

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. The claim to test throughout: **none of these patterns changes what meiosis does**. The alleles segregate identically every time. What changes is the rule that turns a genotype into a phenotype — with one exception, which you will find in Part 3.

Part 1 · Same square, different read-out

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

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

1. One column of your table is identical in all three rows. Identify it and explain what that tells you about what these patterns do and do not change.

2. Two patterns give the same phenotype ratio. Identify them and state what you would have to look at to tell them apart.

Part 2 · Three alleles

Switch to **Three alleles**. Set the parents to each pair below and record the blood groups their children could have.

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

3. State how many ABO alleles exist and how many any one person carries. Explain why those numbers are different.

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

5. One of your crosses produces no child with either parent's blood group. Identify it and explain why a gene with only two alleles could never do this.

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. Record what the daughters and the sons get.

Cross	Daughters	Sons	Same in both sexes?
$X^W X^w \times X^W Y$			
$X^W X^w \times X^w Y$			
$X^W X^W \times X^w Y$			
$X^w X^w \times X^W Y$			

6. Two of these crosses use the same four alleles and differ only in which parent carries the white allele. Identify them, state whether the results are the same, and explain what this shows.

7. Explain why a recessive X-linked phenotype appears far 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. Record the distribution as you add genes.

Genes	Phenotype classes	Commonest class	Offspring at each extreme
1			
2			
3			
4			

8. Write the rule connecting the number of genes to the number of phenotype classes.

9. Explain why intermediate phenotypes are the commonest and the extremes the rarest.

10. Explain why a polygenic trait measured in a real population looks continuous, even though your table has distinct classes in it.

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.