TELEMATIC SCHOOLS PROJECT

2023 SUBJECT WORKBOOK
Grade 12

LIFE SCIENCES

A joint initiative between the Western Cape Education Department and Stellenbosch University.

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Education
FOR YOU

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BROADCAST SESSIONS

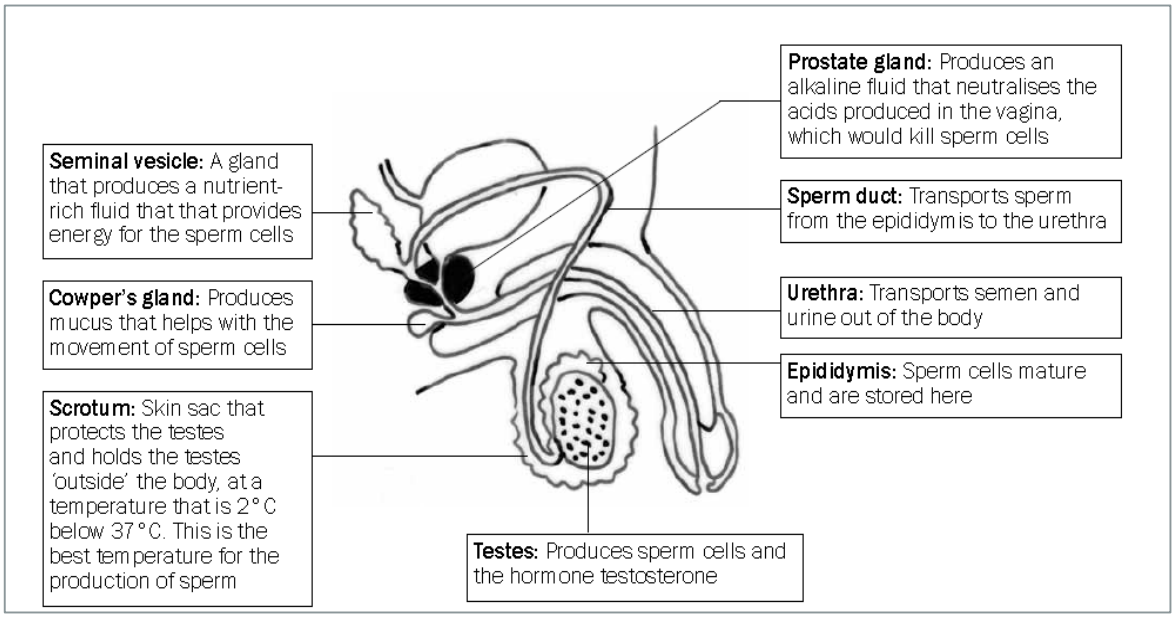
GRADE 12

LIFE SCIENCES

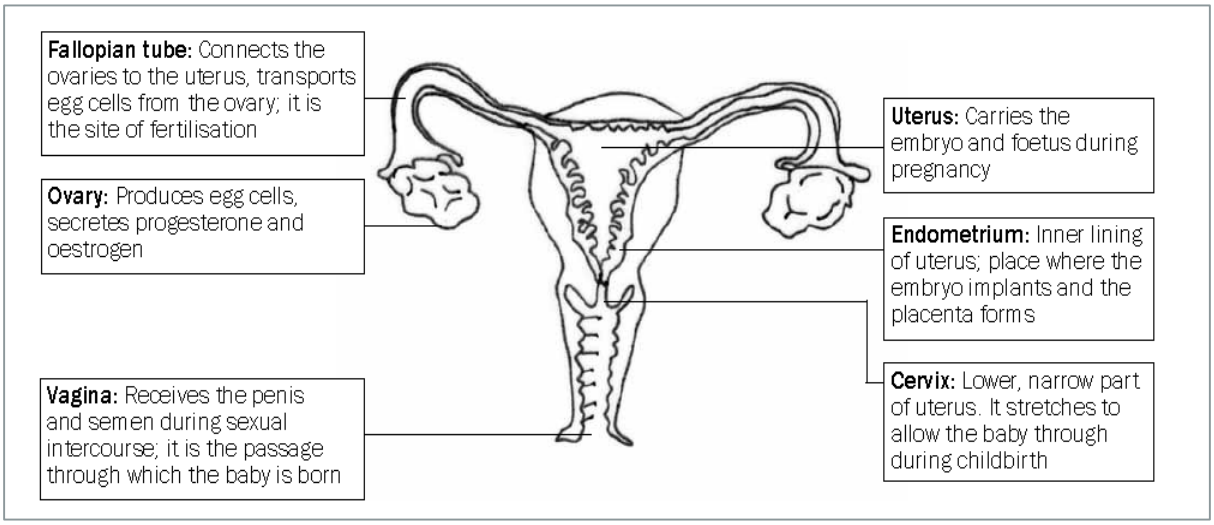
Session	Date	Time	Topic
1	**25/01/2023**	**16h00-17h00**	**Human reproduction**
2	03/05/2023	16h00-17h00	Responding to the environment (humans)
3	**15/05/2023**	**16h00-17h00**	**Endocrine system and homeostasis**

SESSION 1 | HUMAN REPRODUCTION

STRUCTURE OF THE MALE REPRODUCTIVE SYSTEM



STRUCTURE OF THE FEMALE REPRODUCTIVE SYSTEM



PUBERTY

- Puberty is the stage when secondary characteristics develop in males and females.
- You need to know the:

❑ main changes that occur in male characteristics during puberty under the influence of testosterone.

❑ main changes that occur in female characteristics during puberty under the influence of oestrogen.

