

Photosystems and water HL

60 minutes • C1.3.9, C1.3.10 and C1.3.11 • Chapters 8, 9

Pigments in arrays round a reaction centre, why one pigment alone is useless, and photolysis at photosystem II and its consequences for Earth

BY THE END, STUDENTS CAN

- ☐ Describe a photosystem and explain why pigments work only as an array round a reaction centre C1.3.9, C1.3.10
- ☐ Explain how photolysis at photosystem II supplies electrons and protons, and what its waste oxygen did to the Earth C1.3.11

TIMING

0-6	6 min	Do now: annotate it	
6-14	8 min	Redox again	
14-20	6 min	The glowing chlorophyll demonstration	
20-32	12 min	An array and a reaction centre	
32-46	14 min	Water split	
46-54	8 min	A written question	
54-60	6 min	Exit	
	60 min	One lesson	

STARTER

6
min

Do now: annotate it

Annotate it (below): an unlabelled drawing of a chloroplast with the two stages, from SL memory.

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.

08 Pigments in an array

CHAPTER 08 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. On its own, chlorophyll gives the energy straight back, as **red light**.
2. A **photosystem**: hundreds of pigments around a **reaction centre**, in a membrane.
3. The **energy** hops from pigment to pigment, inwards.
4. The reaction centre emits an **excited electron**.
5. Many pigments, many colours, all feeding one reaction centre.

Predict box: Chlorophyll dissolved in propanone glows red under a bright light. Chlorophyll in a leaf hardly glows at all. Why? Hands up or mini whiteboards first.

Answer D: In a leaf the energy is passed on and used

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. Photosystem II has lost electrons.
2. It takes more from **water**.
3. **Photolysis**: electrons refill the reaction centre; **protons** stay in the lumen.
4. The **oxygen** is a waste product.

Show the figure: The shape of the rise is known better than the numbers, so only 0 and today's level are marked. Banded iron formations are mostly older than about 1.8 billion years.

Predict box: Cyanobacteria were splitting water for a long time before oxygen built up in the air. Where did their oxygen go at first? Hands up or mini whiteboards first.

Answer A: Into iron dissolved in the oceans

Remember it: Please Eat Oranges (Protons, Electrons, Oxygen).

THE LESSON

8
min

Redox again

Oxidation is loss of electrons or hydrogen, reduction is gain (a C1.2 recap). Which molecule in photosynthesis is reduced?

6
min

The glowing chlorophyll demonstration

The demonstration below, with [chapter 8's](#) predict made first.

12
min

An array and a reaction centre

[Chapter 8's](#) figure step by step. Then Pass the energy (below).

14
min

Water split

[Chapter 9](#): the predict, the figure, then the Please Eat Oranges tiles. The Great Oxidation figure follows, with the banded iron story told in two minutes.

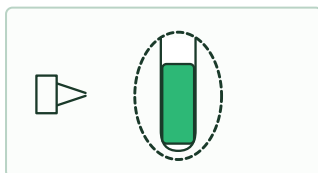
8
min

A written question

A short written question on C1.3.9 to C1.3.11 from the exam maker (in Practise and revise), timed and marked.

A teacher's mnemonic for the order: **Two before One**. Photosystem II goes first, and splits water; photosystem I reduces NADP.

ACTIVITIES



DEMO

Glowing chlorophyll

A boiling tube of spinach extract in propanone, in a dark room, lit from the side by a bright white torch (or a blue LED): it glows deep red. A whole leaf under the same light does not. Ask: where did the energy go in the leaf? ([chapter 8's](#) predict). Safety: propanone, as in Separate the greens.

Needs: extract, a boiling tube, a bright torch, a dark corner.



MODEL

Pass the energy

Students stand as a photosystem: eight to ten “pigments” in a ring round one “reaction centre”, with an “acceptor” beside them. A light card (a photon) handed to any outer pigment is passed inwards hand to hand (the energy moves, not the card’s owner) to the reaction centre, who hands a yellow “electron” token to the acceptor and is left short. Who refills it? (Photolysis, [chapter 9](#).) Then one student alone with a light card can only drop it (heat, or red light).

Needs: light cards and a few yellow tokens.



DO NOW

Annotate it

A chloroplast outline with the two stages shown as boxes, unlabelled. Students label photolysis, waste, reduced NADP, ATP, the thylakoid and the stroma.

Needs: the printed outline.

PLENARY

6

min

Exit

Why can a single chlorophyll molecule not do any part of photosynthesis?

WHAT STUDENTS GET WRONG

Every pigment in a photosystem gives off electrons.

They pass on energy; only the reaction centre emits an electron.

Oxygen from photolysis is used in the Calvin cycle. It is waste; the protons and electrons are used.

STRETCH AND SUPPORT

Stretch: the reaction centres of photosystems II and I absorb best at about 680 and 700 nm (their names, P680 and P700, are beyond the guide). Why might two photosystems in series be needed to lift electrons from water all the way to NADP? (The Z scheme, for discussion.)

Stretch: make a respiration and photosynthesis Tarsia puzzle in the Tarsia builder, ticking C1.2 and C1.3 together.

IN THE GUIDE

8 [Pigments in an array](#)

9 [Water split, oxygen spare](#)

A11 [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 C1.3 at higher level each time, marked as students go and saved to their Exam practice when they are signed in.

biologybybradford.com/exam-maker/sit?topics=C1.3&level=HL&paper=quiz&marks=15&src=ep



PRACTISE AND REVISE

BUILD FOR YOUR CLASS

- [Tarsia puzzle](#), [dominoes](#) and [picture reveal](#) on C1.3, built from its key terms and ready to print
- A [pub quiz](#) with rounds on C1.3, to present or run with no projector
- An [escape room built from the question bank](#) on C1.3

ALREADY ON THE SITE FOR C1.3

- Quiz: [Photosynthesis](#)
- Quiz: [Photosynthesis \(HL\)](#)
- Revision map: [C1.3 Photosynthesis](#), to fill in
- Exam questions: [C1.3 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.

- [C1.3 Photosynthesis \(SL\)](#)
- [C1.3 Photosynthesis \(HL\)](#)

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.