

When the species rule breaks HL

60 minutes • A3.1.12, A3.1.13 • Chapters 9, 10

Asexual species, horizontal gene transfer, and why different chromosome numbers make hybrids infertile

BY THE END, STUDENTS CAN

- ☐ Explain why the biological species concept fails for asexual species and for bacteria that pass genes sideways
A3.1.12
- ☐ Explain why parents with different chromosome numbers are unlikely to have fertile offspring A3.1.13

TIMING

0-6	6 min	Do now: can a bacterium be a species?	
6-20	14 min	Copying and sideways	
20-30	10 min	Where the species concept struggles	
30-50	20 min	Paper chromosomes	
50-60	10 min	Exam question and exit	
	60 min	One lesson	

STARTER

6
min

Do now: can a bacterium be a species?

Ask: "Can you test two bacteria for fertile offspring?" Pairs write what stops them. Take answers, and keep the words partner, clone and plasmid on the board for the next step.

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.

09 When the species rule breaks

CHAPTER 09 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 bacterium reproduces by **copying itself**: two identical cells, with no partner and nothing to test.
2. Two bacteria of **different species**. One carries a **plasmid**, a small ring of DNA, with a gene on it.
3. The cells touch and a bridge forms. A **copy** of the plasmid passes across.
4. The second species now has the gene. No new cell was made: the gene moved **sideways**.

Predict box: A bacterium carries a plasmid with an antibiotic-resistance gene. It touches a bacterium of a different species. What can happen? Hands up or mini whiteboards first.

Answer B: A copy of the plasmid can pass across with no cell dividing

Remember it: Five Apes Hug Grumpy Aunts Happily (Fossils, Apart, Hybrids, Gradual, Asexual, Horizontal transfer).

10 The number that has to match

CHAPTER 10 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 **imagined** species. Q has one long chromosome where P has two short ones, so they have different chromosome numbers.
2. A hybrid gets **both sets**: five chromosomes, an odd number. One cannot have an equal partner.
3. At meiosis each chromosome looks for its match. Two pair neatly, but the long one is left matching **two** at once.
4. Some ways of sharing them out give complete sets. Others give a gamete with part of the genome **twice** and part **missing**. With many such mismatches, most gametes fail.

Predict box: A hybrid cell has 63 chromosomes. Could every one of them have an equal partner at meiosis? Hands up or mini whiteboards first.

Answer A: No: with an odd number, at least one has no partner

THE LESSON

14 Copying and sideways

min
Chapter 9's figure, step by step: binary fission, then conjugation. Run the pass the plasmid role play below for six minutes. Then chapter 9's predict box. Land on horizontal gene transfer as a way for genes to cross a species line without any offspring.

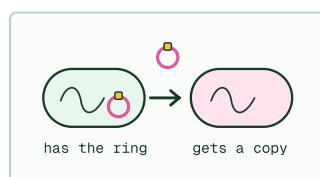
10 Where the species concept struggles

min
Turn over chapter 9's Remember it tiles. In groups, students give one example for each of the six: fossils, populations apart, hybrids, gradual change, asexual species, horizontal transfer. Take the HL half (asexual and horizontal) first.

20 Paper chromosomes

min
Four minutes on chapter 10's figure. Then the paper chromosomes model below, with a coin to share out the chain: 16 minutes, ten tosses a pair, tally the complete and unbalanced sets. Connect it to the mule from A4.1.

ACTIVITIES

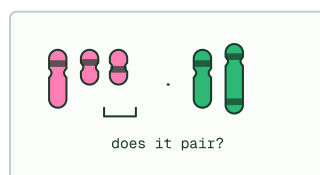


ROLE PLAY · HL

Pass the plasmid

Six students are bacteria. Each holds a card for its species. One holds a paper ring with a coloured sticker (a plasmid with a resistance gene). Cells that touch can pass a copy of the ring by making a second ring on the spot. After two rounds, count the cells holding the ring and ask which species they belong to. Then ask how the species concept would classify them.

Needs: six species cards, paper rings, stickers, sticky tape.



MODEL · HL

Paper chromosomes: a fusion

Strips of card in two colours: species P has three (one long, two short) and species Q has two (one long, one as long as the two short ones together). Students make the hybrid's five strips, pair them, and find the long Q strip matches both short P strips. They share the chain out by tossing a coin ten times and tally complete against unbalanced sets. It is a toy model, since real ratios differ, but many such mismatches multiply the chance of failure.

Needs: two colours of card strips, scissors, a coin, a tally table.

10

min

Exam question and exit

A higher level written question on the species concept or chromosome number from the A3.1 exam maker (in Practise and revise, below), set at HL, then peer-marked. Exit: [chapter 10's](#) predict box on a 63-chromosome hybrid. For homework, [the Check step](#), set at HL.

WHAT STUDENTS GET WRONG

Horizontal gene transfer is bacterial reproduction. Reproduction makes a new cell. Horizontal transfer moves genes between living cells, even of different species.

The hybrid has its parents' chromosome numbers added. It has the two gametes' numbers added: $32 + 31 = 63$ for the mule, not $64 + 62$.

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 three Remember it sets (Green Sloths Inch Along; Five Apes Hug Grumpy Aunts Happily; Cats Eat Any Sausage, Mostly) as a starter or an exit.

Stretch: why is a change in chromosome number a more usual way to make a new species in plants than in animals? Link it to polyploidy in A4.1.

IN THE GUIDE

- 9 [When the species rule breaks](#)
- 10 [The number that has to match](#)
- 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 A3.1 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=A3.1&level=HL&paper=quiz&marks=15&src=ep



PRACTISE AND REVISE

BUILD FOR YOUR CLASS

- [Tarsia puzzle](#), [dominoes](#) and [picture reveal](#) on A3.1, built from its key terms and ready to print
- A [pub quiz](#) with rounds on A3.1, to present or run with no projector
- An [escape room](#) built from the [question bank](#) on A3.1

ALREADY ON THE SITE FOR A3.1

- Quiz: [Diversity of Organisms](#)
- Revision map: [A3.1 Diversity of organisms](#), to fill in
- Exam questions: [A3.1 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.
- [A3.1 Diversity of Organisms](#)

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.