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EASTERN CAPE
EDUCATION

LIFE SCIENCES

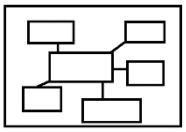
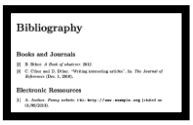
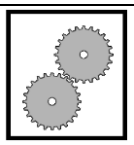
AUTUMN CLASSES

GRADE 12

TERM 1

TEACHER AND LEARNER CONTENT MANUAL

HOW TO USE THIS MANUAL

 MIND MAP	 EXAMINATION GUIDELINE	 CONTENTS	 ACTIVITIES
 BIBLIOGRAPHY	 TERMINOLOGY	 WORKED EXAMPLES	 STEPS

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ACKNOWLEDGEMENT

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Therefore, these notes are **NOT FOR SALE.**

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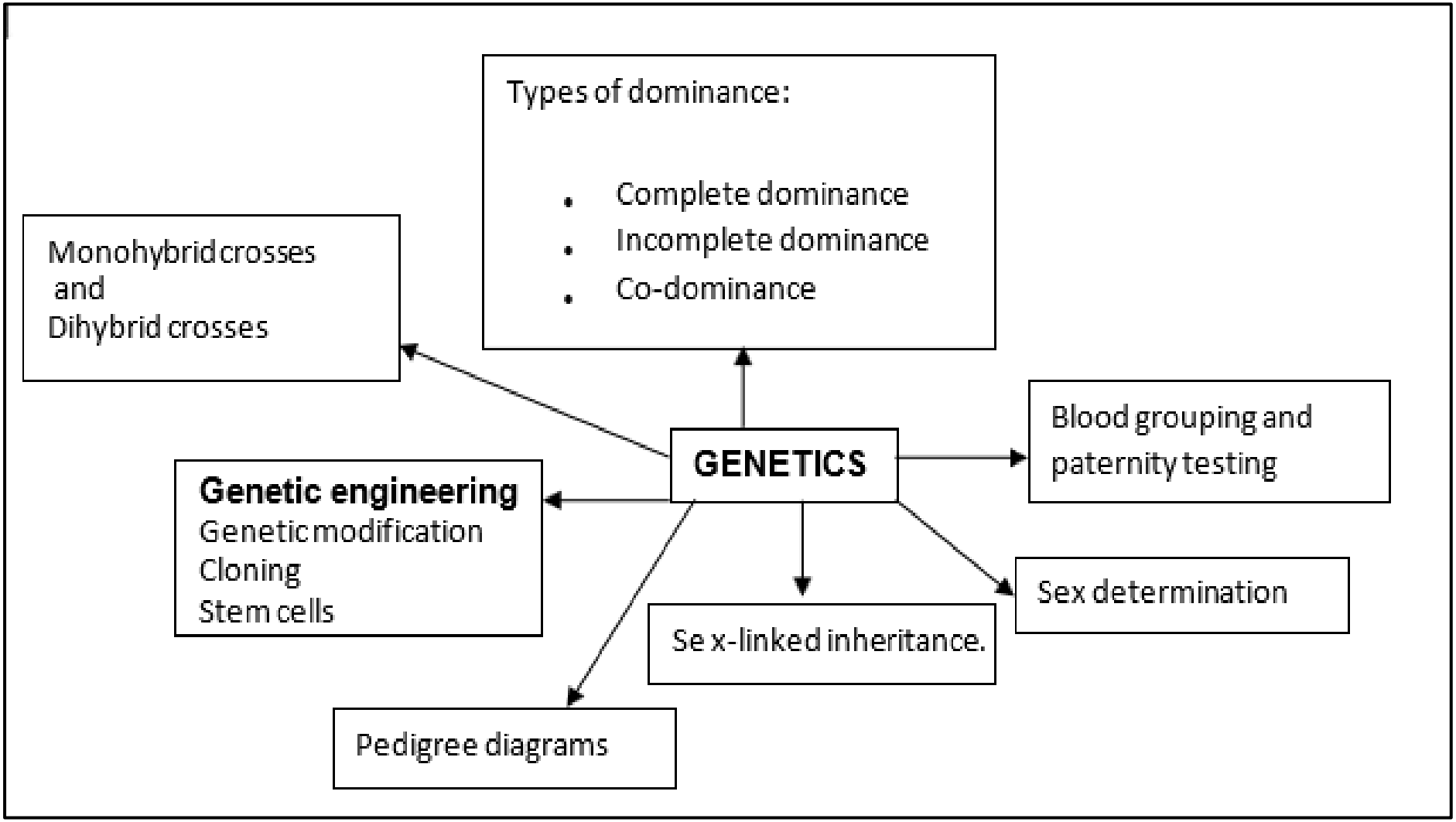
EXAMINATION GUIDELINES: *(Learners should be provided with the official 2021 Examination Guidelines before a particular topic is taught.)*

GENETICS AND INHERITANCE Paper 2: 48 marks	**Term 1 & 2**	**3½ weeks**

CONTENT	ELABORATION
Introduction	❑ Mention of Mendel as the 'father' of genetics
Concepts in inheritance	❑ Chromatin and chromosomes ❑ Genes and alleles ❑ Dominant and recessive alleles ❑ Phenotype and genotype ❑ Homozygous and heterozygous ❑ The Law of Dominance- • When two homozygous organisms with contrasting characteristics are crossed, all the individuals of the F1 generation will display the dominant trait • An individual that is heterozygous for a particular characteristics will have the dominant trait as the phenotype.

TERM 2 **(51 days)**	**Week 1 8/4 -1/4** (4 days)	**Week 2 14/4 - 17/4** (4 days)	**Week3 22/4 -25/4** (4 days)
Curriculum coverage	**38,1%**	**44,5%**	**47,7%**
CAPS TOPIC	**GENETICS AND INHERITANCE (NATIONAL EXAMINATION GUIDELINE PG. 9)**		
CORE CONCEPTS, SKILLS AND VALUES	Concepts of inheritance, Monohybrid crosses, sex determination, sex-linked inheritance	Dihybrid crosses, Blood grouping Genetic lineages/pedigree diagrams, mutations	Genetic engineering, paternity testing and genetic links
REQUISITE PRE- KNOWLEDGE	Revise cell structure and differentiate between chromatin and chromosomes, genes and alleles	Revise format of genetic cross diagrams Interpreting pedigree diagrams	Grade 10: Revise stem cell research and cloning
RESOURCES (OTHER THAN TEXTBOOK) TO ENHANCE LEARNING	Mind the Gap Genetic crosses Past examination papers	Past examination papers	Past examination papers Videos and PowerPoints on genetic engineering
Minimum number of Class Activities	33	39	42
INFORMAL ASSESSMENT	Past examination paper questions Practice questions on genetic crosses Pedigree diagrams Scientific investigations Tests		

