

## INHERITANCE & VARIATION

16 APRIL 2014



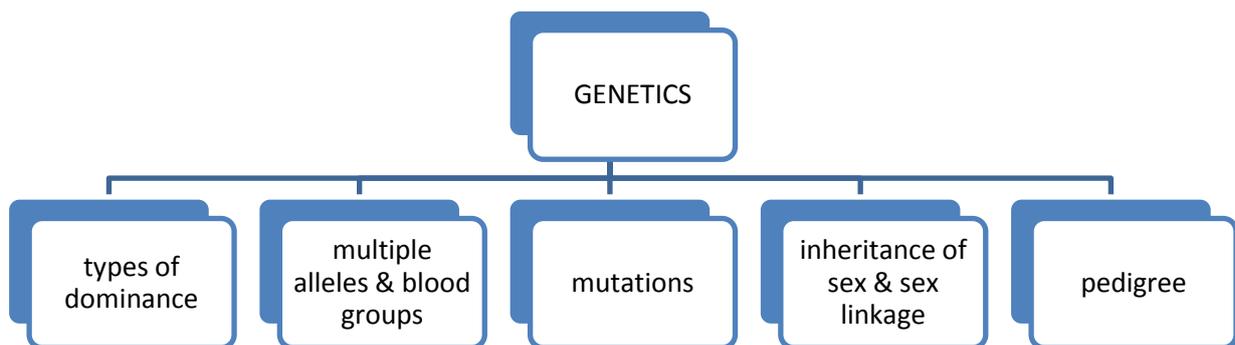
### Lesson Description

In this lesson we:

- Distinguish between complete dominance, incomplete dominance and co-dominance.
- Solve genetics problems.
- Differentiate between sex chromosomes (gonosomes) and autosomes in the karyotypes of human males and females.
- Represent a genetic cross to show the inheritance of sex.
- State what is meant by multiple alleles and explain its manifestation in determining blood groups.
- State what is meant by a mutation and list the causes.
- State what is meant by a genetic pedigree and interpret pedigree diagrams.



### Summary



### Complete Dominance

When two individuals with pure breeding (homozygous) contrasting characteristics are crossed, the  $F_1$  generation all display the dominant characteristic.

### Incomplete Dominance

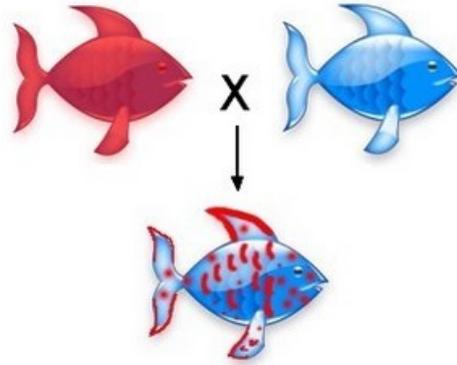
Neither allele is completely dominant over the other. The offspring an intermediate form of the characteristic



*Snapdragons showing incomplete dominance*

### Co-Dominance

Neither allele is completely dominant over the other. Genes have alleles that are **both expressed** in the heterozygote individuals.



Example of co-dominance

### Multiple Alleles

#### Blood Type

Human blood type is governed by the presence of 3 different alleles:

- A
- B
- O

However, each person only has 2 of these 3 alleles in their DNA

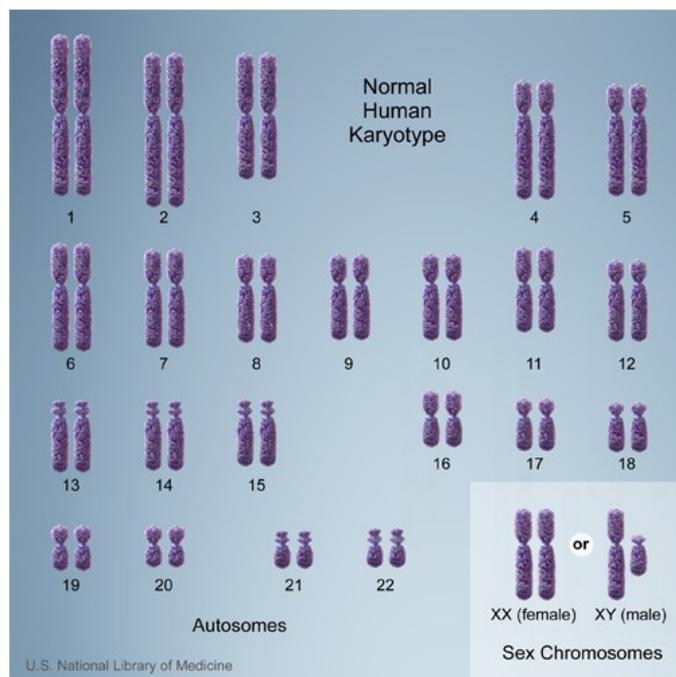
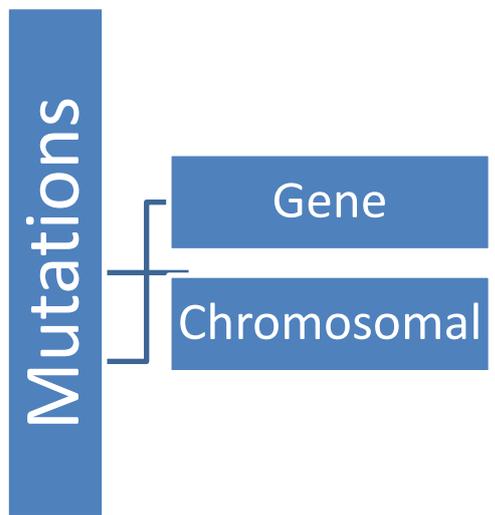
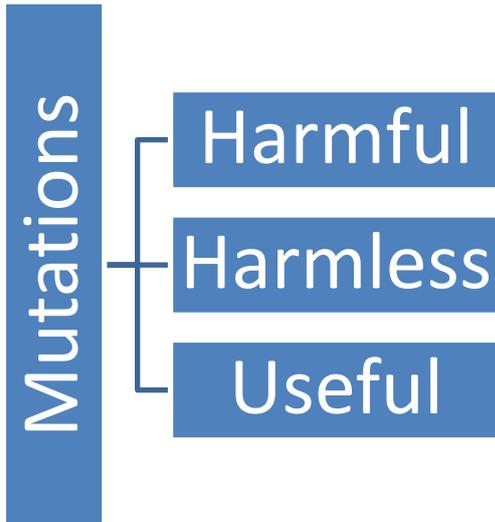
Blood types follow both Co-dominant and simple Dominant inheritance

- The A allele and B allele are **co-dominant** with each other
- The A allele and B allele are both purely **dominant** over the O allele
- The O allele is recessive

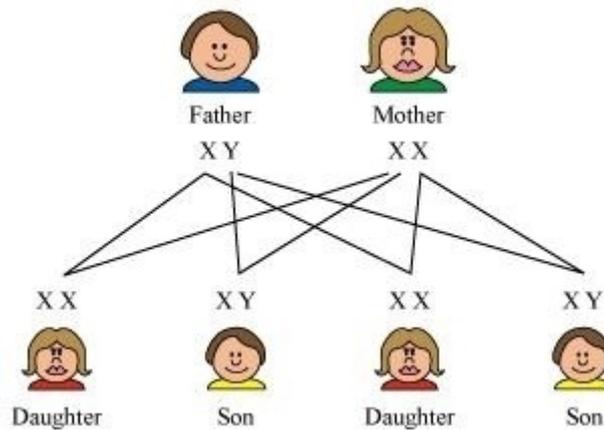
Blood Type	Genotype	Can receive blood from
A	$I^A I^A / I^A i$	A or o
B	$I^B I^B / I^B i$	B or o
AB	$I^A I^B$	All
o	$ii$	o

	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

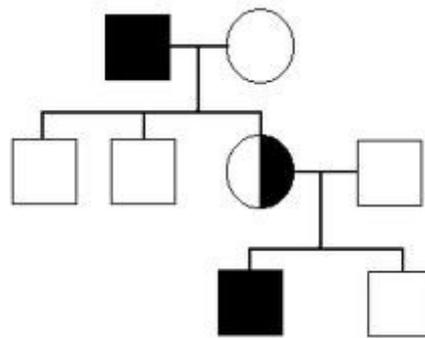
notes for...



notes for...



*Sex Determination in Humans*



*Pedigree Diagrams*



## Test Yourself

Select the most correct answer from the options given. Write down only the correct letter

### Question 1

Which of the following are examples of incomplete dominance?

