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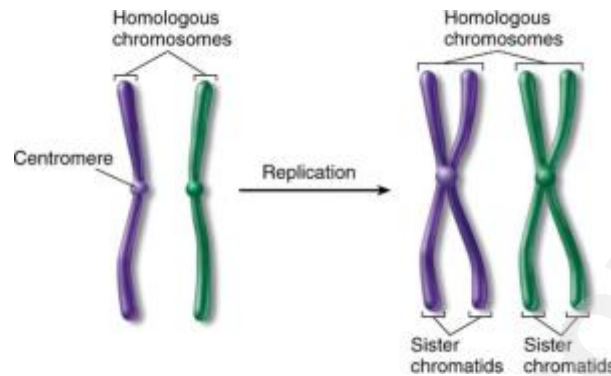


Genetics and Heredity

Review Knowledge

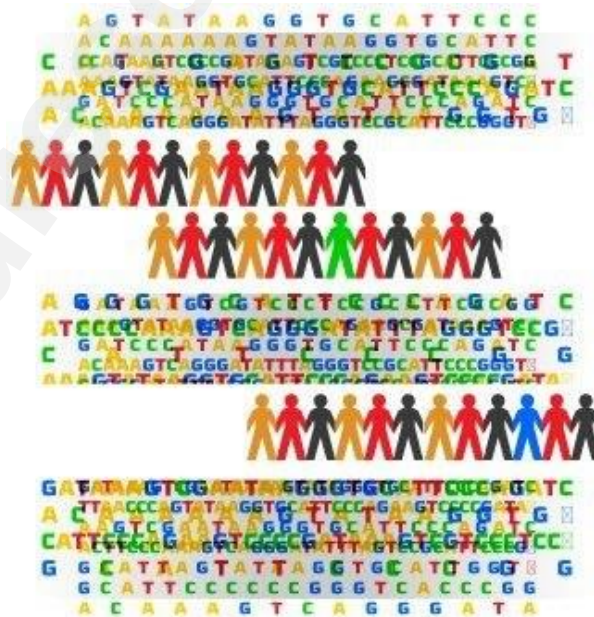
- Every species of plant and animal – a specific number of chromosomes in the nuclei of its cells
- Each chromosome is made up of a sequence of different genes
- A gene is part of the DNA strand that makes up a chromosome and carries information about a specific characteristic
- Each gene carries information on how to make a particular polypeptide or protein
- The polypeptide or protein determines a specific characteristics
- Characteristics are transmitted from parents to their offspring by **haploid gametes** (23 single strand chromosomes)
- Fertilisation = **diploid zygote** (46 single strand chromosomes)
- Zygote has characteristics of both parents
- For every chromosome that the offspring inherits from the mother it inherits similar one from the father
- These similar chromosomes = **homologous chromosomes**
 - **Homologous chromosomes** are the same size + have genes for the same characteristics
 - Ex: a pair of homologous chromosomes will both carry the gene that determines eye colour

- **Somatic cells** = Body cells that contain 46 chromosomes / 23 pairs of chromosomes
- **Gametes** = Sex cells contain 23 chromosomes



Introduction

Genetics is the **science of inheritance** and studies the principles of heredity and variation. The hereditary instruction carried within the DNA ensures that offspring resemble their parents and ensures that **genetic variation** can take place, resulting in survival of the fittest. Many different characteristics in humans are determined by genes, these different characteristics are called genetic traits. Not all genetic traits are visible when you look at a person ex blood type and not all human characteristics are inherited for example some characteristics are determined by the environment ex burn or scar on your skin. Genes are passed on by gametes, these inherited traits may appear in different generations of a family example one family the grandfather and grandson have attached ear lobes but the rest of the family members have free hanging ear lobes. Certain traits are easily traced in families for example Haemophilia which is a blood clotting disorder which is a genetic disorder.



Terminology

- **Chromatin network:** visible as thread-like structures in the nucleus of an inactive cell.
- **Chromosome:** a structure made up of two chromatids joined by a centromere that carries the hereditary characteristics within the DNA.
- **Gene:** a unit of sequenced pieces of DNA that carry the genetic information that will determine the hereditary characteristics of an organism.
- **Allele:** one of two contrasting forms of a gene that determine alternative characteristics in inheritance because they are situated in the same position or locus on homologous chromosomes.
- **Dominant allele:** an allele that masks or suppresses the expression of the allele partner on the chromosome pair and the dominant characteristic is seen in the homozygous (e.g.: TT) and heterozygous state (e.g.: Tt) in the phenotype.
- **Recessive allele:** an allele that is suppressed when the allele partner is dominant. The recessive trait will only be expressed/seen if both alleles for the trait are homozygous recessive e.g.: tt
- **Locus:** The exact position or **location** of a gene on a chromosome.
- **Homozygous:** when two alleles that control a single trait (on the same locus) are **identical**.
- **Heterozygous:** when two alleles that control a single trait (on the same locus) are **different**.
- **Genotype:** This is the total **genetic composition** of an organism. It is the information present in the gene alleles, for example BB, Bb or bb.
- **Phenotype:** This is the external, **physical appearance** of an organism. The phenotype is determined by the genotype. (phenotype, when both recessive gene alleles are present e.g.: bb)
- **Gene mutation:** a change of one or more Nitrogenous bases in the nuclear DNA of an organism.
- **Chromosomal aberrations:** refers to changes in the normal structure or number of chromosomes.
- **Multiple alleles:** when there are more than two possible alleles for one gene locus. e.g. blood groups
- **Complete dominance:** A genetic cross where the dominant allele masks (blocks) the expression of a recessive allele in the heterozygous condition.
- **Incomplete dominance:** A genetic cross between two phenotypically different parents produce offspring different from both parents but with an intermediate phenotype.
- **Co-dominance:** A genetic cross in which both alleles are expressed equally in the phenotype
- **Genetic variation:** this includes a variety of different genes that may differ from maternal and paternal genes resulting in new genotypes and phenotypes.