MINDMAP

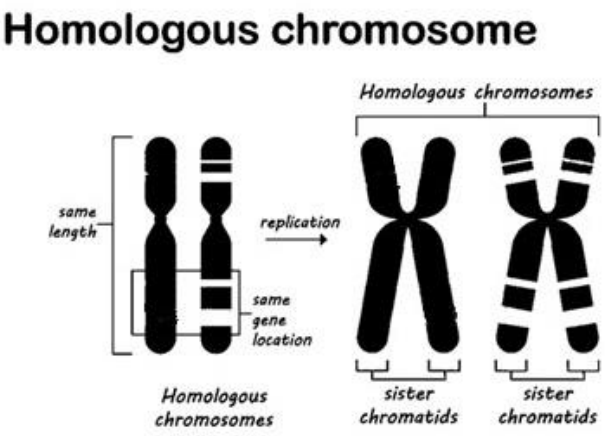
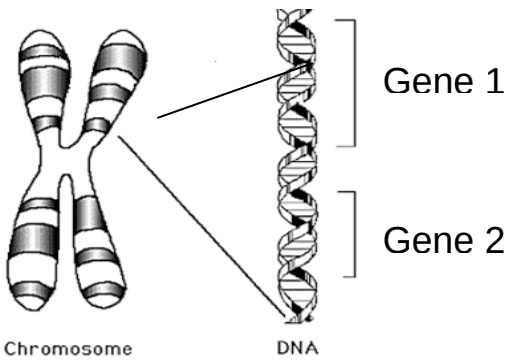

Types of dominance:
Complete dominance
Incomplete dominance
Co-dominance
Monohybrid crosses and Dihybrid crosses
GENETICS
Blood grouping and paternity testing
Genetic engineering
Genetic modification
Cloning
Stem cells
Sex determination
Se x-linked inheritance.
Pedigree diagrams

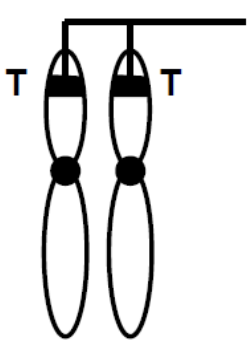
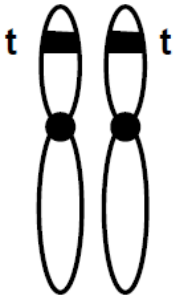
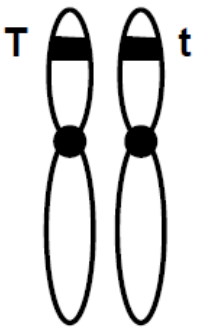
INTRODUCTION

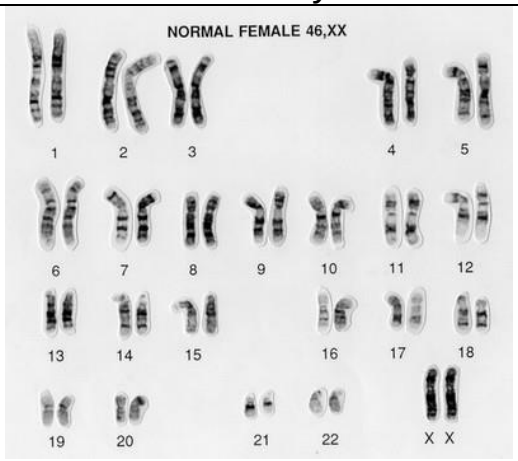
- Genetics is the **study of hereditary** – how genetic characteristics are passed on from parents to child.
- Every individual inherits a set of genes found in chromosomes from a father and a mother which is unique to that individual but similar enough to identify the individual's species

DEFINITIONS AND IMPORTANT TERMS AND CONCEPTS: (30 minutes)

From the diagnostic report teachers must teach learners this is basics the definitions

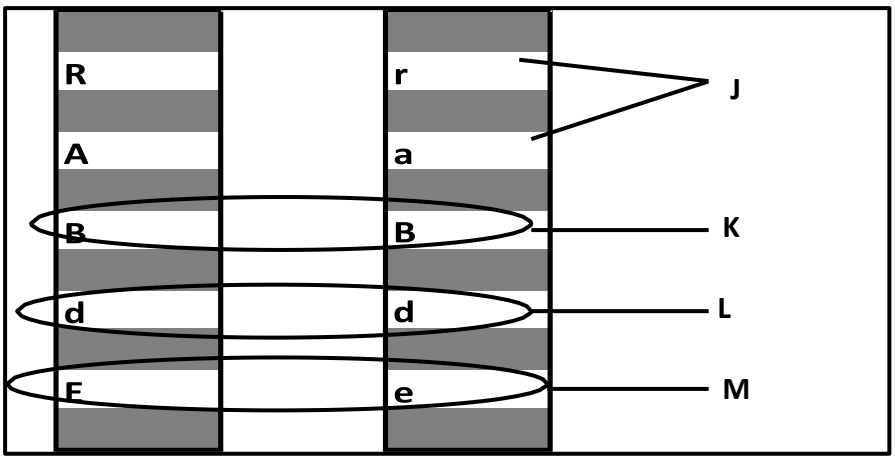
Chromatin	The tangled mas of chromosomes in the nucleus of the cell
Chromosomes	These are thread-like structures forming the chromatin network in the nuclei of all cells. Before the cell divides, the chromosomes replicate to form two threads (DNA molecules) or chromatids which are joined by a centromere. Chromosomes occur in homologous pairs – the one is from the mother (maternal origin) and the other is from the father (paternal origin). The two homologous chromosomes are the same length and carry the same genes. There are 23 homologous chromosomes in each human cell. 
Gene	A gene is the length of DNA nucleotides that codes for one characteristic/protein.Each chromatid is made up of a DNA molecule. Each DNA molecule. Each DNA molecule carries a number of genes. 