GAMETOGENESIS

- Gametogenesis is the formation of gametes by meiosis

SPERMATOGENESIS

- Diploid cells in the seminiferous tubules of the testes undergo **meiosis**
- under the influence of the hormone, **testosterone,**
- to form **haploid sperm cells**

OOGENESIS

- Diploid cells in the ovary undergo mitosis to form numerous follicles.
- At the onset of puberty and under the influence of **FSH.**
- One cell inside a follicle enlarges and undergoes **meiosis.**
- Of the four cells that are produced, only one survives to form a **haploid ovum**.
- This occurs in a monthly cycle.

THE MENSTRUAL CYCLE

- The menstrual cycle includes the uterine and ovarian cycles.
- The menstrual cycle is a series of events that occur in the female body to prepare it for possible pregnancy.
- The pituitary gland/hypophysis secretes **FSH** which stimulates the development of a primary follicle into a **Graafian follicle** in the ovary.
- The **Graafian follicle** secretes **oestrogen** which stimulates the thickening of the lining of the uterus/endometrium.
- Around day 13/14 pituitary gland/hypophysis secretes **LH which** cause **ovulation** to occur.
- The remains of the Graafian follicle develop into the **corpus luteum** which secretes the hormone, **progesterone** which continues to stimulate the thickening of the uterus.
- High levels of progesterone inhibit the production of FSH so that the ovaries are no longer stimulated to produce another follicle (**negative feedback mechanism**).
- If fertilisation does not occur, the corpus luteum degenerates and stops producing progesterone.
- The pituitary gland/hypophysis is no longer inhibited in its production of FSH and a new follicle develops.
- The thick endometrium is no longer maintained, and it degenerates and is shed together with blood and menstruation takes place.
- If fertilisation does occur the corpus luteum continuous to function until the 12th week of pregnancy.

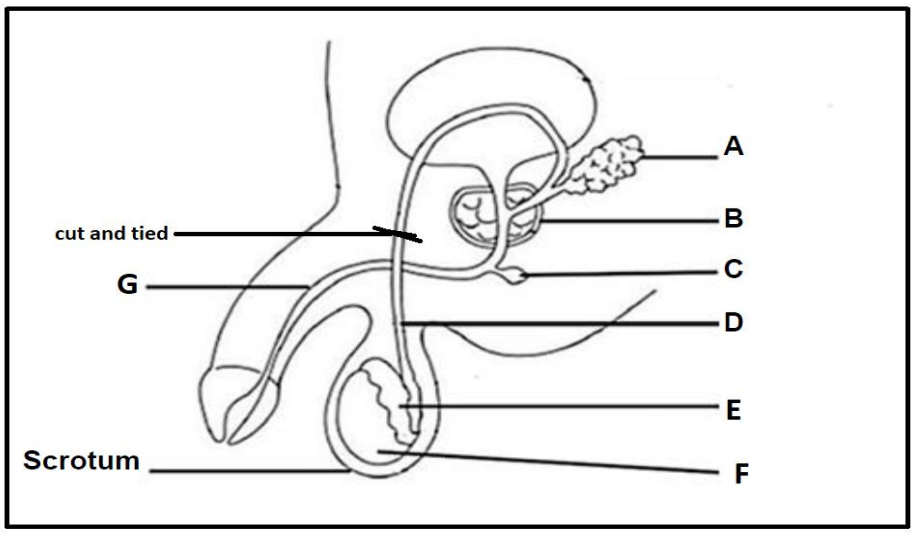
DEVELOPMENT OF THE ZYGOTE UNTIL IMPLANTATION

- The **zygote** divides by mitosis to form a ball of cells called the **morula.**
- The morula further divides to form a hollow ball of cells called the **blastula.**

SESSION 1 | HUMAN REPRODUCTION

QUESTION 1

1.1 The diagram below represents the male human reproductive system.



1.1.1 Give the LETTERS of the structure/s that are involved in each of the following:

(a) Production of the fluid part of semen (1)

(b) Transportation passageway of sperm and semen (1)

(c) Storage and maturation of sperm (1)

1.1.2 Identify:

(a) Gland **B** (1)

(b) The hormone produced by **F**, that brings about the development of male secondary sexual characteristics (1)

1.1.3 During a vasectomy part **D** is cut and tied as shown in the diagram. Semen will still be released during copulation. Explain the composition of the semen after a vasectomy. (3)

1.1.4 In some cases, males are born with part **F** located inside the body because it failed to descend in the scrotum. Explain how this condition may affect male fertility. (3)

ANSWERS

1.1.1 (a) A, B and C✓ (only accept if all three are correct)
(b) D and G✓ (only accept if both are correct)
(c) E✓

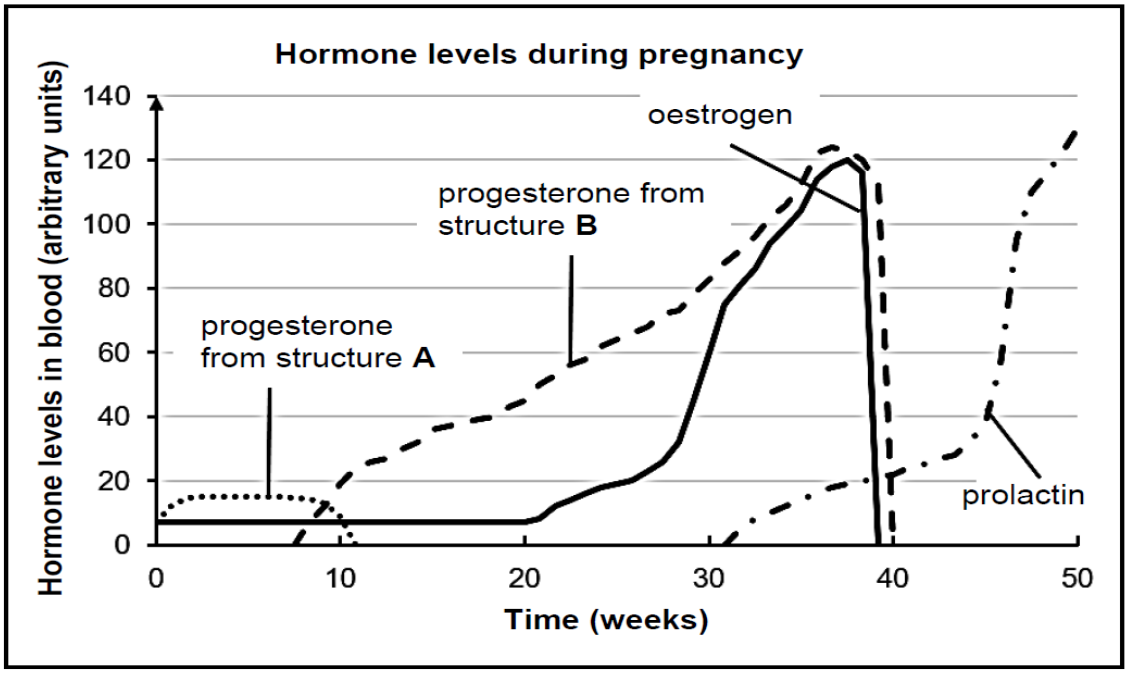
1.1.2 (a) Prostate gland✓
(b) Testosterone✓