- **Monohybrid cross:** when **one pair** of traits (e.g. colour trait) is crossed to determine the possible inheritance in the offspring. There will always be **4** possible combinations.
- **Dihybrid cross:** the crossing of **two pairs** of contrasting traits (e.g. colour trait and height) to determine the possible inheritance of the offspring. There will be 16 possible combinations.
- **Filial generation:** The first generation of parents (**P1**) will produce **offspring** that result from a cross called the **first filial generation (F1)**. The inbreeding of offsprings will produce **F2 (second filial generation)**
- **Karyotype:** The number, shape and arrangement of all the chromosomes in a nucleus of a somatic cell.
- **Sex determination:** There are 22 pairs of autosomes and one pair of sex chromosomes (gonosomes) in the human karyotype. Females have XX males have XY.
- **Sex-linked alleles:** characteristics or traits that are carried on the sex chromosomes.
- **Gene mutation:** A gene mutation is a change in the genetic material/DNA sequencing in the cell.
- **Genetic engineering:** The process where scientists alter, swap or manipulate the gene on the DNA, to produce an organism with desirable characteristics.
- **Cloning:** Process by which genetically identical organisms are produced using biotechnology.

PLEASE COMPLETE THE TERMINOLOGY ASSESSMENT [20]

- You will find this Assessment on MS Teams or you can follow the link below
- The assessment opens on the 15th of April and closes on the 16th of April
- [Assessment 1 Terminology](#)

Variation



- **Variation** is the difference in characteristics among organisms of the same species.
- This is a result of differences in the genes of the organisms (genetic variation) and or the influence of the environment in which the organisms live.
- **Discontinuous variation** = occurs when individuals in a population can be put into groups or categories based on characteristics that ***cannot be measured across a range.***
- Example of discontinuous variation: **Blood Groups**
 - Result of the different genes that people inherit
 - The individual either has the characteristic or not
 - There are NO in-betweens
- **Continuous variation** = there is a range of measurements in a population.
- Variation in height, weight and skin colour in human population. This is due to inherited genes as well as environmental factors.
- Example of continuous variation: Height of learners in your class
- Genetic variation can be passed from one generation to the next
- **Genetic variation can result from the following:**
 - Crossing over
 - Random arrangement of chromosomes during meiosis
 - Mutations



Gregor Mendel



Review of Mendel's observations:

- Traits have multiple forms, for example pea plants can be tall or short
- Offspring get character traits from their parents through some kind of "**factor**" (GENES) they inherit.
- In organisms with two parents, it seems like one factor (gene) comes from each parent through sex cells (gametes).
- Offspring outwardly express only ONE of the TWO factors (genes) that they inherit from their parents.
 - The factor (gene) that gets physically expressed is the Dominant
 - The factor (gene) that does not get physically expressed is the Recessive

The Principles of Heredity



Mendel's Laws:

1. Mendel's principle of Segregation

During gametogenesis the two alleles of a gene separate so that each gamete will receive one allele of a gene for a specific characteristic/trait

2. Mendel's Law of Dominance

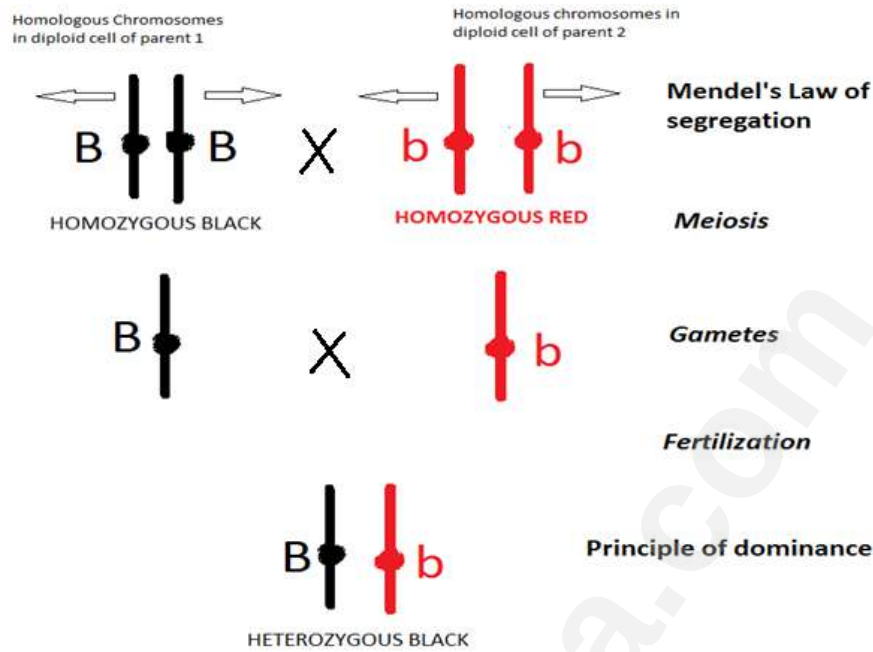
When two individuals with contrasting pure breeding characteristics (homozygous) are crossed, the individuals of the first generation (F1) will **ALL** resemble the parent with the ***dominant characteristic***

3. Mendel's Law of Independent Assortment

Alleles of a gene for one characteristic segregate independently of the alleles of a gene of another characteristic. The alleles for the two different genes will therefore come together randomly during gamete formation. This is also known as random assortment.

Monohybrid Crosses

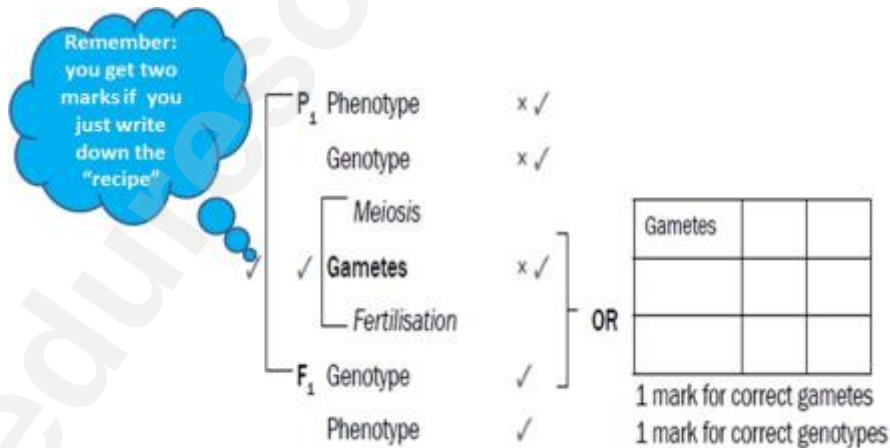
Only **ONE (MONO)** *characteristic/ trait* that is investigated at a time. **Mendel's Law of Segregation** and **Principle of Dominance** are involved in **Monohybrid crosses**