- (i) A child of a curly-haired parent and straight-haired parent that has wavy hair
- (ii) Blood group AB in humans
- (iii) A cross between a red-flowered snapdragon and a white-flowered snapdragon resulting in pink-flowered offspring
- (iv) A red bird and a blue bird mate and their offspring are purple

- A (i), (ii), (iii)
- B (i), (ii), (iv)
- C (ii), (iii) and (iv)
- D (i), (iii), (iv)

### Question 2

Codominance differs from incomplete dominance because

- A Both traits are displayed in codominance
- B An intermediate trait is displayed in incomplete dominance

- C Both rely on successful negotiation between parents
- D Both A and B

### Question 3

Hemophilia is a sex-linked disorder. The daughter of a hemophiliac father and a carrier mother has a \_\_\_\_\_ probability of being hemophiliac.

- A 100%
- B 25%
- C 50%
- D 33%

### Question 4

In an X-linked, or sex-linked, trait, it is the contribution of \_\_\_\_\_ that determines whether a son will display the trait.

- A The mother
- B The father
- C The paternal grandfather
- D The maternal grandfather

### Question 5

Indicate whether each of the statements in COLUMN I applies to **A only**, **B only**, **both A and B** or **none** of the items in COLUMN II. Write **A only**, **B only**, **both A and B** or **none** next to the question number.

	COLUMN I	COLUMN II
1	The type of mutation where only one nitrogenous base is replaced with another in the mRNA template	A: Gene mutation B: Chromosomal aberration
2	A genetic disorder in which the person lacks the ability to produce the pigment melanin	A: Colour blindness B: Haemophilia
3	Chromosomes other than the sex chromosomes	A: Gonosomes B: Autosomes
4	Inheritance of the disorder linked to a sex chromosome	A: Haemophilia B: Sickle cell Anaemia
5	Chromosome pair 23 as XY	A: Male B: Female

### Question 6

Give the correct biological term for each of the following descriptions. Write only the term next to the question number (a to d) in your ANSWER BOOK.

- a.) None of the alleles dominant and produce intermediate form in the offspring
- b.) The number, shape and arrangement of all the chromosomes in the nucleus
- c.) More than two alleles or alternative forms of a gene
- d.) Characteristics controlled by genes which are located on the sex chromosomes



## Improve your Skills

### Question 1

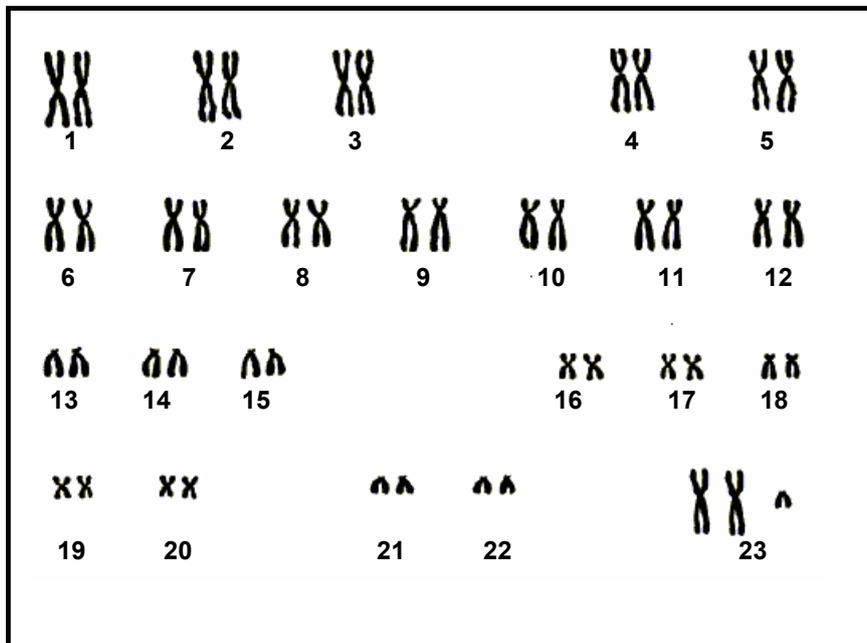
- 1.1 A boy's mother had a patch of white hair called a 'white forelock' which is caused by a dominant allele H. The mother is heterozygous for this trait. His father does not have a 'white forelock'. The symbol for the recessive allele is h. Represent a genetic cross to determine the possible genotypes and phenotypes of the children. (6)
- 1.2 What type of dominance is illustrated in this cross? (1)
- 1.3 Rabbits with brown fur colour (B) were crossed with rabbits with white fur colour (W). All the resultant offspring were cream. Represent a genetic cross to determine the possible genotypes and phenotypes of the offspring in the F1 and F2 generations. (6)
- 1.4 What type of dominance is illustrated here? Provide a reason for your answer. (2)
- 1.5 In an experiment to show co-dominance, plants with white flowers were crossed with plants with red flowers. All the offspring in the F1 generation have red flowers with white spots. The F1 offspring were interbred. The results of the cross between the F1 offspring are shown below:

Phenotype	Red	Red with white spots	White
Number of offspring	210	420	210

- 1.5.1 Provide the genotypes of all the varieties shown in the table above. (3)
- 1.5.2 Give the ratio of the different phenotypes shown in the table. (1)
- 1.5.3 Use the data in the table to draw a pie chart to illustrate the proportions of the different genotypes. (6)

### Question 2

The karyotype below is that of a male person with a genetic disorder called Klinefelter syndrome.



**A karyotype of a male with Klinefelter syndrome**

- 2.1 Provide the numbers of the chromosomes which are autosomes and of those that are gonosomes? (2)

notes for...

- 2.2 State ONE visible difference between the karyotype above and the karyotype of a normal male. (2)
- 2.3 Use your knowledge of meiosis to explain how Klinefelter syndrome could have resulted. (6)
- 2.4 Andrew and Sabeeha have 9 children. All girls. What is the probability that their 10th child will be a boy? Illustrate your diagram with a punnet square only. (2)

**Question 3**

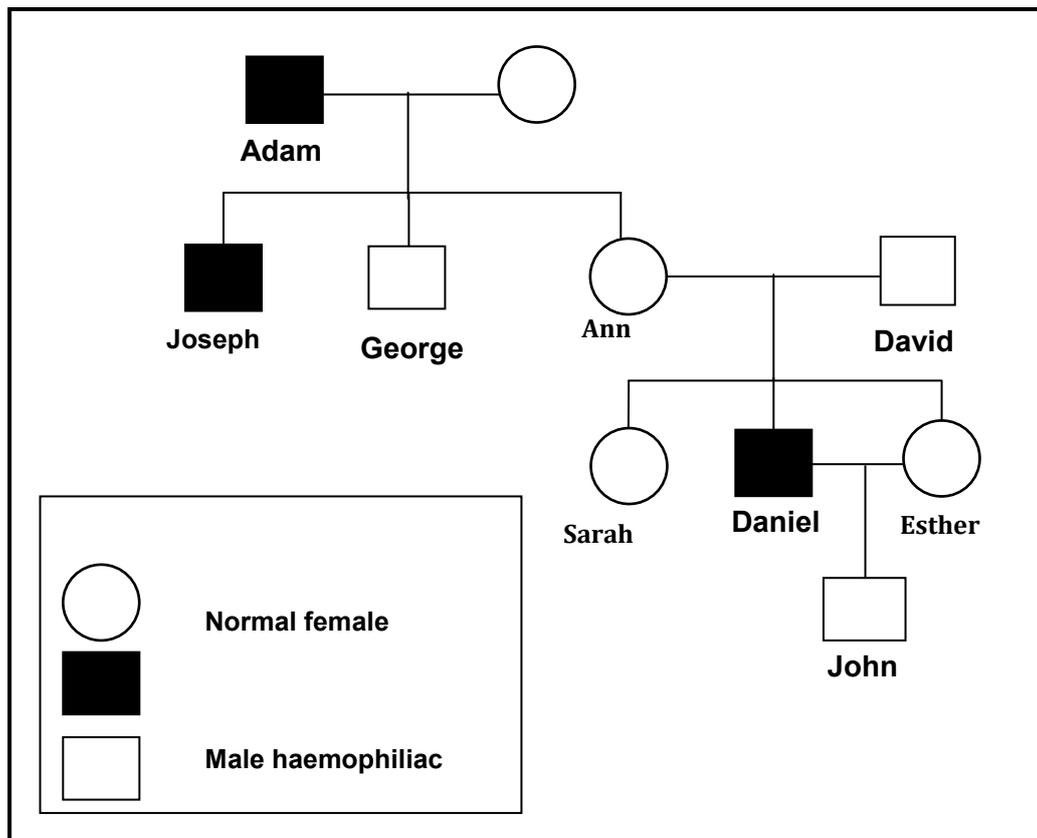
The table below shows the percentage distribution of blood groups in a province in South Africa.