Locus	The position at which particular gene is found. Homologous chromosomes have the same genes at the same locus.
Allele	Alleles are the different forms of a gene which are found at the same locus on homologous chromosomes. e.g. Tall and short are alleles for the characteristic of height. When describing characteristics, alleles are represented by using letters. A capital letter is used to represent the dominant allele and a small letter to represent the recessive allele. Tall plant – T (dominant) Short plant – t (recessive
Homozygous	For each characteristic there are two alleles. If the alleles for the characteristic are the same, it is said to be homo**zygous** for that characteristic Dominant allel (T) -tall plant Recessive allele (t) -short plant  • homozygous dominant (both alleles are dominant) • genotype TT • phenotype – tall  • homozygous recessive (both alleles are recessive) • genotype tt • phenotype – short
Heterozygous	If the alleles for the characteristic are different, it is said to be heterozygous or hybrid e.g. Tt – heterozygous for tall  • heterozygous (one dominant and one recessive allele) • genotype Tt • phenotype - tall
Multiple alleles	There are not always only two alleles for a characteristic. Sometimes there may be multiple. e.g there are three alleles for human blood groups (A, B and O)

Genotype	The genetic composition (make-up) of an organism. The genotype for hair colour can be TT, Tt or tt
Phenotype	This is the physical appearance of an organism produced by the genotype. e.g. Tall plant The phenotype is partly governed by genes but is also shaped by external factors such as exercise and diet.
Dominant Allele	The dominant allele is the allele that will be expressed in the heterozygous condition. e.g. If a person has a tall and a short allele (Tt) then they will be tall as tall is dominant over short.
Recessive Allele	The recessive allele is the allele that is not expressed (masked) in the heterozygous condition (Tt). e.g. short plant. The short allele is hidden by the tall allele The recessive allele is only expressed when both alleles are recessive.
Multiple alleles	More than two alternative form of a gene at the same locus. E.g. Blood groups are controlled by 3 alleles. Namely I^A, I^B and i. All three alleles are present in the population, but and individual can only have 2 alleles
Genome	The complete set of human genes found in the body
Karyotype	A Karyotype shows all the chromosomes in a cell. They are shown in pairs and ordered from largest to smallest 
Autosomes	non-sex chromosomes
Gonosomes	sex chromosomes Females – XX Males - XY

Activity1:

1.1 The diagram below represents a pair of homologous chromosomes.



1.1.1 Write down ONLY the LETTER **(J, K, L or M)** that shows the following: (4)

(a) Homozygous recessive

(b) Heterozygous

(c) Homozygous

(d) Different genes for different traits

1.1.2 (6)

List and explain the THREE types of dominance **[10]**

Activity 2

2.1.1 State the relationship between a gene and a protein? (2)

2.1.2. What is an allele? (2)

2.1.3. Give the term that describes a pair of alleles that are: (2)

(a) The same

(b) Different

2.1.4. Write a definition of homologous chromosomes using the terms “genes” and “alleles”. (3)

[9]

Activity 3

3.1.1 Draw a pair of homologous chromosomes. Label the chromosomes with THREE sets of genes, one with homozygous dominant alleles, one with homozygous recessive alleles and one with heterozygous alleles. (5)

Genetics and sexual reproduction:

During sexual reproduction, offspring are produced that resemble the parents.

Remember that **two haploid** gametes are the result of the process of **meiosis**.

The gametes fuse during reproduction and the result is a **diploid zygote**, containing a double set of chromosomes.

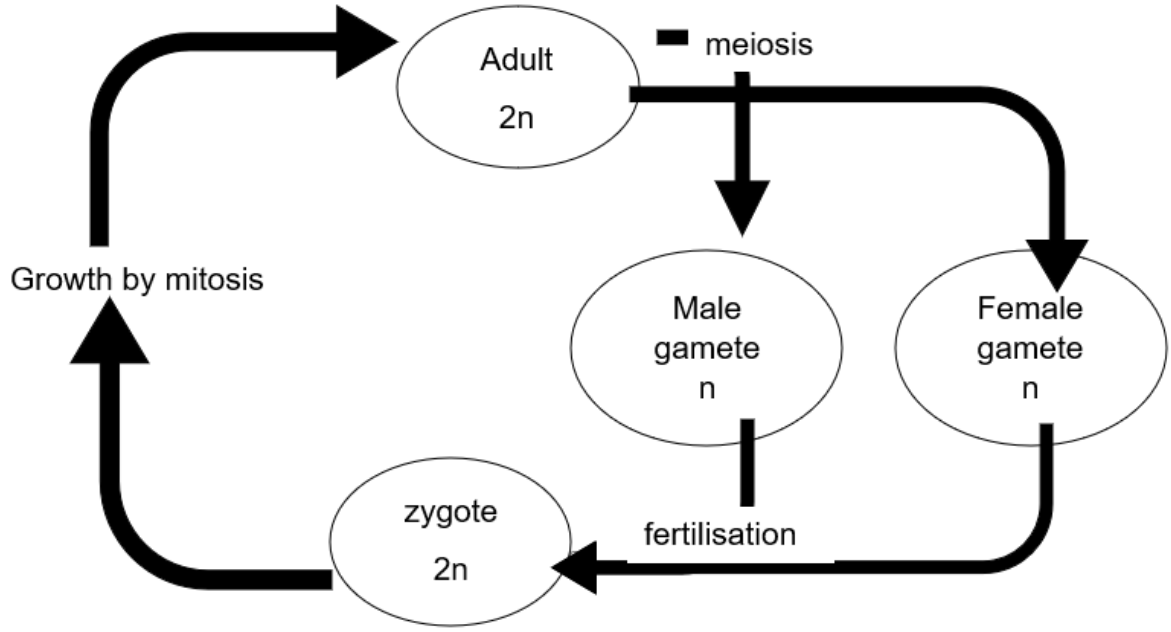
One set of the chromosomes came from the male gamete, which contains the DNA from the father.

One set of chromosomes came from the female gamete and contains the DNA from the mother.

The child therefore contains DNA from both parents

.

How are genes passed from parent to offspring?



Monohybrid crosses

GENETICS AND INHERITANCE Paper 2: 48 marks	Term 1 & 2	3½ weeks

Monohybrid crosses	❑ Format for representing a genetics cross ❑ Mendel's Principle of Segregation –An organism possesses two 'factors' which separate or segregate so that each gamete contains only one of these 'factors' ❑ Types of dominance: • Complete dominance – one allele is dominant and the other is recessive, such that the effect of the recessive allele is masked by the dominant allele in the heterozygous condition • Incomplete dominance – neither one of the two alleles of a gene is dominant over the other, resulting in an intermediate phenotype in the heterozygous condition • Co-dominance – both alleles of a gene are equally dominant whereby both alleles express themselves in the phenotype in the heterozygous condition ❑ Genetics problems involving each of the three types of dominance ❑ Proportion and ratio of genotypes and phenotypes