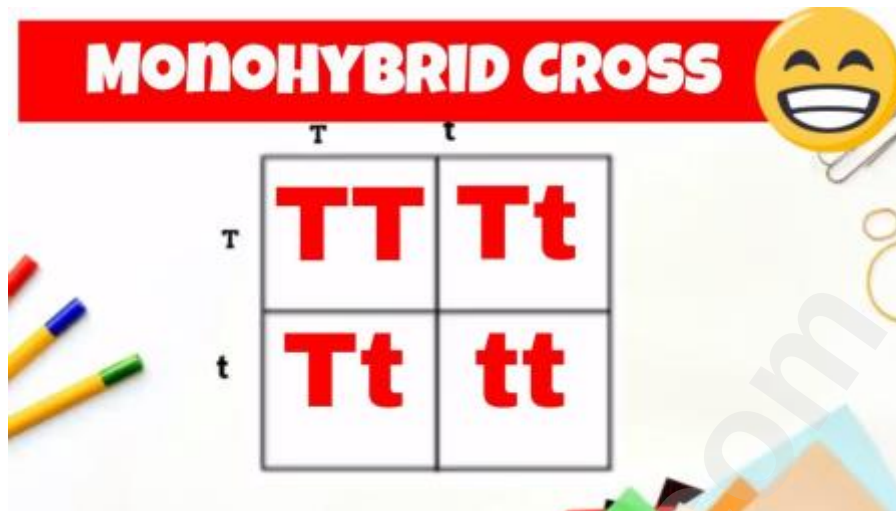
1 - This is an example of what Monohybrid crosses will look like. It also shows where Mendel's Laws and Principles are at work.

Steps to Solve Monohybrid Crosses

1. Determine the **dominant** characteristic. 2. Determine the key i.e. symbol/letter to be used. 3. Determine the **phenotypes** and **genotypes** of the parents. 4. Determine the genes of each **gamete** after meiosis. 5. Determine the alleles of the zygote after fertilization – **F1 - genotype**. 6. Describe the phenotypes of the **F1-generation**



2 - ALWAYS USE THIS TEMPLATE



3 - This video explains how to use a punnet square. A punnet square is there simply to help you determine the alleles that will be inherited from each parent. This punnet square can be used with the above template.

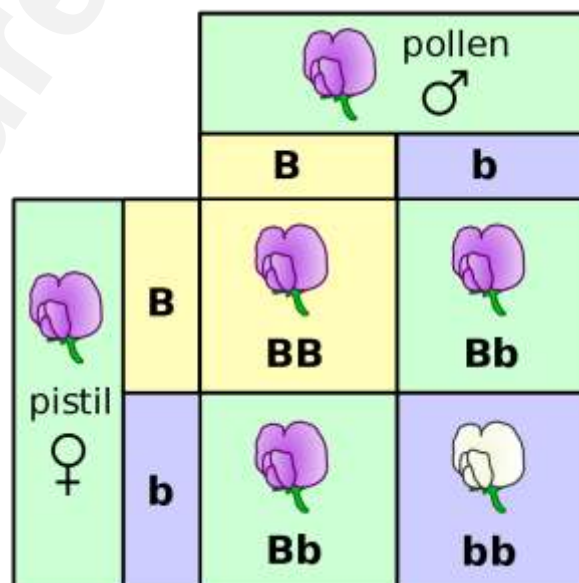
Review of the video: 1. Homozygous Dominant (HH) **Dominant allele + Dominant allele = Dominant Phenotype** 2. Heterozygous (Hh) **Dominant allele + Recessive allele = Dominant Phenotype** 3. Homozygous Recessive (hh) **Recessive allele + Recessive allele = Recessive Phenotype**

Pick one letter for a GENE

- Recessive allele always use a lower case letter
- Dominant allele always use the Capital letter

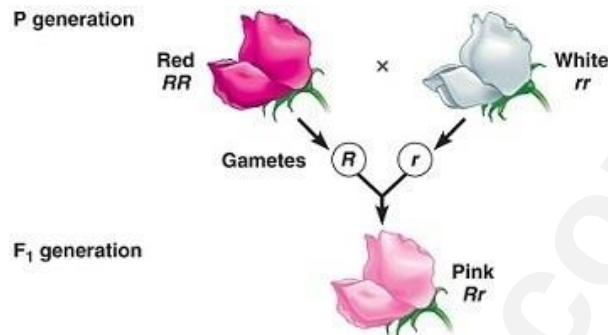
Three different "TYPES" of Monohybrid crosses

1. Complete Dominance



A genetic interaction where **one allele** of a **gene suppress** the **expression** of an **alternative allele** in the **F1 heterozygote** (e.g. Bb) so that the phenotype is the same as that of the dominant allele.

2. Incomplete Dominance



A pattern of inheritance in which a cross between two phenotypically different parents produces an offspring different from both parents but containing partial features of both, therefor forming the intermediate.

3. Co-dominance

Both alleles are equally dominant and therefore both are expressed in the phenotype.

Blood Type	Genotype		Can Receive Blood From:
A	$i^A i^A$ $i^A i$	AA AO	A or O
B	$i^B i^B$ $i^B i$	BB BO	B or O
AB	$i^A i^B$	AB	A, B, AB, O
O	ii	OO	O

4 - Co-dominance in humans



5 - Co-dominance in animals



6 - Co-dominance in flowers

Solving Genetic Problems: Monohybrid crosses (Complete Dominance)

Question 1

A homozygous tall plant is crossed with a homozygous short plant. What is the genotype and phenotype of the offspring?

P ₁ phenotype	Tall	x	Short									
genotype	TT	x	tt									
Meiosis	(Mendel's Law of Segregation)											
Gametes	T, T x t, t											
Fertilisation	<table><tr><th>gametes</th><th>T</th><th>T</th></tr><tr><th>t</th><td>Tt</td><td>Tt</td></tr><tr><th>t</th><td>Tt</td><td>Tt</td></tr></table>			gametes	T	T	t	Tt	Tt	t	Tt	Tt
gametes	T	T										
t	Tt	Tt										
t	Tt	Tt										
F ₁	Tt Tt Tt Tt											
Genotype:	Tt											
Phenotype:	Tall											
(Individuals of F ₂ all display the dominant characteristic)												



7 - Memo for Question 1

Question 2

In humans, the ability to roll the tongue is because of a dominant gene. Use the letters (R) to represent rolling and (r) for non-rolling and show diagrammatically, by means of a genetic cross, how a man who is a roller, who marries a woman who is also a roller, may have a girl who cannot roll her tongue.

