JENN
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LIFE SCIENCES

GRADE 12

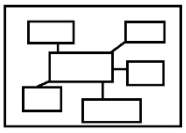
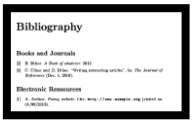
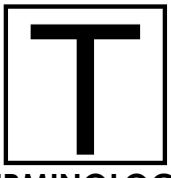
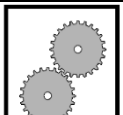
2026 WINTER CLASSES

TEACHER AND LEARNER CONTENT MANUAL

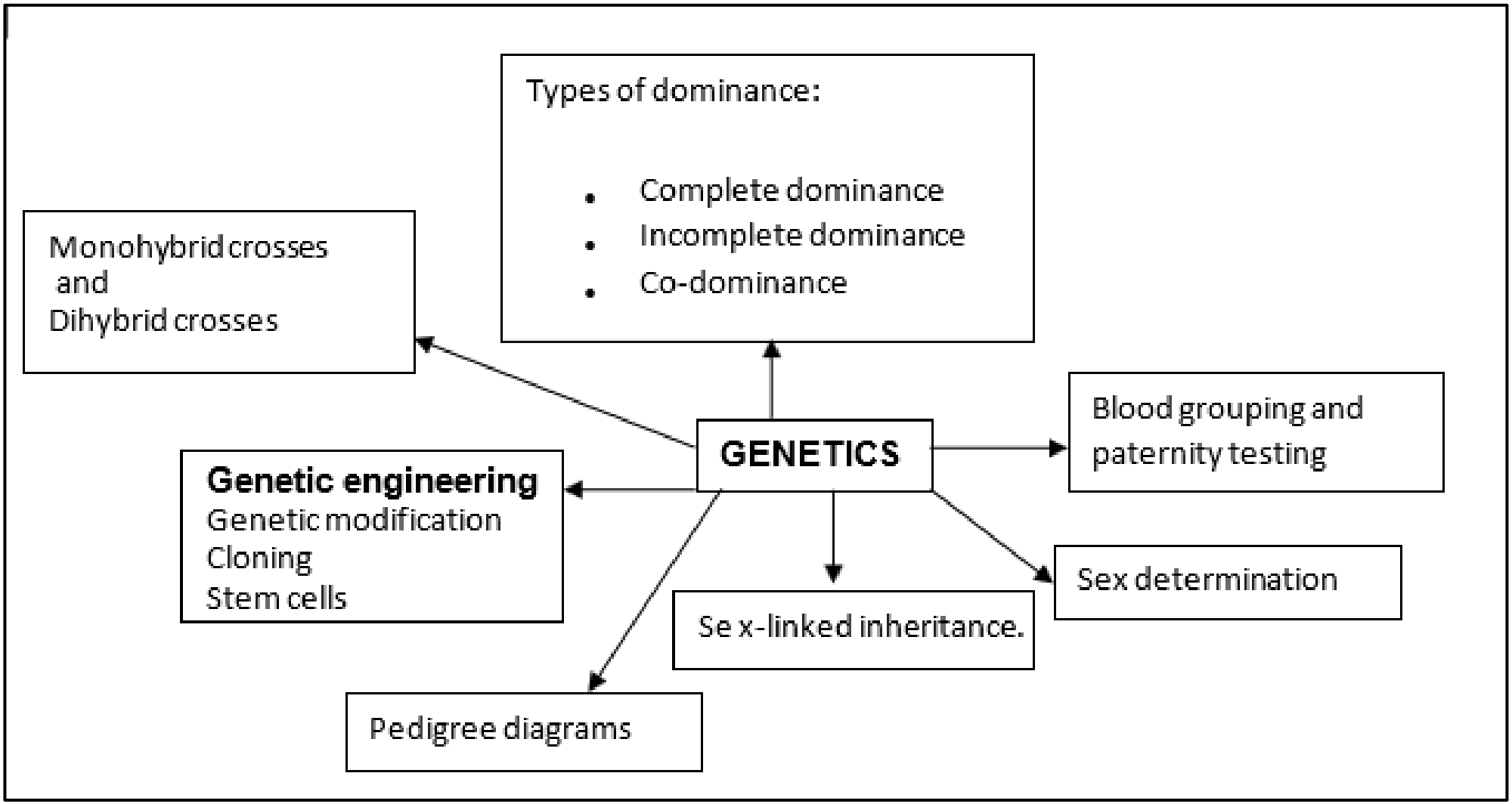
TOPICS

1. Concepts in Inheritance
2. Monohybrid crosses
3. Sex determination
4. Sex – Linked Inheritance
5. Blood groupings
6. Genetic lineages/pedigrees

ICON DESCRIPTION

 MIND MAP	 EXAMINATION GUIDELINE	 CONTENTS	 ACTIVITIES
 BIBLIOGRAPHY	 TERMINOLOGY	 WORKED EXAMPLES	 STEPS

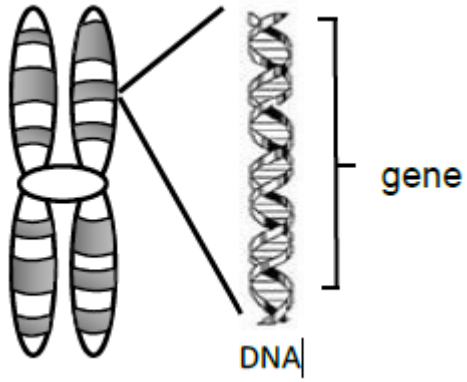
CONTENTS PAGE


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

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.

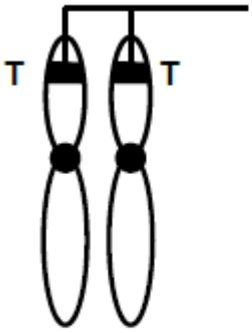
TERMINOLOGY -Their explanation and supporting diagrams and notes

gene	a segment of DNA in a chromosome that contains the code for a particular characteristic	
alleles	gene which occur at the same locus on homologous chromosomes	dominant allele (T) - tall plant recessive allele (t) - short plant

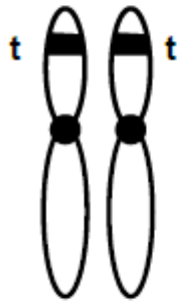
T

genotype	genetic composition of an organism
Phenotype	the physical appearance of an organism based on the genotype, e.g. tall, short
dominant allele	an allele that is expressed (shown) in the phenotype when found in the heterozygous (Tt) and homozygous (TT) condition
recessive allele	an allele that is masked (not shown) in the phenotype when found in the heterozygous (Tt) condition; only expressed in the homozygous (tt) condition
Heterozygous	two different alleles for a particular characteristic, e.g. Tt
homozygous	two identical alleles for a particular characteristic, e.g. TT or tt

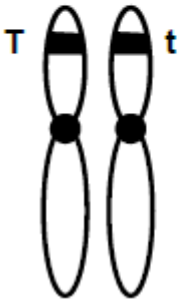
alleles



- homozygous dominant (both alleles are dominant) genotype TT
- phenotype – tall



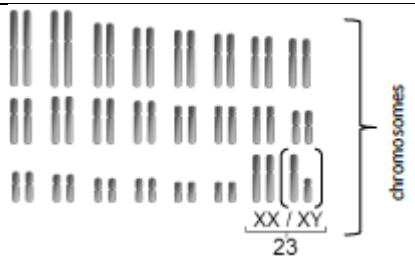
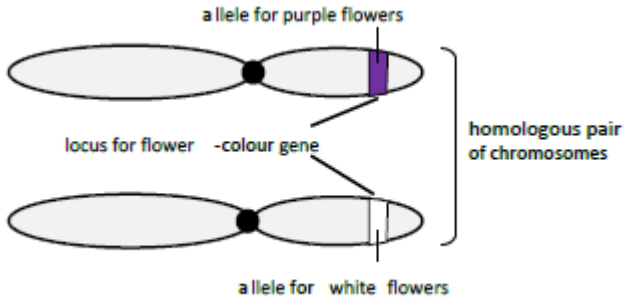
- homozygous recessive (both alleles are recessive)
- genotype tt
- phenotype – short



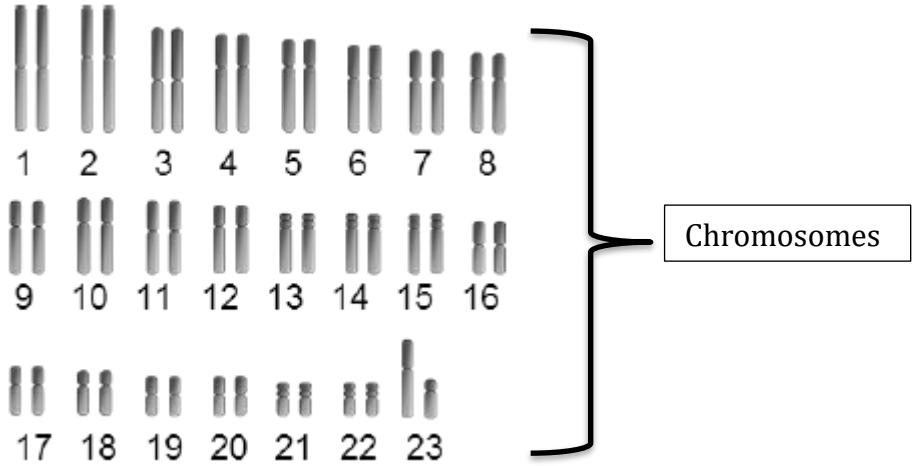
- heterozygous (one dominant and one recessive allele)
- genotype Tt
- phenotype - tall

T

monohybrid cross	only one characteristic or trait is shown in the genetic cross	- Flower colour only, e.g. yellow or white flower **OR** – shape of seeds only, e.g. round seeds or wrinkled seeds	
dihybrid cross	two different characteristics shown in genetic cross	Example: flower colour, e.g. yellow or white flower – AND – shape of seeds, e.g. round seeds or wrinkled seeds	
complete dominance	a genetic cross where the dominant allele masks the expression of a recessive allele in the heterozygous condition	The allele for tall (T) is dominant over the allele for short (t) - offspring will be **tall** because the dominant allele (T) masks the expression of the recessive allele (t)	
incomplete dominance	cross between two phenotypically different parents produce offspring different from both parents but with an intermediate phenotype	a red-flowered plant is crossed with a white flowered plant – with incomplete dominance, offspring will have **pink flowers - intermediate colour**	red × white flower pink flowers
co-dominance	cross in which both alleles are expressed equally in the phenotype	red-flowered plant is crossed with a white flowered plant – with co-dominance, the offspring has flowers with red and white patches	red × white flower flowers with red and white patches
multiple alleles	more than two alternative forms of a gene at the same locus	blood groups are controlled by three alleles, namely I^A, I^B and i. all three alleles are present in a population, but an individual can only have two alleles	
sex-linked characteristics	traits that are carried in the sex chromosomes	Some examples: haemophilia and colour blindness - alleles for haemophilia (or colour blindness) are indicated as superscripts on the sex chromosomes, e.g. X^HX^H (normal female), X^HX^h (normal female), X^hX^h (female with haemophilia), XHY (normal male), X^hY (male with haemophilia). Both haemophilia and colour blindness are caused by recessive alleles.	

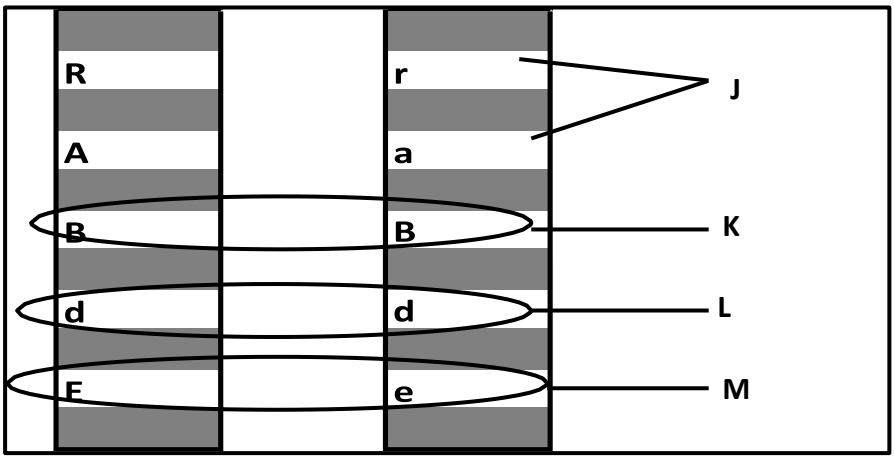
karyotype	the number, shape and arrangement of the chromosomes in the nucleus of a somatic cell	
cloning	process by which genetically identical organisms are formed using biotechnology	Dolly the sheep was cloned using a diploid cell from one parent; therefore, it had the identical genetic material of that parent
genetic modification	manipulation of the genetic material of an organism to get desired changes	An example: insertion of the human insulin gene into the plasmid of bacteria so that the bacteria produce human insulin
human genome	mapping of the exact position of all the genes in all the chromosomes of a human	Example: haemophilia is the last gene on the X chromosome; gene number 3 on chromosome 4 is responsible for a particular characteristic
homologous pair of chromosomes	a set of one maternal and one paternal chromosome that pair up with each other inside a cell during meiosis – homologous chromosomes are the same size and shape, and carry the same or similar alleles	
		

T

Karyotype	The number, shape and arrangement of all the chromosomes in the nucleus of a somatic cell.	
autosome	the first 22 pairs of chromosomes which control the appearance, structure and functioning of the body	
Gonosomes (sex chromosomes)	the pair of chromosomes (XX or XY) responsible for sex determination	

Activity 1

1.1The 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:

(a) Homozygous recessive (1)
(b) Heterozygous (1)
(c) Homozygous (1)
(d) Different genes for different traits (1)

(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:

(a) The same (1)
(b) Different (1)

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)

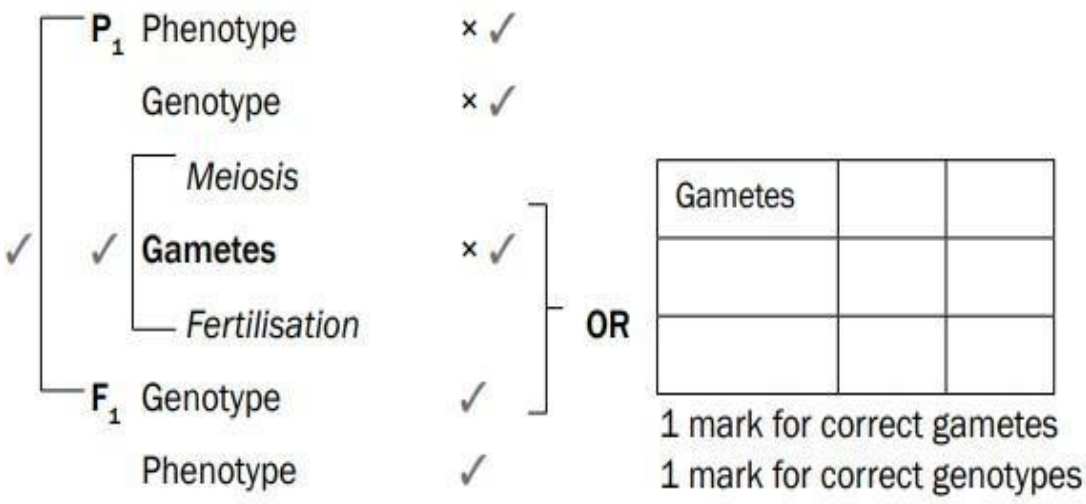
(5)

GENETICS AND INHERITANCE Paper 2: 48 marks	Term 1 & 2	3½ weeks
Monohybrid crosses	❑ Format for representing 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' (remove all the high lighting ❑ 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		

MONOHYBRID CROSSES

A specific template is used to solve Monohybrid Crosses.

