

Codominance & Incomplete Dominance

Key ideas

Incomplete dominance: the heterozygote is *in between* (red × white → pink). **Codominance:** both alleles show fully (red and white hairs → roan; $I^A I^B$ → type AB).

Multiple alleles: blood type has three alleles: I^A and I^B are codominant, and both are dominant to i .

Sex-linked: genes on the X chromosome. Females are XX, males are XY, so males show X-linked recessive traits with just one allele.

A Name the inheritance pattern

3 marks

Choose: complete dominance, incomplete dominance, codominance, sex-linked. ½ mark each.

Scenario	Inheritance pattern
1. A red snapdragon is crossed with a white snapdragon. All offspring are pink.	
2. A red cow and a white bull have a roan calf with both red hairs and white hairs.	
3. A tall pea plant crossed with a short pea plant gives only tall offspring.	
4. Parents with type A and type B blood have a child with type AB blood.	
5. Two parents with normal colour vision have a colour-blind son.	
6. A black chicken and a white chicken produce chicks with black and white speckled feathers.	

B Incomplete dominance crosses

4 marks

Complete each Punnett square and give the phenotype ratio. 2 marks each.

7. Snapdragon flower colour shows incomplete dominance: $C^R C^R$ = red, $C^R C^W$ = pink, $C^W C^W$ = white. Cross two pink snapdragons.

Parents: _____

Phenotype ratio: _____

8. Cross a pink snapdragon with a white snapdragon.

Parents: _____

Phenotype ratio: _____

C Codominance crosses

4 marks

9. Coat colour in cattle is codominant: $C^R C^R$ = red, $C^R C^W$ = roan, $C^W C^W$ = white. Cross two roan cattle.

Parents: _____

Phenotype ratio: _____

10. Cross a roan bull with a red cow.

Parents: _____
Phenotype ratio: _____

D Blood types: multiple alleles

6 marks

11. Give the possible genotype(s) for each blood type. (½ mark each)

Blood type	Possible genotype(s)
Type A	
Type B	
Type AB	
Type O	

12. A woman with genotype $I^A i$ has children with a man who is $I^B i$. Complete the Punnett square and give the blood type ratio. (2 marks)

Parents: _____
Phenotype ratio: _____

13. A type A mother and a type B father have a type O child. What are the genotypes of both parents? Explain.

14. Could a man with type AB blood be the father of a type O child? Explain.

E Sex-linked inheritance

4 marks

15. Colour blindness is X-linked recessive. A carrier woman ($X^B X^b$) has children with a man with normal vision ($X^B Y$). What is the chance that a **son** is colour-blind? (2 marks)

Parents: _____
Phenotype ratio: _____
Son colour-blind: _____

16. Explain why X-linked recessive disorders such as colour blindness are more common in males than in females.

17. A man with haemophilia ($X^h Y$) has children with a woman who is not a carrier ($X^H X^H$). What fraction of their daughters will be carriers, and what fraction of their sons will have haemophilia?

F Spot the mistake

2 marks

18. A student says: "Pink snapdragons prove that the red and white alleles blend together permanently." Explain the error and correct it.

19. A student says: "A roan cow has pink hairs because red and white are codominant." Explain the error and correct it.

Codominance & Incomplete Dominance

Name: _____

ANSWER KEY

Date: _____ Score: ____ / 23

Key ideas

Incomplete dominance: the heterozygote is *in between* (red × white → pink). **Codominance:** both alleles show fully (red and white hairs → roan; $I^A I^B$ → type AB).

Multiple alleles: blood type has three alleles: I^A and I^B are codominant, and both are dominant to i .

Sex-linked: genes on the X chromosome. Females are XX, males are XY, so males show X-linked recessive traits with just one allele.

A Name the inheritance pattern

3 marks

Choose: complete dominance, incomplete dominance, codominance, sex-linked. ½ mark each.

Scenario	Inheritance pattern
1. A red snapdragon is crossed with a white snapdragon. All offspring are pink.	Incomplete dominance
2. A red cow and a white bull have a roan calf with both red hairs and white hairs.	Codominance
3. A tall pea plant crossed with a short pea plant gives only tall offspring.	Complete dominance
4. Parents with type A and type B blood have a child with type AB blood.	Codominance (multiple alleles)
5. Two parents with normal colour vision have a colour-blind son.	Sex-linked (X-linked recessive)
6. A black chicken and a white chicken produce chicks with black and white speckled feathers.	Codominance

B Incomplete dominance crosses

4 marks

Complete each Punnett square and give the phenotype ratio. 2 marks each.

