

Genes that travel together HL

60 minutes • D3.2.18 to D3.2.20 • Chapter 14

The loci of human genes, linkage on a chromosome, recombinants made by crossing over, and reading a test cross

BY THE END, STUDENTS CAN

- ☐ Find the loci of human genes and their polypeptide products in a database D3.2.18
- ☐ Explain autosomal gene linkage D3.2.19
- ☐ Identify recombinants in crosses involving two linked or unlinked genes D3.2.20

TIMING

0-6	6 min	Do now	
6-21	15 min	Where are the genes?	
21-33	12 min	Linkage and the vertical line	
33-50	17 min	Crossing over by hand	
50-60	10 min	Counting recombinants	
	60 min	One lesson	

STARTER

- 6 min** **Do now**
- A chromosome carries many genes. If two genes sit on the same chromosome, will they be passed on together? Students write a one-line prediction and a reason.

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.

14 Genes that travel together

CHAPTER 14 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.

- Unlinked** genes sit on different chromosome pairs, so all four kinds of gamete are equally likely.
- Linked** genes sit on the same chromosome. With no crossing over, only the two **parental** gametes, AB and ab, are made.
- Crossing over** between the genes swaps the ends of two chromatids and makes the **recombinant** gametes Ab and aB. The other two chromatids are unchanged, so recombinants are few.
- A **test cross** ($AaBb \times aabb$) shows it: mostly parental types and a few recombinants. Recombinant frequency = $30 \div 200 = 15\%$.

Predict box: A test cross $AaBb \times aabb$ gives 48 AB, 47 ab, 3 Ab and 2 aB. What does this suggest? Hands up or mini whiteboards first.

Answer C: The genes are linked, and crossovers are rare between them

THE LESSON

15

min

Where are the genes?

The gene database task below. Students look up two genes from the card, write each locus and polypeptide, and say whether the pair could assort independently.

12

min

Linkage and the vertical line

Chapter 14's figure. Students rewrite one genotype with the vertical line notation and name which alleles travel together. Then the predict box on the test cross.

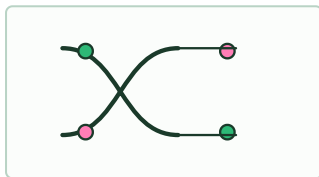
17

min

Crossing over by hand

The pipe-cleaner model below. Pairs cross over once between two loci, read off the gametes and say which are recombinants. Repeat with the loci close together, then far apart.

ACTIVITIES

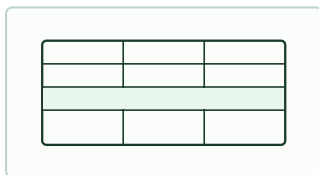


MODEL

Crossing over with pipe cleaners

Pairs take two pipe cleaners (green and pink) with two beads on each, one near each end, to stand for the alleles of two genes. Twist the two cleaners together at one point and cut at the twist, then swap the cut ends. Read off the two new chromosomes. Which combinations are parental and which are recombinant? Do it once with the twist between the beads, once with it outside them. Repeat with beads close together and far apart, and tally how often the twist falls between them.

Needs: pipe cleaners in two colours, beads, scissors.



DATA TASK

Gene loci database

Students open a human gene database that your school can reach (the NCBI Gene and Ensembl databases are two) and look up the genes for the haemoglobin subunits. For each, record the chromosome, the position and the polypeptide it codes for. The beta globin gene (HBB) and the alpha globin genes (HBA1 and HBA2) are on different chromosomes, and a related gene (HBD) lies next to HBB. Ask which pairs could assort independently and which would be linked. If you cannot use the database, give the table from the card and ask the same questions.

Needs: devices with internet access, a recording sheet.

PLENARY

10

min

Counting recombinants

A test cross gave 86, 84, 16 and 14 offspring in the four classes. Students pick out the recombinants and give the recombinant percentage (15 percent). Discuss what a result near 50 percent would mean.

WHAT STUDENTS GET WRONG

Recombinants are mutants. A recombinant has a new combination of existing alleles, made by crossing over, not a new allele.

STRETCH AND SUPPORT

Support: a pre-drawn chromosome pair with the loci marked, to colour in when crossing over.

Stretch: in the test cross above, what would the four classes look like if the recombinants were half of all the offspring? *Close to 1:1:1:1, as if the genes were unlinked.*

IN THE GUIDE

- 14** [Genes that travel together](#)
- 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 D3.2, built from its key terms and ready to print
- A [pub quiz](#) with rounds on D3.2, to present or run with no projector
- An [escape room built from the question bank](#) on D3.2

ALREADY ON THE SITE FOR D3.2

- Lesson: [Linked Genes & Chi-Squared](#)
- Lesson: [Dihybrid Crosses & Test Crosses](#)
- Lesson: [Inheritance](#)
- Summary doodle: [Inheritance](#)
- Quiz: [Inheritance \(HL\)](#)
- Quiz: [Inheritance](#)
- Revision map: [D3.2 Inheritance](#), to fill in
- Exam questions: [D3.2 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.
- [D3.2 Inheritance](#)

EXAM PRACTICE

Check yourself

Set it for homework: a fresh paper of exam-bank questions on D3.2 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=D3.2&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.