Non-Mendelian Inheritance

Essential Question

How are traits inherited when one allele is not simply dominant?

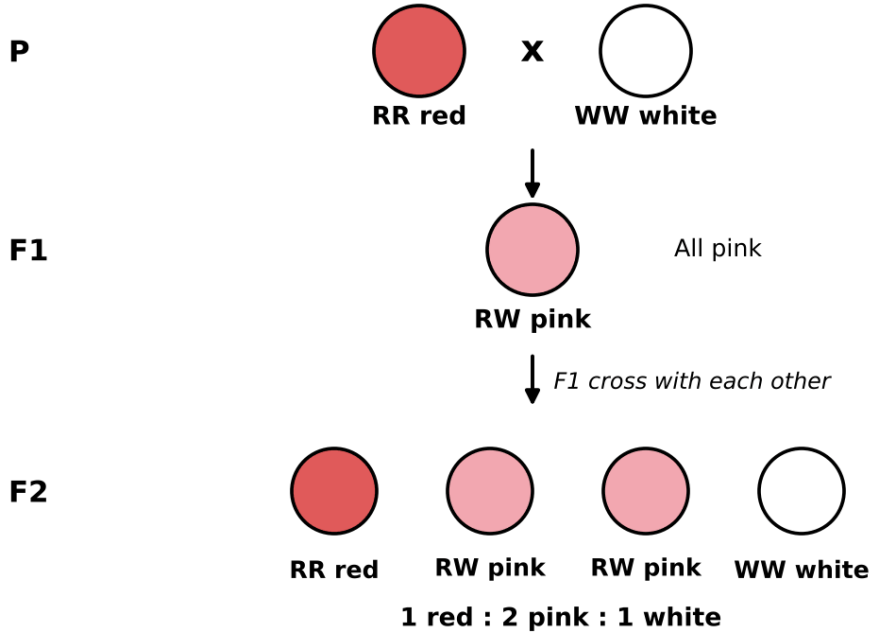
Beyond Simple Dominance

- Complete dominance: the dominant allele hides the recessive one
- Incomplete dominance: the heterozygote is a blend of the two homozygotes
- Codominance: the heterozygote shows both traits fully
- Ratios help tell them apart: 3 : 1 or 1 : 2 : 1

Pattern	Heterozygote looks like	Offspring of two heterozygotes	Example
Complete dominance	The dominant homozygote	3 : 1 (two phenotypes)	Purple or white pea flowers
Incomplete dominance	A blend of the two	1 : 2 : 1 (three phenotypes)	Red x white snapdragons give pink
Codominance	Both traits, side by side	1 : 2 : 1 (three phenotypes)	Roan cattle

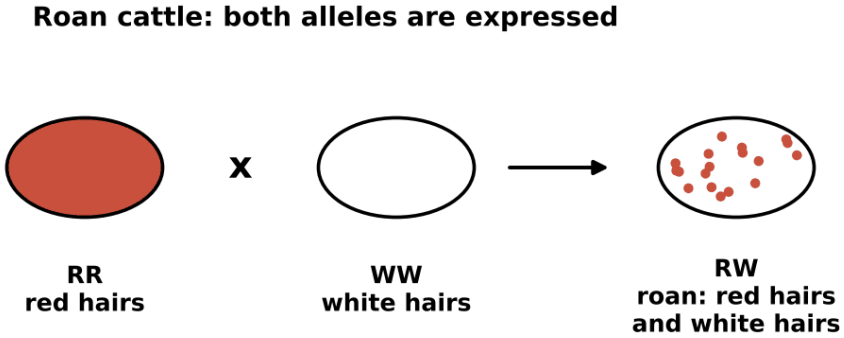
Incomplete Dominance

- Neither allele completely masks the other
- The heterozygote has an in-between phenotype
- Red x white snapdragons give pink offspring
- Two pink parents give 1 red : 2 pink : 1 white



Codominance

- Both alleles are expressed in the heterozygote
- Each allele has its own visible effect
- Roan cattle have both red hairs and white hairs
- Not a blend: you can still see each trait



Roan is not a blend: each hair is red or white.

Multiple Alleles and ABO Blood Types

- Some genes have more than two alleles in a population
- Each person still has only two alleles of the gene
- ABO blood type has three alleles: I^A, I^B, and i
- I^A and I^B are codominant and both are dominant over i

Genotype	Blood type
$I^A I^A$ or $I^A i$	A
$I^B I^B$ or $I^B i$	B
$I^A I^B$	AB
ii	O

Example 1: Incomplete Dominance

In snapdragons, R = red and W = white, and RW plants are pink. Two pink plants are crossed and produce 80 offspring. (a) Give the genotype ratio. (b) Give the phenotype ratio. (c) About how many of each color are expected?

Parent 1	Parent 2	Offspring
RW (pink)	RW (pink)	80

Solution: Incomplete Dominance

(a) Punnett square: RW x RW gives RR, RW, RW, and WW, so the genotype ratio is 1 RR : 2 RW : 1 WW.

(b) Phenotypes: Each genotype has its own phenotype: RR is red, RW is pink, WW is white. The ratio is 1 red : 2 pink : 1 white.

(c) Counts: Red: 1/4 x 80 = 20. Pink: 2/4 x 80 = 40. White: 1/4 x 80 = 20.

Answer: (a) 1 : 2 : 1. (b) 1 red : 2 pink : 1 white. (c) 20 red, 40 pink, 20 white.

Example 2: Classify the Pattern

Classify each scenario as complete dominance, incomplete dominance, or codominance, and give the clue from the data.

Scenario	Data
(a) Two heterozygous tall pea plants are crossed.	About 75 tall : 25 short
(b) A black chicken and a white chicken are crossed. Their blue-gray offspring are crossed.	24 black : 51 blue-gray : 25 white
(c) A red cow and a white cow have a calf.	The calf has red hairs and white hairs mixed together

Solution: Classify the Pattern

(a) Complete dominance: There are two phenotypes in about a 3 : 1 ratio, so one allele hides the other.

(b) Incomplete dominance: There are three phenotypes in about a 1 : 2 : 1 ratio (24 : 51 : 25 is close), and the heterozygote is a blend (blue-gray) between the two parents.

(c) Codominance: The heterozygote shows both parents' traits at the same time, with red hairs and white hairs each visible, not blended.

Answer: (a) Complete dominance. (b) Incomplete dominance. (c) Codominance.

Example 3: ABO Blood Types

A father has blood type A with genotype I^Ai. A mother has blood type B with genotype I^Bi. (a) List the blood types their children can have and the probability of each. (b) Two parents both have type O. Can they have a child with type A? Explain.

Parent	Blood type	Genotype
Father	A	I^Ai
Mother	B	I^Bi

Solution: ABO Blood Types

(a) Punnett square: The father's gametes are I^A or i, and the mother's are I^B or i. The boxes are I^A I^B, I^Ai, I^Bi, and ii.

Blood types: I^A I^B is type AB, I^Ai is type A, I^Bi is type B, and ii is type O. Each has a probability of 1/4.

(b) Two type O parents: Type O is genotype ii, so both parents can give only i. All children are ii and have type O. A child with type A would need an I^A allele that neither parent has.

Answer: (a) AB, A, B, and O, each 1/4. (b) No. All children would be type O.

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Big Ideas

- Complete dominance gives 3 : 1 from two heterozygotes
- Incomplete dominance gives a blend, with a 1 : 2 : 1 ratio
- Codominance shows both traits, also with a 1 : 2 : 1 ratio
- Some genes have more than two alleles, but each person has only two
- ABO blood type has three alleles: I^A, I^B, and i