Mendel as father of genetics

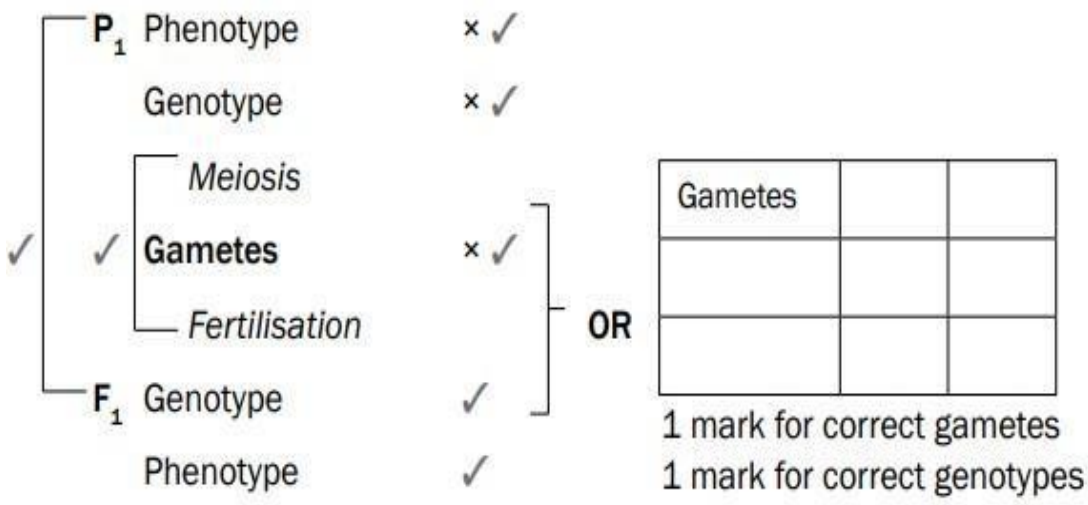
Gregor Mendel, an Austrian monk (a type of priest), is regarded as the father of genetics for his work on garden pea plants that helped explain **how genes are passed from parents to offspring.**

Mendel's work on the genetics of peas began with the observing peas to determine what traits were inherited. He noticed at least 7 traits that appeared to be inherited.

MONOHYBRID CROSSES

A specific template is used to solve Monohybrid Crosses. ***(Use the following genetic problem format or template to solve all monohybrid genetic problems)***

Format for representing genetics cross
Template



Mendel's Principle of Segregation

An organism possesses two 'factors' which separate or segregate so that each gamete contains only one of these 'factors'

Mendel's Law of Dominance

When two individuals with contrasting pure breeding characteristics are crossed, the individuals of the first generation (F_1) will **ALL** resemble the parent with the dominant characteristic.

EXAMPLES

P_1 **Phenotype:** Tall plants x short plants
Genotype: TT x tt
Meiosis
Gametes: T , T x t , t **(Principle of Segregation)**
Fertilization

	T	**T**
t	Tt	Tt
t	Tt	Tt

F_1
Genotype: 100 % Tt (heterozygous tall)
Phenotype: 100% Tall (**Law of Dominance)**

Note: that the F_1 offspring have characteristics from both parents but in the phenotype, all display the dominant characteristic.

The offsprings of the F_1 (Tt) grow and mature to become P_2. The offsprings of P_2 are known as F_2.

P_2 **Phenotype:** Tall plants x Tall plants
Genotype: T t x T t
Meiosis
Gametes: **T , t** x **T , t**

Fertilization

	T	**t**
T	TT	Tt
t	Tt	tt

F_2 **Genotype:** **1 TT : 2 Tt : 1 tt**
homozygous tall: heterozygous Tall : homozygous short

Phenotype: **75% tall : 25% short**

Types of dominance:

- **Complete dominance** – one allele is dominant and the other is recessive, such that the effect of the recessive allele is masked by the dominant allele in the heterozygous condition
- **Incomplete dominance** – neither one of the two alleles of a gene is dominant over the other, resulting in an intermediate phenotype in the heterozygous condition
- **Co-dominance** – both alleles of a gene are equally dominant whereby both alleles express themselves in the phenotype in the heterozygous condition

MONOHYBRID CROSSES WITH COMPLETE DOMINANCE

There are basically **FOUR types of crosses**.

CROSS EXAMPLE 1: (Homozygous dominant x Homozygous recessive)

We will use one general trait e.g. hair colour:

B = brown hair colour (dominant trait)
b = blonde hair colour (recessive trait)

P_1 (first parent generation)

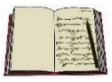
Phenotype: Brown x blonde
Genotype: BB x bb
Meiosis
Gametes: B , B x b , b
Fertilization

	B	**B**
b	Bb	Bb
B	Bb	Bb

F_1 (first filial generation = first offspring)

Genotype: Bb
Phenotype: 100% brown

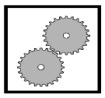
Activity 4*:(Mind the Gab)*



Eye colour is controlled by two alleles, brown **(B)** and blue**(b)**.

Use a genetic cross to determine the possible genotypes and phenotypes of the children of a homozygous brown eyed male and a blue eyed female.

[6]



CROSS EXAMPLE 2: (Homozygous dominant x Heterozygous)

P_1 **Phenotype:** Brown x Brown
Genotype: BB x Bb
Meiosis
Gametes: B, B x B , b
Fertilisation

	B	**B**
B	BB	BB
b	Bb	Bb

F_1 **Genotype:** 2 BB: 2Bb
1 : 1
Phenotype: 100% brown

Activity 5*:(Mind the Gab)*

In humans the ability to roll the tongue is due to a dominant allele. A man who is heterozygous for tongue-rolling and a woman who is homozygous for tongue rolling have children.

Use the symbols **T** and **t** for the alleles of the tongue-rolling characteristic and represent a genetic cross to determine the possible genotypes and phenotypes of the children.

[6]

CROSS EXAMPLE 3: **(Homozygous recessive x Heterozygous)**

P_1 **Phenotype:** Blonde x Brown
Genotype: bb x Bb
Meiosis
Gametes: b , b x B , b
Fertilisation

	b	**b**
B	Bb	Bb
b	bb	bb

F_1 **Genotype:** 2Bb: 2bb
1 : 1
Phenotype: 50% brown and 50% blonde
1 : 1

Activity 6: *(DBE/November 2023)*

5.1. Polydactyly is a condition that leads to extra fingers or toes. It is caused by a dominant allele.

A man who is heterozygous for polydactyly has a wife who is not polydactyl

Using the letters **R** and **r**, do a genetic cross to show the percentage chance

that their children will have polydactyly. **[6]**

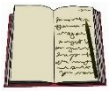
CROSS EXAMPLE 4: **(Heterozygous x Heterozygous)**

P_1 **Phenotype:** Brown x Brown
Genotype: Bb x Bb
Meiosis
Gametes: B , b x B , b
Fertilisation

	B	**b**
B	BB	Bb
b	Bb	bb

F_1 **Genotype:** 1 BB : 2Bb : 1bb
1 : 2 : 1
Phenotype: 75% brown and 25% blonde
3 : 1

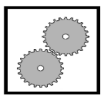
Activity 7



Height in plants is controlled by two alleles. Tall (T) and Short (t). Two plants that were heterozygous for plant height were crossed. Use a genetic cross to show the phenotypic ratio of their offspring. **[6]**

MONOHYBRID CROSSES WITH INCOMPLETE DOMINANCE

- **Neither one of the two alleles of a gene is dominant over the other, resulting in an intermediate phenotype in the heterozygous condition**



A homozygous red-flowering plant crossed with a homozygous white- flowering plant produce plants that have pink flowers (Figure 6).

