

Is it chance? Chi-squared and the dry lab HL

60 minutes • D3.2.21 • Chapter 15 • The dry lab

Using the chi-squared test to decide whether a dihybrid cross matches the expected ratio, and applying it in a simulated experiment

BY THE END, STUDENTS CAN

☐ Use a chi-squared test on data from a dihybrid cross D3.2.21

TIMING

0-5	5 min	Do now	
5-17	12 min	The five steps	
17-32	15 min	The bead bag	
32-55	23 min	The dry lab	
55-60	5 min	Plenary: the decision	
60 min		One lesson	

STARTER

5 min **Do now**

Flip a coin 10 times. Heads and tails 5 and 5 is expected. What if you get 7 and 3? 9 and 1? Write where you would start to doubt the coin.

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.

15 Is it chance? The chi-squared test

CHAPTER 15 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.

- 160 F2 plants: the **expected** counts from 9 : 3 : 3 : 1 (90, 30, 30 and 10) against **observed** counts (made up).
- χ^2 is the sum of $(O - E)^2 \div E$ over the four classes: **2.13**.
- With 3 degrees of freedom and $p = 0.05$ the **critical value** is 7.81. 2.13 is below it, so you do not reject the null hypothesis: chance can explain the difference.
- A test cross of linked genes (made-up counts 112, 21, 18 and 109 from 260 offspring) gives $\chi^2 = \mathbf{127.5}$, far past 7.81. Reject the null: the genes are probably linked.

Predict box: A chi-squared value of 2.1 with 3 degrees of freedom is compared with a critical value of 7.81. What do you conclude? Hands up or mini whiteboards first.

Answer B: Do not reject the null: chance could explain it

Remember it: Hungry Elves Cook Delicious Cakes (Hypotheses, Expected, Calculate, Degrees of freedom, Compare).

THE LESSON

12

min

The five steps

Chapter 15's figure and the Remember it tiles. Work the worked example together: say the null and alternative hypotheses, find the expected numbers, total $(O - E)^2 \div E$, find the degrees of freedom and compare with the critical value.

15

min

The bead bag

The activity below. Each group samples from a bag of beads in a 9 : 3 : 3 : 1 ratio and tests its sample. How many groups reject the null hypothesis, and what should that number be?

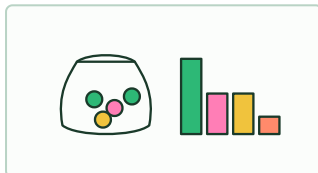
23

min

The dry lab

The dry lab, in pairs. Students choose unlinked or linked genes, make a test cross and test the brood against 1 : 1 : 1 : 1. Then the mystery: breed as many broods as needed and give a verdict. The coach under the bench covers repeats and evaluation.

ACTIVITIES



MODEL

The bead bag

Each group has a bag with 9 parts green round, 3 green wrinkled, 3 yellow round and 1 yellow wrinkled (for example 90, 30, 30 and 10 beads, or a proportion of it). Draw 80 beads with replacement, shaking between draws, tally the four colours, and work out chi-squared against the 9 : 3 : 3 : 1 expectation. Compare it with the critical value for 3 degrees of freedom. Pool the class results on the board: about 1 group in 20 should reject the null hypothesis even though the bag is right. Ask what this tells you about what a rejection means.

Needs: bags of four colours of beads, a calculator, the critical value table.

DRY LAB

Fly crosses: linked or not?

The dry lab above, with the tasks and questions under it. It works on a phone as well as a laptop, and the results download as a CSV for pooling. The genes are invented and the fly is made up, so say so in the debrief. The coach under the bench takes students through variables, repeats and evaluation.

Needs: one device per pair.

PLENARY

5

min

Plenary: the decision

Each pair states one decision in a full sentence: "The value of ... is ... than the critical value, so we ... the null hypothesis, so ...". Take two and correct the wording together.

WHAT STUDENTS GET WRONG

"Not rejecting the null hypothesis proves it." It means the data are consistent with chance, not that the genes are unlinked.

"Any difference under 5 percent is chance." The 0.05 probability level is not a percentage difference in the counts. It is the chance of a value this large if the null hypothesis is true.

STRETCH AND SUPPORT

Support: a table with the observed, expected, difference, squared and divided columns ready to fill in.

Stretch: why does a very large brood make it easier to reject the null hypothesis, even for a tiny departure from the ratio?

IN THE GUIDE

- 15** [Is it chance? The chi-squared test](#)
- Lab** [Dry lab: Fly crosses: linked or not?](#)
- 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.