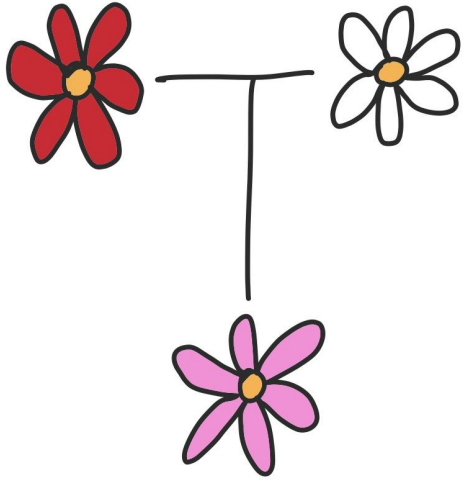
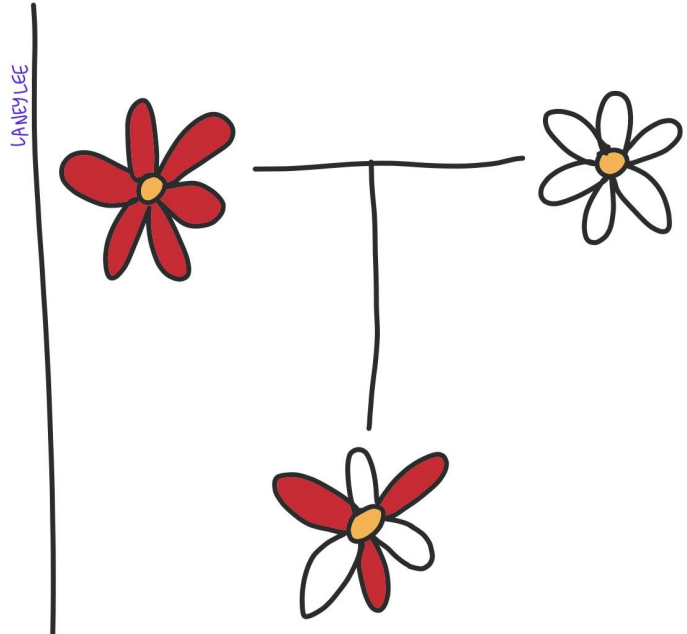
5.2 Variations in Heredity

SBI3U – Incomplete Dominance, Codominance & Multiple Alleles

Patterns of heredity are not always as simple as Mendel thought…



INCOMPLETE DOMINANCE



CODOMINANCE

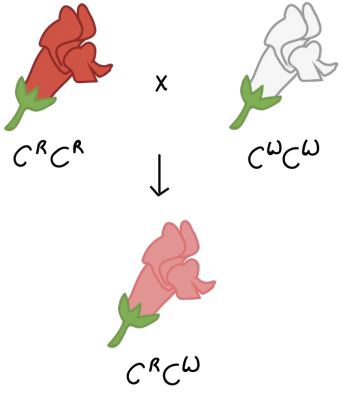
Incomplete Dominance

- **neither allele** is dominant
- a **blended phenotype** appears in the offspring.
- **genotype is heterozygous**
  - E.g. Snap dragons (C^RC^W)

Incomplete Dominance

What happens if you cross a pure breeding (homozygous) red snapdragon and a pure breeding (homozygous) white snapdragon?

P_{gen} – Red Flower C^RC^R X White Flower C^WC^W



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

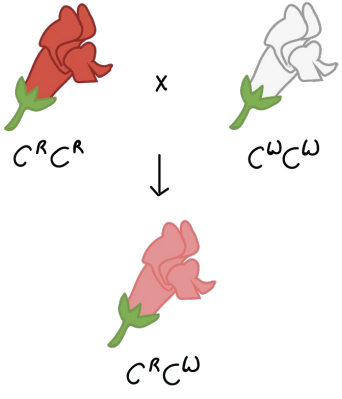
F_1 Genotypic ratio:

F_1 Phenotypic ratio:

Incomplete Dominance

What happens if your cross a pure breeding (homozygous) red snapdragon and a pure breeding (homozygous) white snapdragon?