7. Snapdragon flower colour shows incomplete dominance: $C^R C^R$ = red, $C^R C^W$ = pink, $C^W C^W$ = white. Cross two pink snapdragons.

	C^R	C^W
C^R	$C^R C^R$	$C^R C^W$
C^W	$C^R C^W$	$C^W C^W$

Parents: $C^R C^W \times C^R C^W$

Phenotype ratio: 1 red : 2 pink : 1 white

8. Cross a pink snapdragon with a white snapdragon.

	C^W	C^W
C^R	$C^R C^W$	$C^R C^W$
C^W	$C^W C^W$	$C^W C^W$

Parents: $C^R C^W \times C^W C^W$

Phenotype ratio: 1 pink : 1 white

C Codominance crosses

4 marks

9. Coat colour in cattle is codominant: $C^R C^R$ = red, $C^R C^W$ = roan, $C^W C^W$ = white. Cross two roan cattle.

	C^R	C^W
C^R	$C^R C^R$	$C^R C^W$
C^W	$C^R C^W$	$C^W C^W$

Parents: $C^R C^W \times C^R C^W$

Phenotype ratio: 1 red : 2 roan : 1 white

10. Cross a roan bull with a red cow.

	C ^R	C ^R
C ^R	C ^R C ^R	C ^R C ^R
C ^W	C ^R C ^W	C ^R C ^W

Parents: C^RC^W × C^RC^R

Phenotype ratio: 1 red : 1 roan

D Blood types: multiple alleles

6 marks

11. Give the possible genotype(s) for each blood type. (½ mark each)

Blood type	Possible genotype(s)
Type A	$I^A I^A$ or $I^A i$
Type B	$I^B I^B$ or $I^B i$
Type AB	$I^A I^B$
Type O	ii

12. A woman with genotype $I^A i$ has children with a man who is $I^B i$. Complete the Punnett square and give the blood type ratio. (2 marks)

	I^B	i	
I^A	$I^A I^B$	$I^A i$	Parents: $I^A i \times I^B i$ Phenotype ratio: $1 AB : 1 A : 1 B : 1 O$
i	$I^B i$	ii	

13. A type A mother and a type B father have a type O child. What are the genotypes of both parents? Explain.

Mother $I^A i$ and father $I^B i$. The type O child is ii , so each parent must carry an i allele.

14. Could a man with type AB blood be the father of a type O child? Explain.

No. An AB man ($I^A I^B$) always passes on I^A or I^B , so his child cannot be ii .

E Sex-linked inheritance

4 marks

15. Colour blindness is X-linked recessive. A carrier woman ($X^B X^b$) has children with a man with normal vision ($X^B Y$). What is the chance that a **son** is colour-blind? (2 marks)

	X^B	Y	
X^B	$X^B X^B$	$X^B Y$	Parents: $X^B X^b \times X^B Y$ Phenotype ratio: $1 \text{ normal daughter} : 1 \text{ carrier daughter} : 1 \text{ unaffected son} : 1 \text{ affected son}$ Son colour-blind: $1/2 = 50\%$ (no daughters are colour-blind; 1/2 are carriers)
X^b	$X^B X^b$	$X^b Y$	

16. Explain why X-linked recessive disorders such as colour blindness are more common in males than in females.

Males (XY) have only one X chromosome, so one recessive allele causes the trait. Females need two copies, one on each X.

17. A man with haemophilia ($X^h Y$) has children with a woman who is not a carrier ($X^H X^H$). What fraction of their daughters will be carriers, and what fraction of their sons will have haemophilia?

All daughters are carriers ($X^H X^h$); no sons have haemophilia (they get Y from the father).

F Spot the mistake

2 marks

18. A student says: "Pink snapdragons prove that the red and white alleles blend together permanently." Explain the error and correct it.

Crossing two pink flowers gives red, pink and white offspring again, so the alleles stay separate. Only the phenotype is intermediate.

19. A student says: "A roan cow has pink hairs because red and white are codominant." Explain the error and correct it.

In codominance both phenotypes appear separately: a roan cow has a mix of red hairs and white hairs, not pink ones.