

Building and reading cladograms HL

60 minutes • A3.2.6, A3.2.7 • Chapters 6, 7 • The dry lab

Choosing a tree by parsimony, reading nodes and clades, and what changes when you change the data

BY THE END, STUDENTS CAN

- ☐ Build a cladogram from sequence data using parsimony, and say why different criteria can give different trees A3.2.6
- ☐ Read a cladogram: its root, nodes and terminal branches, its clades and common ancestors A3.2.7

TIMING

0-6	6 min	Do now: who goes with whom?	
6-20	14 min	Parsimony by hand	
20-32	12 min	Cladogram cards	
32-42	10 min	Reading a cladogram	
42-54	12 min	Grow a tree	
54-60	6 min	Exit	
	60 min	One lesson	

STARTER

- 6 min** **Do now: who goes with whom?**
- Four short sequences on the board with a fifth as the outgroup. Pairs mark the sites where two species share a difference from the outgroup and say which two species they would put together. Do not reveal the tree yet.

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 The tree with the fewest changes

CHAPTER 06 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.

- A made-up stretch of six sites in one gene. Pink marks where a species **differs from the orangutan**, the outgroup.
- Three trees could join the human, chimpanzee and gorilla. Sites 4 and 6 differ in only **one species**, so they cost one change on every tree and cannot choose between them.
- Count the changes each tree needs to explain all six sites. Tree 1 needs 7, tree 2 needs 10 and tree 3 needs 9.
- Parsimony** picks the tree that explains the data with the fewest changes: tree 1, with the human and chimpanzee as closest relatives.

Step through the figure (2 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

- The table gives each beetle's traits (made up for teaching). Moss is the outgroup: its states are taken as the ancestral ones.
- One tree, with a bar on each branch where a trait changes: 7 changes. Can you find a tree that needs fewer?

Step through the figure (2 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. The table gives each beetle's traits (made up for teaching). Moss is the outgroup: its states are taken as the ancestral ones.
2. One tree, with a bar on each branch where a trait changes: 16 changes. Can you find a tree that needs fewer?

Predict box: Three possible trees need 14, 11 and 11 changes. What does parsimony tell you? Hands up or mini whiteboards first.

Answer A: The two trees that need 11 are tied, so more data is needed to choose between them

07 Reading a cladogram

CHAPTER 07 IN THE SLIDES

Switch the figure through Parts and Spin it, and have the class say what will change before each.

Show the figure: Answer questions about a cladogram: common ancestors, clades and which pairs are closest relatives.

Predict box: In a cladogram, species X and Y branch from node 1, and node 1 and species Z branch from node 2. Which statement is correct? Hands up or mini whiteboards first.

Answer B: X is closer to Y than to Z, because X and Y share a more recent ancestor

Remember it: Rabbits Nibble Tasty Carrots Slowly (Root, Node, Terminal branch, Clade, Sister groups).

THE LESSON

14 min Parsimony by hand

Chapter 6's figure step by step. Students count the changes on the three trees from the table, and compare with the figure's counts of 7, 10 and 9. Then the cladogram tool: join the beetles, watch the count, and ask whether a tree with fewer changes exists. Run it again with the DNA column. Finish with the predict box on a tie.

12 min Cladogram cards

The sorting cards below: groups place five organisms on a tree from a table of features, then write one change on each branch. Compare trees across groups and ask why two groups could end with different trees.

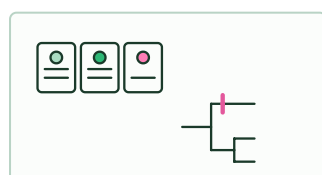
10 min Reading a cladogram

Chapter 7's figure: tap the root, a node, a terminal branch, a clade and sister groups, then spin the tree. Turn over the mnemonic tiles. Pairs use the read task in the tool.

12 min Grow a tree

The dry lab. Pairs run the tree lab on features, add one feature at a time, and record the winning tree and its score each time. Then they switch to sequence data and ask whether the winner changes.

ACTIVITIES



CARDS

Cladogram cards

Five cards, one for each of a lamprey, a shark, a frog, a lizard and a mouse, each with a strip of features (jaws, four limbs, an amnion around the embryo, hair). Groups arrange the cards into a tree so that each feature appears once, mark the branch where each feature first appears, and count the changes. Then give one group a card with a feature that fits nowhere neatly, and ask what they do. A rewrite of the classic sorting-cookies idea, with no food: the point is the counting.

Needs: printed cards and tape for the branches, one set per group; the cladogram tool for checking.

PRACTICE

Make your own sequences

Each pair writes four six-base sequences and an outgroup, then swaps with another pair. The other pair draws the three possible trees, counts the changes on each and says which tree is most parsimonious, and whether two trees tie. Pairs check each other's counts. Ask them to design a set with a tie.

Needs: squared paper; no devices needed.

DRY LAB

Grow a tree

The [dry lab](#) above, with the tasks and questions under it. It works on a phone as well as a laptop, and the results can be copied into a table for the class.

Needs: one device per pair.

PLENARY

6

min

Exit

A cladogram is a hypothesis. Give one thing that could make a scientist redraw it.

WHAT STUDENTS GET WRONG

"The tip at the top is the most advanced." Every node can be spun, so the order of the tips means nothing. Only the branching order carries meaning.

"A node is a real species we know of." A node is a hypothetical common ancestor. It need not be a known fossil.

"The most parsimonious tree is the true one." It is the most probable on the data, and it can change when more data is added.

STRETCH AND SUPPORT

Support: give the captions of each figure as a cut-up storyboard to put in order, and use the key terms (tap the dotted words) as a glossary.

Support: the two mnemonics (King Philip Came Over For Good Soup; Rabbits Nibble Tasty Carrots Slowly) as a starter, with the tiles turned over for the answers.

Support: for parsimony by hand, give a table with the three trees already drawn, so students only count.

Stretch: in [the dry lab](#), find a data set where adding one feature changes the winning tree, and explain what that feature does.

IN THE GUIDE

6 [The tree with the fewest changes](#)

7 [Reading a cladogram](#)

Lab [Dry lab: Grow a tree](#)

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 A3.2, built from its key terms and ready to print
- A [pub quiz](#) with rounds on A3.2, to present or run with no projector
- An [escape room built from the question bank](#) on A3.2

ALREADY ON THE SITE FOR A3.2

- Quiz: [Cladistics \(HL\)](#)
- Revision map: [A3.2 Classification and cladistics](#), to fill in
- Exam questions: [A3.2 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.

- [A3.2 Classification and Cladistics \(HL\)](#)

EXAM PRACTICE

Check yourself

Set it for homework: a fresh paper of exam-bank questions on A3.2 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=A3.2&level=HL&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.