1.1.3 The semen will not contain sperm✓ because they are not transported✓ but will contain all other secretions of the accessory glands✓. The vasectomy occurred before✓ the accessory glands.

1.1.4 The temperature of the testes inside the body will be too high✓. No normal sperm will be produced✓. The man will be infertile✓/not able to reproduce.

QUESTION 2

2.1 The graph below shows the hormonal changes in a female's body during pregnancy.



2.1.1 Identify the following structures:
(a) **A** (1)
(b) **B** (1)
2.1.2 Name the gland that produces the hormone prolactin. (1)
2.1.3 Explain the high secretion of prolactin after week 40. (2)
2.1.4 Explain the significance of the levels of oestrogen and progesterone dropping towards the end of pregnancy. (2)
2.1.5 Describe the effect that the drop in progesterone level has on the ovarian cycle. (5)

ANSWERS

2.1.1 (a) Corpus luteum✓

(b) Placenta✓

2.1.2 Pituitary gland ✓/Hypophysis

2.1.3 The foetus was born ✓ after 40 weeks, and milk is the only food source ✓ for the baby/milk must be produced/After birth, prolactin stimulates milk production/lactation to feed the baby.

2.1.4 There is no need to maintain the endometrium any longer ✓ and allows the placenta's removal✓/release

2.1.5 The drop in progesterone level stimulates the pituitary gland ✓ /hypophysis to secrete FSH ✓ The high level of FSH stimulates the development of a primary follicle ✓ into a Graafian follicle ✓ that leads to ovulation ✓

QUESTION 3

3.1 The FSH test is sometimes used to determine the cause of infertility in females. The levels of FSH usually indicate the number of follicles in the ovaries. If the number of follicles are low or depleted, the pituitary gland will secrete more FSH.

An investigation was conducted to compare the average FSH levels in 4 different age groups.

The procedure was done as follows:

- 1 000 females were asked to participate (250 in each of the four age groups).
- The females were all healthy and not using any hormone-based contraceptives.
- Their blood FSH levels were measured on day 3 of the menstrual cycle for 5 cycles.
- The average FSH levels in their blood were calculated per age group.

The results are shown in the table below.

AGE GROUP	AVERAGE FSH LEVELS
20-32	7,0
33-25	7,8
26-40	8,0
41-50	8,5

3.1.1 State TWO factors, regarding the females, that should have been kept constant during the investigation. (2)
3.1.2 State TWO ways in which the reliability of the results was ensured. (2)
3.1.3 State ONE conclusion that can be drawn from the results. (2)
3.1.4 Explain why the oestrogen levels may remain low in the blood of the females in the 41-50 age group. (3)
3.1.5 Explain why females that were using progesterone-based pills were excluded from the investigation. (3)

ANSWERS

3.1.1 Must have regular menstrual cycles✓; They must not become pregnant✓; Diet✓

3.1.2 250 females per group were used✓/1000 females participated

Measurement was done for 5 cycles✓

3.1.3 Older groups of woman have a higher (average) FSH level than the younger groups ✓✓

OR

Younger groups of woman have a lower (average) FSH level than the older groups. ✓✓

3.1.4 The Graafian follicles secretes oestrogen✓ but since the number of follicles are low✓, less/no oestrogen will be secreted. ✓

3.1.5 A high concentration of progesterone✓ inhibits the pituitary gland✓/ results in reduced FSH secretion. This will decrease the validity of the investigation✓

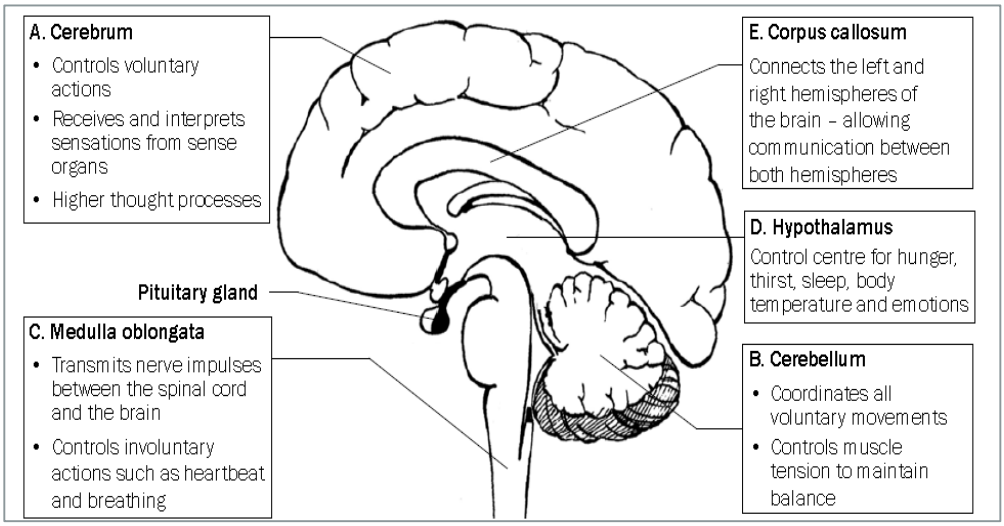
.