P₁ Phenotype **Roller** x **Roller**

Genotype **Rr** x **Rr**

Meiosis

Gametes **R** , **r** **R** , **r**

Fertilisation

	R	r
R	RR	Rr
r	Rr	rr

F₁

Genotype: **RR**, **Rr**, **Rr**, **rr**

Ratio: 1 : 2 : 1

Phenotype: **Roller** **Roller** **Roller** **Non-roller**

Ratio: 3 : 1

8 - Memo for Question 2

Practice Questions

In the questions that follow we will use one general trait e.g. hair colour:

B = brown hair colour (dominant trait)

b = blonde hair colour (recessive trait)

1. A homozygous dominant parent crossed with a homozygous recessive parent
2. A heterozygous parent crossed with a heterozygous parent
3. A Homozygous dominant parent crossed with a heterozygous parent
4. A Homozygous recessive parent crossed with a heterozygous parent

Complete this work, send me a picture on MS Teams as a private message for your memo.

PLEASE COMPLETE ASSESSMENT 2 [24]

- You will find this Assessment on MS Teams or follow the link below
- The assessment opens on the 17th of April and closes on the 20th of April
- [Assessment 2 Monohybrid cross - Complete dominance](#)

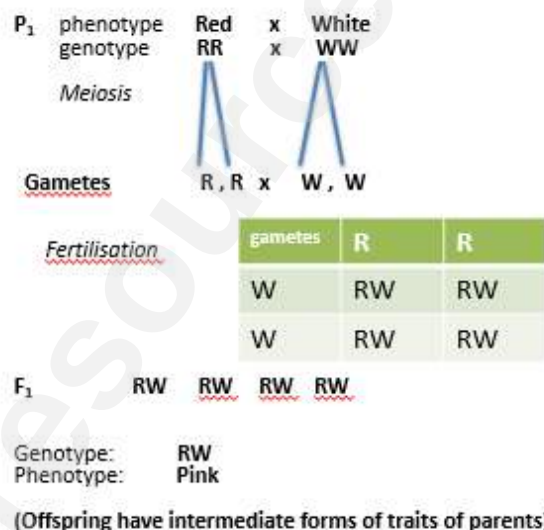
Solving Genetic Problems: Monohybrid crosses (Incomplete Dominance)



9 - Watch this video before attempting the questions!

Question 1

In a certain species of rose plants, there is incomplete dominance between the alleles for red and white flower colour. Determine the genotypes and phenotypes of the F₁ generation (offspring).



10 - Memo for Question 1

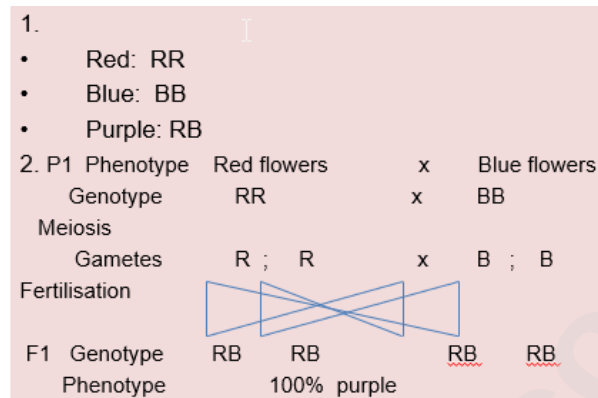
Question 2

SpongeBob loves growing flowers for his pal Sandy! Her favourite flowers, Poofkins, are found in red, blue and purple. Use the information provided and your knowledge of incomplete dominance to complete each section below.

1. Write the correct genotype for each colour if R represents a red gene and B represents a blue gene.

Red: _____ Blue: _____ Purple: _____

2. Draw a genetic cross to indicate what the genotypes of the resulting flowers if SpongeBob crossed a Poofkin with red flowers with a Poofkin with blue flowers.

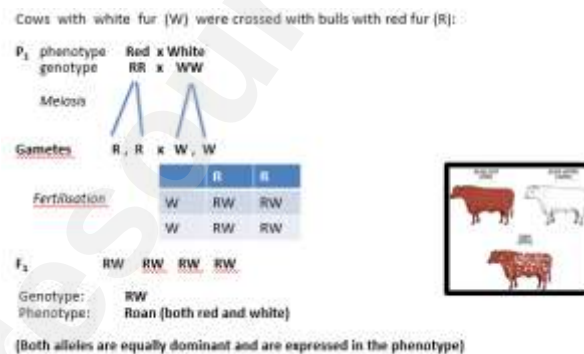


11 - Memo for Question 2

Solving Genetic Problems: Monohybrid crosses (Co-dominance)

Question 1

Cows with white fur (W) were crossed with bulls with red (R). Determine the genotypes and phenotypes of the F1 generation (offspring).



Question 2

In certain marine invertebrates the colour of the shell is under the control of one gene with three alleles. In different combinations, the three alleles produce four phenotypes: orange, yellow, orange-yellow and black. The table below shows the results of the offspring produced from crosses involving parents of different phenotypes.

CROSS	PHENOTYPES OF SHELLS	
	PARENTS	OFFSPRING
1	Yellow x yellow	27 yellow: 9 black
2	Black x black	All black
3	Orange x orange	30 orange: 10 black
4	Orange x yellow	All orange- yellow

1. Name and describe the type of dominance shown by cross 4.

(3)

2. Which shell colour is controlled by the recessive allele? (1)

3. Use information in the table to support your answer to QUESTION 2. (2)

Memo:

1. Co-dominance - The phenotypes/alleles of the parents are equally dominant (orange and yellow) and are both expressed in the phenotype of the offspring

2. Black

3. In cross 1 both parents are yellow / none of the parents are black - But black appears in the phenotype of the offspring

OR

- In cross 3 both parents are orange / none of the parents are black

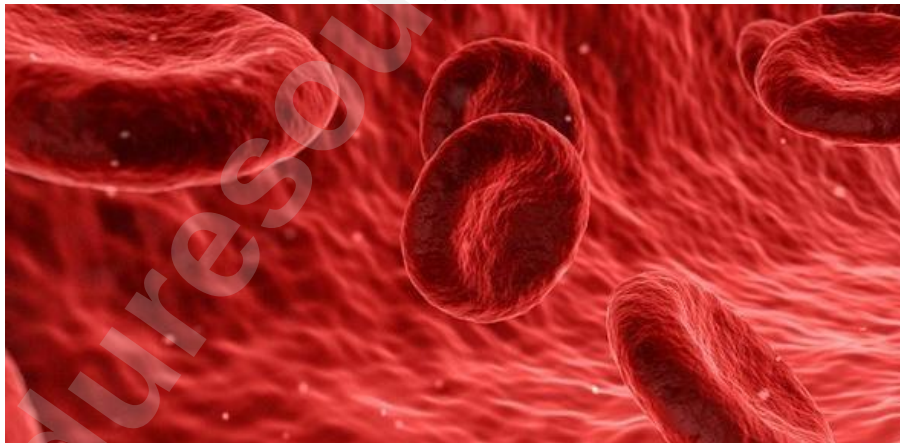
- but black appears in the phenotype of the offspring

OR

- The ratio of the offspring in cross 1 (yellow and yellow/ cross 3 (orange and orange) is 3 yellow/orange:1 black

- The smaller proportion represents the recessive allele/black

Co-dominance - Blood groups



Blood groups are another example of Co-dominance. Blood groups are controlled by multiple alleles.

