THE SLIDES

Step through the figure (3 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. A water molecule squeezes **between the phospholipids**: it crosses, but slowly.
2. Through an **aquaporin**, water passes in single file, very fast.
3. With more solute inside, more water enters than leaves: **net flow in**.

> **Predict box:** A frog's egg normally takes in little water. Scientists inject it with mRNA for an aquaporin and drop it in pure water. What happens? Hands up or mini whiteboards first.
>
> **Answer A: It takes in water much faster than a normal egg, swells and bursts, because water now has a channel in**

04 Charge across a membrane

CHAPTER 04 IN THE SLIDES

Switch the figure through No acetylcholine, Acetylcholine bound and Voltage-gated, and have the class say what will change before each.

> **Predict box:** A toxin from pufferfish blocks the voltage-gated sodium channels of nerve cells. What happens to the nerves? Hands up or mini whiteboards first.
>
> **Answer B: They cannot send impulses, because Na^+ cannot rush in when the charge across them changes**

THE LESSON

7 min — Down the gradient

Chapter 1's film: which particles cross between the lipids, which need a channel, and which cannot cross. Define the gradient, and ask what keeps one going.

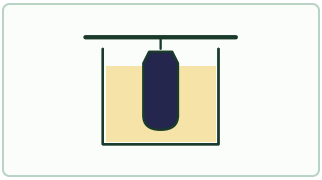
9 min — Doors in the wall

Chapter 2's figure: shut channel, open channel, pump. Then chapter 3's aquaporin and chapter 4's gated channels. For each, students say on mini whiteboards: passive or active, and what it lets through.

31 min — What gets out of the bag

Dialysis tubing for real, or the dry lab on the Lab tab (activity below): starch and glucose inside, iodine water outside, samples every 5 minutes. Groups test bags of different lengths or temperatures and compare their rates over the first 5 minutes.

ACTIVITIES



DRY LAB

What gets out of the bag

Soak a 10 cm length of dialysis tubing, tie one end, fill it with 10 mL of 1% starch and 1% glucose, tie the other end and rinse the outside. Hang it in a beaker of water with a few drops of iodine solution. Every 5 minutes, dip a glucose test strip in the water outside (or take a sample for Benedict's test). Watch the bag turn blue-black, and finish with an iodine test of the outside water. The dry lab on the Lab tab varies the length and temperature with repeats.

Needs: dialysis (Visking) tubing, thread, 1% starch and 1% glucose solutions, iodine solution, beakers, glucose test strips or Benedict's reagent and a hot water bath, a stopwatch, eye protection.

PLENARY

8 min

Exit

On paper: "Explain why glucose but not starch appeared outside the bag, and why its concentration leveled off" (3 points). Then chapter 2's predict box for anyone who finishes.

WHAT STUDENTS GET WRONG

"Molecules move to where there are fewer of them on purpose." They move at random; the net movement is down the gradient.

"Diffusion stops when the two sides are equal." Movement continues both ways; the net movement stops.

"Facilitated diffusion uses energy because a protein is involved." It is passive: down the gradient, no ATP.

"Water only crosses through aquaporins." A little crosses the bilayer; aquaporins let far more through.

STRETCH AND SUPPORT

Stretch: sketch the graph of rate of entry against outside concentration for simple diffusion and for facilitated diffusion, and explain the difference.

Support: a hill diagram to annotate: down the hill is passive, up is active, with the proteins drawn as doors.

For revision: students can drill this unit's key terms on Cramly.

IN THE GUIDE

1 Downhill, for free
2 A door through the bilayer
3 Water in single file
4 Charge across a membrane
Lab Dry lab: What gets out of the bag
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 2.5, 2.6, 2.8 each time, marked as students go and saved to their Exam practice when they are signed in.

biologybybradford.com/exam-maker/sit?program=ap&units=U2&ced=2.5,2.6,2.8&paper=quiz&marks=15&src=ep

PRACTISE AND REVISE

BUILD FOR YOUR CLASS

- Tarsia puzzle, dominoes and picture reveal on Unit 2, built from its key terms and ready to print
- A pub quiz with rounds on Unit 2, to present or run with no projector
- The Cell Factory Lockdown escape room, or an escape room built from the question bank on Unit 2

ALREADY ON THE SITE FOR UNIT 2

- Lesson: Passive Transport & Osmosis
- Lesson: Active & Bulk Transport
- Lab: The Endomembrane System
- Quiz: Membrane Transport & Facilitated Diffusion
- Quiz: Tonicity, Osmoregulation & Transport Mechanisms
- Exam questions: Unit 2 in the exam maker, a paper with scoring guidelines

CARD SETS ON SPLYCR

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

- Unit 2: Cell Structure and Function (part 1)
- Unit 2: Cell Structure and Function (part 2)
- Unit 2: Cell Structure and Function (part 3)

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.