

Meiosis and Genetic Diversity

Learning objective 5.2.A Explain how meiosis generates genetic diversity.

Name: _____

Date: _____

Period: _____

Use the tool **Every Gamete Is New**. Part 1 uses **Line up the pairs**, Part 2 uses **One crossover** and Part 3 uses **Multiply it out**. Three mechanisms generate the variation, and **two of them can be counted exactly**. Do the counting yourself before you accept any quoted total.

Part 1 • Counting what assortment gives

Open **Line up the pairs**. Set the slider to each number of pairs in turn and open **Every gamete this cell could make**. Write out the full list yourself for 1, 2 and 3 pairs before you check it.

Pairs	Your prediction	Gametes listed	Write the list out
1			
2			
3			
4			

1. Write the general rule connecting the number of homologous pairs to the number of possible gametes.

2. Explain why adding one more pair doubles the list rather than adding two entries to it.

Part 2 · What one crossover does

Switch to **One crossover**. Two genes, **A/a** and **B/b**, sit on the same homologous pair. Record the four chromatids with the crossover off and then on.

	The four chromatids	Parental	Recombinant	Distinct combinations
No crossover				
One crossover				

3. A single crossover leaves two of the four chromatids unchanged. Explain why, in terms of which chromatids take part in the exchange.

4. Count the A, a, B and b alleles in each row of your table. State what you find and explain what it tells you about what crossing over does and does not do.

Part 3 · Multiplying it out

Switch to **Multiply it out**. The vertical axis is **logarithmic** — each gridline is ten times the one below it. Read off the values at each number of pairs.

Pairs	Gametes from assortment	Zygotes from two such parents
1		
5		
10		
15		
20		
23		

5. Explain why random fertilisation multiplies the number of possible offspring rather than adding to it.

6. The figures in your table leave out crossing over entirely. Explain why crossing over cannot be given a fixed multiplier, and what that means for any total you are quoted.

Part 4 · Putting it together

These do not need the tool.

7. Name the three mechanisms that generate genetic diversity, and state where in meiosis or fertilisation each one happens.

8. Two genes are on the same chromosome. Explain why independent assortment alone can never separate them, and what can.

9. A student says crossing over creates new alleles. Correct the statement and name the process that does create new alleles.

10. Explain why genetic variation within a population matters for that population's survival when conditions change.

What the model simplifies

The assortment tab goes up to four pairs because the grid has to stay readable. The rule is the same at 23, and the counting tab shows what it gives there.

The counting tab uses a logarithmic vertical axis. Each equal step up the axis is a tenfold increase, so a straight line on that axis is exponential growth, not linear growth. On a linear axis the first twenty points would all sit flat on the baseline.

Crossing over is drawn as a single exchange between two genes, involving one chromatid from each homologue. Real bivalents usually have more than one crossover, they can involve different pairs of chromatids at different points, and the chance of a crossover falling between two genes rises with the distance between them — the basis of genetic mapping, which is beyond this course.

The 2^n figure counts independent assortment only, and the fertilisation figure squares it. Neither includes crossing over, which multiplies the total by an amount that varies from one meiosis to the next. Any single quoted total for 'possible children' is a floor with assumptions attached.

The two homologues are labeled M and P for the parent each came from. Real chromosomes carry no such label; the letters record provenance, not appearance.