Twenty building blocks

60 minutes • 1.7.A • Chapters 1, 2, 3 • The dry lab

Amino acids and their parts, peptide bonds and the N and C ends, and how R groups set each amino acid's properties

BY THE END, STUDENTS CAN

- [ ] Describe the parts of an amino acid and explain how dehydration synthesis joins them by peptide bonds into a chain with an amino (N) end and a carboxyl (C) end 1.7.A
- [ ] Explain how the chemistry of R groups, hydrophobic, hydrophilic, charged or polar, gives each amino acid its properties 1.7.A
- [ ] Describe primary, secondary, tertiary and quaternary structure and the bonds or interactions that hold each 1.7.A
- [ ] Explain how a change in the sequence of amino acids can change the shape, and so the function, of a protein 1.7.A
- [ ] Explain how heat, pH and solvents denature a protein, and why a denatured protein no longer works 1.7.A

TIMING

0–5	5 min	**Do now: twenty letters**	
5–12	7 min	**Four groups round a carbon**	
12–20	8 min	**Peptide bonds**	
20–27	7 min	**Sort the R groups**	
27–52	25 min	**Which amino acids?**	
52–60	8 min	**Exit**	
	60 min	**One lesson**	

STARTER

5 min

Do now: twenty letters

An alphabet of twenty letters, words ten letters long. How many different words? Pairs estimate, then work it out (20^{10}, about ten million million). Keep the number for later: every one is a possible protein.

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 Twenty monomers, one pattern

CHAPTER 01 IN THE SLIDES

Step through the figure (6 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. The **alpha carbon** makes four bonds.
2. An **amine group** goes on the left bond: a nitrogen with two hydrogens.
3. A **carboxyl group** goes on the right bond: a carbon with a double bond to one oxygen and a single bond to an OH.
4. One **hydrogen** atom goes on the bottom bond.
5. The last bond carries the **R group**. It stands for whatever side chain this amino acid has.
6. Three different amino acids: the same core in each, and only the **R group** differs.

> **Predict box:** Two amino acids have the same amino group, carboxyl group and hydrogen. What has to be different for them to be two kinds of amino acid? Hands up or mini whiteboards first.
>
> **Answer B: The R group, the side chain on the central carbon, which differs in every one of the twenty**

02 A chain with a beginning and an end

CHAPTER 02 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. Two amino acids, $\mathbf{R_1}$ and $\mathbf{R_2}$, with the carboxyl group of the first facing the amine group of the second.
2. The **OH** from the carboxyl group and one **H** from the amine group are lit: they will leave as **water**.
3. The carbon bonds to the nitrogen and the water drifts away. The new C-N bond is a **peptide bond**.
4. A **dipeptide**, drawn as an examiner wants it. It still has an amine group at one end and a carboxyl group at the other.

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. Two **amino acids**.
2. An OH from one and an H from the other face each other.
3. They leave as **water**, and a **peptide bond** joins the carbon to the nitrogen: **dehydration synthesis**, making a **dipeptide**.
4. Add water and the peptide bond splits again, the OH back to the carbon and the H to the nitrogen: **hydrolysis**.

> **Predict box:** A polypeptide of 120 amino acids is made in a cell. How many peptide bonds does it have, and how many water molecules were released? Hands up or mini whiteboards first.
>
> **Answer B: 119 bonds and 119 waters**

03 Hydrophobic, hydrophilic, charged

CHAPTER 03 IN THE SLIDES

Show the figure: Six R groups, drawn as condensed formulas, and four bins. Which bin does each belong in, and what tells you?

Show the figure: Spot each lane on the origin line, run the solvent up the paper, dry it, spray with ninhydrin, and measure each spot from the origin. Rf = distance moved by the spot ÷ distance moved by the front.

> **Predict box:** A protein dissolves in the cytoplasm. Where in its folded shape would you expect to find most of its hydrophobic R groups? Hands up or mini whiteboards first.
>
> **Answer B: Packed in its core, out of contact with water, while hydrophilic and charged R groups face outward**

THE LESSON

7 min

Four groups round a carbon

Chapter 1's figure a step at a time: the central carbon, the amino group, the carboxyl group, the hydrogen, then the R group swapping. Ask what stays the same in all twenty.

8 min

Peptide bonds

Chapter 2's figure, then the Join amino acids element: students add three amino acids and count the waters. Point to the N end and the C end, and ask which end the next one joins.

7 min

Sort the R groups

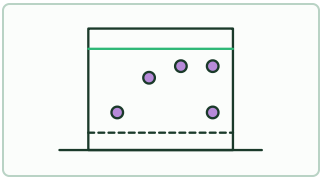
Chapter 3's sorter in pairs: hydrophobic, polar, charged. Ask where each kind would sit in a protein dissolved in water, inside or on the surface.

25 min

Which amino acids?

The chromatography dry lab under chapter 3 (activity below): spot the standards, run the paper, spray with ninhydrin, measure Rf values, and identify the amino acids in unknown X, a protein broken down into its amino acids.

ACTIVITIES



DRY LAB

Which amino acids?

The chromatography dry lab under chapter 3: spots of known amino acids and an unknown on a paper, run in solvent, then sprayed with ninhydrin. Students tap each spot to measure it, work out Rf values and match the unknown. A protein run as it is stays on the start line; broken down into its amino acids first, it gives several spots. Ask why: the R groups set how far each amino acid moves.

Needs: phones or laptops, a ruler for checking Rf by hand on a screenshot.

PLENARY

8 min

Exit

On paper: draw two amino acids joining, label the peptide bond, the water and the N and C ends (3 marks). Then chapter 3's predict box for anyone who finishes.

WHAT STUDENTS GET WRONG

"The R group is the same in every amino acid." It is the one part that differs; the rest is shared.

"A peptide bond forms between two R groups." It joins the carboxyl group of one amino acid to the amino group of the next.

"A chain can grow from either end." The ends differ: an amino (N) end and a carboxyl (C) end.

STRETCH AND SUPPORT

Stretch: leucine runs further up the paper than lysine. Use their R groups to explain why.

Support: a labeled diagram of an amino acid and of a dipeptide to annotate before drawing either from memory.

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

IN THE GUIDE

1 Twenty monomers, one pattern
2 A chain with a beginning and an end
3 Hydrophobic, hydrophilic, charged
Lab Dry lab: Unfold a protein
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 1.7 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=U1&ced=1.7&paper=quiz&marks=15&src=ep

PRACTISE AND REVISE

BUILD FOR YOUR CLASS

- Tarsia puzzle, dominoes and picture reveal on Unit 1, built from its key terms and ready to print
- A pub quiz with rounds on Unit 1, to present or run with no projector
- The Frozen Lake Station escape room, or an escape room built from the question bank on Unit 1

ALREADY ON THE SITE FOR UNIT 1

- Lesson: Proteins
- Quiz: Proteins
- Exam questions: Unit 1 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 1: Chemistry of Life (part 1)
- Unit 1: Chemistry of Life (part 2)

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.