Important things to remember when working with blood groups

- You can only have one blood group
- You can only have two alleles for a blood group
- But there are three different alleles
- And there are four blood groups

When doing any genetic crosses with blood groups we follow the same template as all the other crosses, however the way we **write the alleles differs**! The alleles are now written like the image indicates.

Inheritance of the ABO Blood System in Humans			
	I^A	I^B	i
I^A	$I^A I^A$ A	$I^A I^B$ AB	$I^A i$ A
I^B	$I^B I^A$ AB	$I^B I^B$ B	$I^B i$ B
i	$i I^A$ A	$i I^B$ B	ii O

Blood group (Phenotype)	Alleles (Genotype)
A	$I^A I^A$ or $I^A i$
B	$I^B I^B$ or $I^B i$
AB	$I^A I^B$
O	ii

Lets look at an example

A man with blood group AB marries a woman with blood group O. Predict the nature of their possible offspring.

P₁ Phenotype **AB** x **O**
Genotype $I^A I^B$ x ii
Meiosis
Gametes I^A I^B i i
Fertilisation

Gametes	I^A	I^B
i	$I^A i$	$I^B i$
i	$I^A i$	$I^B i$

F₁ Genotype: $I^A i$ and $I^B i$
Ratio: 1 : 1
Phenotype: **Blood group A** and **Blood group B**
Ratio: 1 : 1

Now you try this activity

- Human blood groups are controlled by multiple alleles.

a) How many alleles control blood groups? b) Which TWO alleles are co-dominant in the inheritance of blood groups? c) A man is heterozygous for blood group A and marries a woman who has blood group O. Use a genetic cross to show the phenotypic ratio of their offspring.

Memo

a) 3

b) A and B

c) The memo for (c) is the image attached

P ₁	Phenotype	Blood group A	x	Blood group O
	Genotype	I ^A i	x	ii
Meiosis				
	Gametes	I ^A , i	x	i, i
			OR	
F ₁	Genotype	I ^A i	I ^A i	ii
	Phenotype	2 blood group A:	2 blood group O	
	Phenotypic ratio is	1:1	*	
Marking				
	P ₁ and F ₁			
	Meiosis and fertilisation			
	* compulsory mark			

PLEASE COMPLETE ASSESSMENT 3 [12]

- You will find this Assessment on MS Teams or follow the link below
- The assessment opens on the 22nd of April and closes on the 23rd of April
- [Assessment 3: Monohybrid crosses - Incomplete and Co-dominance](#)

Sex-linked Inheritance



To understand sex linked inheritance we need to understand **Sex Determination**

- Females have XX **sex chromosomes** while males have **XY sex chromosomes**.
- Each time fertilisation occurs, there is a 50% chance of the zygote being male and a 50% chance of the zygote being female, $X + X = XX$ and $X + Y = XY$.

P₁ Phenotype: male x female
Genotype: XY x XX
Meiosis
Gametes: X, Y x X, X
Fertilization

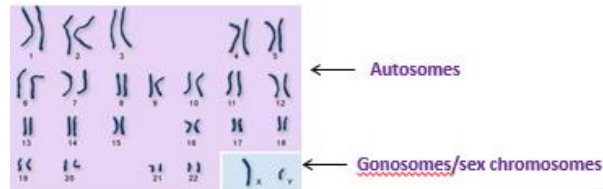
	X	X
X	XX	XX
Y	XY	XY

F₁ Genotype: XX XX : XY XY
 1 : 1
Phenotype: 50% females : 50% males
 1 : 1

Gonosomes inheritance

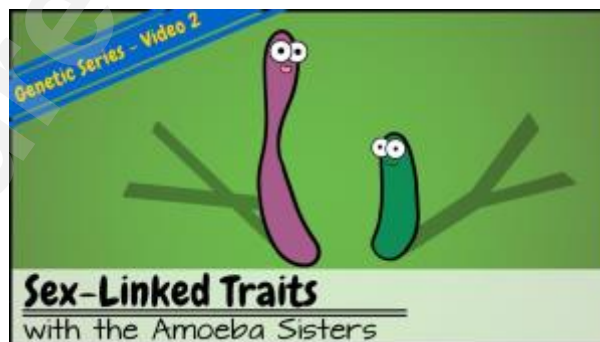
- Genes** located on a **sex chromosome** are called **sex linked genes**.

- In **humans** the term usually **refers to X-linked** characteristics: genes located **only on X chromosomes**.
- **Fathers** can pass **X-linked alleles** to their **daughters**, but not sons.
- **Mothers** can pass **sex-linked alleles** to **both** sons and daughters.



Common sex-linked disorders

1. Haemophilia - A sex-linked condition where blood fails to clot properly



INHERITANCE OF HAEMOPHILIA AS AN EXAMPLE OF A SEX – LINKED DISEASE

- Males have only one **X chromosome**.
- The **Y chromosome** has no gene for blood clotting.
- This means that the condition of haemophilia is seen in males with only one recessive allele present.

- A female with one recessive allele will be a carrier because the other X chromosome will carry the normal dominant gene. This dominant allele will mask the effect of the recessive allele.
- A female will only be haemophilic if she has both homozygous recessive alleles.

