AP BIOLOGY · UNIT 5 · TOPIC 5.2

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**. Each Part names the tab it uses, and Part 4 does not use the tool. Three mechanisms generate the variation, and **two of them can be counted exactly**.

Part 1 · Counting what assortment gives

Open **Line up the pairs**. For each number of pairs in the table, predict the number of gametes. For 1, 2 and 3 pairs, write out the full list of gametes. Then set the Homologous pairs in the cell slider to that number, open **Every gamete this cell could make**, and record the Distinct gametes possible readout. For 4 pairs, do not write out the list.

Pairs	Your prediction	Distinct gametes possible	Write the list out
1			
2			
3			
4			

1. Using the Part 1 table, describe the relationship between the number of homologous pairs, n, and the number of different gametes that independent assortment can produce.

2. Explain why adding one more homologous pair doubles the number of possible gametes rather than adding two 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 readouts with the crossover box (A crossover occurs between the two genes) unchecked, and then checked.

	The four chromatids	Parental	Recombinant	Distinct combinations
No crossover				
One crossover				

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

4. (a) Using the Part 2 table, identify the number of A, a, B and b alleles among the four chromatids, with no crossover and with one crossover.

(b) Explain what this result indicates about the effect of crossing over on alleles.

Part 3 · Multiplying it out

Switch to **Multiply it out**. The vertical axis is **logarithmic**: each gridline is ten times the one below it. Drag the Homologous pairs slider to each number of pairs in the table and record the readouts.

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

5. Explain why random fertilization multiplies the number of possible zygotes rather than adding to it.

6. The numbers in the Part 3 table do not include crossing over.
(a) Explain why crossing over does not multiply the number of possible gametes by a fixed amount.

(b) A textbook states a single total for the number of genetically different children that two parents could have. Describe a limitation of this total.

Part 4 · Putting it together

These do not need the tool.

7. (a) Identify the three mechanisms that generate genetic diversity in sexually reproducing organisms.

(b) For each mechanism, identify when it occurs during meiosis or fertilization.

8. Two genes are on the same chromosome.
(a) Explain why independent assortment alone cannot produce new combinations of the alleles of these two genes.

(b) Identify the process that can produce new combinations of these alleles.

9. A student claims that crossing over creates new alleles.
(a) Evaluate the student's claim.

(b) Identify the process that creates new alleles.

10. Explain how genetic variation within a population increases the likelihood that the population will persist when environmental 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 homolog. 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. This is the basis of genetic mapping, which is beyond this course.

The 2^n figure counts independent assortment only, and the fertilization 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 homologs are labeled M and P for the parent each came from. Real chromosomes carry no such label; the letters record provenance, not appearance.