Template for representing 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'

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: Tt x Tt
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

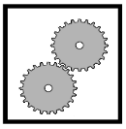
Phenotype: **75% tall : 25% short**

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 **Phenotype:** Brown Hair x blonde hair
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 hair

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
Ratio: **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

Activity 6

6.1. 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 plantw produce plants that have pink flowers.

- 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)

EXAMPLE

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

Alleles R – Red W – White

P1 Phenotype Red flowers x White flowers
Genotype RR x WW
MEIOSIS
Gametes R , R x W , W

FERTILIZATION

	R	R
W	RW	RW
W	RW	RW

F1 Genotype All RW
Phenotype All Pink

If we cross the F1 generation what colour will we get

P1 Phenotype Pink x Pink
Genotype RW x RW
MEIOSIS
Gametes R W x R W

FERTILIZATION

	R	W
R	RR	RW
W	RW	WW

F1 Genotype RR; RW; RW; WW
Phenotype 1 Red; 2 Pink; 1 White

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

EXAMPLE

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 x W W

FERTILIZATION

	R	R
W	RW	RW
W	RW	RW

F1 Genotype All RW
Phenotype All Roan

If we cross the F1 generation, we will get the following result

P1 Phenotye Roan coat x Roan coat

Genotype RW x RW

MEIOSIS

Gametes R W x R W

F1 FERTILIZATION

	R	W
R	RR	RW
W	RW	WW

F1 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.

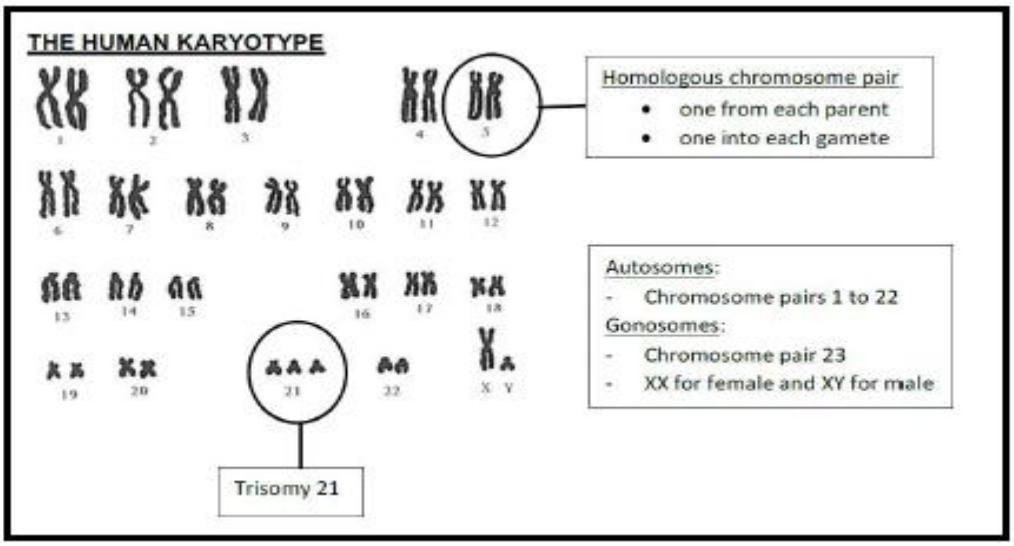
Use a genetic cross to explain his results in the F1 generation **[6]**

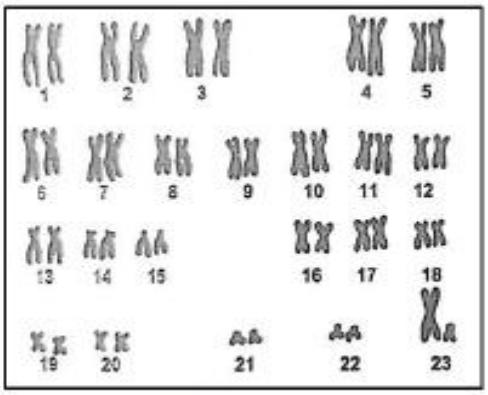
Sex determination	❑ 22 pairs of chromosomes in humans are autosomes and one pair of chromosomes are sex chromosomes/gonosomes ❑ Males have XY chromosomes and females have XX chromosomes ❑ Differentiate between sex chromosomes (gonosomes) and autosomes in the karyotypes of human males and females ❑ Representation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

- A male has 44 +XY chromosomes and therefore his gametes will either have 22+X or 22+Y
- A female has 44 + XX chromosomes and therefore all her gametes will always have 22+X

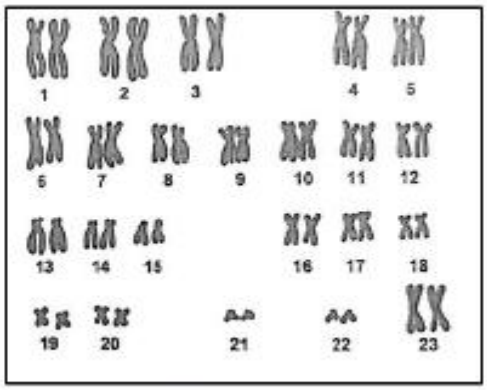
Karyotypes

A **karyotype** is the number, shape and arrangement of all the chromosomes in the nucleus of a somatic cell.





Male karyotype



Female karyotype

P_1 **phenotype** **man** **x** **woman**

genotype **XY** **x** **XX**

Meiosis

Gametes **X , Y x X , X**

gametes	X	X
X	XX	XX
Y	XY	XY

Fertilisation

F_1 **XX XX XY XY**

Genotype: 2 **XX , 2 XY**

Phenotype: **2 FEMALE, 2 MALE**

ACTIVITY 10 *(FS/SEPTEMBER 2022)*

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

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

- A genetic disorder caused by or linked to gene(s) located in the sex chromosome.
- In humans, the sex chromosomes are the X chromosome and Y chromosome.
- A female individual possesses two X chromosomes whereas a male has X chromosome and Y chromosome.
- Since the X chromosome carries more genes that are not found in the Y chromosome, the X chromosome is more commonly linked to genetic mutations and disorders.
- Usually, the X-linked traits and disorders are expressed more in males than in females because the males have only one copy of the X chromosome.
- A typical example of this is the genetic disorder, haemophilia, caused by a defect in a gene located in the X chromosome.

EXAMPLE

Haemophilia is a sex-linked disease caused by the presence of a recessive allele (X^h). A normal father and heterozygous mother have children. Construct a genetic cross to determine the possible genotype and phenotype of the children of the parents.

Remember when you answer this question it is important to identify the letters used to indicate the recessive and dominant alleles for this disorder.

P1 **Phenotype** **Normal father x Normal mother**

Genotype X^HY x X^HX^h

Meiosis

Gametes X^h Y X^H X^h

Fertilization

Gametes	X^H	Y
X^H	X^HX^H	X^HY
X^h	X^HX^h	X^hY

F1 **Genotype** **X^HX^H; X^HX^h; X^HY; X^hY**

Phenotype **50% Normal female; 25% Normal male; 25% Affected male**

IMPORTANT:

In an exam you may be asked to do other sex-linked disorders other than haemophilia and colour-blindness. Unless stated otherwise, follow the same format as in haemophilia and colour-blindness.

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)

Activity 11 (*DBE/2023)*

11.1 In humans, haemophilia is caused by a recessive allele on the X-chromosome (Xh). **(7)**
A woman, who is heterozygous for haemophilia, marries a man with haemophilia.
Use a genetic cross to show the percentage chance of the couple having a *daughter* who is homozygous for normal vision.

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	

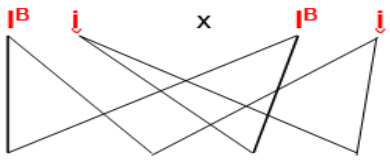
Example of a monohybrid cross using blood types:

*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

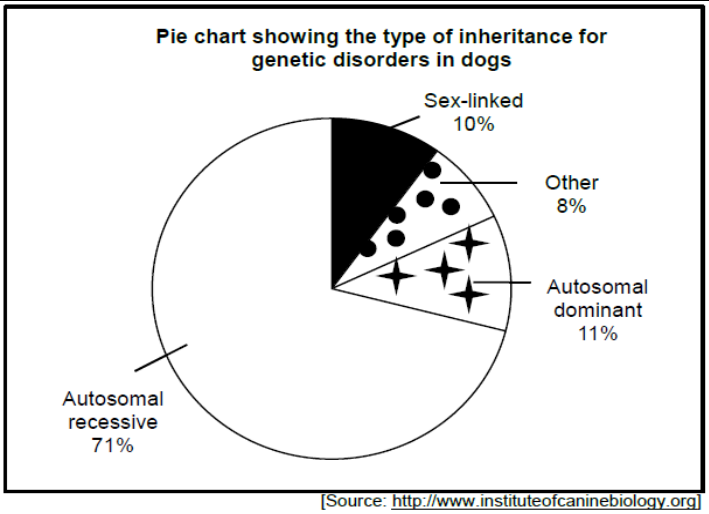
Gametes	I^B	i
I^B	I^BI^B	I^Bi
i	I^Bi	ii

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

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

Activity 12 *(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]

12.1. 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)

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

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

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

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

[10]

GENETIC LINEAGES/PEDIGREE

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.

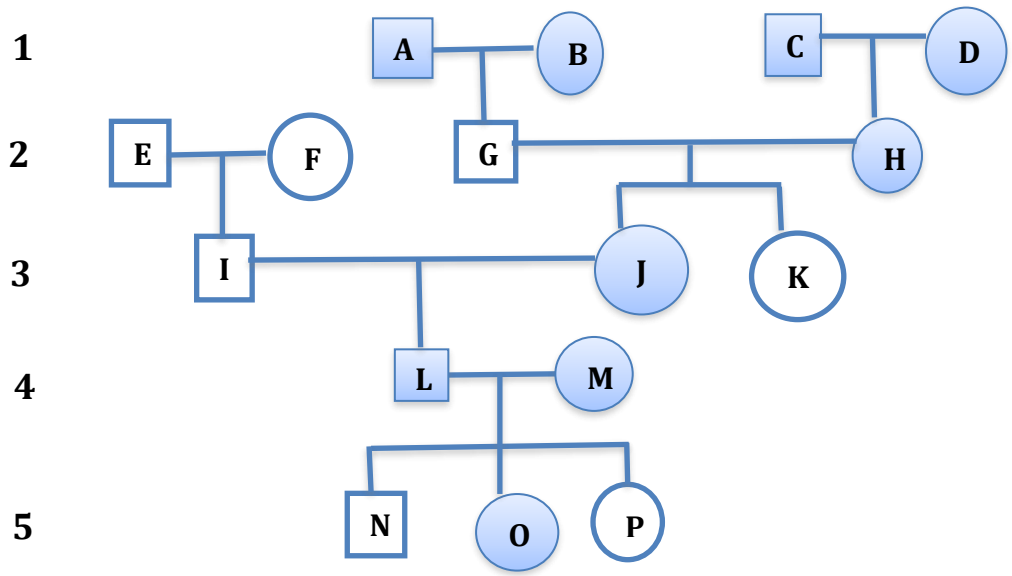
Pedigree diagrams can show autosomal dominant and recessive alleles but also sex-linked alleles (Alleles on the X chromosome/gonosome)

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

(You must know meaning of 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



Female with blonde

Male with blonde

Female with

Male with

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 up towards 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

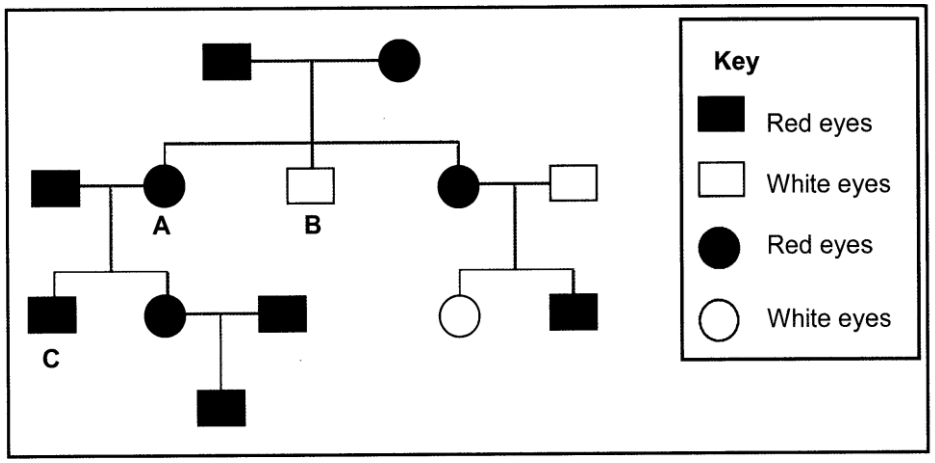
Let us see if you were right:

- 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 13 *(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.