The human nervous system is subdivided into two main systems i.e.

- ❑ **Central nervous system** – consisting of the brain and spinal cord
- ❑ **Peripheral nervous system** – consisting of nerves that conduct impulses to and from the brain and spinal cord. It includes 12 pairs of cranial nerves and 31 pairs of spinal nerves.

THE BRAIN

- The brain is enclosed by the skull and the spinal cord by the vertebral column
- Both the brain and spinal cord are enclosed by the **meninges.**

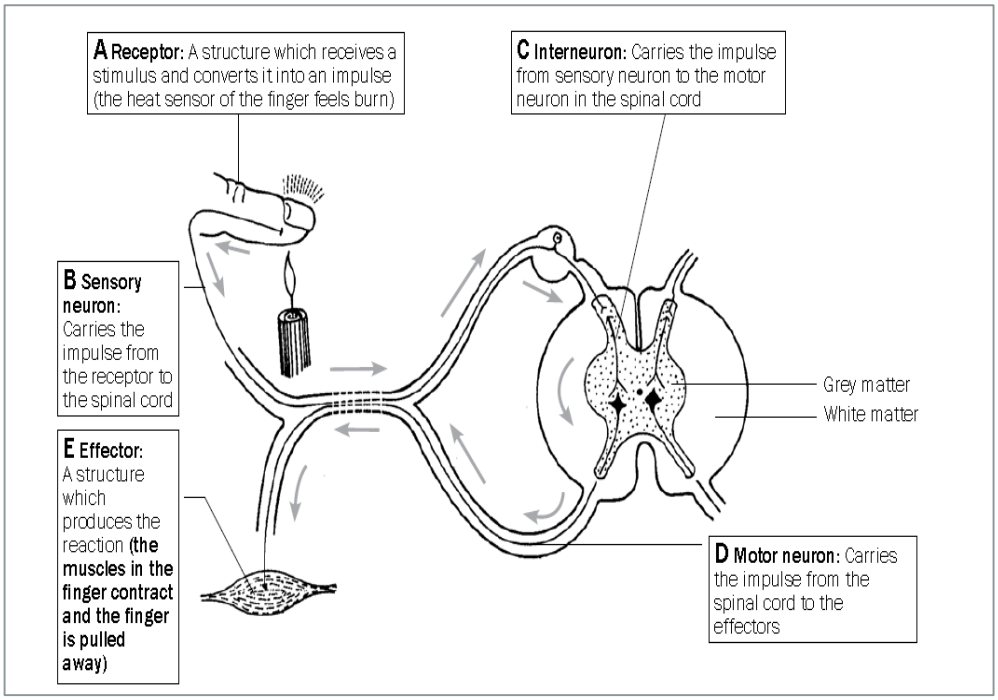


THE SPINAL CORD

The spinal cord consists of:

- ❑ a central canal that is filled with cerebrospinal fluid
- ❑ grey matter and white matter.

THE SIMPLE REFLEX ARC



SESSION 2 | RESPONDING TO THE ENVIRONMENT (HUMANS)

THE HUMAN EYE

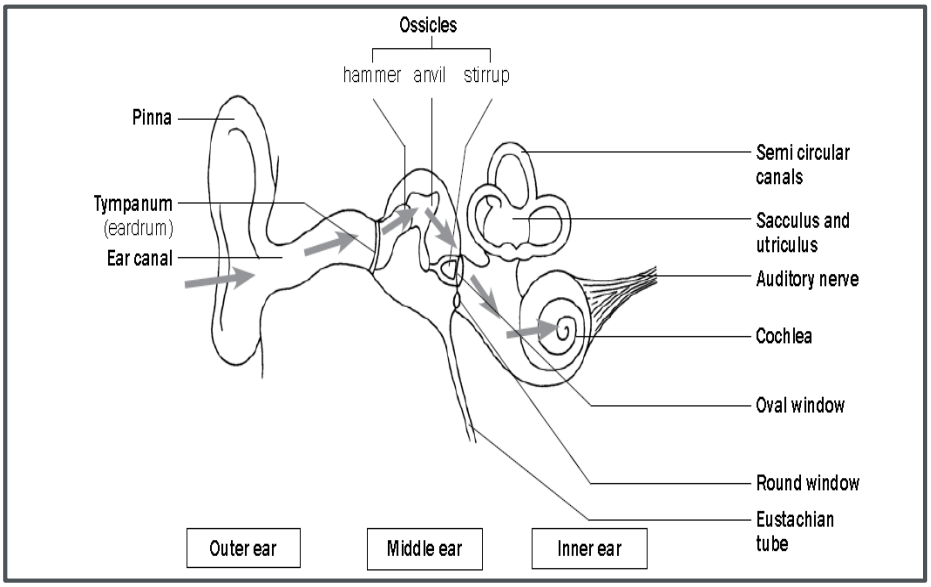
ACCOMMODATION

DISTANT VISION (OBJECTS FURTHER THAN 6M)	NEAR VISION (OBJECTS CLOSER THAN 6M)
Ciliary muscles relax	Ciliary muscles contract
Ciliary body moves further away from the lens	Ciliary body moves closer to the lens
Suspensory ligaments tighten (becomes taut)	Suspensory ligaments slacken
Tension on lens increases	Tension on lens decreases
Lens is less convex	Lens becomes more convex
Light rays are refracted less	Light rays are refracted more
Light rays are focused on the retina and image falls on the retina	Light rays are focused on the retina and image falls on the retina