Example 1 : Normal male crossed with a female carrier

EXAMPLES
For a normal male and female carrier (heterozygous) cross:

P₁ Phenotype: normal male x female carrier
Genotype: $X^{H}Y$ x $X^{H}X^{h}$
Meiosis:
Gametes: X^{H}, Y x X^{H}, X^{h}
Fertilization

	X^{H}	Y
X^{H}	$X^{H}X^{H}$	$X^{H}Y$
X^{h}	$X^{H}X^{h}$	$X^{h}Y$

F₁ Genotype: 1 $X^{H}X^{H}$: 1 $X^{H}X^{h}$: 1 $X^{H}Y$: 1 $X^{h}Y$
normal female : female carrier : normal male : haemophilic male
25% : 25% : 25% : 25%

Phenotype : 50% normal females : 25% normal males : 25% haemophilic males

Example 2 : Affected male crossed with a normal female

For an affected male and normal female cross:

P₁ Phenotype: affected male x normal female
Genotype: $X^{h}Y$ x $X^{H}X^{H}$
Meiosis:
Gametes: X^{h}, Y x X^{H}, X^{H}
Fertilization

	X^{h}	Y
X^{H}	$X^{H}X^{h}$	$X^{H}Y$
X^{H}	$X^{H}X^{h}$	$X^{H}Y$

F₁ Genotype: $X^{H}X^{h}$: $X^{H}X^{h}$: $X^{H}Y$: $X^{H}Y$
50% of F₁ is female carriers : 50% of F₁ is normal males
1 : 1

Phenotype : 100% normal

Colour Blindness



INHERITANCE OF COLOUR BLINDNESS AS AN EXAMPLE OF A SEX – LINKED DISEASE

- Males have only one X **chromosome**.
- The **Y chromosome** has no gene for colour sight.
- This means that the condition of colour blindness is seen in males with only one recessive allele present.
- A female with one recessive allele will be a carrier because the other X chromosome will carry the normal dominant gene. This dominant allele will mask the effect of the recessive allele.
- A female will only be colour blind if she has both homozygous recessive alleles.

Example 1: A colour blind male crossed with a normal female (non-carrier)

P ₁	Phenotype	Colour blind man	x	Normal non carrier female
	Genotype	X ^b Y	x	X ^B X ^B
Meiosis	Gametes	X ^b Y		X ^B X ^B
Fertilisation				
		X ^b	Y	
	X ^B	X ^B X ^b	X ^B Y	
	X ^B	X ^B X ^b	X ^B Y	
F1	Genotype:	50 % X ^B X ^b ; 50% X ^B Y		
	Phenotype:	50% female carriers, 50% normal males		

PLEASE COMPLETE ASSESSMENT 4 [28]

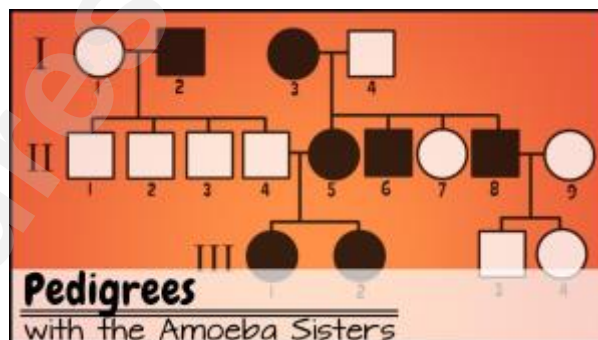
- You will find this Assessment on MS Teams or follow the link
- The assessment opens on the 27th of April and closes on the 28th of April

- [Assessment 4: Sex linked disorders](#)

Genetic Pedigree Diagrams



Autosomal recessive traits

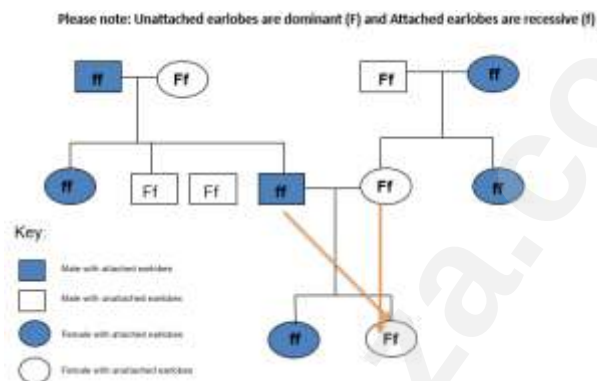


Autosomal recessive traits: Steps to interpret questions

Follow the following steps when interpreting pedigree diagrams:

1. Study any **key and opening statement/s** and look for **dominant characteristics** and phenotypes.
2. Fill in the **genotype of all the individuals with the recessive condition** (It has to have 2 **lower case** letters e.g. ff).

3. For every individual in the diagram that has the recessive condition, it means that each gene was obtained from each of the parents.
4. **Work backwards** and fill in **one recessive gene for each parent**.
5. If the **parents showed the dominant characteristic** fill in the **second letter** which has to be a **capital letter**.
6. Any other individual showing the dominant characteristic will most likely be homozygous dominant – two capital letters.



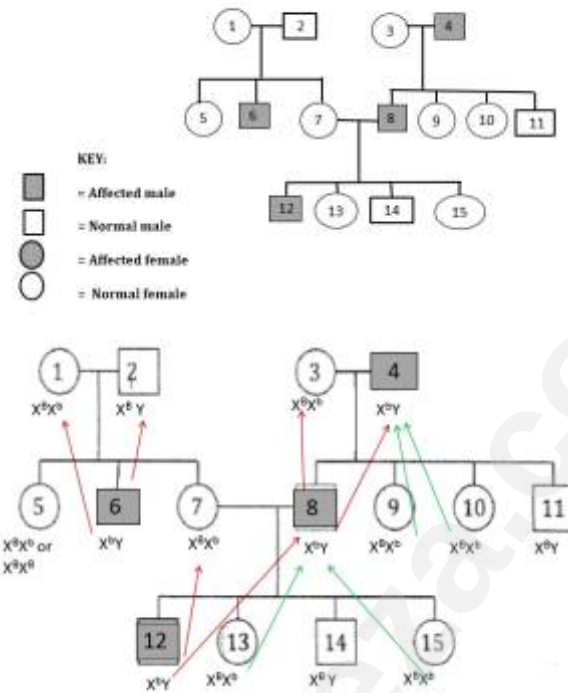
Sex-linked recessive traits

Sex-linked recessive traits: Steps to interpret questions

Follow the following steps when interpreting pedigree diagrams:

1. Study any **key and opening statement/s** and look for **dominant characteristics** and phenotypes.
2. Fill in the **genotype of all the individuals with the recessive condition** (It has to have 2 **lower case** letters e.g. ff).
3. For every individual in the diagram that has the recessive condition, it means that each gene was obtained from each of the parents.
4. **Work backwards** and fill in **one recessive gene for each parent**.
5. If the **parents showed the dominant characteristic** fill in the **second letter** which has to be a **capital letter**.
6. Any other individual showing the dominant characteristic will most likely be homozygous dominant – two capital letters.