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

13.2 Give the:

a) Phenotype of fruit fly C (1)

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

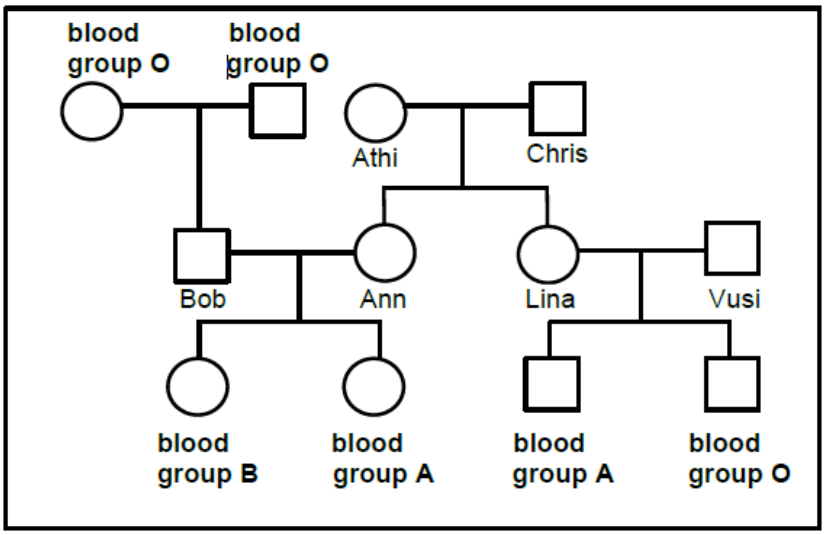
13.3 Explain how offspring B inherited white eyes. (3)

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

[10]

ACTIVITY 14 *(DBE/NOVEMBER 2023)*

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



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

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

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

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

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

14.4.2 Give the genotype of Bob. (1)

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

[8]

LIFE SCIENCES

GRADE 12

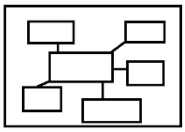
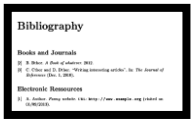
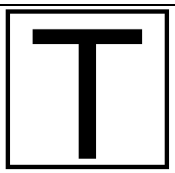
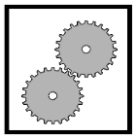
TERM 2

TEACHER AND LEARNER CONTENT MANUAL

TOPICS

RESPONDING TO THE ENVIRONMENT (HUMANS)

HOW TO USE THIS MANUAL

 MIND MAP	 EXAMINATION GUIDELINE	 CONTENTS	 ACTIVITIES
 BIBLIOGRAPHY	 TERMINOLOGY	 WORKED EXAMPLES	 STEPS

CONTENTS PAGE

RESPONDING TO THE ENVIRONMENT (HUMANS)

RESPONDING TO THE ENVIRONMENT (HUMANS) Paper 1: 54 marks	**Term 2**	**4 weeks**

CONTENT	**ELABORATION**
Introduction	❑ The nervous system (involving nerves) and endocrine system (involving hormones) are two components that help humans respond to the environment

Introduction

❑ The nervous system (involving nerves) and endocrine system (involving hormones) are two components that help us respond to the environment

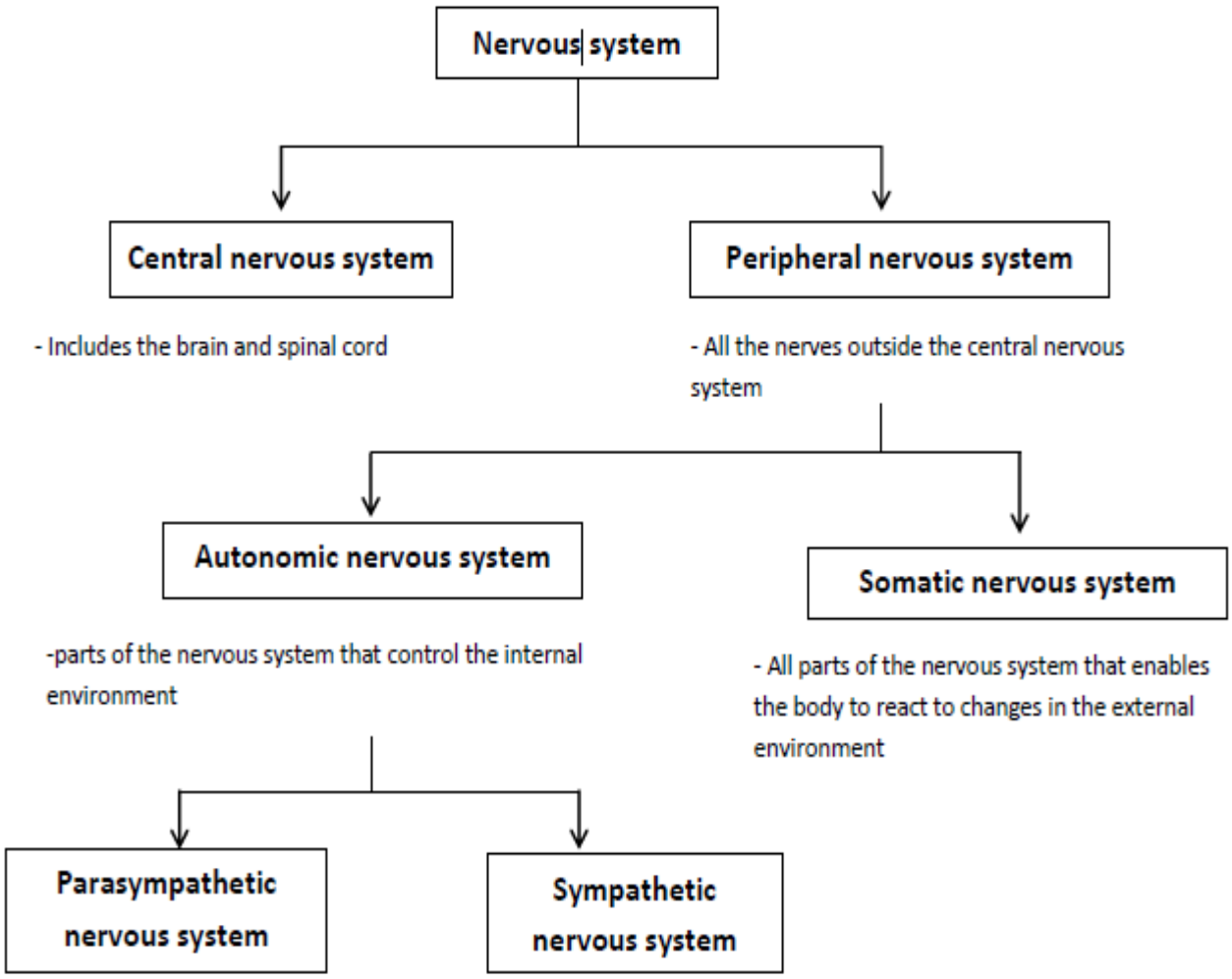
❑ Stimulus is a detectable change in the external or internal environment

CONTENT	**ELABORATION**
Human nervous system	❑ The need for a nervous system in humans: • Reaction to stimuli (stimuli can be extemal and internal) • Coordination of the various activities of the body
Central nervous system	❑ The brain and spinal cord are protected by: • Meninges (Individual names not required) • Cranium and vertebrae • Cerebrospinal fluid ❑ Location and functions of the following parts using a diagram: • Brain o Cerebrum o Cerebellum o Corpus callosum o Medulla oblongata • Spinal cord

Human nervous system

The need for a nervous system in humans:

- Reaction to stimuli (stimuli can be external and internal)
- Coordination of the various activities of the body

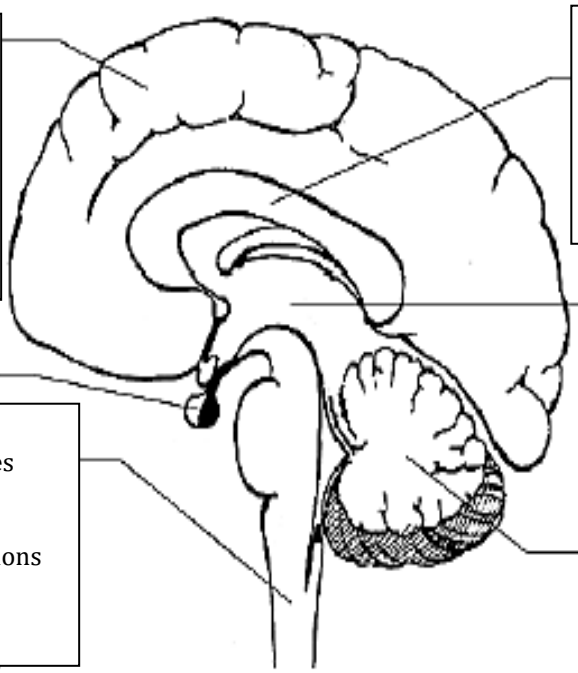


Central nervous system

- The brain and spinal cord are protected by meninges and the Cerebrospinal fluid and Cranium
- Meninges are membranes that surround and protect the central nervous system
- Cerebrospinal fluid functions acts a shock absorber and prevents dehydration

The structure and functions of the brain

A. Cerebrum
. Controls voluntary actions
· Receives and interprets sensations from sense organs
. Higher thought processes



E. Corpus callosum
• Connects the left and right hemispheres of the brain – allowing communication between both hemispheres

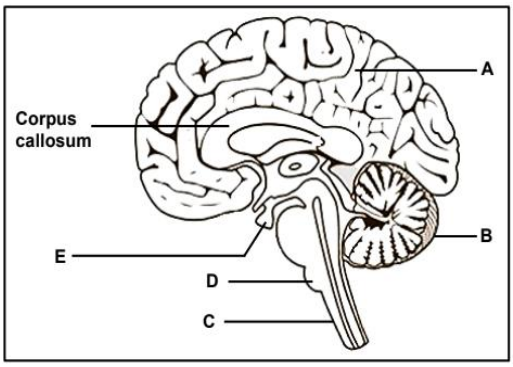
D. Hypothalamus
• Control centre for hunger, thirst, sleep, body temperature and emotions
• Hypothalamus produce ADH

B. Cerebellum
• Coordinates all voluntary movements
• Controls muscle tension to maintain balance

C. Medulla oblongata
. Transmits nerve impulses between the spinal cord and the brain
. Controls involuntary actions such as heartbeat and breathing

ACTIVITY 2.1 (DBE/November 2023)

2.1. The diagram below represents part of the central nervous system of a human.



2.1.1 Identify:
a) Part C (1)
b) Gland E (1)

2.1.2 Give the LETTER of the part that controls voluntary actions. (1)

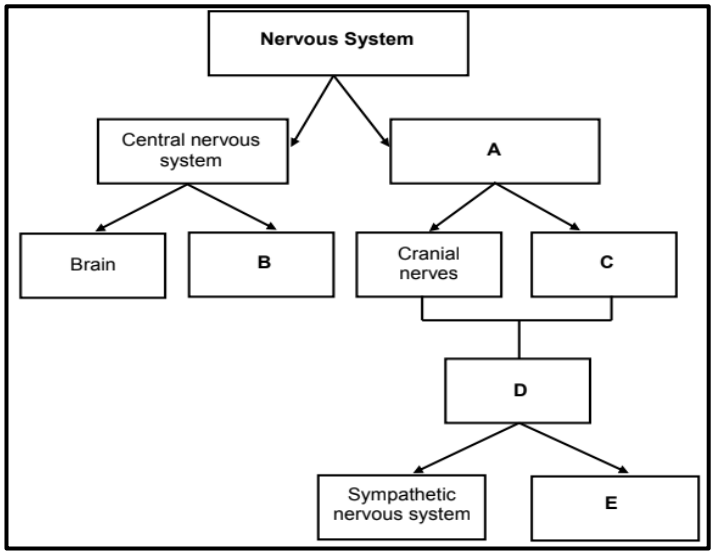
2.1.3 Describe the location of the corpus callosum. (2)

A learner suffered a brain injury during a rugby match. He could still breathe properly but he experienced occasional loss of memory and balance.

2.1.3 Explain why:
a) The learner could still breathe properly (2)
b) It is possible that the injury affected part B (2)
c) The hearing of the learner could also be affected because of the injury (2)

ACTIVITY 2.2 (DBE/2023)

2.2 The flow diagram below represents the components of the nervous system.



2.2.1 Identify the component of the nervous system represented by:
- a) A (1)
- b) D (1)

2.2.2 Name the type of nerves found at C. (1)

2.2.3 Give the LETTER and NAME of the component that slows down the heart rate when an emergency situation has passed. (2)

2.2.4 Name the nerve cells that make up nervous tissue. (1)

2.2.5 State TWO ways in which the brain is protected. (2)

(8)

CONTENT	ELABORATION
Peripheral nervous system	❑ Location and functions of the peripheral nervous system (cranial and spinal nerves)
Autonomic nervous system	❑ Location and functions of the autonomic nervous system (sympathetic and parasympathetic sections)

ACTIVITY 2.3 (KZN PRE EXAM 2023)

2.3.1 Describe the functioning of the autonomic nervous system. **(5)**

Peripheral nervous system (PNS)

- Includes all nerves outside the brain and spinal cord (cranial and spinal nerves)
- Transmits impulses from the body to the CNS and from the CNS to the body
- PNS forms the somatic nervous system and autonomic nervous system
- **Somatic nervous system** – receives information form sensory organs and the brain
- **Autonomic nervous system** – controls involuntary actions