Because neither of the alleles (Red or white) is dominant we can't use just one letter, so we use the letters of each allele. E.g. **R** for red and **W** for white.

If a flower is RR it will be red
WW it will be white
But if it is RW it will be pink (a blend of the two colours)

Look at the cross below to see how all offspring will be pink.

Alleles R – Red W – White

P1 Phenotype Red X White ✓
Genotype RR X WW ✓
MEIOSIS ✓
Gametes R R W W ✓
F1 ✓
FERTILIZATION

	R	R
W	RW	RW
W	RW	RW

✓

Genotype All RW ✓
Phenotype All Pink ✓

If we cross the F1 offspring we will get the following result

P1 Phenotype Red X White ✓

Genotype RW X RW ✓

✓ MEIOSIS

✓ Gametes R . W R W ✓

F1 FERTILIZATION

	R	W
R	RR	RW
W	RW	WW

✓

Activity 8

8.1. In rabbits, fur colour may be black, white or grey. The inheritance of fur colour is controlled by two alleles namely:
Black fur (**B**) and White fur (**W**)

8.1.1 Explain why fur colour in rabbits an example of inheritance with incomplete dominance is. (2)

8.1.2. Use a genetic cross to show the expected genotypes and phenotypes of the offspring when a grey male mates with a black female. (2)

[8]

MONOHYBRID CROSSES WITH CO-DOMINANCE

- Co-dominance – both alleles of a gene are equally dominant whereby both alleles express themselves in the phenotype in the heterozygous condition

In a certain breed of cattle, coat colour may be red, white or roan.
Roan cattle have red and white patches.
Both red and white are EQUALLY dominant. We use R for red and W for white because both are dominant

.

Therefore, a cow who is:

RR will be red

WW will be white

RW will have red and white(roan)

Alleles R – Red W – White ✓

P1 Phenotype Red X White

Genotype RR X WW ✓

✓ MEIOSIS

✓ Gametes R , R W W ✓

F1 FERTILIZATION

	R	R
W	RW	RW
W	RW	RW

✓

Genotype All RW ✓

Phenotype All Roan ✓

If we cross the F1 offspring we will get the following result

P1 Phenotye Roan coat X Roan coat ✓

Genotype RW X RW ✓

✓ MEIOSIS

✓ Gametes R , W R , W ✓

F1 FERTILIZATION

	R	W
R	RR	RW
W	RW	WW

✓

Genotype 1 RR : 2 RW : 1 WW ✓

Phenotype 1 Red : 2 Roan : 1 White ✓

Activity 9 *(DBE/2021)

A farmer has an orchard of apple trees. Each apple produced expressed red and yellow colour equally (red-yellow apples). To extend his apple orchard, the farmer collected seeds from the red-yellow apples and grew them. When the new trees matured, he found that some of the trees produced red apples **(R)**, others produced yellow apples **(Y)** and the rest produced apples that were red yellow. Use a genetic cross to explain his results in the F1 generation **[6]**

BLOOD GROUPS AS AN EXAMPLE OF CO-DOMINANCE

Blood grouping	❑ Different blood groups are a result of multiple alleles ❑ The alleles I^A, I^B and **i** in different combinations result in four blood groups ❑ Genetics problems involving the inheritance of blood type

Blood grouping

- Different blood groups are a result of **multiple alleles**
- Human blood type is determined by three different alleles, known as I^A, I^B and **i.**
- The I^A and I^B alleles are co-dominant.
- The **i** allele is recessive.
- Since I^A and I^B are co-dominant (i.e. both are equally dominant), when they come together in a person's blood type they form I^AI^B which is the genotype for blood type **AB**
- The possible human phenotypes for blood group are type **A**, type **B,** type **AB** and type **O.**
- Type **A** and **B** individuals can be either homozygous (I^AI^A **or** I^BI^B, respectively), or heterozygous (I^Ai **or** I^Bi), respectively.

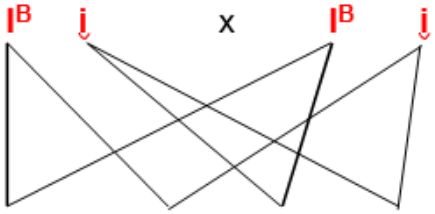
Phenotype	Genotype	
Blood group	Homozygous	Heterozygous
A	I^AI^A	I^Ai
B	I^BI^B	I^Bi
AB		I^AI^B
O	ii	

Example of a monohybrid cross using blood types:

*A man and a woman both have blood group **B**. Use a genetic cross to show how itis possible for them to have a child with blood group **O**.*

P_1		Phenotype	**Blood group B**	x	**Blood group B**
		Genotype	**I^Bi**	x	**I^Bi**

Meiosis — Gametes: **I^B i** x **I^B i**



Fertilisation

F_1 Genotype: **I^BI^B I^Bi I^Bi ii**

Phenotype: **3 Blood group B : 1 Blood group O**

OR

P_1		Phenotype	**Blood group B**	x	**Blood group B**
		Genotype	**I^Bi**	x	**I^Bi**

Meiosis — Gametes: **I^B i** x **I^B i**

Fertilisation

Gametes	I^B	i
I^B	I^BI^B	I^Bi
i	I^Bi	ii

F_1 Phenotype: **3 Blood group B : 1 Blood group O**

Genotype: **I^BI^B I^Bi I^Bi ii**

Activity 10

10.1 Draw a genetic diagram to show the possible genotypes of the children born to a man with blood group O and a woman with blood group AB. (8)

10.2 Is it possible for a man with blood group A and a woman with blood group B to have a child with blood group O? (1)

10.3 Draw a punnet diagram to show how this is possible. (4)

Activity 11

Explain how blood grouping can be used in paternity testing. (8)