P_{gen} – Red Flower C^RC^R X White Flower C^WC^W



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

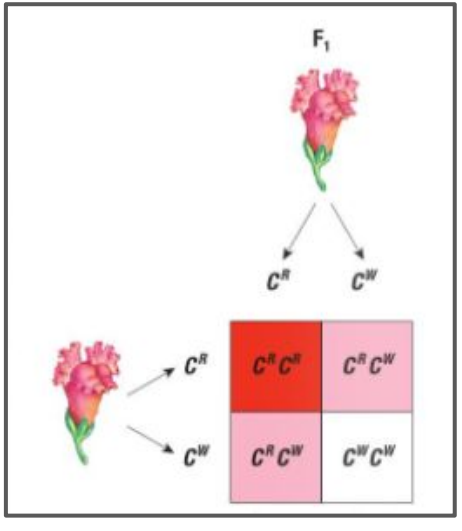
F_1 Genotypic ratio:
100% C^RC^W

F_1 Phenotypic ratio:
100% pink flowers

Incomplete Dominance

What would happen if you were to cross two of the heterozygous individuals from the F1 generation?

F1 – Pink Flower C^RC^W X Pink Flower C^RC^W



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

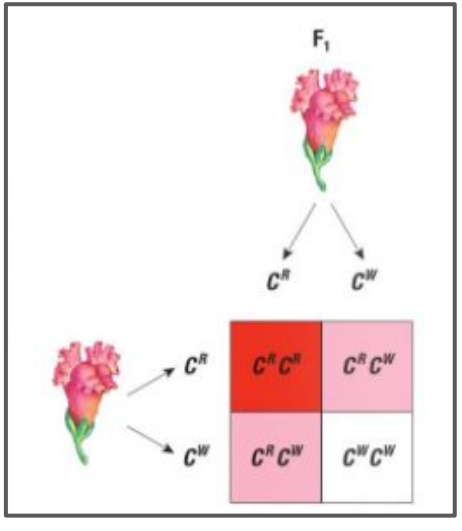
F2 Genotypic ratio:

F2 Phenotypic ratio:

Incomplete Dominance

What would happen if you were to cross two of the heterozygous individuals from the F1 generation?

F1 – Pink Flower C^RC^W X Pink Flower C^RC^W



	C^R	C^W
C^R	C^RC^R	C^RC^W
C^W	C^RC^W	C^WC^W

F2 Genotypic ratio:
1 C^RC^R: 2C^RC^W: 1C^WC^W

F2 Phenotypic ratio:
1 red: 2 pink: 1 white

Incomplete Dominance

What would happen if you were to cross a red and a pink flower?

Cross a red flower and a pink flower.
Write the genotypic and phenotypic ratios.

Genotypic ratio:

Phenotypic ratio:

Answer

Cross a red flower and a pink flower.
Write the genotypic and phenotypic ratios.

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

Genotypic ratio:
1 C^RC^R: 1C^RC^W

Phenotypic ratio:
1 red: 1 pink

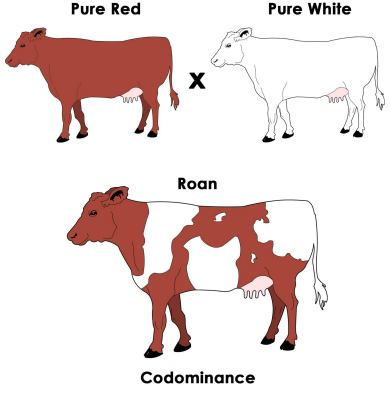
Codominance

- **both alleles** are expressed
- both parental phenotypes seen in offspring (**not** a blend)
- genotype is heterozygous
  E.g. Roan cattle have red **and** white hairs

Codominance

What would happen if you crossed a pure breeding (homozygous) red cow and a pure breeding (homozygous) white cow?