PUPILARY MECHANISM

IN BRIGHT LIGHT	IN DIM LIGHT
Radial muscles of the iris relax	Radial muscles of the iris contract
Circular muscles of the iris contract	Circular muscles of the iris relax
Pupil constricts (becomes smaller)	Pupil dilates (enlarges)
Less light enters the eye	More light enters the eye

THE HUMAN EAR



SESSION 2 | RESPONDING TO THE ENVIRONMENT (HUMANS)

HEARING

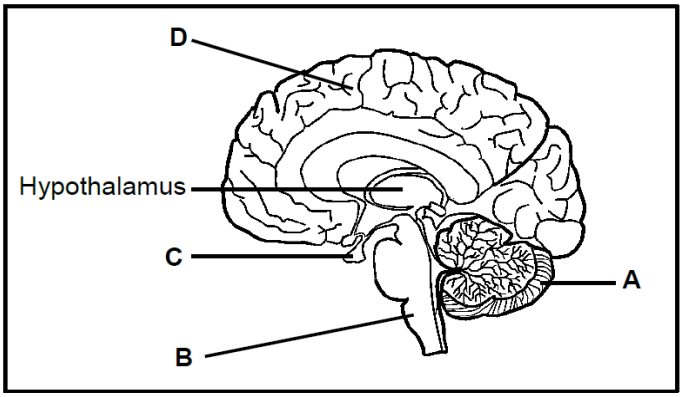
- The pinna traps and directs the sound waves into the external auditory canal/ear canal/meatus.
- This causes the tympanic membrane to **vibrate.**
- The **vibrations** are transmitted to the auditory ossicles.
- The ossicles amplify the vibrations and transmit it to the oval window.
- The oval window vibrates creating **pressure waves** in the fluid/endolymph of the cochlea.
- This stimulates the organ of Corti to convert the wave into an **impulse.**
- The impulse travels along the auditory nerve to the **cerebrum** where it is interpreted.

BALANCE

- The **maculae** in the **utriculus and sacculus** are stimulated by **changes in the position of the head.**
- The **cristae** in the **semi-circular canals** are stimulated by **changes in the direction and speed of movement**.
- When stimulated, the cristae and maculae convert the **stimuli** into nerve **impulses.**
- The nerve impulses are transmitted through the **auditory nerve** to the **cerebellum** where they are interpreted.
- The cerebellum then sends impulses via the motor neurons to the **skeletal muscles** to restore balance.

QUESTION 1

1.1 The diagram below shows part of the human brain.



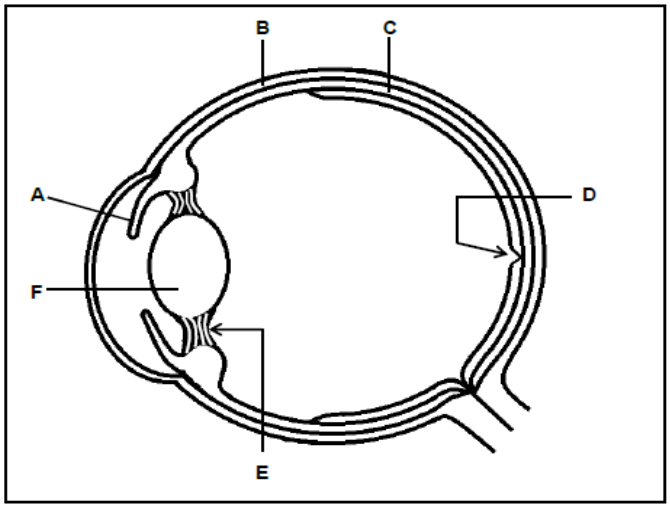
1.1.1 Identify part **A**. (1)
1.1.2 State TWO functions of part **D**. (2)
1.1.3 State ONE way in which the brain is protected. (1)

ANSWERS

1.1.1 Cerebellum ✓
1.1.2 Higher thought processes ✓; interpretation of all senses ✓; controls all voluntary actions ✓
1.1.3 Meninges ✓; cranium ✓

QUESTION 2

2.1 The diagram below represents the structure of the human eye.



2.1.1 Identify part **C**. (1)
2.1.2 Give ONE function of part **E**. (1)
2.1.3 State why the clearest image will form when light rays fall on part **D**. (1)
2.1.4 Explain ONE way in which part **B** is structurally different from part **F**. (4)
2.1.5 Describe how the muscles in part **A** function to increase the amount of light entering the eye. (3)
2.1.6 Describe how a blurred image forms if a person with normal vision wears spectacles with biconvex lenses while reading a book. (3)

ANSWERS

2.1.1 Choroid✓

2.1.2 - Holds the lens in position✓
- Connects the lens to the ciliary body✓
- Plays a role in accommodation✓

2.1.3 - (D/the yellow spot) has the highest concentration of cones✓

2.1.4 - Part B/sclera is opaque✓✓/does not allow light to pass through/ white
- part F/lens is transparent✓✓/allows light to pass into the eye