Autonomic nervous system

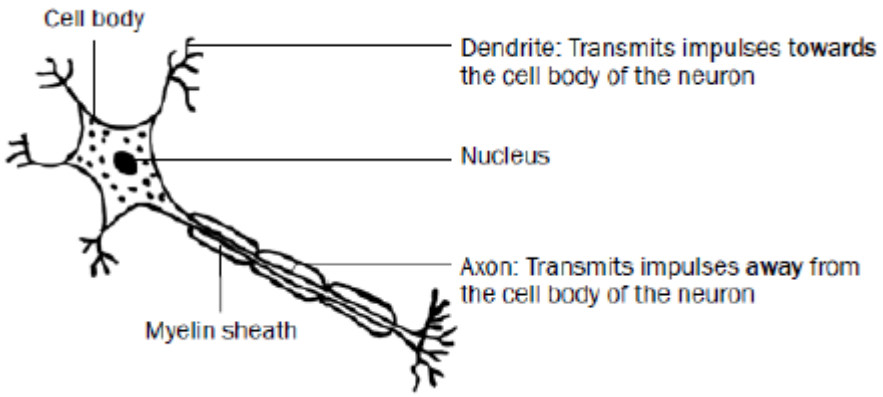
- Consist of the sympathetic and parasympathetic system
- **Sympathetic nervous system** – prepare the body for the stress or emergency by increasing the heart rate and breathing rate
- **Parasympathetic nervous system** – slows down the body by decreasing the heart rate and breathing rate
- The sympathetic nervous system and parasympathetic nervous system work **antagonistically** (work against each other)
- Each organ will have nerves both sympathetic and parasympathetic systems and this is called **Double innervation**

CONTENT	ELABORATION
Structure and functioning of a nerve	❑ Nerves transmit impulses to and from all parts of the body and are made up of neurons (sensory or motor) ❑ Functions of sensory and motor neurons ❑ Structure and functions of parts of sensory and motor neurons, using diagrams: nucleus, cell body, cytoplasm, myelin sheath, axon and dendrites
The simple reflex arc	❑ Definition of a reflex action and a reflex arc ❑ Structure of a reflex arc and functions of each part, using a diagram: receptor, sensory neuron, dorsal root of spinal nerve, spinal cord, interneuron, motor neuron, ventral root of spinal nerve, effector and synapses ❑ Functioning of a simple reflex action, using an example ❑ Significance of a reflex action ❑ Significance of synapses

Structure and functioning of a nerve

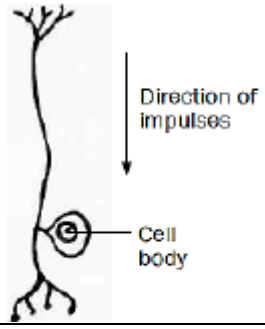
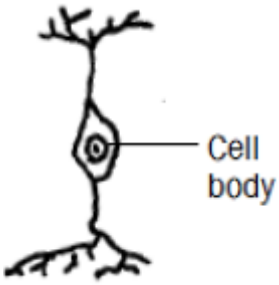
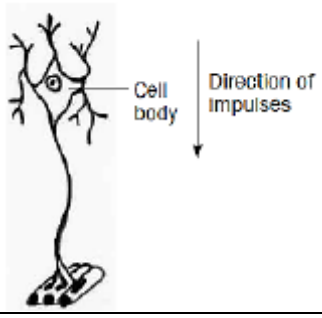
- Nervous tissue is made up of nerve cells called Neurons
- All neurons consist of a cell body, dendrites and an axon
- Impulses always travel from the dendrites to the cell body then to the axon

Structure of the neuron

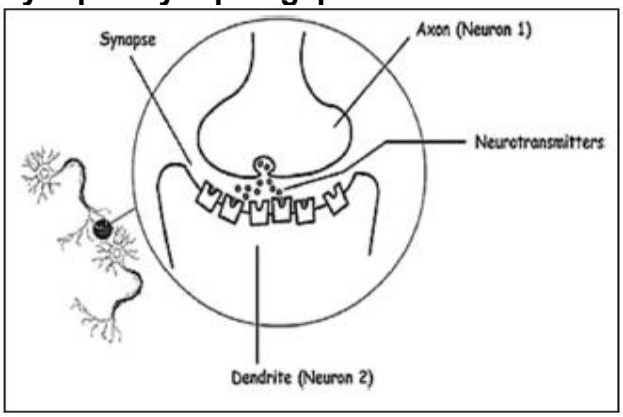


- **Myelin sheath** – surrounds (insulates) the axons of a neuron in order to accelerate the speed of transmission of an impulse

- **Nucleus** – controls all the cell's functions
- **Cell body** – consists of the cytoplasm with a nucleus

	Sensory neuron (Afferent	Interneuron/connector neuron	Motor neuron (Efferent)
Structure			
Function	carry impulses from receptors to CNS	carry impulses inside CNS from sensory neuron to motor neuron	carry impulses from the CNS to effectors (muscles and glands)
Polarity (Position of cell body)	**Unipolar/bipolar** (Dendrites at each pole)	**Multipolar** (Many dendrites leaving the cell body)	**Multipolar** (Many dendrites leaving the cell body)

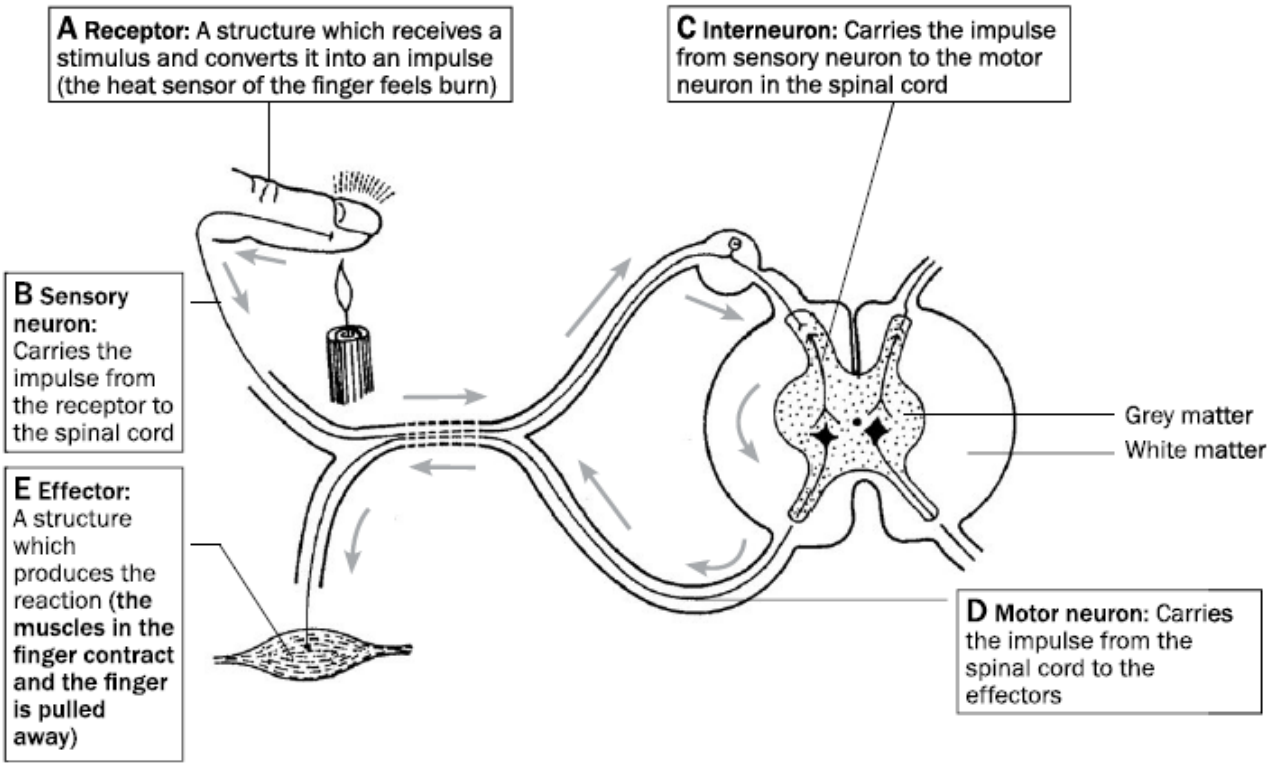
Synapse/synaptic gap



- -**Synapse** is a point where an impulse passes from the end of one neuron to the dendrite of the next
- -Therefore the neurons never touch each other.
- -The synaptic gap insures impulses can only **travel in one direction** and it prevents continuous stimulation of the neurons

The simple reflex arc

- Reflex action – is a rapid, automatic (involuntary) response to a stimulus received by an organ or other receptor
- Reflex arc – the path taken by an impulse in bringing about a response to a stimulus during a reflex action



The path of a reflex arc:

Receptor (A) - Sensory neuron (B) - Interneuron (C) - Motor neuron (D) - Effector (E)

- Sensory neurons enter the **Dorsal root** of the spinal nerves, while interneurons are situated in the spinal cord and motor neurons leave the spinal cord through the **Ventral root**
- **Dorsal root ganglion** contains cell bodies of sensory neurons
- **White matter** consist of myelinated axons of numerous neurons and **Grey matter** consist of cell body and dendrites of numerous neurons

Describing a reflex action

- Receptors in the skin
- receive the stimulus
- Stimulus is converted into a nerve impulse
- The impulse travels along the sensory neuron towards the spinal cord
- along the dorsal root of the spinal nerve
- In the spinal cord, the sensory neuron makes synaptic contact with the connector/interneuron
- and then the impulses are transmitted along the motor neuron
- along the ventral root of the spinal nerve to the effector organ/muscle
- which contracts and pulls the hand away

- The reflex action provides a quick response to the stimulus so injury is minimised

Examples of reflex action

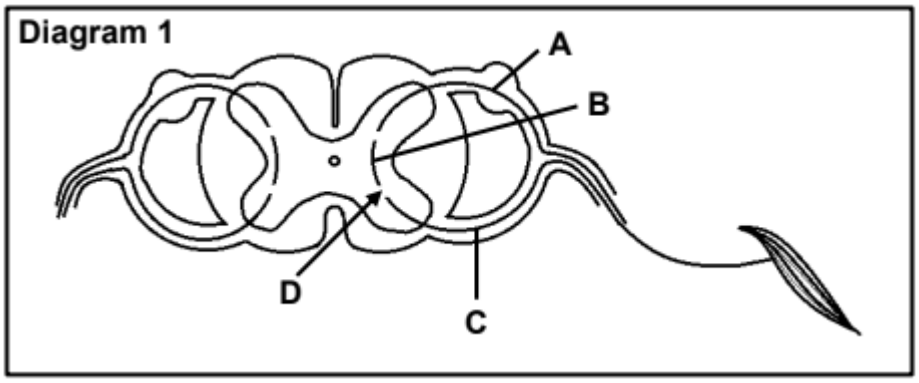
- Blinking
- Coughing
- Sneezing
- knee-jerk
- Pulling your hand away from a hot object

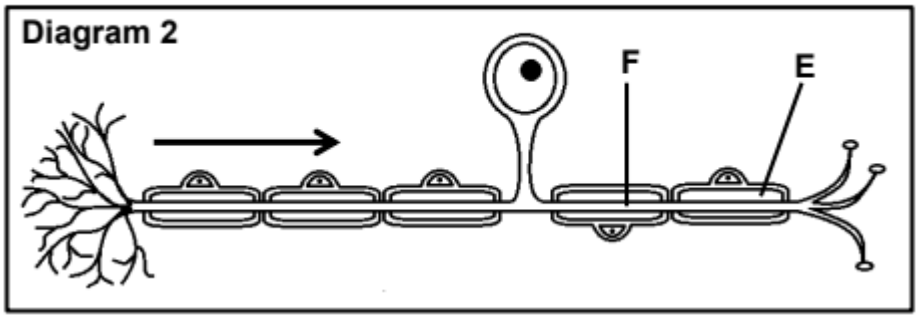
Significance of a reflex action

- Helps to protect the body by reacting quickly
- The interneuron makes a short cut not going to the brain/uses a reflex pathway that is immediately available

ACTIVITY 2.4 (DBE/2022)

2.4 Diagram 1 below represents part of a reflex arc and diagram 2 represents a neuron.





2.4.1 Identify:

a) Layer E (1)

b) Structure F (1)

2.4.2 Which neuron (A, B or C):

a) Represents the type of neuron shown in diagram 2 (1)

b) Is damaged when a person can feel the stimulus but cannot respond to it (1)

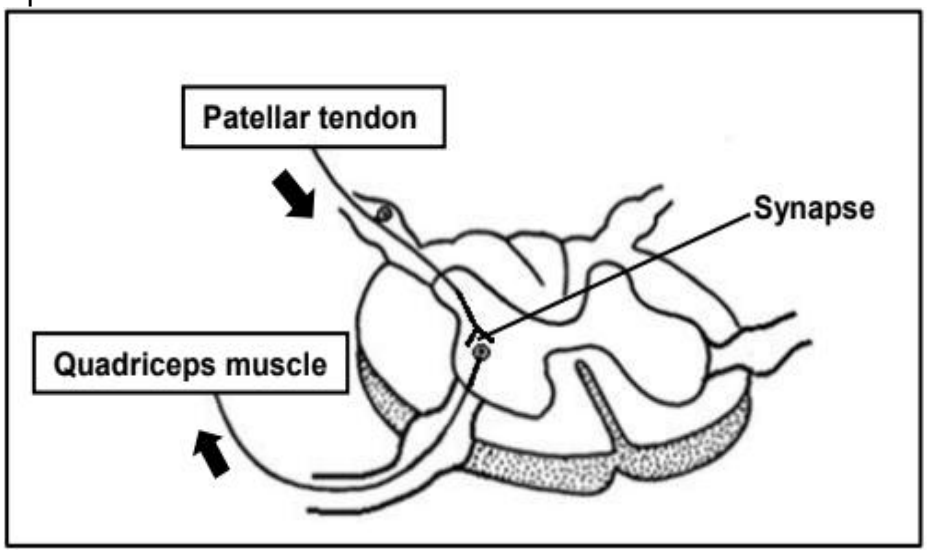
2.4.3 Give the LETTER and NAME of the part that ensures one-directional flow of the impulse. (2)

(6)

ACTIVITY 2.5 (DBE/November 2023)

2.5 The efficiency and speed of the knee-jerk reaction is very important for balance and movement. The stimulation of the patellar tendon, just below the kneecap (patella), causes the contraction and relaxation of the quadriceps muscle in the upper leg.

The diagram below represents the reflex arc for the knee-jerk reaction containing only ONE synapse. The arrows indicate the transmission of nerve impulses.