P_{gen} – Red Cow C^RC^R X White Cow C^WC^W



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

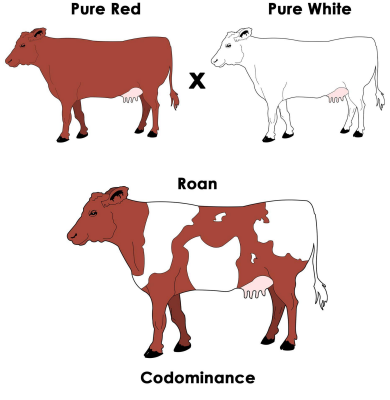
F_1 Genotypic ratio:

F_1 Phenotypic ratio:

Codominance

What would happen if you crossed a pure breeding (homozygous) red cow and a pure breeding (homozygous) white cow?

P_{gen} – Red Cow C^RC^R X White Cow C^WC^W



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

F_1 Genotypic ratio:
100% C^RC^W

F_1 Phenotypic ratio:
100% roan cows

Codominance

What would happen if you were to cross two of the heterozygous roan coated individuals from the F1 generation?

F1 - Roan Coat C^RC^W X Roan Coat C^RC^W

F2 Genotypic ratio:

F2 Phenotypic ratio:

Codominance

What would happen if you were to cross two of the heterozygous roan coated individuals from the F1 generation?

F1 – Roan Coat C^RC^W X Roan Coat C^RC^W

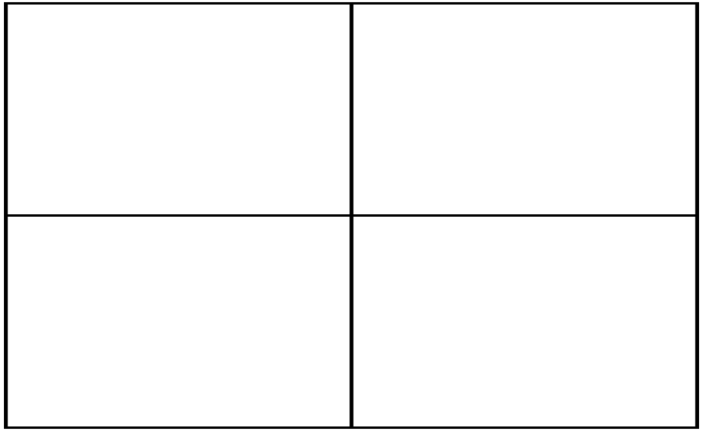
	C^R	C^W
C^R	C^RC^R	C^RC^W
C^W	C^RC^W	C^WC^W

F2 Genotypic ratio:
1 C^RC^R: 2C^RC^W: 1C^WC^W

F2 Phenotypic ratio:
1 red: 2 roan: 1 white

Codominance - Practice

Cross a roan coated cow with a red coated cow. Write the genotypic and phenotypic ratios.



Genotypic ratio:

Phenotypic ratio:

Answer

Cross a roan coated cow with a red coated cow. Write the genotypic and phenotypic ratios.

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

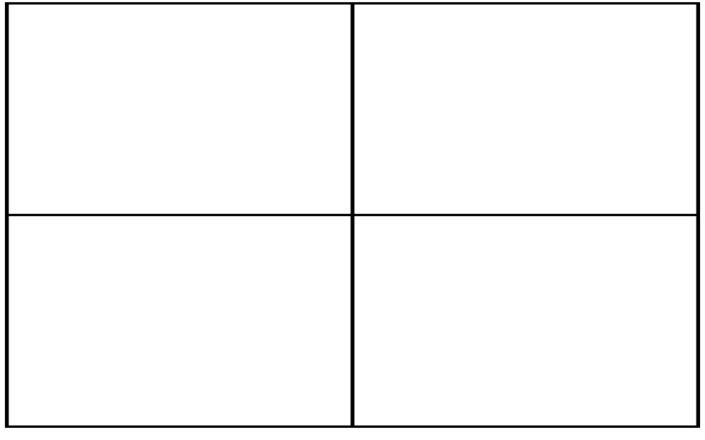
Genotypic Ratio:
1 C^RC^R : 1 C^RC^W

Phenotypic Ratio:
50% Red Coat: 50% Roan Coat

Note: one of the two parents is called a bull. But cow is the general name.

Codominance - Practice

Cross a roan coated cow with a white coated cow. Write the genotypic and phenotypic ratios.



Genotypic ratio:

Phenotypic ratio:

Answer

Cross a roan coated cow with a red coated cow. Write the genotypic and phenotypic ratios.