OR

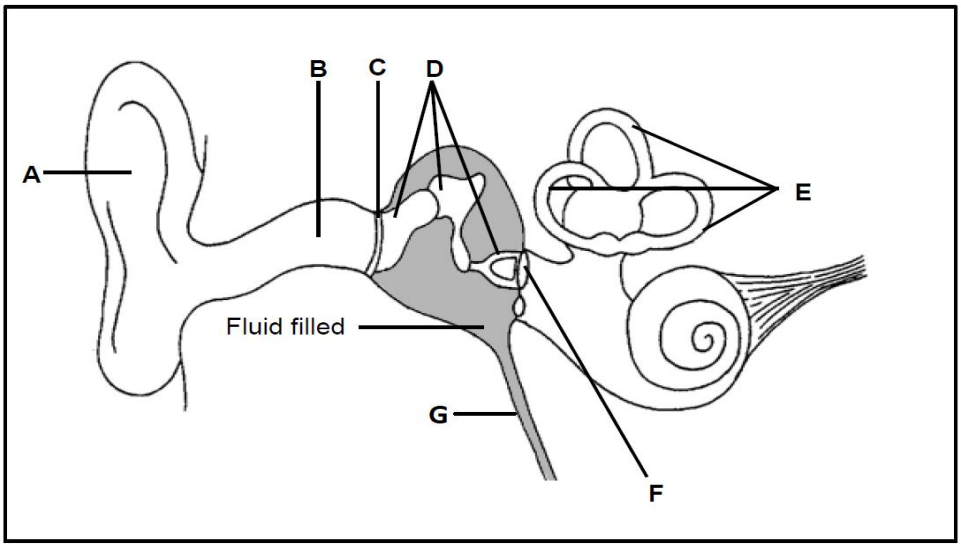
- Part B/sclera is non-elastic✓✓/maintains the shape of the eye
- part F/lens is elastic✓✓/able to change its shape

2.1.5 - The circular muscles relax✓
- The radial muscles contract✓
- causing the pupil to dilate✓

2.1.6 - The lenses in the spectacles will refract the light rays✓
- The lens of the eye also refracts✓ the light rays
- The light rays will therefore be focused in front of the retina✓

QUESTION 3

3.1 The diagram below represents part of the human ear with a middle-ear infection.



3.1.1 Identify part:
- (a) **B** (1)
- (b) **C** (1)
- (c) **D** (1)
- (d) **F** (1)

3.1.2 State ONE function of part **A**. (1)

3.1.3 Explain how middle-ear infection could affect hearing. (4)

3.1.4 Describe the role of part **G.** (2)

3.1.5 Describe how part **E** is involved in maintaining the balance when there is a change in the speed and direction of movement of the head. (4)

ANSWERS

3.1.1 **B** – auditory canal✓; **C** – tympanic membrane✓; **D** – ossicles✓; **F** – oval window✓

3.1.2 Collects sound waves✓/directs sound waves towards the auditory canal

3.1.3 Part D/ossicles do not vibrate freely✓
Fewer/no vibrations will be sent to the oval window✓
Fewer/no pressure waves will be set up in the cochlea✓
The organ of Corti will be stimulated less✓
The cerebrum is stimulated differently✓/not stimulated which leads to hearing loss✓

3.1.4 It equalizes pressure ✓on either side of the tympanic membrane✓

3.1.5 The cristae are stimulated ✓to convert the stimuli to impulses✓
The impulses are sent to the cerebellum✓ where they are interpreted✓
The cerebellum sends impulses to the skeletal muscle✓ to maintain balance.

- **Endocrine glands:** ductless glands that release their secretions (hormones) directly into the bloodstream.
- **Exocrine glands** – glands that release their secretions through ducts to a body cavity or to the outside e.g. salivary glands that secrete saliva through ducts that open in the mouth cavity.
- **Hormones** are organic compounds and chemical messengers.
- Most **hormone**s are proteins.
- **Hormones** are secreted by endocrine glands in small quantities directly into the bloodstream.

You should know the **location** of each of the following **glands**, using a diagram, the **hormones** they secrete and **function(s**) of each hormone:

- ❑ Hypothalamus (ADH)
- ❑ Pituitary/Hypophysis (GH, TSH, FSH, LH, prolactin)
- ❑ Thyroid glands (thyroxin)
- ❑ Islets of Langerhans in the pancreas (insulin, glucagon)
- ❑ Adrenal glands (adrenalin, aldosterone)
- ❑ Ovary (oestrogen, progesterone)
- ❑ Testis (testosterone)

HOMEOSTASIS

- **Homeostasis** as the process of maintaining a constant, internal environment within narrow limits, despite changes that take place internally and externally.
- Factors such as carbon dioxide, glucose, salt, water concentration, temperature and pH must be kept constant in the internal environment (tissue fluid).

NEGATIVE FEEDBACK MECHANISMS

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

Negative feedback mechanism involving TSH and thyroxin

When thyroxin levels in the blood increase above normal	When thyroxin level increase below normal
• Hypophysis is stimulated • Hypophysis produces less TSH • Low TSH level stimulates the thyroid gland • The thyroid gland secretes less thyroxin • The thyroxin level decreases and returns to normal	• Hypophysis is stimulated • Hypophysis produces more TSH • High TSH level stimulates the thyroid gland • The thyroid gland secretes more thyroxin • The thyroxin level increases and returns to normal

Negative feedback mechanism involving insulin and glucagon

When glucose level in the blood increases above normal levels	When glucose level in the blood decreases below normal levels
• The islets of Langerhans in the pancreas are stimulated • and secrete insulin into the blood • Insulin is transported to the liver • where it stimulates the conversion of excess glucose into glycogen which is then stored • The glucose level in the blood decreases and returns to normal	• The islets of Langerhans in the pancreas are stimulated • and secrete glucagon into the blood • Glucagon is transported to the liver • where it stimulates the conversion of stored glycogen into glucose • The glucose level in the blood increases and returns to normal

Negative feedback mechanism controlling the concentration of carbon dioxide (CO_2)

- When the carbon dioxide concentration in the blood increases above normal levels e.g. after or during an exercise.
- Chemoreceptors in the wall of the aorta and in the carotid arteries are stimulated.
- The chemoreceptors send nerve impulses to the respiratory and cardiovascular centres in the medulla oblongata of the brain.
- The medulla oblongata sends nerve impulses to the diaphragm and intercostal muscles.
- These muscles contract more actively, and this increases the rate and depth of breathing and more carbon dioxide -rich air is exhaled.
- The cardiovascular centre sends impulses to the heart and the heart beats faster.
- Carbon dioxide is transported faster to the lungs and exhaled.
- The carbon dioxide concentration in the blood returns to normal.