The following pedigree diagram is for colour blindness. Determine the possible genotypes for number 1-15. Colour blindness is a sex linked condition. Use X^b to indicate the affected allele and X^B to indicate the normal allele.



PLEASE COMPLETE ASSESSMENT 5 [28]

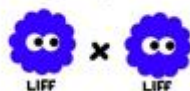
- You will find this Assessment on MS Teams or follow the link
- The assessment opens on the 27th of April and closes on the 28th of April
- [Assessment 5: Genetic Pedigree Diagrams](#)

Dihybrid Crosses



- A dihybrid cross involves the inheritance of two characteristics.
- According to the **Law of Independent Assortment**, alleles of a gene for one characteristic segregate independently of the alleles of a gene for another characteristic.
- The alleles for the two genes will therefore come together randomly during gamete formation.
- This means that the two characteristics are transmitted to the offspring independently of one another.
- The above law only applies if the genes for the two characteristics are not on the same chromosome.

MENDELIAN GENETICS: THE DI-HYBRID CROSS



	LF	Lf	If	if
LF	CC	CC	cc	cc
Lf	CC	CC	cc	cc
If	cc	cc	cc	cc
if	cc	cc	cc	cc

L=LARGE F=FLUFFY
l=SMALL f=SMOOTH

Steps to follow when solving a dihybrid cross

Step 1

- Identify the phenotypes of the two hamsters for each of the two characteristics.

Step 2

- Choose letters to represent the alleles for the gene responsible for each characteristic.

Step 3

- Write the genotypes of each parent.

Step 4

- Determine the possible gametes that each parent can produce.
- Remember that each parent will have two alleles for each gene.
- The gametes of each parent will have only one allele for each gene because of segregation during meiosis.
- Remember that because of the principle of independent assortment an allele for one gene could appear in the same gamete with any of the alleles for the other gene.

Step 5

- Enter the possible gametes at the top and side of a Punnett square.

Step 6

- Because of random fertilisation, gametes from both parents could fuse in different combinations to form the offspring.
- In the punnet square, write down the genotypes of the offspring that will result from each possible combination of gametes

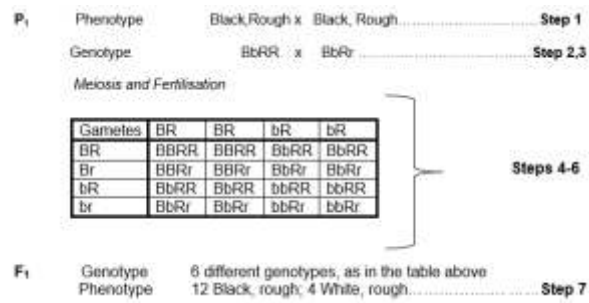
Step 7

- Determine the phenotypes of the offspring from the genotypes obtained in the punnet square.

Example 1

In hamsters, the allele for black coat colour (B) is dominant over the allele for white coat colour (b). The allele for rough coat (R) is dominant over the allele for smooth coat (r). If you cross a hamster that is heterozygous black and homozygous rough, with one that is heterozygous black and heterozygous rough, what will be the phenotypes and genotypes of the offspring?

Memo for Example 1



To get the gametes remember we take each parent, we then take **ONE** allele from each trait. Make sure that you first use the B with both the R, then go to the b with both R.

Example: BbRR

1. We take a BR, then BR, then bR and bR
2. We do this for both parents

PLEASE COMPLETE ASSESSMENT 6 [23]

- You will find this Assessment on MS Teams or follow the link
- The assessment opens on the 1st of May and closes on the 4th of May
- [Assessment 6: Dihybrid crosses](#)

Mutations



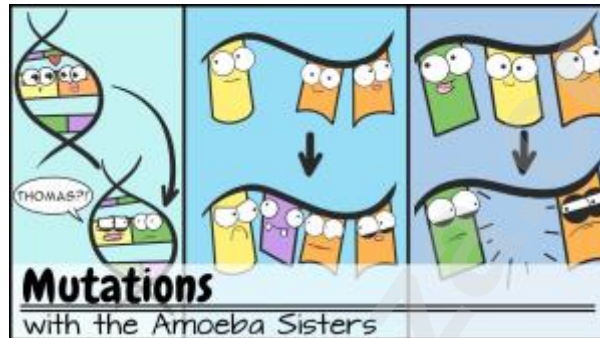
A mutation is a sudden change in the genetic composition of an organism.

- **Gene mutation** - A gene mutation is a **change** in the genetic material or DNA sequence in the cell.
- **Chromosome mutation/chromosomal aberration** - Change in the number or structure of the chromosomes.

Effects of mutation

Mutations assist the organism to **adapt** to its environment:

- **HARMFUL MUTATIONS** : causes changes in DNA that can cause errors in protein sequencing, that can result in partially or completely non- functional proteins.
- **HARMLESS MUTATIONS** : Have no effect on the structure or functioning of the organism.
- **USEFUL MUTATIONS** : Can be advantageous to the organism and they are passed on from parent to offspring.



Genetic Engineering

Genetic Engineering is the process where scientists alter, swap or manipulate the genes on the DNA, to produce an organism with desirable characteristics.

We will look at three examples of Genetic Engineering:

1. Cloning
2. Stem Cells Research
3. Genetically Modified Organisms (GMO)
4. Biotechnology

There are **advantages and disadvantage** to Genetic Engineering (*you need to know these*)