	C^R	C^W
C^W	C^RC^W	C^WC^W
C^W	C^RC^W	C^WC^W

Genotypic Ratio:
1 C^RC^W : 1 C^WC^W
Phenotypic Ratio:
1 Roan Coat: 1 White Coat

Codominance - Practice

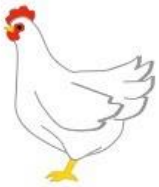
Cross a speckled chicken and a black hen. What is the phenotypic ratio of the offspring?

P_{gen} – Spotted C^BC^W x Black C^BC^B

Phenotype	Black	Speckled	White
Genotype	C^BC^B	C^BC^W	C^WC^W

Answer

Cross a speckled chicken and a black hen. What is the phenotypic ratio for offspring?



Phenotype	Black	Speckled	White
Genotype	C^BC^B	C^BC^W	C^WC^W

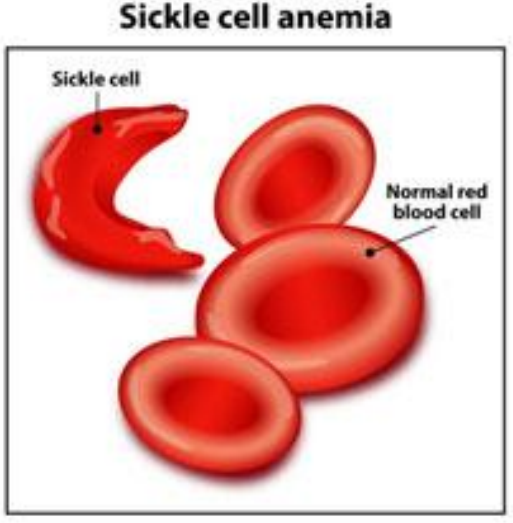
P_{gen} – Speckled C^BC^W X Black C^BC^B

Phenotypic ratio:

50% Black: 50% Speckled

	C^B	C^B
C^B	C^BC^B	C^BC^B
C^W	C^BC^W	C^BC^W

Codominance - SCA



Sickle cell anemia (SCA)

- **Normal** hemoglobin allele **Hb^N**
- **Sickle cell** allele **Hb^S**

Genotypes and their phenotype

- **$Hb^N Hb^N$** = normal; no resistance to malaria
- **$Hb^N Hb^S$** = carrier, rarely have symptoms; **resistant to malaria**
- **$Hb^S Hb^S$** = have sickle cell anemia; resistant to malaria

Heterozygous advantage:
a survival benefit for individuals who inherit two different alleles for the same trait.

Monohybrid cross between two SCA carriers.

Genotypes	Phenotypes
Hb^NHb^N	Normal haemoglobin
Hb^NHb^S	Sickle cell trait
Hb^SHb^S	Sickle cell anaemia

Genotypes Hb^NHb^S Hb^NHb^S

Gametes Hb^N Hb^S Hb^N Hb^S

	Hb^N	Hb^S
Hb^N	Hb^NHb^N	Hb^NHb^S
Hb^S	Hb^NHb^S	Hb^SHb^S

Offspring	Normal	Sickle cell trait	Sickle cell anaemia
Proportions	**25%**	**50%**	**25%**

Multiple Alleles

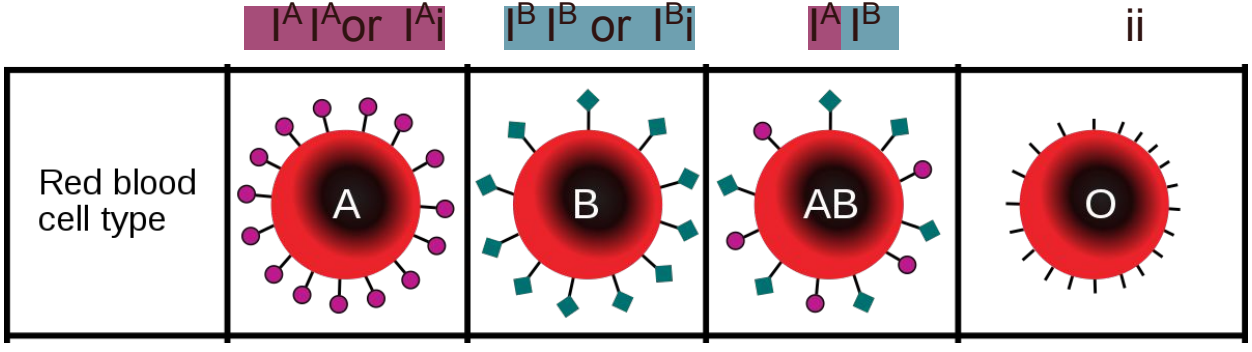
Human blood type is **both** a codominant and dominant genetic trait.