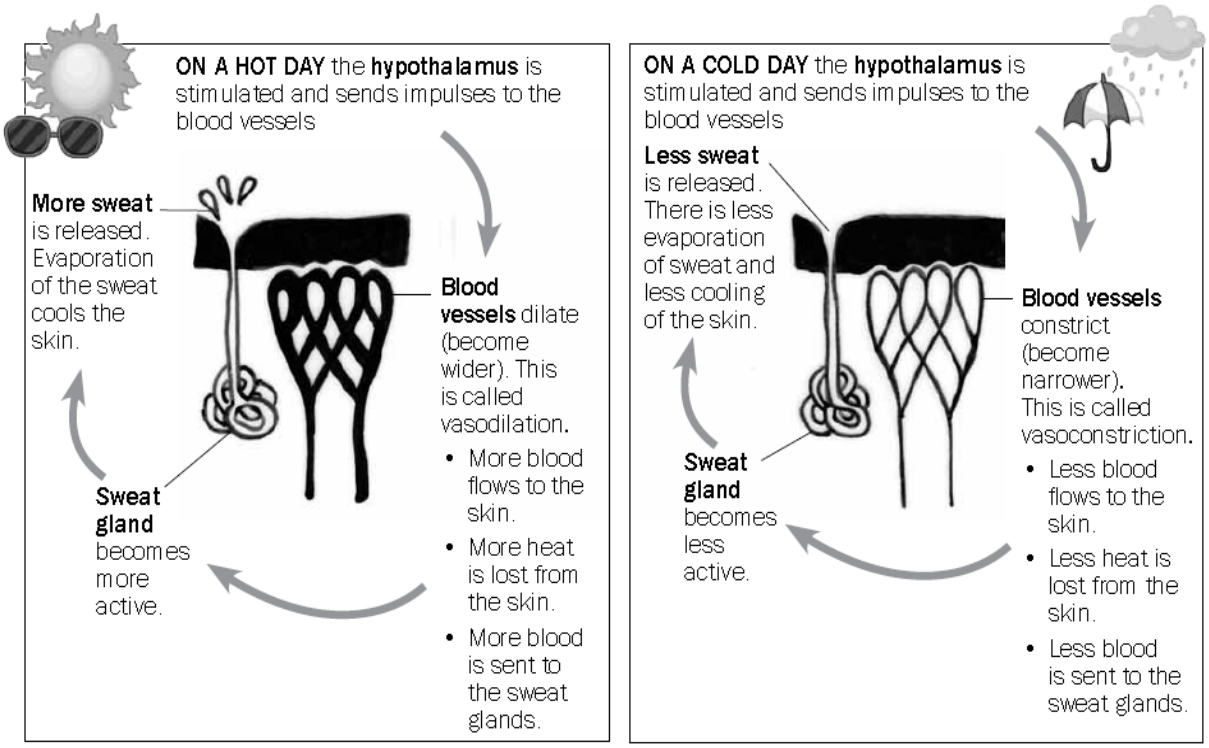
Negative feedback mechanism controlling the concentration of water

When the blood has more water than normal	When the blood has less water than normal
• The hypothalamus is stimulated • and sends impulses to the hypophysis to secrete less or stop secreting the hormone ADH • Less ADH/no ADH is transported in the blood to the kidneys • The collecting ducts and distal convoluted tubules of the kidney become less permeable to water • Less water is re-absorbed and passed to the surrounding blood vessels • More water is excreted in the urine and the water level in the blood returns to normal	• The hypothalamus is stimulated • and sends impulses to the hypophysis to secrete more of the hormone ADH • ADH is transported in the blood to the kidneys • The collecting ducts and distal convoluted tubules of the kidney become more permeable to water • More water is re-absorbed and passed to the surrounding blood vessels • Less water is excreted in the urine and the water level in the blood returns to normal

Negative feedback mechanism controlling the concentration of salts

When the salt level in the blood increases	When the salt level in the blood decreases
• Receptor cells in the afferent and efferent arterioles of the kidney detects the high salt/sodium ion level • The adrenal gland is stimulated • to stop secreting aldosterone/to secrete less aldosterone • The re-absorption of sodium ions from the renal tubules in the kidney into the blood vessels decreases • The sodium ion concentration in the blood decreases and returns to normal	• Receptor cells in the afferent and efferent arterioles of the kidney detects the low salt/sodium ion level • The adrenal gland is stimulated • to secrete more aldosterone • The re-absorption of sodium ions from the renal tubules in the kidney into the blood vessels increases • The sodium ion concentration in the blood increases and returns to normal

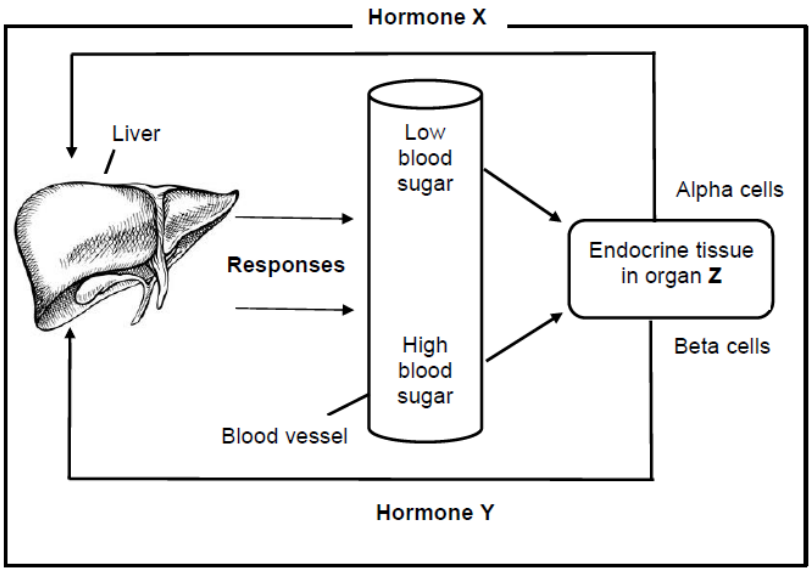
Negative feedback mechanism for controlling temperature/thermoregulation



