AP BIOLOGY · UNIT 5 · TOPIC 5.4

Non-Mendelian Genetics

Learning objective 5.4.A Explain deviations from Mendelian patterns of inheritance.

Name: Date: Period:

Use the tool **When 3:1 Does Not Happen**. Each Part uses the tab of the same name. **None of these patterns changes what meiosis does**: the alleles segregate the same way every time. What changes is the rule that turns a genotype into a phenotype, with one exception, in Part 3.

Part 1 · Same square, different read-out

Open **Same square, different read-out**. The cross is **Rr × Rr** in every case. Click each of the three patterns and fill in the table.

Pattern	The heterozygote Rr looks	Genotype ratio	Phenotype ratio	Classes
Complete dominance				
Incomplete dominance				
Codominance				

1. (a) Identify the column of the Part 1 table that is the same in all three rows.

(b) Explain what this observation indicates about how the three patterns of inheritance differ.

2. (a) Identify the two patterns in the Part 1 table that give the same phenotype ratio.

(b) Describe the observation that would distinguish these two patterns.

Part 2 · Three alleles

Switch to **Three alleles**. Set Parent 1 and Parent 2 to each pair below, then record the Parents' blood groups and Possible children readouts.

Parent 1	Parent 2	Parents' blood groups	Possible children
AO	BO		
AB	OO		
AA	OO		

3. (a) Identify the number of ABO alleles that exist in the human population.

(b) Identify the number of ABO alleles that one person carries.

(c) Explain why these two numbers are different.

4. Explain how the ABO gene can show codominance and complete dominance at the same time.

5. (a) Identify the cross in the Part 2 table that produces no child with the blood group of either parent.

(b) Explain why this result could not occur for a gene with two alleles, one completely dominant to the other.

Part 3 · One X or two

Switch to **One X or two**. These are **Drosophila** eye-color crosses; the gene is on the X chromosome. Click each cross and record the Daughters, Sons and Same in both sexes? readouts.

Cross	Daughters	Sons	Same in both sexes?
$X^wX^w \times X^wY$ (carrier mother × red-eyed father)			
$X^wX^w \times X^wY$ (carrier mother × white-eyed father)			
$X^wX^w \times X^wY$ (homozygous red mother × white-eyed father)			
$X^wX^w \times X^wY$ (white-eyed mother × red-eyed father)			

6. In the Part 3 table, the crosses homozygous red mother × white-eyed father and white-eyed mother × red-eyed father are reciprocal crosses: they differ only in which parent carries the white allele.
(a) Describe how the offspring of the two crosses differ.

(b) Explain how this difference provides evidence that the eye-color gene is on the X chromosome.

7. Explain why a recessive X-linked phenotype appears much more often in males than in females.

Part 4 · Adding up

Switch to **Adding up**. Both parents are heterozygous at every gene, and the phenotype depends on **how many** contributing alleles an offspring has. Drag the Genes contributing to the trait slider from 1 to 4 and record the readouts at each setting.

Genes	Phenotype classes	Most common class	Chance of an extreme
1			
2			
3			
4			

8. Using the Part 4 table, describe the relationship between the number of genes, n, and the number of phenotype classes.

9. Explain why intermediate phenotypes are the most common and the extreme phenotypes are the least common.

10. Explain why a polygenic trait measured in a real population appears continuous, even though the Part 4 table has distinct classes.

What the model simplifies

The flower colors are the conventional teaching example. Real pigment genetics is more involved than one gene with two alleles, and roan cattle coats are used for codominance because the two colors really are visible side by side rather than blended.

The eye-color cross is Drosophila, where the X-linked white-eye gene was first described. Human X-linked conditions follow the same rules, but the fly cross is used here because a reciprocal cross can actually be performed.

Sex determination is drawn as XX and XY. That system is not universal: birds use ZZ/ZW, some reptiles use temperature, and the human system has more to it than one gene on the Y. What the model needs is only that one sex has two copies of the X-linked gene and the other has one.

The polygenic model gives every contributing allele the same effect and adds them with no interaction and no environmental input. Real polygenic traits have alleles of unequal effect, genes that interact, and an environmental contribution, which is why a real distribution is smooth rather than stepped.

Every cross assumes all genotypes survive equally and are counted equally. A genotype that is lethal or hard to detect distorts the observed ratio without changing the inheritance at all.