- There are **4 blood types**
- The particular gene has **3 different alleles: I^A, I^B and i.**

Phenotype	Genotype
Type A	I^AI^A ,I^Ai
Type B	I^BI^B ,I^Bi
Type AB	I^AI^B
Type O	ii

Multiple Alleles - Blood Types

Each allele codes for a different enzyme that places different types of sugars on the surface of a red blood cell.



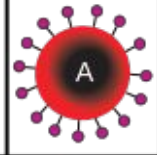
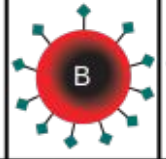
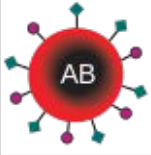
- Type AB blood is an example of codominance. Alleles I^A and I^B are both expressed fully.

- Alleles ***I^A*** **and** ***I^B*** **both dominate** over the allele ***i***
- **i** is the **recessive allele**

Multiple Alleles - Blood Types & Transfusions

Your immune system will produce **antibodies** against any blood **antigens** you do not have in your own blood.

If an incompatible blood type is transfused, there will be an immune response that will lead to blood clumping potentially putting a patient's life at risk.

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in Plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in Red Blood Cell	A antigen	B antigen	 A and B antigens	None

Type O blood is known as the "universal donor."

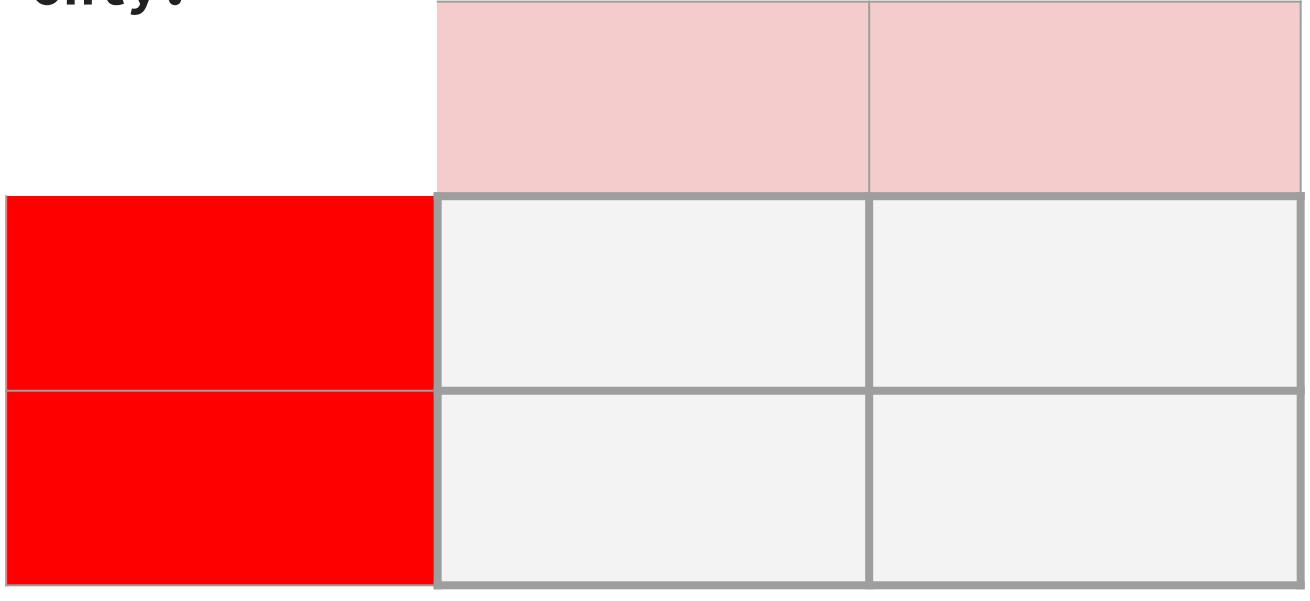
Type AB blood is the "universal recipient".