BLOOD GROUPS			
A	B	AB	O
35	15	10	40

- 3.1 How many genes control the blood groups shown above? Explain your answer. (3)
- 3.2 Explain how it is genetically possible to have four blood groups in a population. (2)
- 3.3 Use a genetic diagram to illustrate how a man with blood group A and a woman with blood group B can have a child with blood group AB. Assume that both parents are homozygous.

**Question 4**

Study the pedigree diagram of a family where some individuals have haemophilia. Haemophilia is a sex-linked disorder. Use  $X^H$  for normal blood clotting and  $X^h$  for the haemophiliac trait.



- 4.1 From the pedigree diagram above, state the relationship between gender and the incidence of haemophilia. (2)

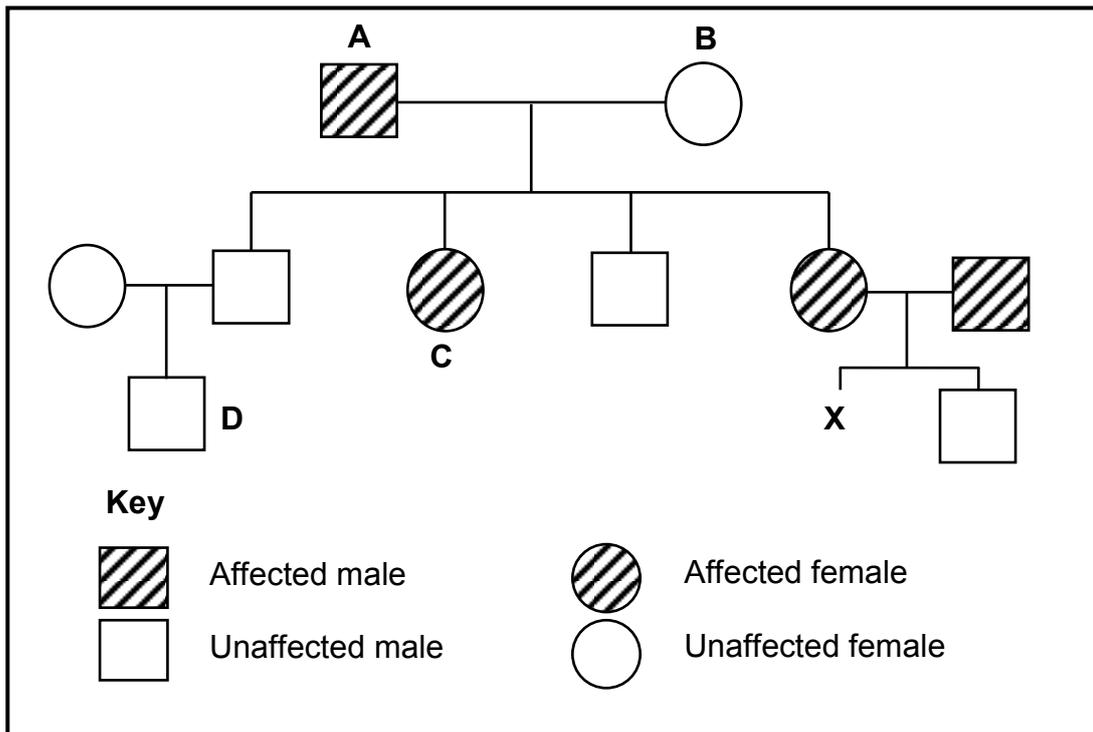
4.2 Write down ALL the possible genotypes of:

- a.) Adam
- b.) Ann
- c.) John

(6)

**Question 5**

A scientist gathered information about the affected and unaffected individuals for a certain genetic disorder. The genetic disorder is caused by a dominant allele. The findings of the scientist are represented in the pedigree diagram below.



5.1 Using the letters R and r to represent the dominant and recessive alleles respectively, state the genotype of individual: (2)

- a.) A
- b.) D

5.2 What is the percentage chance of individual X having a genetic disorder? (2)

5.3 If individual C marries an unaffected male, state the possible genotype(s) of their offspring. (2)



**Links**

- **LX Live 2013:**  
<https://www.youtube.com/watch?v=WS3B1EYM3RQ&list=PLOaNAktW5HLRVviGcDRDLzfezhqXdLygU&index=5>
- **LX Lesson:**  
<https://www.youtube.com/watch?v=AXQiN-bolzA&index=5&list=PLOaNAktW5HLQOqIIPY7QGcEGHpCm9RgtY>