SESSION 3 | ENDOCRINE SYSTEM AND HOMEOSTASIS

QUESTION 1

1.1 The diagram below represents the homeostasis of blood glucose in the human body.



1.1.1 Identify hormone **Y.** (1)

1.1.2 Name:

(a) Organ **Z** (1)

(b) The endocrine tissue in organ **Z**. (1)

1.1.3 Describe the response that is carried out when a person has not eaten any sugar-containing food for six hours. (6)

ANSWERS

1.1.1 Insulin

1.1.2 (a) Pancreas ✓

(b) Islets of Langerhans ✓

1.1.3 - Negative feedback reaction ✓
- The glucose concentration in the blood drops below normal ✓
- The islets of Langerhans/pancreas detect the drop and secretes glucagon ✓in the blood which is transported to the liver ✓ /muscle cells
- Glucagon stimulates the conversion of glycogen to glucose ✓
- The glucose concentration in the blood returns to normal ✓

QUESTION 2

2.1 Researchers at the University of Cape Town used the novel Infrared Thermal Technology (ITT), a technique with high sensitivity and digital accuracy, to measure the heat released by the human skin under different environmental temperature conditions. The results are shown in the table below.

Temperature (°C)	Average heat released (µJoule/cm^2/min)
16	30
20	50
24	70
28	110
32	160
36	200
40	200
44	200

2.1.1 Give the TERM used to describe the homeostatic control of body temperature. (1)

2.1.2 Describe how the blood vessels of the skin increased the average heat released when the environmental temperature increased from 16 °C to 36 °C. (3)

2.1.3 Explain why sweating plays a more important role in maintaining body temperature, when the environmental temperature increases from 36 °C to 44 °C. (4)

ANSWERS

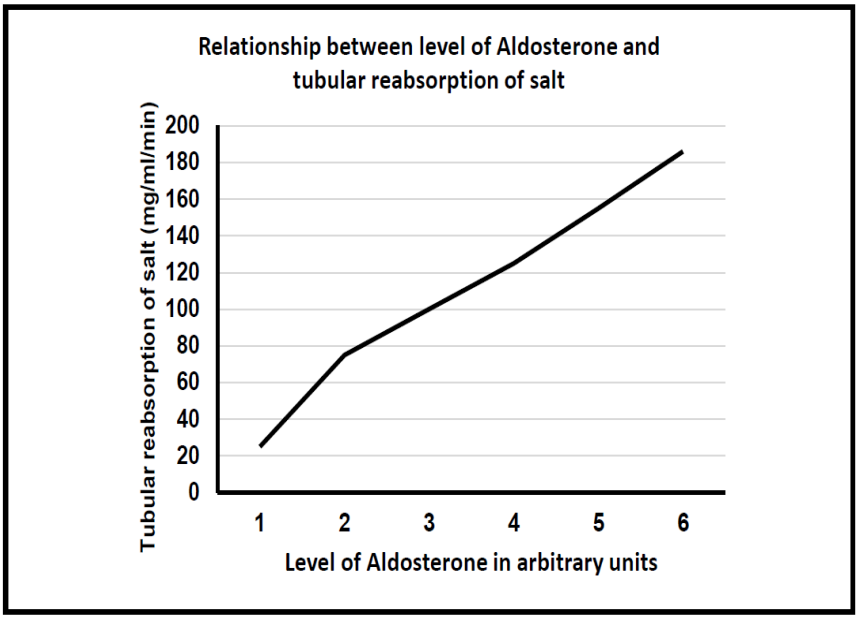
2.1.1 Thermoregulation ✓

2.1.2 – **As the environmental temperature increases**
– the hypothalamus is stimulated ✓
– and sends impulses to the blood vessels ✓ of the skin
– Blood vessels dilate ✓ /blood vessels become wider/vasodilation occurs
– More blood flows to the surface of the skin ✓
– More heat radiates from the skin ✓

2.1.3 – As the environmental temperature increases above/beyond body temperature ✓
– the average heat released/lost through radiation reaches its maximum ✓
– therefore, increased sweating will occur ✓ /sweat glands become more active
– As the sweat is evaporated ✓
– it allows the body temperature to decrease ✓ /more cooling of the skin will occur.

QUESTION 3

3.1 The graph below shows the relationship between the levels of aldosterone in the blood and tubular reabsorption of salt in the kidney.



3.1.1 Name the gland that produces aldosterone. (1)
3.1.2 What was the rate of tubular reabsorption when the level of aldosterone was 6 arbitrary units? (1)
3.1.3 Explain why the trend in the graph indicates that the person had a very low salt content in the blood. (3)
3.1.4 Calculate the percentage increase in reabsorption between 2 and 5 arbitrary units of aldosterone. (3)

ANSWERS

3.1.1 Adrenal gland✓
3.1.2 185 mg/ml/min✓
3.1.3 - Aldosterone is responsible for lowering salt content✓
- as the levels of aldosterone increases✓
- the tubular reabsorption of salt will increase✓

3.1.4 (150 – 75) ÷ 75 ✓
= 75/75 × 100✓
= 100✓%

LINKS TO ONLINE RESOURCES

TOPIC	LINK AND QR CODE
Responding to the environment (humans)	https://bit.ly/3VAuV7a
Human reproduction	https://bit.ly/3MDYqB1
The eye, the ear and homeostasis	https://bit.ly/3yNeVVA