Multiple Alleles Practice

A woman with Type A blood whose genotype is I^Ai marries a man who is Type B whose genotype is I^Bi.

What are the possible blood types of their children? Give phenotypes only.

Phenotypes:



Multiple Alleles Answer

A woman with Type A blood whose genotype is I^Ai marries a man who is Type B whose genotype is I^Bi.

What are the possible blood types of their children? Give phenotypes only.

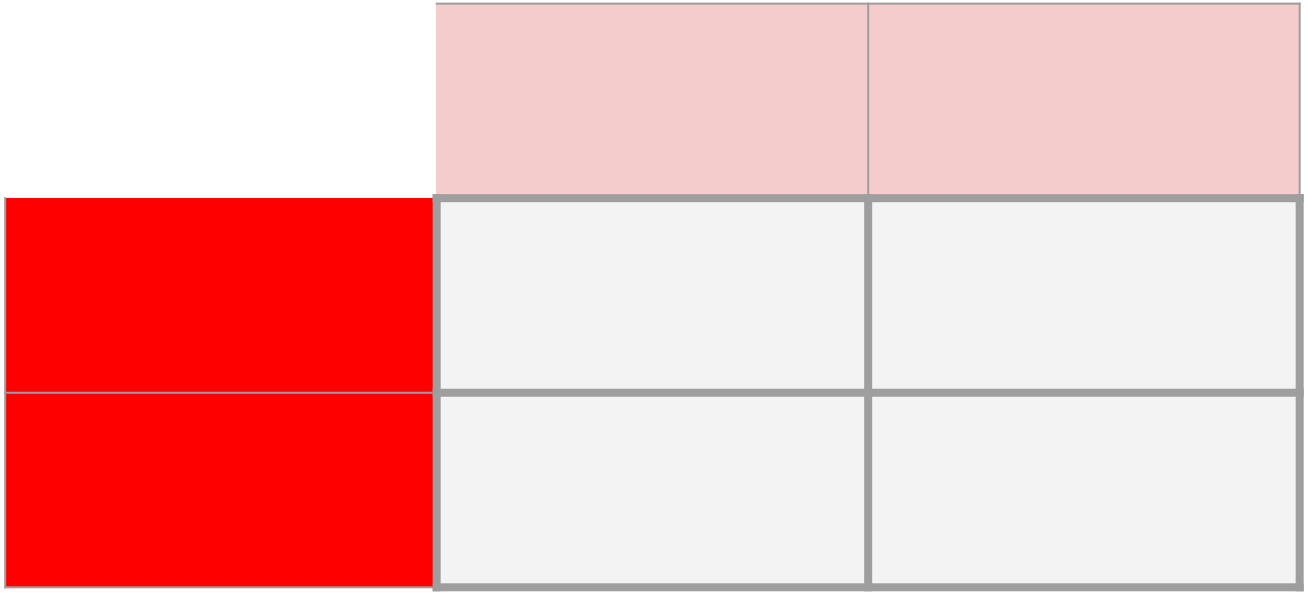
	I^A	i
I^B	I^AI^B	I^Bi
i	I^Ai	ii

Phenotypes:
25% blood type AB
25% blood type A
25% blood type B
25% blood type o

Multiple Alleles Practice

What are the possible genotypes of the children from an AB father and an O mother?

Give genotypic ratios of offspring.



Multiple Alleles Answer

What are the possible genotypes of the children from an AB father and an O mother?