2.5.1 What is a reflex action? (2)

2.5.2 State:

a) ONE reason why a synapse is significant (1)

b) The importance of the knee-jerk reaction (1)

2.5.3 Describe the pathway of the impulse in this reflex arc to bring about the knee-jerk reaction. (5)

(9)

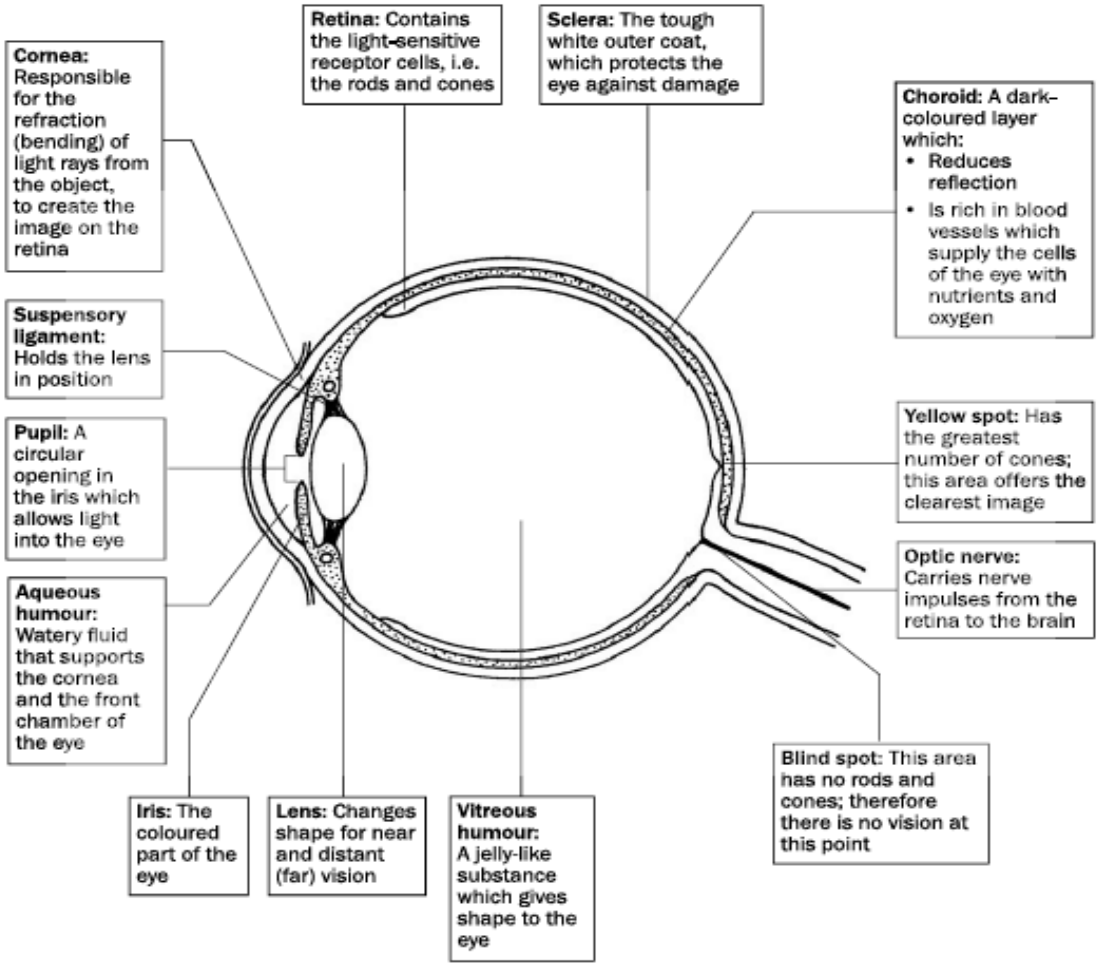
CONTENT	ELABORATION
Disorders of the CNS	❑ Causes and symptoms of the following disorders of the nervous system: • Alzheimer's disease • Multiple sclerosis

Disorders of the CNS

Alzheimer's disease (AD)	Multiple sclerosis
• An irreversible neuro-degenerative disease that damages the mental and intellectual functioning of the brain • Usually occurs in older people but is not part of normal aging process • Symptoms include memory loss, diminished intellectual capacity and loss of judgment	• Occurs when the body's own immune system destroys the myelin sheath. • A person with multiple sclerosis has problems with sensation, movement and mental abilities • Symptoms include muscle weakness, speech difficulties and visual problems

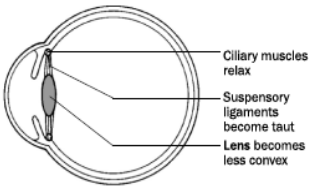
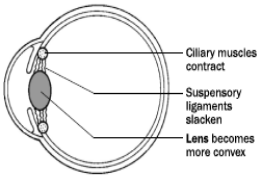
CONTENT	ELABORATION
Human eye	❑ Structure of the human eye and functions of the different parts, using a diagram ❑ Binocular vision and its importance ❑ The changes that occur in the human eye for each of the following, using diagrams: • Accommodation • Pupillary mechanism ❑ The nature and treatment of the following visual defects, using diagrams: • Short-sightedness • Long-sightedness • Astigmatism • Cataracts
Human ear	❑ Structure of the human ear and the functions of the different parts, using a diagram ❑ Functioning of the human ear in: • Hearing (include the role of the organ of Corti, without details of its structure). Distinguish between the transmission of: o Sound waves: Pinna to tympanic membrane o Vibrations: Tympanic membrane to oval window o Pressure waves: Oval window to organ of Corti o Impulses: Organ of Corti to auditory nerve • Balance (include the role of maculae and cristae, without details of their structure). Describe how balance is maintained when there is a change in: o The position of the head o The speed and direction of head movement ❑ Cause and treatment of the following hearing defects: • Middle ear infection (the use of grommets) • Deafness (the use of hearing aids and cochlear implants)

The structure and functions of an eye



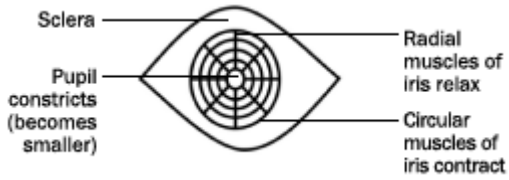
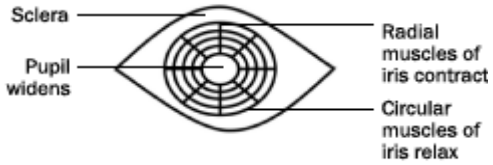
Accommodation

- Accommodation is the adjustment of the shape of the lens to see objects clearly whether they are far away or close by.
- This table below shows the process of accomodation

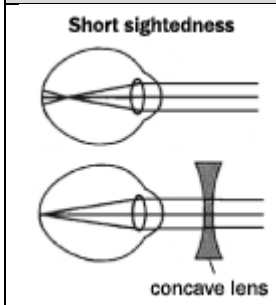
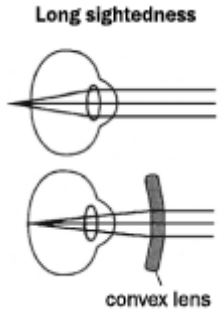
Distant vision (objects further than 6 m)	Near vision (objects closer than 6 m)
1. Ciliary muscles relax 2. Suspensory ligaments tighten (become taut) 3. Tension on lens increases 4. Lens is less convex (flatter) 5. Light rays are refracted (bent) less 6. Light rays are focused onto the retina	1. Ciliary muscles contract 2. Suspensory ligaments slacken 3. Tension on lens decreases 4. Lens becomes more convex (more rounded) 5. Light rays are refracted (bent) more 6. Light rays are focused onto the retina
 *Figure 6.8 Distant vision*	 *Figure 6.9 Near vision*

Pupillary mechanism

- The pupillary mechanism (or pupil reflex) regulates the amount of light entering the eye by adjusting the size of the pupil.
- The table below shows the process of pupillary mechanism

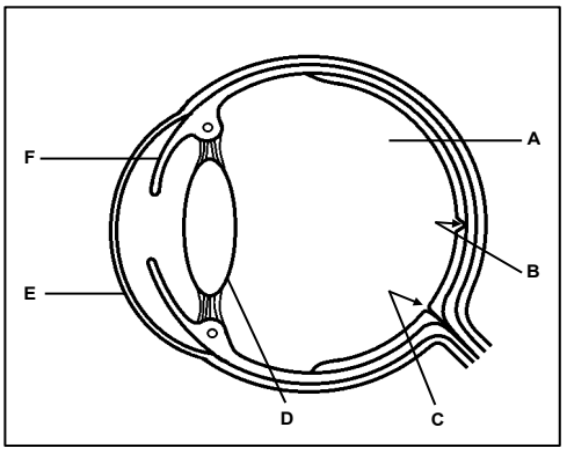
Light is bright	Light is dim
1. Radial muscles of the iris relax 2. Circular muscles of the iris contract 3. Pupil constricts (gets smaller) 4. Less light enters the eye 	1. Radial muscles of the iris contract 2. Circular muscles of the iris relax 3. Pupil widens (gets bigger) 4. More light enters the eye 

Visual defects

	Visual defect	Nature of the defect	Corrective measures
	Short- sightedness Near objects can be seen clearly (myopia)	•Inability of lens to become more flat/eyeball is longer than normal •Lens bends the light rays too much •As a result it falls in front of the retina . causing the image to be blurred •Cannot see distant objects clearly	Wearing glasses with converging (biconcave) lens
	Long- sightedness Objects far away can be seen clearly (hyperopia)	•Inability of lens to become more convex/eyeball is shorter than normal •Lens does not bend light rays enough •As a result it falls behind the retina •causing the image to be blurred •Cannot see near objects clearly	Wearing glasses with converging (biconvex) lens
	Astigmatism	•The curvature of the lens or •cornea is uneven resulting in •distorted images	Glasses with lenses shaped to correct the distortion
	Cataracts	•Lens becomes cloudy and •opaque	Surgery to replace the lens with a synthetic lens

ACTIVITY 2.6 (DBE/2023)

2.6 The diagram below represents the human eye.



2.6.1 Identify structure F. (1)

2.6.2 State TWO functions of fluid A. (2)

2.6.3 Describe the structural difference between area B and area C. (2)

2.6.4 Name the visual defect that occurs when the curvature of part E is uneven. (1)

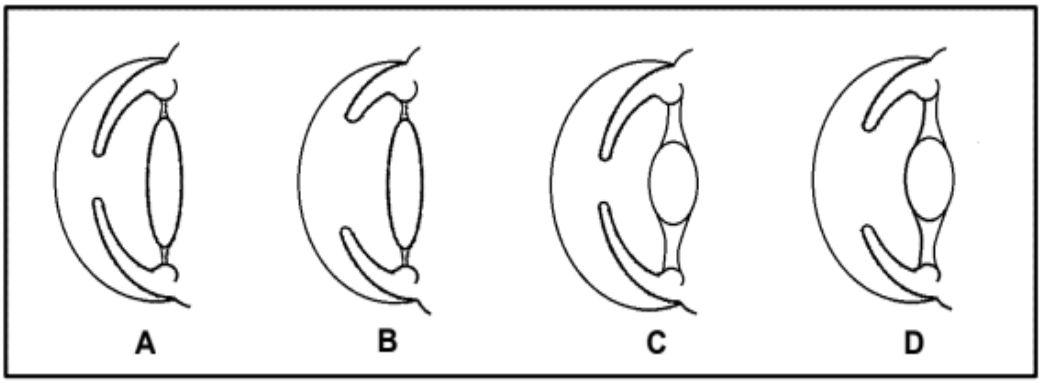
2.6.5 Explain how the sight of a person will be affected if cataracts developed in part D. (3)

2.6.6 Describe the process of accommodation that takes place when an object is less than 6 metres away from the eye. (6)

(15)

ACTIVITY 2.7 (DBE/2022)

2.7 The diagrams below show part of the eye under different conditions.



2.7.1 Name the process that occurs when the:

a) Curvature of the lens changes to focus on a near or distant object (1)

b) Pupil size changes to regulate the amount of light entering the eye (1)

2.7.2 Give the LETTERS of TWO diagrams (A, B, C or D) that represent the condition of the eye of a person:

a) In dim light (2)

b) Focusing on a distant object (2)

2.7.3 Give the LETTERS of TWO diagrams (A, B, C or D) that represent the eye of a person whose:

a) Ciliary muscles are contracted (2)

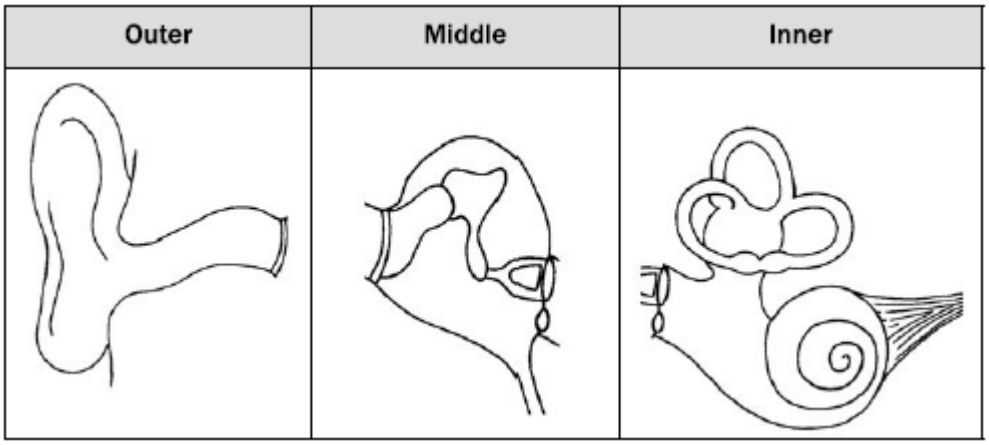
b) Radial muscles are relaxed (2)

(10)

