

Inhibitors, pathways and energy

60 minutes • 3.2.B, 3.3.A, 3.3.B • Chapters 6, 7, 8 • The dry lab

Competitive and noncompetitive inhibition, feedback in pathways, and coupling with ATP, ending on a timed free response

BY THE END, STUDENTS CAN

- ☐ Predict how temperature, pH, substrate and product concentrations and inhibitors change the rate of a reaction 3.2.B
- ☐ Describe why a living cell needs a constant input of energy, and how ATP couples an uphill reaction to a downhill one 3.3.A
- ☐ Explain why energy pathways run in small steps, and what the same pathways in every domain of life tell us 3.3.B

TIMING

0-5	5 min	Do now: two extra lines	
5-15	10 min	Block it or bend it	
15-25	10 min	Dry lab, Task 3	
25-37	12 min	Pathways and feedback	
37-49	12 min	Paying for uphill reactions	
49-60	11 min	Free response, timed	
	60 min	One lesson	

STARTER

- 5 min** **Do now: two extra lines**
- Sketch rate against substrate concentration. Add a line for something that competes for the active site, and one for something that changes the site's shape from elsewhere.

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.

06 Inhibitors block the site, or bend it

CHAPTER 06 IN THE SLIDES

Switch the figure through None, Competitive and Noncompetitive, and have the class say what will change before each.

Predict box: Two reactions are slowed by inhibitors. You add a large excess of substrate to both. One gets back almost its full rate; the other does not. What does the one that recovered contain? Hands up or mini whiteboards first.

Answer B: A competitive inhibitor, outnumbered by substrate

Remember it: Copycat Nope Another (Competitive, Noncompetitive, Allosteric site).

07 Staying alive takes a constant supply of energy

CHAPTER 07 IN THE SLIDES

Switch the figure through Energy flowing in and Energy cut off, and have the class say what will change before each.

Step through the figure (4 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. Making glutamine from glutamate and ammonia is **uphill**: $\Delta G = +14$ kJ/mol. On its own it hardly happens.
2. Splitting ATP into ADP and phosphate is **downhill**: $\Delta G = -31$ kJ/mol. The products are more stable than ATP was.
3. The enzyme glutamine synthetase **couples** them: ATP hands its end phosphate to glutamate. Glutamyl phosphate is unstable, ready to react.
4. Ammonia takes the phosphate's place, making glutamine. Overall $+14 - 31 = -17$ kJ/mol: downhill, so it runs. Respiration then rebuilds the ATP.

Predict box: Reaction X has $\Delta G = +20$ kJ/mol. Which of these would make it run in a cell? Hands up or mini whiteboards first.

Answer C: Coupling X to ATP hydrolysis (-31)

Remember it: Exits Enters (Exergonic, Endergonic).

08 Pathways go in small steps, shared by all life

CHAPTER 08 IN THE SLIDES

Step through the figure (4 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. A pathway: **each product is the next enzyme's substrate**, so threonine is turned into isoleucine step by step (three steps here; the real pathway has five).
2. The cell makes more isoleucine than it is using, and it **builds up**.
3. Isoleucine binds an **allosteric site** on enzyme 1 and bends its active site. The first step stops, so the whole pathway stops.
4. As the cell uses isoleucine to build proteins, the level falls, isoleucine **lets go**, and the pathway runs again: negative feedback.

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. Bacteria, archaea and eukaryotes all **run on ATP**, and all break glucose down by versions of **glycolysis**, several of whose enzymes have closely similar sequences in all three.
2. All three groups trace back to **one common ancestor**. Archaea and eukaryotes share a more recent one as well.
3. The simplest explanation: the ancestor **already had** ATP and glycolysis, and every line of descent kept them. Shared, conserved pathways are evidence of common ancestry.

Predict box: The end product of a pathway builds up in a cell. What happens to the first enzyme of that pathway? Hands up or mini whiteboards first.

Answer D: It is slowed: the product binds it elsewhere

THE LESSON

10
min

Block it or bend it

Chapter 6's figure: compare the do-now sketches with the curves, then drag the substrate up with each inhibitor and count the molecules. Zanamivir and penicillin as the real cases; flag the cyanide trap.

10
min

Dry lab, Task 3

Pairs run the substrate series with no inhibitor, then competitive, then noncompetitive, and report each rate at 10% peroxide as a percentage of the uninhibited one. Or run it on the board and have the class predict each point.