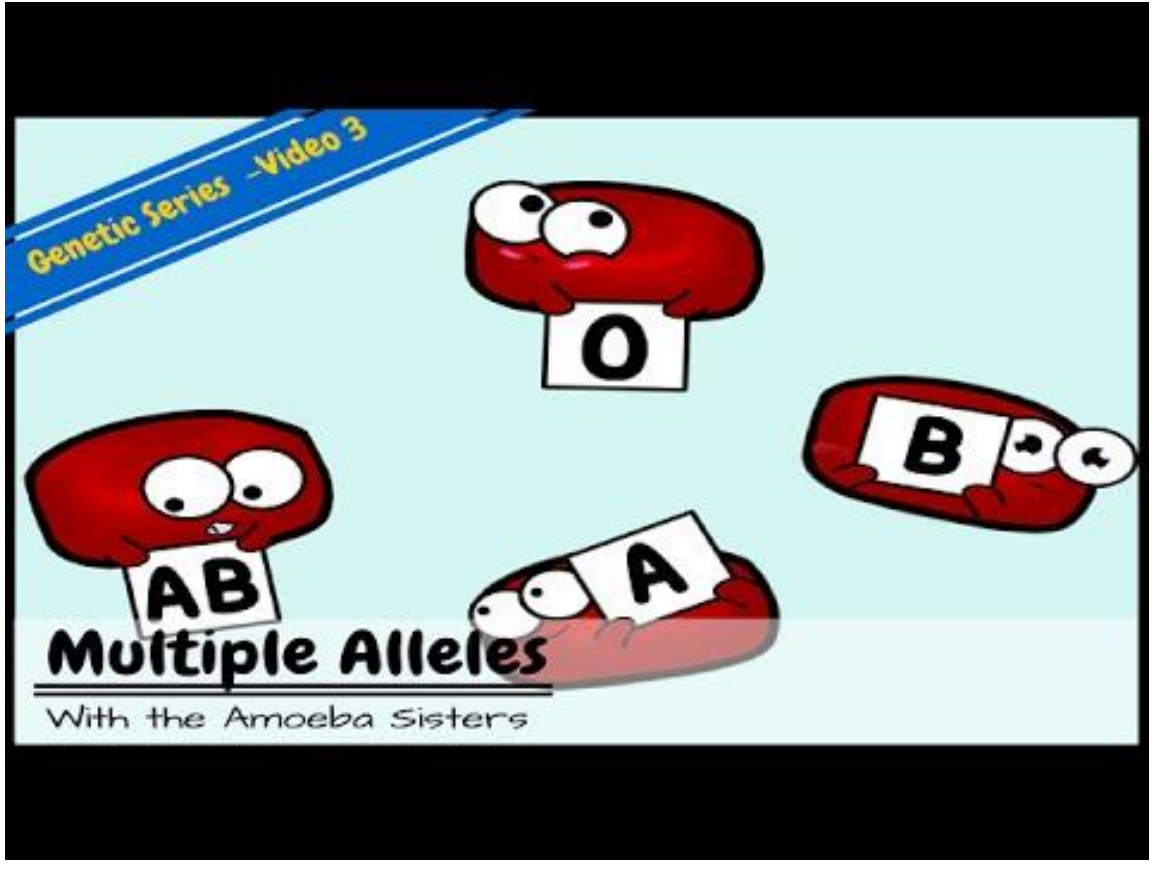
Give genotypic ratios of offspring.

Genotypes:
50% I^Ai
50% I^Bi

Phenotypes:
50% blood type A
50% blood type B

	i	i
I^A	I^Ai	I^Ai
I^B	I^Bi	I^Bi

Multiple Alleles - Recap



Amoeba Sisters Handout

Fill out the Amoeba Sisters handout while watching!

Homework:

- ❑ Read textbook section 5.2

Complete worksheets...

- ❑ codominance & incomplete dominance
- ❑ blood types

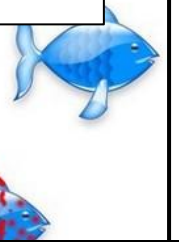
5.2 Summary

- Alleles that determine the phenotype regardless of the presence of other alleles follow a pattern of inheritance called complete dominance.
- A heterozygous individual with an intermediate phenotype between the phenotypes of the two homozygous individuals follows a pattern of inheritance called incomplete dominance.
- Codominance occurs when both alleles are fully expressed. Type AB blood is an example of codominance.
- Blood type is an example of a gene with multiple alleles. The three blood type alleles are I^A, I^B, and i. Different combinations of the three alleles produce type A, type B, type AB, and type O blood.