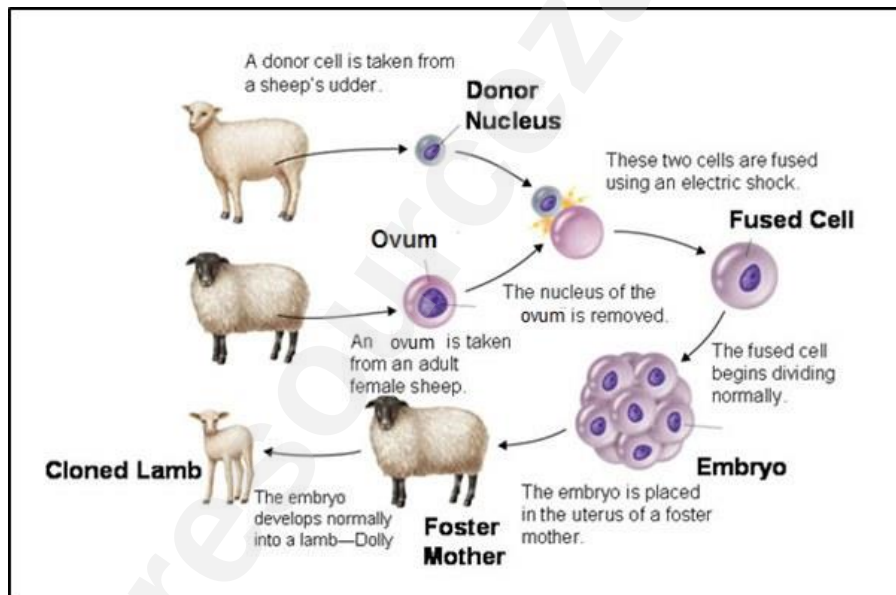
Advantages of Genetic engineering	Disadvantages of Genetic engineering
• Production of medication/ resources cheaply • Control pests with specific genes inserted into a crop • Uses specific genes to increase crop yields/ food security • Selecting genes to increase shelf-life of plant products	• Expensive/ research money could be used for other needs • Interfering with nature or immoral • Potential health impacts • Unsure of long-term effects

1. Cloning

Cloning is the process of producing similar populations of genetically identical individuals that occurs in nature when organisms such as bacteria, insects or plants reproduce asexually. A sheep called Dolly was cloned successfully in 1997.

Process:

- With cloning, the nucleus of a **somatic** cell ($2n$) of one organism is removed.
- An ovum (n) is taken from an ovary of **another organism**.
- The nucleus of the ovum is destroyed.
- The somatic cell's nucleus ($2n$) is then placed inside the ovum.
- The ovum is put back into a uterus where it is allowed to grow and differentiate into an embryo.
- When the new offspring is produced, it is identical to the original organism.



2. Stem Cell Research

A **stem cell** is any cell in the body that can **differentiate** into any specialised type of tissue in the body.

Stem cells can be **harvested** from:

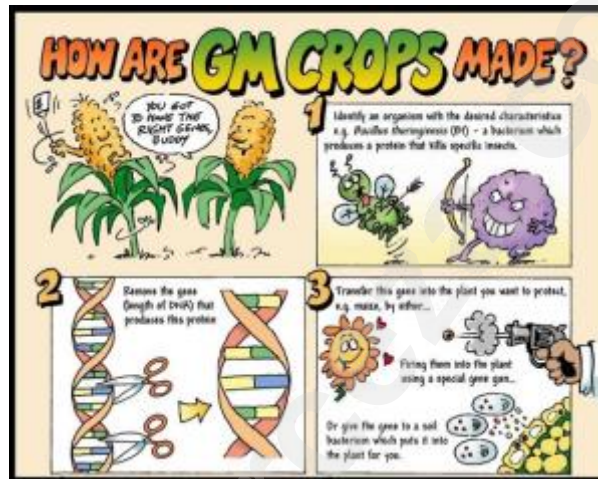
- umbilical cord blood (once a baby has been born)
- a foetal blastocyst
- bone marrow.

Stem cells can be used to **treat**:

- cancers like Leukemia

- degenerative diseases like Multiple Sclerosis
- diabetes mellitus where the pancreas no longer produces insulin
- muscle damage
- organ damage
- certain genetic diseases in conjunction with gene therapy

3. Genetically Modified Organisms (GMO)



Genetically modified organisms (GMOs) are living **organisms** whose **genetic** material has been artificially manipulated in a laboratory through **genetic** engineering.

This creates combinations of plant, animal, bacteria, and virus genes that do not occur in nature or through traditional crossbreeding methods.

Advantages of Genetically Modified Crops:

- **Better for the environment** - Since GMOs require much less chemicals to thrive, the impact on the environment is lessened. The pesticides and other chemicals commonly used on non GMO crops emit greenhouse gases and pollute the ground soil.
- **Resistance to disease** - One of the modifications made to the crops is an added resistance to disease that would normally kill off the crops. This keeps the yields high and the prices for the consumers low.
- **Sustainability** - GMOs provide a stable and efficient way to sustain enough crops to feed the ever growing population of people in the world. This was the main goal of GMO crops in the first place.
- **Increased flavour and nutrition** - Along with resistances to insects and disease, the genes of the crops can also be altered to have a better flavor and increased nutritional value. This is good all around.
- **Longer shelf life** - Genetically modified foods have a longer shelf life. This improves how long they last and stay fresh during transportation and storage.

- **Keeps it affordable** - One of the biggest effects that the use of GMOs has had on our everyday life is the prices of produce and other foods. Since more crops can be yielded, the prices can be much lower.

4. Biotechnology

Biotechnology is the use of living systems and organisms to develop or make products, or "any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use" (UN Convention on Biological Diversity, Art. 2).

Paternity Testing and DNA Profiling

An analysis, usually of the **DNA** or **blood type** of a mother, child, and putative father, to estimate the probability that the man is the biological father of the child.

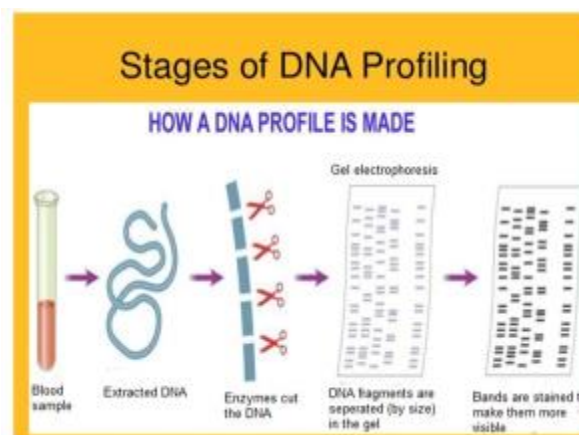
Paternity testing can be done using the following ways:

Blood grouping

- Genotypes of the mother and the suspected man's blood groups are compared with those of the child
- If the genotypes for the blood groups of the man and the mother could not lead to the blood group of the child the man is not the father of the child
- If the genotypes for the blood groups of the man and the mother could lead to the blood group of the child it cannot be said with certainty that the man is the father of the child because other males have the same blood group.

DNA profiles

- Every person except identical twins has her/his own unique DNA profile.
- It can be described as an arrangement of black bars representing DNA
- Fragments of the person.
- It is used to: Identify paternity



PLEASE COMPLETE ASSESSMENT 7 [20]

- You will find this Assessment on MS Teams or follow the link
- The assessment opens on the 5th of May and closes on the 6th of May
- [Assessment 7: Paternity Testing Essay](#)

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