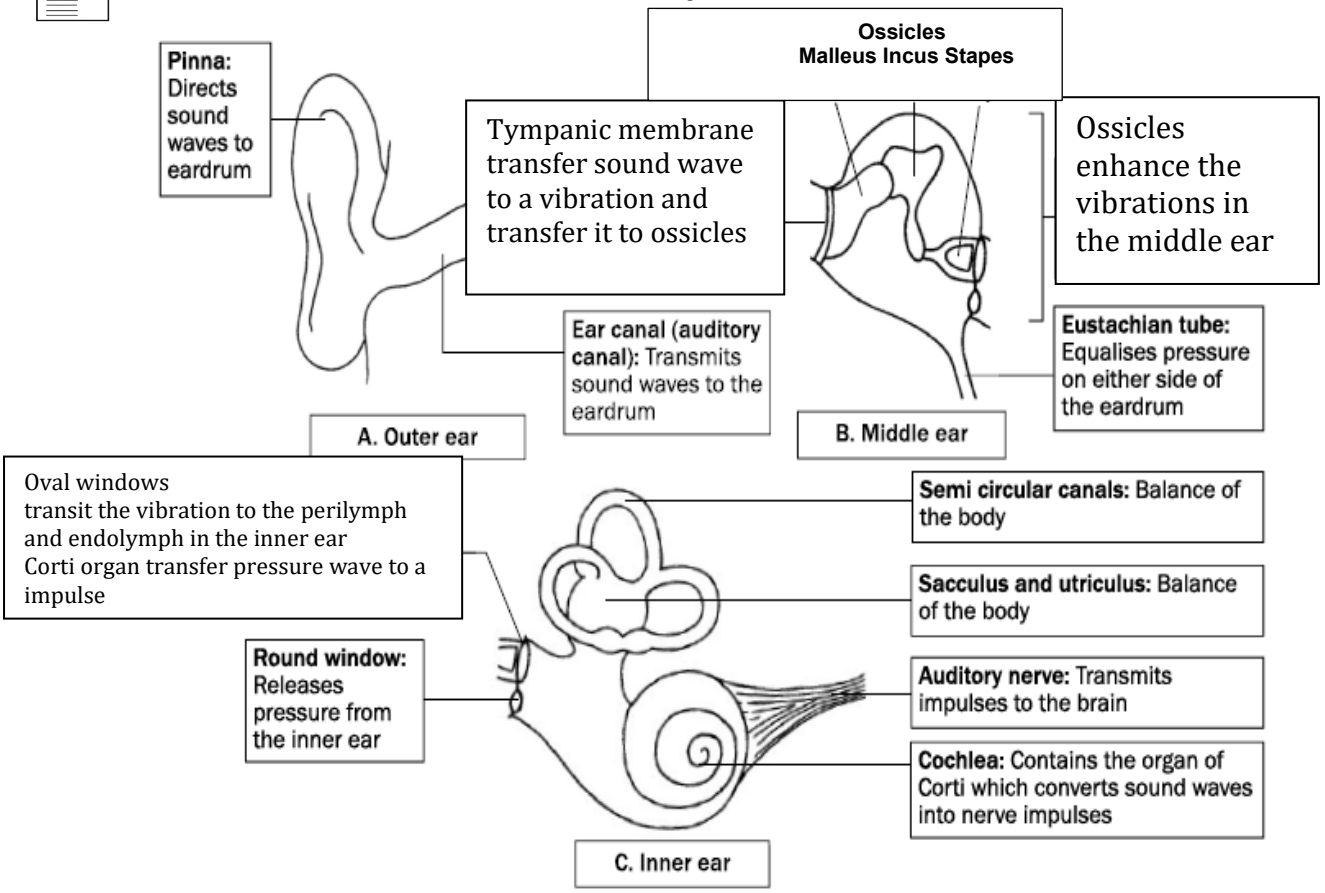
Structure of the ear

The human ear consists of three main parts:

- The outer ear
- The middle ear
- The inner ear

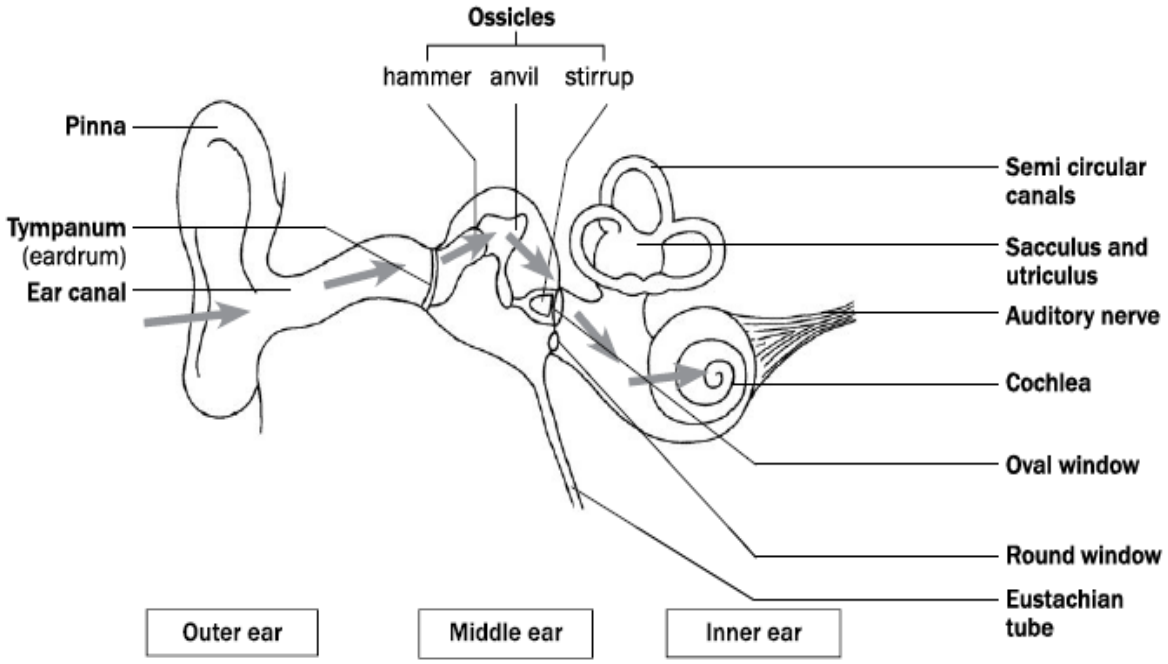


The structure and function of each part of the human ear.



Hearing

Below shows how the three parts of the ear work together to make it possible for us to hear. The grey arrows show the path of a sound wave.



Read the information in table below in conjunction with the picture above to understand how hearing takes place.

Part of ear	What it does during the hearing process
Pinna	Traps the sound waves and directs them into the auditory canal.
Tympanic membrane	Vibrates and transmits the vibrations to the ossicles in the middle ear.
Ossicles	The ossicles amplify the vibrations and carry them via the middle ear to the membrane of the oval window.
Oval window	Vibrates and causes pressure waves in the inner ear.
Cochlea	These vibrations cause the sensory cells in the organ of Corti to be stimulated in the cochlea and nerve impulses are generated.
Auditory nerve	Transmits nerve impulses to the cerebrum to be interpreted.

Balance

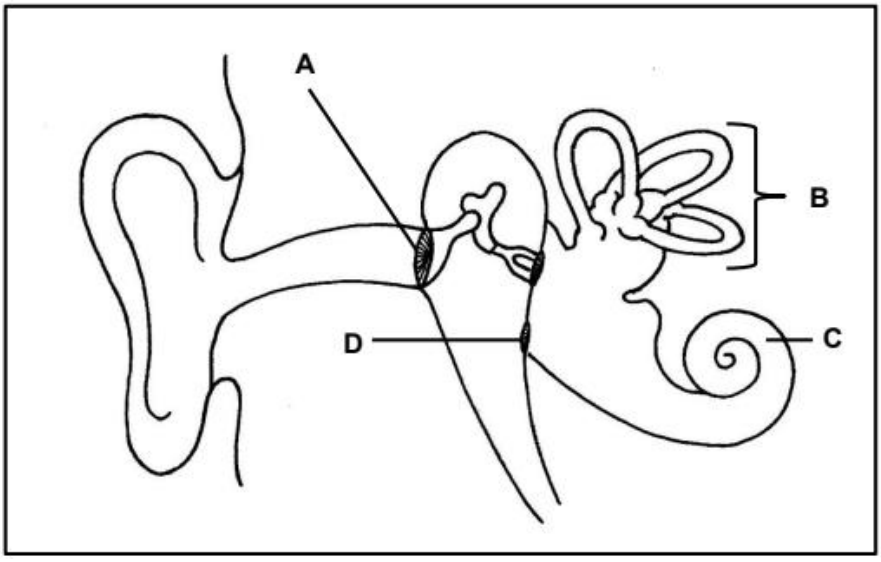
- A change in the direction and speed of the body causes the movement of fluid in the semicircular canals which stimulates the cristae
- A change in the position of the head stimulated the maculae in the utriculus and sacculus
- The stimuli were converted into impulses which were transported along the auditory nerve and interpreted in the cerebellum
- which then sent impulses to the muscles
- to restore balance and equilibrium

Hearing defects

Hearing defect	Causes	Treatment
Middle ear infection	Bacterial infection that disturbs the functioning of the Eustachian tube (blocked by fluid	• Inserting a grommet • Antibiotics
Deafness	• Injury to parts of the ear • Injury to parts of the brain responsible for hearing • Hardened wax • Fused ossciles	• Hearing aids • Cochlear implants

ACTIVITY 2.8 (DBE/November 2022)

2.8 The diagram below represents a part of the human ear.



2.8.1 Identify part C. (1)

2.8.2 State ONE function of:

a) Part D (1)

b) The receptors found in part C (1)

2.8.3 Explain why a build-up of ear wax at part A may result in temporary hearing loss. (2)

2.8.4 A grommet is a small device that allows the air to move into and out of the middle ear. This prevents pressure build-up in the middle ear.

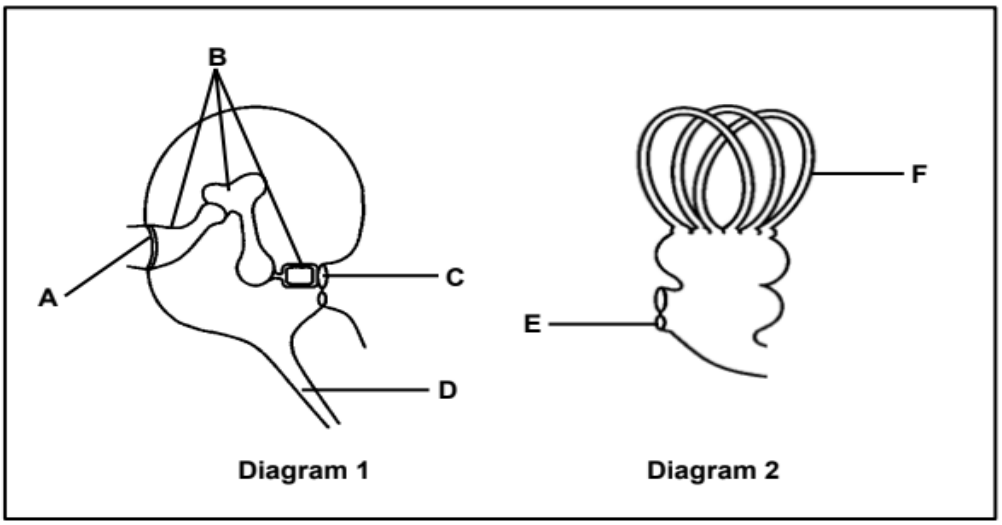
Explain how the use of grommets in the treatment of middle-ear infections prevents hearing loss. (4)

2.8.5 Describe how the receptors in part B are involved in maintaining balance when there are changes in the speed and direction of movement of the head. (4)

(13)

ACTIVITY 2.9

2.9 The diagrams below show parts of the middle and inner ear.



2.9.1 Identify part F. (1)

2.9.2 Give the collective term for bones B. (1)

2.9.3 Give the LETTER and NAME of the structure that:

a) Equalises pressure between the outer and middle ear (2)

b) Creates pressure waves in the inner ear (2)

2.9.4 Name the receptors that are stimulated by a change in the:

a) Position of the head (1)

b) Direction and speed of movement of the head (1)

(6)

JENN

Training and Consultancy

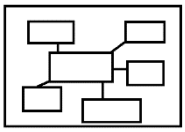
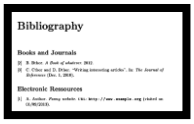
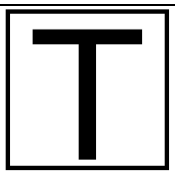
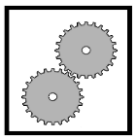
The path to enlightened education