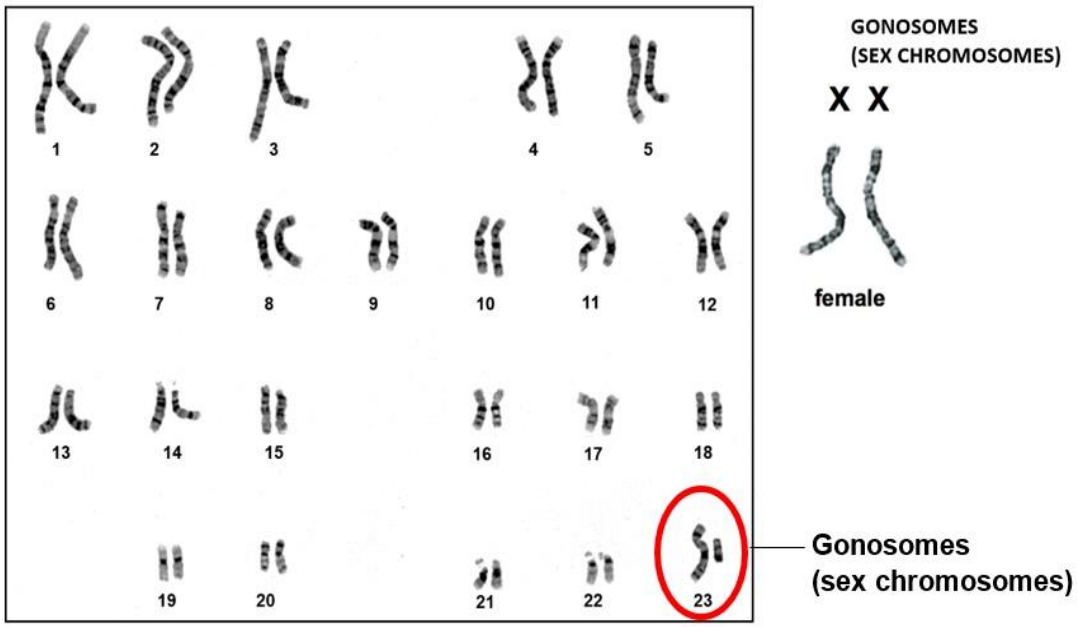
Sex determination in humans

Sex determination	❑ 22 pairs of chromosomes in humans are autosomes and one pair of chromosomes are sex chromosomes/gonosomes ❑ Males have XY chromosomes and females have XX chromosomes ❑ Differentiate between sex chromosomes (gonosomes) and autosomes in the karyotypes of human males and females ❑ Representation of a genetic cross to show the inheritance of sex

- Humans have 46 chromosomes (i.e. 23 from the mother and 23 from the father).
- Of these 46 chromosomes, 44 control the appearance, structure and functioning of thebody. These are called **autosomes**.
- Chromosome pair 23 determines the sex of the individual and are called the **gonosomes**.
- In a female the gonosomes are two large X chromosomes and in the male there is one large X chromosome and a smaller Y chromosome.

Each species has its own unique number, shape and size of chromosomes – this is called the **karyotype**.

An example of a karyotype



After meiosis: an egg cell will have 22 autosomes + an X gonosome.

Males have two types of sperm: half will have 22 + X chromosomes the other half will have 22 + Y chromosomes

- Depending on which sperm reaches the egg there is a 50% chance of the zygote being male and a 50% chance of the zygote being female.

*A sex determination cross does not change. It is always a cross between **XX and XY.***

P_1 Phenotype: Male x Female
Genotype: XY x XX
Meiosis
Gametes: X , Y x X , X
Fertilization

	X	**X**
X	XX	XX
Y	XY	XY

F_1 Genotype: XX XX : XY XY
1 : 1
Phenotype: 50% females: 50% males
1 : 1

SEX – LINKED INHERITANCE

Sex-linked inheritance	❑ Sex-linked alleles and sex-linked disorders ❑ Genetics problems involving the following sex-linked disorders: • Haemophilia • Colour-blindness

Sex-linked characteristics are characteristics (traits) that are carried on the X chromosome. Sex linked alleles can cause some sex-linked genetic disorders like colour blindness and haemophilia.

- A person is **colour-blind** if unable to tell different colours apart. For example, red-green colour-blindness is caused by an absence of the proteins that makeup the red or green cones (photoreceptors) in the retina of the eye resulting in the person not being able to tell the difference between red and green.

- **Haemophilia** is the inability of the blood to clot due to lack of a blood clotting factor. If the sufferer were to cut themselves, the wound would continue to bleeduntil a clotting factor is transfused in hospital.
- Colour-blindness and haemophilia is caused by the recessive allele on the X-chromosome normally shown as (X^b) for colour-blindness and (X^h) for haemophilia

Inheritance of haemophilia

Genotype	Phenotype
X^HX^H	Female without haemophilia
X^HX^h	Female without haemophilia
X^hX^h	Haemophiliac female
X^HY	Male without haemophilia
X^hY	Haemophiliac male

Inheritance of colour-blindness

Genotype	Phenotype
X^BX^B	Female with normal vision
X^BX^b	Female with normal vision
X^bX^b	Colour-blind female
X^BY	Male with normal vision
X^bY	Colour-blind male

NB!!!! **Do not add any letter to the Y chromosome**

Examples of application questions on Sex-linked diseases

1. Explain why males have a greater chance of having haemophilia than females.
   Male only have one X chromosome (XY).
   They only need one recessive allele (X^h) to have haemophilia
   The X^h on a male cannot be masked by a dominant allele

2. Explain why females have a lower chance of having colour blindness than males.
   Females have two X chromosomes (XX).
   And need TWO recessive alleles to have colour blindness /X^b X^b
   In females a dominant allele on one X chromosome would mask the effect of the recessive allele (X^B masks X^b)

EXAMPLES

For a male without haemophilia and female who is heterozygous for haemophilia cross:

P_1 Phenotype: Male without haemophilia x female without haemophilia
Genotype: X^HY x X^HX^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^hY**

F_1 Genotype: **1** $X^H X^H$: **1** $X^H X^h$ **1** $X^H Y$ **1** $X^h Y$

Phenotype
2 female without haemophilia : 1 Male without haemophilia : 1 Male with haemophilia
50% : 25% : 25%

For a male with haemophilia and female without haemophilia cross:

P_1 Phenotype: Male with haemophilia x female without haemophilia
Genotype: $X^h Y$ x $X^H X^H$
Meiosis
Gametes: X^h , Y x X^H , X^H

Fertilization

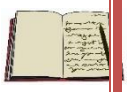
	X^h	**Y**
X^H	X^HX^h	X^HY
X^H	$X^H X^h$	X^HY

F_1 Genotype X^HX^h X^HX^h X^HY X^HY

Phenotype 50% Females without haemophilia : 50% males without haemophilia
1 : 1

NB: The phenotype cannot be *heterozygous for haemophil*ia or *carrier of haemophilia* as this refers to the genotype. The phenotype must be **Female without haemophilia.**

Activity 12
Classwork (12.1& 12.2) ; Homework (12.3)