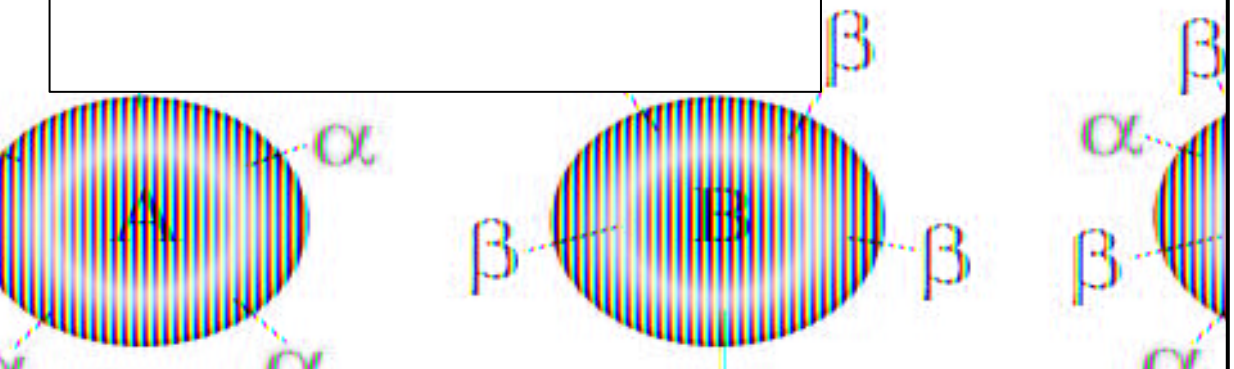
Codominance

n animal can be black, white or
potted

each
nt

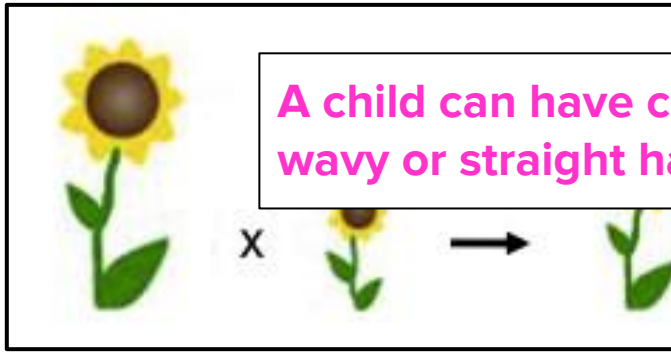


Birds can have white, blue or white with blue-tipped feathers.



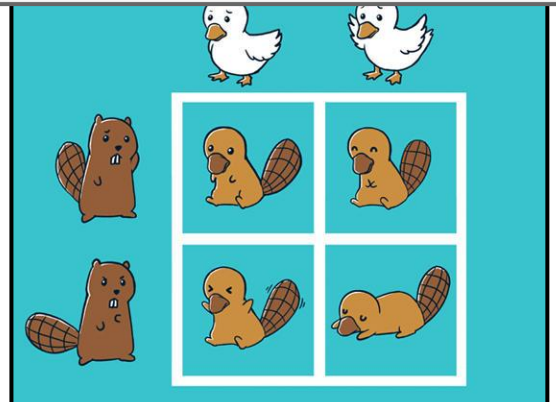
CATEGORIZE

Incomplete Dominance



A child can have c
wavy or straight ha

The newly formed phen
combination of both the



Incomplete Dominance & Codominance Comparison

Incomplete dominance	Co-dominance
Two alleles which are in contrast with each other are present but neither is dominant over one another.	Two alleles are present which are in contrast with each other and both of them express their characteristics freely.
The phenotype that is created is an intermediate of the two contrasting alleles.	The newly formed phenotype is a combination of both the parent alleles.
Eg: The kind of inheritance in dog-flower, of the snapdragon or antirrhinum species.	Eg: AB blood groups in humans.
In the above example, the intermediate trait is expressed in recession.	In the above example, both alleles are present to produce RBC surface antigens A and B.