LIFE SCIENCES

TOPICS
ENDOCRINE SYSTEM
AND HOMEOSTASIS

TEACHER AND LEARNER CONTENT MANUAL

HOW TO USE THIS MANUAL

 MIND MAP	 EXAMINATION GUIDELINE	 CONTENTS	 ACTIVITIES
 BIBLIOGRAPHY	 TERMINOLOGY	 WORKED EXAMPLES	 STEPS

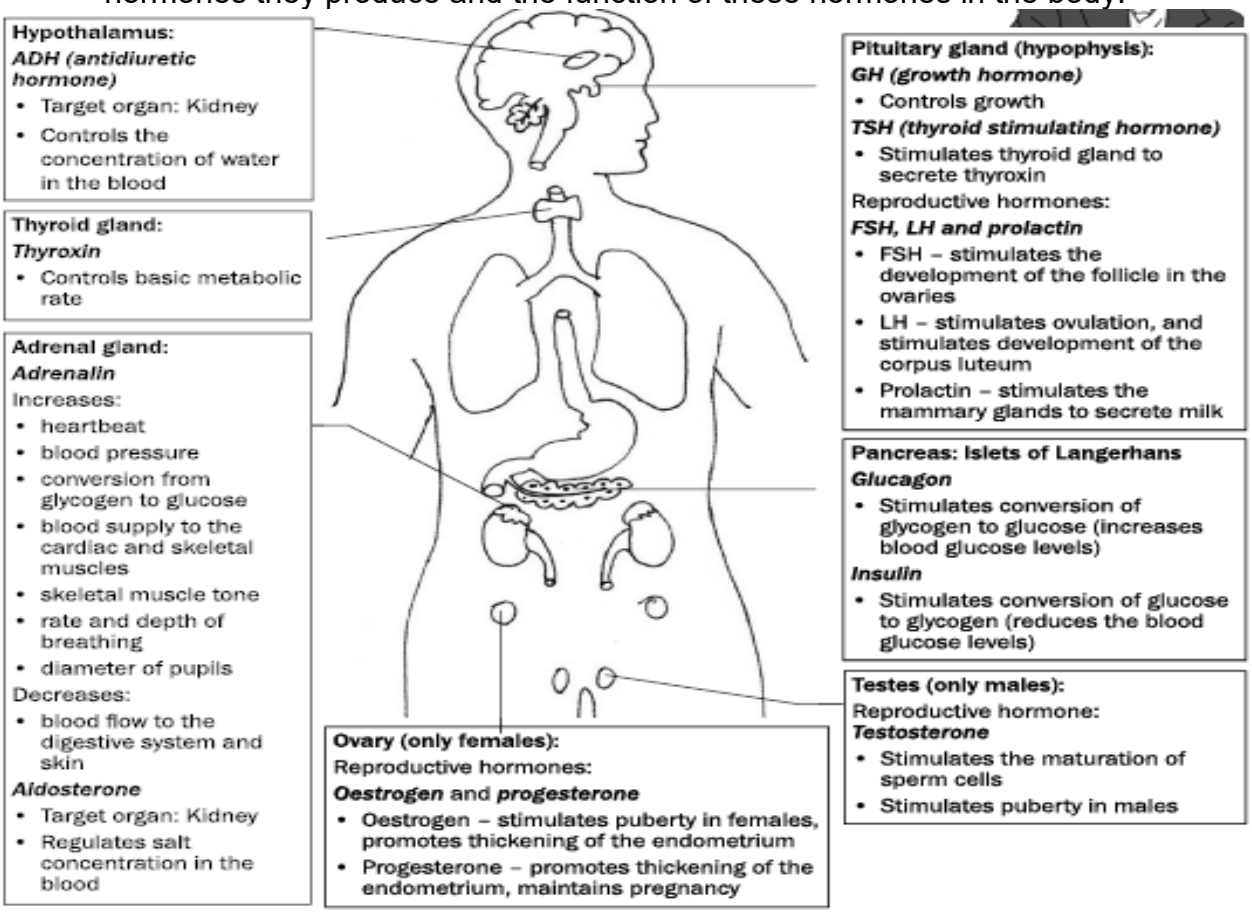
CONTENTS **PAGE**

ENDOCRINE SYSTEM AND HOMEOSTASIS Paper 1: 54 marks	Terms 2 and 3	2 % weeks

CONTENT	ELABORATION
Endocrine system	❑ Difference between an endocrine and an exocrine gland ❑ Definition of a hormone ❑ Location of each of the foliowing glands, using a diagram, the hormones they secrete and function(s) of each hormone: • Hypothalamus (produces ADH which is then stored and released by the pituitary gland) • Pituitary/Hypophysis (GH, TSH, FSH, LH, prolactin) • Thyroid gland (thyroxin) • Islets of Langerhans in the pancreas (insulin, glucagon) • Adrenal glands (adrenalin, aldosterone) • Ovary (oestrogen, progesterone) • Testis (testosterone)

The human endocrine system

- The endocrine system is responsible for chemical coordination and regulates
- activities that take place inside the body. The endocrine system consists of glands that produce different hormsones, which are the body's chemical messengers. The figure below shows the glands of the endocrine system, the
- hormones they produce and the function of these hormones in the body.



Negative feedback

- Homeostasis is a process of maintaining a constant internal environment (blood and tissue fluid) within the body. This enables the body to function efficiently, despite changes in the external or internal environment.

- Negative feedback mechanisms operate in the human body to detect changes or imbalances in the internal environment and to restore the balance.

General sequence of events in a negative feedback mechanism

Step 1: An imbalance is detected.

Step 2: A control centre is stimulated.

Step 3: Control centre responds.

Step 4: Message sent to target organ/s.

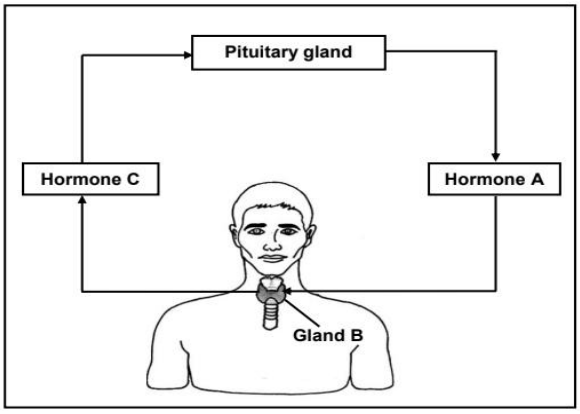
Step 5: The target organ responds.

Step 6: It opposes/reverses the imbalance.

Step 7: Balance is restored.

ACTIVITY 3.1 (DBE/November 2022)

3.1 The diagram below shows the interaction between two endocrine glands.



3.1.1 Name the type of interaction that occurs between hormone A and gland B. (1)

3.1.2 Identify:

a) Gland B (1)
b) Hormone A (1)
c) Hormone C (1)

3.1.3 Name the disorder that results when gland B is overstimulated and becomes enlarged. (1)

3.1.4 Which hormone (A or C) will be expected to be high in the blood of the person with the disorder named in QUESTION 3.1.3? (1)

(6)

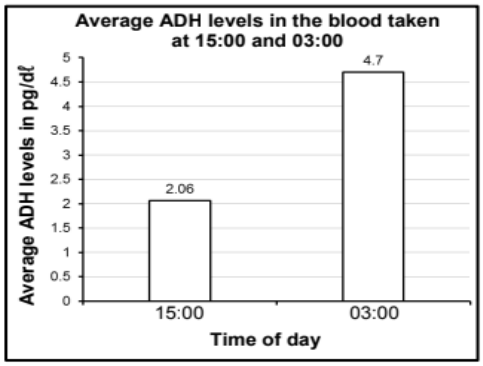
ACTIVITY 3.2 (DBE/2022)

3.2 An investigation was conducted to determine the change in the ADH levels in the blood and the volume of urine produced over a 24-hour period.
The procedure was as follows:

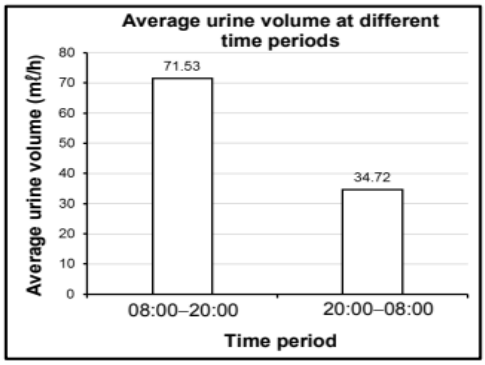
- One healthy adult participated in the investigation.
- The intake of food and liquids of this person was controlled for the duration of the investigation.
- The ADH levels in the blood were measured at 15:00 and 03:00 for 5 days and the average was calculated.
- The volume of urine produced from 08:00 to 20:00 was measured for 5 days and the average was calculated.
- The volume of urine produced from 20:00 to 08:00 was measured for 5 days and the average was calculated.

The results are shown in the graphs below.

GRAPH A



GRAPH B



3.2.1 Calculate the difference between the average volume of urine (ml/h) produced during the 2 time periods. Show ALL workings. (2)

3.2.2 Explain how the ADH levels in the blood at 03:00 affects the volume of urine produced between 20:00 and 08:00. (4)

3.2.3 Explain ONE advantage of the high ADH levels at 03:00. (2)

3.2.4 A patient whose renal tubules are impermeable to water, underwent the same investigation.
Explain why the ADH levels are expected to remain high all the time. (3)

(11)

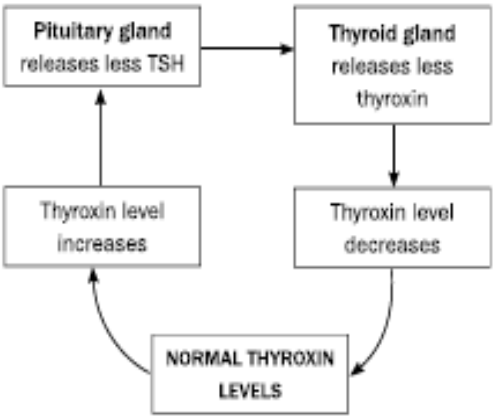
Example of a negative feedback mechanism

We will look at the regulation of thyroxin in the human body. There are two glands involved in the control of thyroxin levels:

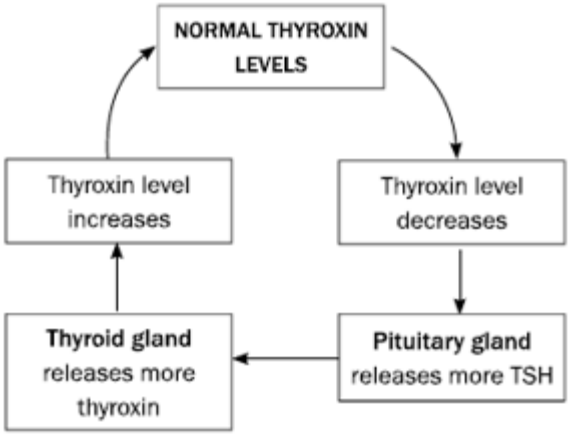
- Gland 1: Thyroid gland (releases thyroxin)
- Gland 2: Pituitary gland (releases TSH)

Let us now look at the sequence of events in this feedback mechanism.
When you read the flow diagrams, start with NORMAL THYROXIN LEVELS.

Situation 1	
Thyroxin levels increase above normal limits	
Step 1:	Thyroxin levels **increase** above normal limits
Step 2:	Pituitary gland is stimulated
Step 3:	Pituitary gland produces less TSH
Step 4:	Low TSH level stimulates the thyroid gland
Step 5:	The thyroid gland secretes less thyroxin
Step 6:	The thyroxin level thus decreases
Step 7:	Thyroxin level returns to normal

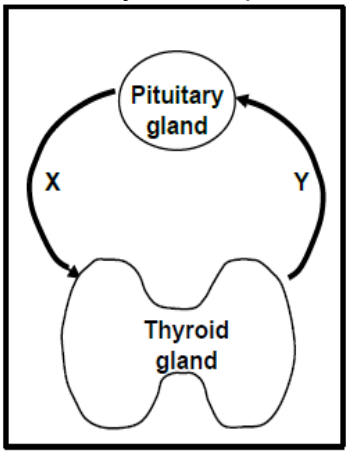


Situation 2	
Thyroxin levels decrease below normal limits	
Step 1:	Thyroxin levels decrease below normal limits
Step 2:	Pituitary gland is stimulated
Step 3:	Pituitary gland produces more TSH
Step 4:	High TSH level stimulates the thyroid gland
Step 5:	The thyroid gland secretes more thyroxin
Step 6:	The thyroxin level thus increases
Step 7:	Thyroxin level returns to normal



ACTIVITY 3.3

3.3 The diagram below represents a negative feedback mechanism. X and Y represent hormones secreted by the respective glands.



3.1.1 What is the role of any negative feedback mechanism in the human body? (1)

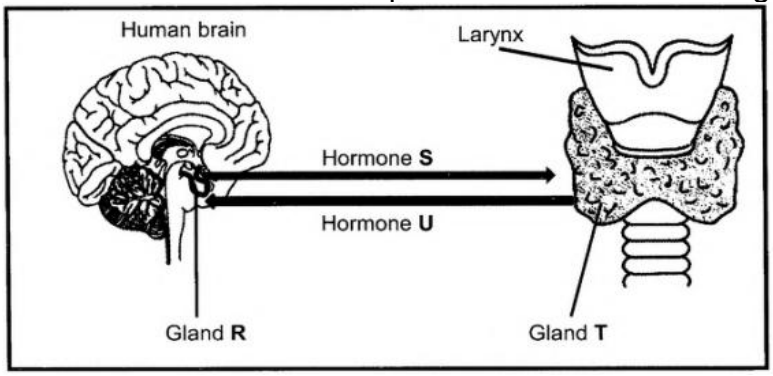
3.1.2 Identify hormone X. (1)

3.1.3 Explain the consequences for a person if hormone Y remained abnormally high for extended periods of time. (3)

(5)

ACTIVITY 3.4 (Preparatory Examination September 2022)

3.4 The diagram below shows a relationship between two endocrine glands.



3.4.1 Identify glands:
- (a) R (1)
- (b) T (1)

3.4.2 Identify hormones:
- (a) S (1)
- (b) U (1)

3.4.3 State which hormone (U or S), controls metabolic rate. (1)

3.4.4 State the gland (R or T) that enlarges due to the lack of iodine in the diet? (1)

(6)

CONTENT	ELABORATION
Introduction - Homeostasis	❑ Homeostasis is the process of maintaining a constant, internal environment with-in narrow limits, despite changes that take place internally and externally. ❑ The conditions within cells depend on the conditions within the internal environment (the tissue fluid) ❑ Factors such as glucose, carbon dioxide, water, salt concentration,temperature and pH must be kept constant in the intemal environment (tissue fluid)
Homeostasis: Negative feedback mechanisms	❑ Negative feedback mechanisms controlling the levels of each of the following inthe body: • Thyroxin • Blood glucose • Blood carbon dioxide • Water (osmoregulation) • Salt ❑ Disorder resulting in an imbalance in levels of blood glucose - Diabetes mellitus ❑ Thermoregulation - Structure of the skin, using a diagram, with an emphasis on the role of blood vessels and sweat glands in the process of thermoregulation ❑ Role of the following in negative feedback mechanism for controlling temperature/thermoregulation: • Sweating • Vasodilation • Vasoconstriction

Introduction

- Homeostasis is the process of maintaining a constant, internal environment with-in narrow limits, despite changes that take place internally and externally.
- A small changes in temperature, glucose levels, carbon dioxide levels, water levels and salt levels of the internal environment affects the homeostatic balance of the body.
- Negative feedback mechanisms operate in the human body to detect these changes or imbalances in the internal environment and to restore the balance.

General sequence of events in a negative feedback mechanism :

Step 1: An imbalance is detected.
Step 2: A control centre is stimulated.
Step 3: Control centre responds.
Step 4: Message sent to target organs/s.
Step 5: The target organ responds.
Step 6: It opposes/reverses the imbalance.
Step 7: Balance is restored.
Message sent to target organs/s The target organ responds.