12.1. It has been said that chromosomes are largely responsible for the fact that, in human populations, there are approximately as many as men as there are women.
(Do a genetic cross to validate this statement) (6)

12.2. Explain why the chances of men having a sex-linked disorder is much higher than it is for women. (4)

12.3. Describe how sex is determined in humans (10)

[20]

Activity 13 *(FS/September 2022)*

13.1. Using your knowledge of gonosomes, explain why the sex of a child is determined by the male gamete. (4)

Activity 14 (*DBE/2023)*

1.1. In humans, colour blindness is caused by a recessive allele on the X-chromosome ($\mathbf{X^b}$).
A woman, who is heterozygous marries a man with colour blindness.
Use a genetic cross to show the percentage chance of the couple having a *daughter* who is homozygous for normal vision. (7)

Activity 15

15.1 Determine the possible genotypes and phenotypes of their offspring by representing a genetic cross. (8)

15.2 What is the percentage chance that they have a child who is unaffected male? (2)

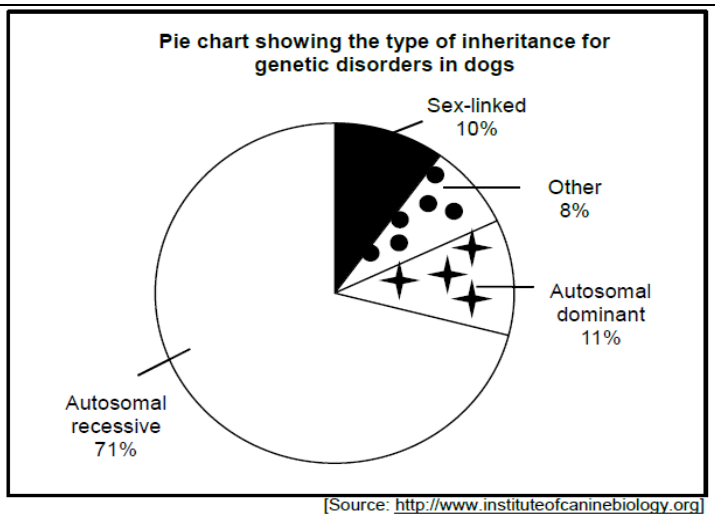
15.3 Explain why this disorder, although it is sex-linked, does NOT affect males only. (2)

Activity 16 *(DBE/Feb.–Mar. 2016)*

Scientists wanted to determine which type of inheritance accounted for most of the selected genetic disorders in dogs.

To do this they sequenced the genomes of a large number of dogs of the same breed that suffered from the genetic disorders.

The results of the investigation are shown below.



[Source: http://www.instituteofcaninebiology.org]

16.1. If 2 000 dogs were studied in this investigation, how many dogs had disorders that were caused by autosomal dominant inheritance? Show ALL calculations (3)

16.2. State TWO ways in which the scientists could improve the reliability of their results. (2)

16.3. State ONE factor that was kept constant in this investigation. (1)

16.4. Explain why there is no need to keep the age of the dogs constant in this type of investigation. (2)

16.5. Provide a conclusion for this investigation. (2)

[10]

Genetic lineages/pedigrees	❑ A genetic lineage/pedigree traces the inheritance of characteristics over many generations ❑ Interpretation of pedigree diagrams

Interpretation of pedigree diagrams

A pedigree diagram/ genetic lineage traces the inheritance of characteristics over many generations in a family.

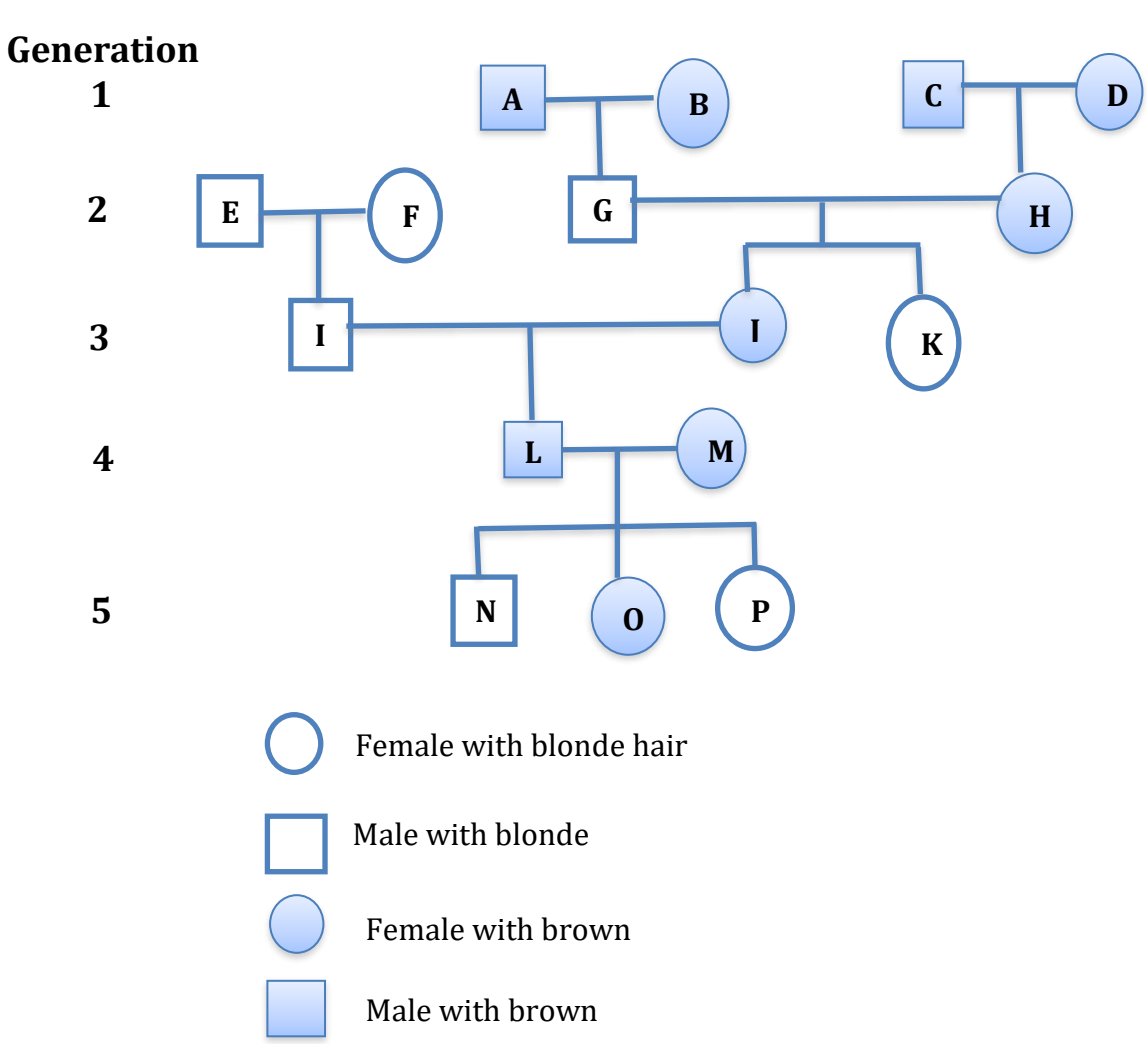
Pedigree diagrams can show autosomal dominant and recessive alleles but also sex-linked alleles (Alleles on the X chromosome/gonosome)

In a pedigree diagram symbols are used to show the status of an individual.