12
min

Pathways and feedback

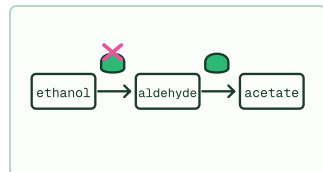
The alcohol pathway reading (activity below), then chapter 8's feedback figure, stopped at step 3 for students to predict step 4. Close with the tree: why the same pathway in every domain?

12
min

Paying for uphill reactions

Chapter 7: energy on and off for the cell, then the glutamine coupling a step at a time. Students add the ΔG values themselves before step 4 shows the total.

ACTIVITIES



READING

A pathway in the liver

Ethanol is turned into acetaldehyde by alcohol dehydrogenase, acetaldehyde into acetate by aldehyde dehydrogenase, and acetate into acetyl CoA, which enters the Krebs cycle. Ask: which enzyme has acetaldehyde as its product, and which as its substrate? What builds up if the second enzyme is slow? Methanol poisoning is treated with fomepizole, which binds the active site of alcohol dehydrogenase: why does that help, and what kind of inhibitor is it?

Needs: nothing but the guide. Fomepizole stops methanol being turned into formaldehyde and formic acid, the toxic products, while the methanol is excreted.

PLENARY

11
min

Free response, timed

Two parts of a free-response question on inhibitors or coupling, from the Unit 3 exam maker (in Practise and revise, below), in 6 minutes, then swap and mark against the scoring guide. For homework, the Check step: a fresh paper on 3.1 to 3.3 from the exam bank, marked as students go.

WHAT STUDENTS GET WRONG

"Breaking ATP's bond releases energy." Breaking any bond takes energy. ATP hydrolysis is exergonic because the products are more stable. Make students write the corrected sentence.

"A competitive inhibitor lowers the maximum rate." It raises the substrate needed to reach the same maximum. The graphs in chapter 6 and Task 3 of the dry lab settle it.

Errors that turn up in published slides. Iodine with starch is blue-black, not purple; a positive biuret test is purple (blue means no protein); zanamivir stops neuraminidase cutting sialic acid, not hemagglutinin; cyanide binds the metal center of cytochrome c oxidase and is not an allosteric inhibitor.

STRETCH AND SUPPORT

Support: drag a figure's slider and describe what moves before explaining why; the SPITE and Exits / Enters tiles as a checklist.

Support: a printed, pre-drawn energy diagram to annotate during chapter 2, and the free-response table with the rows to compare already highlighted.

IN THE GUIDE

- 6** [Inhibitors block the site, or bend it](#)
- 7** [Staying alive takes a constant supply of energy](#)
- 8** [Pathways go in small steps, shared by all life](#)
- Lab** [Dry lab: Catalase and hydrogen peroxide](#)
- A11** [The whole guide, with the figures that play](#)
- PPTX** [This lesson's slides, in the order of this plan](#)

PRACTISE AND REVISE

BUILD FOR YOUR CLASS

- [Tarsia puzzle, dominoes and picture reveal](#) on Unit 3, built from its key terms and ready to print
- A [pub quiz](#) with rounds on Unit 3, to present or run with no projector
- [The Kelp Light Habitat](#) escape room, or an [escape room built from the question bank](#) on Unit 3

ALREADY ON THE SITE FOR UNIT 3

- Lesson: [Enzymes](#)
- Lesson: [Environmental Impacts on Enzyme Function](#)
- Lesson: [Cellular Energy](#)
- Quiz: [Enzymes](#)
- Quiz: [Environmental Impacts on Enzyme Function](#)
- Quiz: [Cellular Energy](#)
- Exam questions: [Unit 3 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 3: Cellular Energetics \(part 1\)](#)
- [Unit 3: Cellular Energetics \(part 2\)](#)
- [Unit 3: Cellular Energetics \(part 3\)](#)

EXAM PRACTICE

Check yourself

Set it for homework: a fresh paper of exam-bank questions on 3.1 to 3.3 each time, marked as students go and saved to their Exam practice when they are signed in.

[biologybybradford.com/exam-maker/sit?](https://biologybybradford.com/exam-maker/sit?program=ap&units=U3&ced=3.1,3.2,3.3&paper=quiz&marks=15&src=ep)

[program=ap&units=U3&ced=3.1,3.2,3.3&paper=quiz&marks=15&src=ep](https://biologybybradford.com/exam-maker/sit?program=ap&units=U3&ced=3.1,3.2,3.3&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.