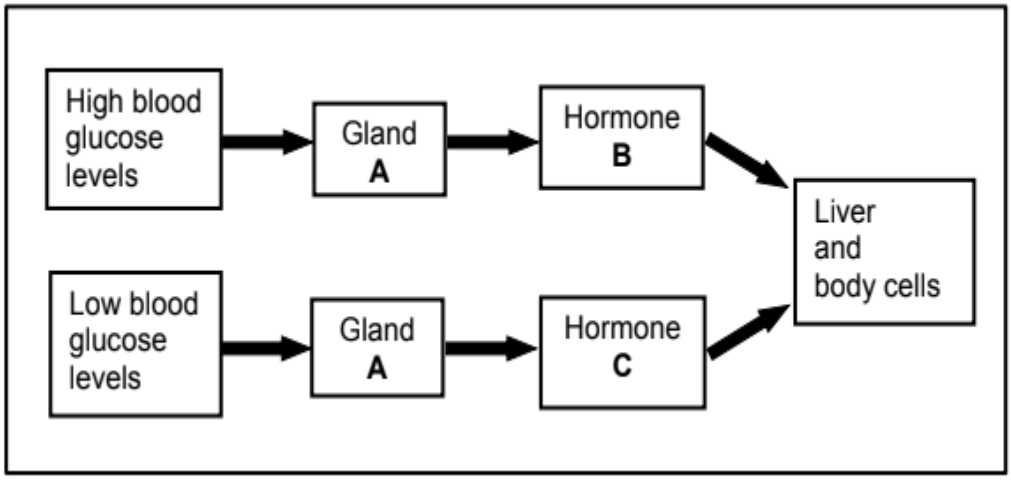
The regulation of glucose levels in the internal environment

When the glucose level in the blood increases above normal levels:	
Step 1	Glucose levels in the blood **increase** above normal levels
Step 2	The **pancreas** is stimulated
Step 3	to secrete **insulin** into the blood
Step 4	**Insulin** travels in the blood to the **liver**
Step 5	where it stimulates the conversion of excess glucose to **glycogen** which is then stored
Step 6	The glucose level in the blood now **decreases**
Step 7	and returns to **normal**

When the glucose level in the blood decreases below normal levels:	
Step 1	Glucose levels in the blood **decrease** above normal levels
Step 2	The pancreas is stimulated
Step 3	to secrete **glucagon** into the blood
Step 4	**Glucagon** travels in the blood to the **liver**
Step 5	where it stimulates the conversion of excess **glycogen to glucose** which is then stored
Step 6	The glucose level in the blood now **increases**
Step 7	and returns to **normal**

ACTIVITY 3.5 (DBE/November 2022)

3.5 The diagram below shows the homeostatic control of blood glucose levels.



3.5.1 Identify:

(a) Gland A (1)

(b) Hormone C (1)

3.5.2 A certain disorder causes decreased production of hormone B.

a) Explain how this will affect the blood glucose levels. (3)

b) Name the disorder. (1)

3.5.3 Scientists have been investigating the use of adrenalin as a treatment for people who cannot produce hormone C.
Explain why this treatment may work. (3)

(9)

The regulation of carbon dioxide levels in the internal environment

When the CO_2 level in the blood increases above normal levels:	
Step 1	CO_2 levels in the blood **increase** above normal levels
Step 2	Receptor cells in the carotid artery in the neck are stimulated
Step 3	To send impulses to the medulla oblongata in the brain
Step 4	Medulla oblongata stimulates breathing muscles (intercostal muscles and diaphragm) and heart
Step 5	Breathing muscles contract more actively - increases the rate and depth of breathing. The heart beats faster.
Step 6	More CO_2 is taken to and exhaled from the lungs
Step 7	The CO_2 level in the blood returns to normal

The regulation of water balance in the internal environment (osmoregulation)

When the blood has less water than normal:	
Step 1	Blood has less water than normal
Step 2	The hypothalamus is stimulated
Step 3	and sends impulses to the pituitary gland to secrete more ADH
Step 4	ADH travels in the blood to the kidneys
Step 5	ADH increases the permeability of the collecting ducts and the distal convoluted tubules of the kidney
Step 6	More water is re-absorbed and passed to the surrounding blood vessels
Step 7	The water level in the blood returns to normal

When the blood has more water than normal:	
Step 1	Blood has more water than normal
Step 2	The hypothalamus is stimulated
Step 3	and sends impulses to the pituitary gland to stop secreting ADH/to secrete less ADH
Step 4	No ADH/less ADH travels in the blood to the kidneys
Step 5	The collecting ducts and the distal convoluted tubules of the kidney become less permeable to water
Step 6	Less water is re-absorbed and passed to the surrounding blood vessels. More water is now lost
Step 7	The water level in the blood returns to normal

When the salt level in the blood decreases	
Step 1	The salt level in the blood decreases
Step 2	Receptor cells in the afferent and efferent arterioles of the kidney detect the low salt level
Step 3	The adrenal gland is stimulated
Step 4	into secreting more aldosterone
Step 5	Aldosterone increases the re-absorption of sodium ions from the renal tubules in the kidney into the surrounding blood vessels
Step 6	The salt level in the blood vessels increases
Step 7	and returns to normal

When the salt level in the blood increases:	
Step 1	The salt level in the blood increases
Step 2	Receptor cells in the afferent and efferent arterioles of the kidney detect the high salt level
Step 3	The adrenal gland is stimulated
Step 4	to stop secreting aldosterone/to secrete less aldosterone
Step 5	This decreases the re-absorption of sodium ions from the renal tubules in the kidney into the surrounding blood vessels
Step 6	The salt level in the blood vessels decreases
Step 7	and returns to normal

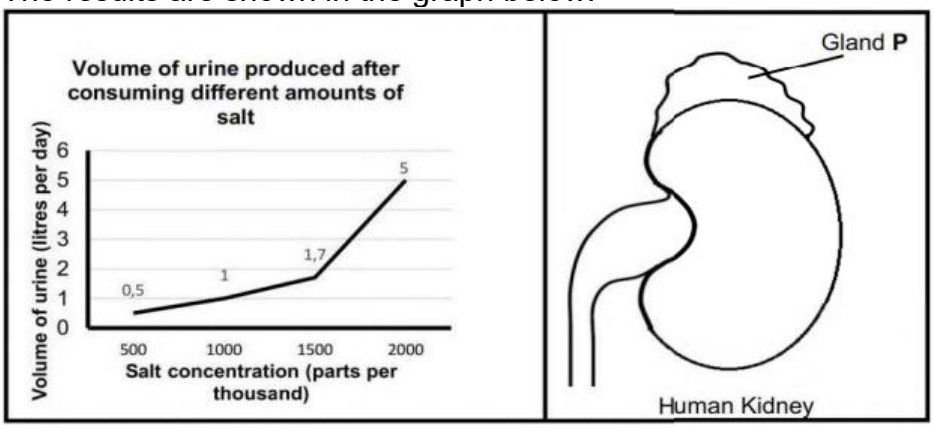
ACTIVITY 3.6(KZN Preparatory Examination 2023)

3.6 The diagram and the graph below relate to the control of salt levels in the body.
An investigation was conducted to determine the relationship between the amount of salt consumed and the volume of urine produced
The graph and diagram below refer to the control of salt concentration in the human body.
The following procedure was followed:

- One man participated in the investigation
- He was given the same volume of salt solution to drink every day for four days
- He drank the solution daily at 7H00
- Each day the amount of salt consumed was increased by adding more salt to the same volume of water

- The volume of urine produced by the participant was measured daily

The results are shown in the graph below.



3.6.1 Identify gland P. (1)

3.6.2 Name the hormone produced by gland P:

a) which controls salt concentration in the blood. (1)

b) that prepares the body for emergency. (1)

3.6.3 Calculate the percentage increase in the volume of urine between 500 and 1000 parts per thousand. (3)

3.6.4 Explain the results of this investigation as represented by the graph (5)

3.6.5 Explain how the results on the graph would be different if gland P had an over secretion of the hormone named in QUESTION 3.6.2 (a). (3)

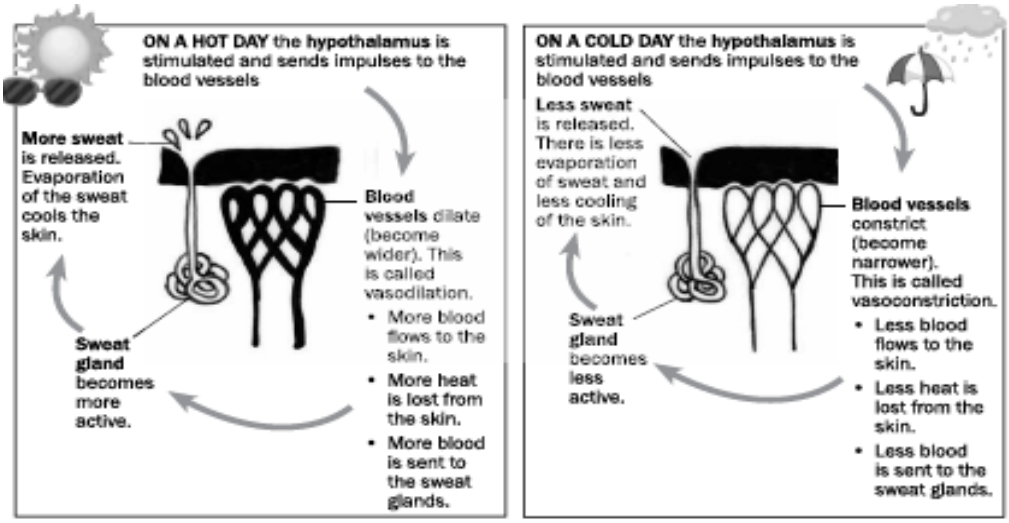
(14)

The process of temperature regulation

Temperature regulation is the control of body temperature to keep it as close to 37C as possible to enable the body to function normally.

Body temperature is regulated by the hypothalamus in the brain and the blood vessels and sweat glands in the skin.

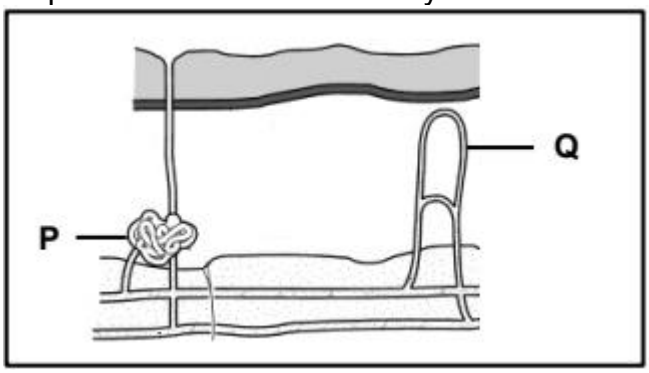
EXAMPLE



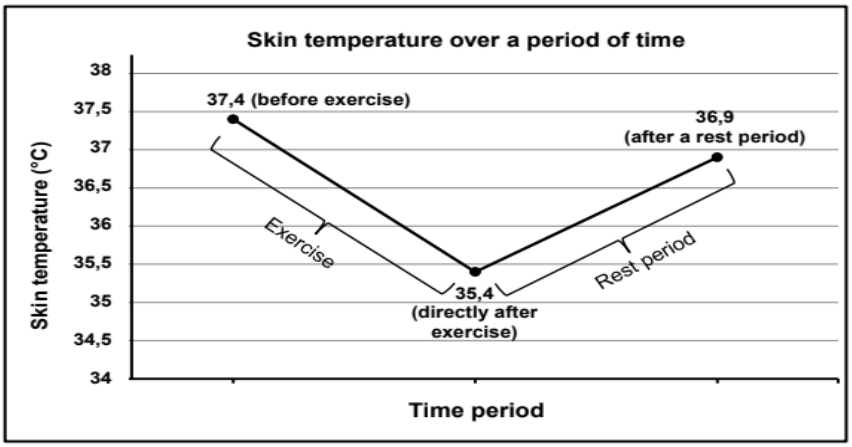
ACTIVITY 3.7 (DBE/November 2023)

3.7 A twelve-year-old boy participated in physical exercise for 45 minutes, followed by a 15-minute rest period. The skin temperature of the boy was measured and the results were recorded.

The diagram below represents the skin of the boy before exercise.



The graph below shows the changes in skin temperature over a period of time.



3.7.1 Name the:

a) Homeostatic mechanism that brings about the change in skin temperature (1)

b) Part of the brain that is responsible for the mechanism named in QUESTION 3.7.1(a) (1)

3.7.2 From the diagram, identify the following parts:

a) P (1)

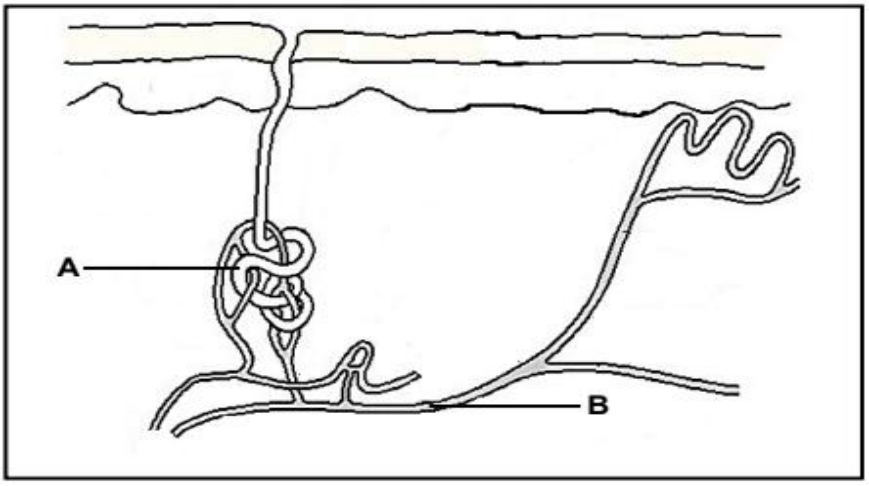
b) Q (1)

3.7.3 Calculate the percentage decrease in the average skin temperature of the boy before and directly after exercise.
Show ALL working. (3)

3.7.4 Explain the roles of part P and Q in the change in skin temperature from before exercise to directly after exercise. (6)
(13)

ACTIVITY 3.8 (DBE/2023)

3.8 The diagram below shows parts of the skin that are involved in thermoregulation**.**

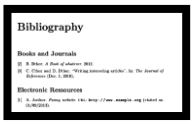


3.8.1 Give TWO reasons why part A is classified as an exocrine gland. (2)

3.8.2 Describe the role of skin receptors in thermoregulation. (2)

3.8.3 Explain why structure B dilates on a hot day. (2)

(6)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- **2014-2020 National Diagnostic Report on learner performance**
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- **Mind the Gap**
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- **Gauteng Grade 12 Life Sciences Exam Kit**
- **Internet**
- **Adapted from Mr S.J Silaule's notes**