(You must know these symbols)

NOTE:

- Squares represent males and circles represent females
- The horizontal line between a square and a circle shows thatthey have mated.
- The vertical line flowing from the horizontal line represents the offspring of the two parents.
- A shaded square or circle means the individual has the disorder



HOW TO TACKLE ANSWERING PEDIGREE DIAGRAM QUESTIONS

Step 1: Mark all the **homozygous recessive** individuals with blonde hair.
This will be all the white shapes: E, F, G, I, K, N and P as **bb** on the pedigree chart.

Step 2: Work from the generation line 5 <u>up towards</u> the generation line 1 so that you start with the last offspring on the pedigree diagram. To produce an offspring with **bb**, BOTH parents must have at least one homozygous recessive gene (**b**).

If the parent is a white shape – then the parent is **bb** and already marked. If the parent is a shaded shape and produced a **bb** offspring, then the parent must be heterozygous **Bb**. Mark the **Bb** parents on the pedigree diagram.

Step 3: Parents that are shaded shapes and produce only shaded shape offspring, can be homozygous **BB** or heterozygous **Bb**. Look to the next generation and then work backwards. Mark the parents on the pedigree diagram.

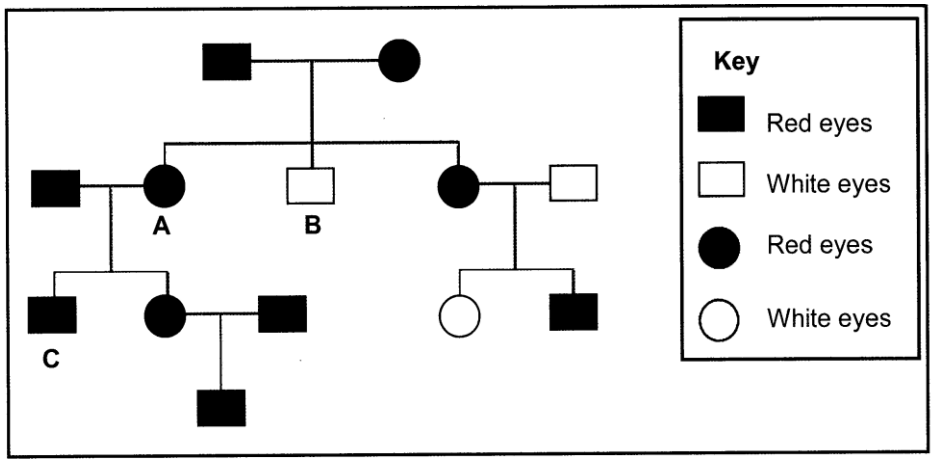
Step 4: Answer the questions that relate to the pedigree diagram.
Try to work out the genotype of A, B, C, D, H, J, L, M and O on your own first.

Let us see if you were right:

- A and B are **Bb** because they produce G (**bb**)
- If C is **BB** then D must be **Bb** or C is **Bb** then D is **BB** because H must be **Bb** to produce K (**bb**)
- J is **Bb** because G is **bb** and H is **Bb** (produced sister K - **bb**)
- L and M are both **Bb** because parent J is **Bb** and I is **bb** so they cannot be homozygous BB AND L and M produce a son (N) and daughter (P) that are both homozygous **bb**
- Offspring O can be either **BB** or **Bb** because both parents are heterozygous **Bb**

Activity 17 *(KZN/Sept2022)*

In fruit flies, red eyes **(R)** is dominant over white eyes.
The pedigree diagram below shows the inheritance of eye colour in fruit flies over a few generations.



17.1 State the number of generations represented in this pedigree diagram. (1)

17.2 Give the:

a) Phenotype of fruit fly C (1)

b) Possible genotype(s) of fruit fly A (2)

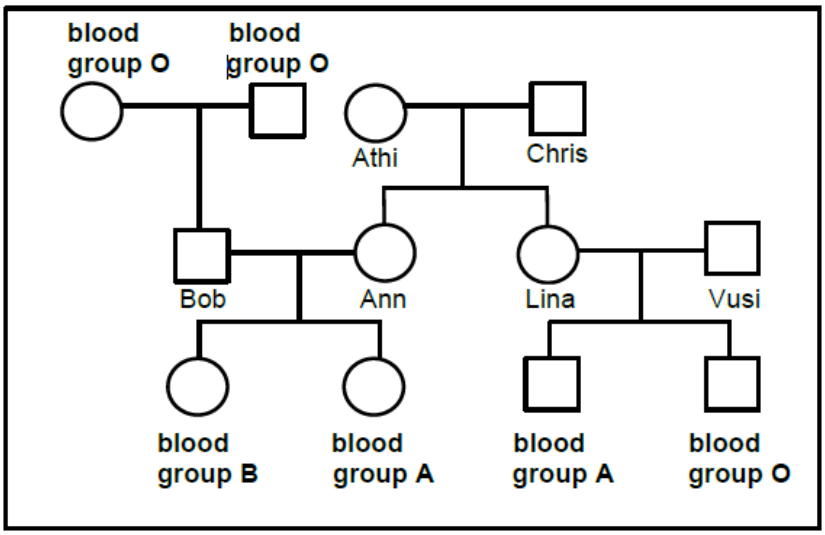
17.3 Explain how offspring B inherited white eyes. (3)

17.4 Calculate the percentage of female fruit flies with red eyes. Show all working. (3)

[10]

Activity 18 *(DBE/November 2023)*

The diagram below shows the inheritance of blood groups in a family.



18.1. Name the type of diagram shown. (1)

18.2 Give the number of alleles that control blood groups. (1)

18.3 How many generations are represented in the diagram? (1)

18.4. Lina's genotype is I^A i.

18.5 State ALL the possible genotypes of Vusi. (2)

18.6. Give the genotype of Bob. (1)

18.7 Give the name of the individual which displays co-dominance. (2)

[8]