Life Sciences
Part 1

CLASS TEXT & STUDY GUIDE

Liesl Sterrenberg, Helena Fouché, Grace Elliott & Mariechen Vermeulen

GRADE
12
CAPS

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THE ANSWER SERIES *Your Key to Exam Success*

Grade 12 Life Sciences 3-in-1 Part 1 CAPS

CLASS TEXT & STUDY GUIDE

This book is PART 1 of a SET of 2 Life Sciences study guides comprehensively covering the Grade 12 CAPS curriculum.

It contains the 1 Knowledge Area examined in Paper 1 (National final exam):

- Life Processes in Plants and Animals

Key Features:

- Comprehensive, accessible notes per module
- Carefully selected, graded questions and answers per module
- 'Rapid-fire' questions for key concepts and terms
- Clear, explanatory diagrams
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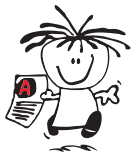
As you work methodically through this study guide, you will become increasingly prepared to achieve excellent results in your exams.



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Part 1

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WHAT IS LIFE SCIENCES?

Life Sciences is the scientific study of living things from molecular level to their interaction with one another and the environment.

- Living systems exhibit levels of organisation from molecules to biomes.
- Life on earth is dynamic, with homeostasis maintaining balance at every level of organisation.
- Life is characterised by changes over time.

AIMS IN LIFE SCIENCES

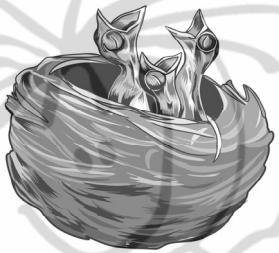
Specific Aim 1: Knowing Life Sciences

(concepts, processes, phenomena, mechanisms, principles, theories, laws, models, etc.)

Specific Aim 2: Investigating phenomena in Life Sciences

Specific Aim 3: Appreciating and Understanding the History, Importance and Applications of Life Sciences in Society.

Comparison between precocial development and altricial development

Precocial development	Altricial development
Large eggs with about 35% yolk	Smaller eggs with about 20% yolk
Young are born with eyes open	Young are born with eyes closed
Young are born with down/fur	Young are born without down/fur
Young become independent early and care for themselves	Young are dependent on their parents for longer
Most of the energy is spent on prenatal development – less parental care	Most of the energy is spent on postnatal care – more parental care
Example  **Mare and her precocial foal**	**Example**  **Altricial owl chicks with eyes still closed and no down feathers**

PARENTAL CARE

- Parental care is any behavioural pattern where parents spend time and/or energy on the feeding and protection of their offspring.
- In animals where most of the energy input of parents is prenatal, there is usually very little or no postnatal parental care.
- In animals where prenatal energy input is less, postnatal parental care is intensive, requiring much more energy.

NOTE

In animals where good parental care occurs, fewer young are usually produced, because their chance of survival is much better.

- **Examples of parental care include:**
  - guarding of eggs
  - incubation of eggs
  - keeping the young warm
  - feeding the young
  - protection from predators

NOTE

Different groups of animals display varying degrees of parental care.

Fish

- Most fish display little or no parental care.
- After fertilisation the eggs are abandoned and the young have to survive on their own.

Amphibians

- Amphibians show little parental care.
- Parental care involves only the guarding and protection of the eggs.

Reptiles

- Most reptiles display no parental care.
- Reptiles are terrestrial animals and lay eggs that are hatched by the heat of the sun.

- Crocodiles, however, guard their eggs and protect their young after hatching. Some lizards and snakes also guard their eggs.

Birds

- Birds display a great degree of parental care.
- The parents build nests in which the eggs are laid and incubated. The nest helps to protect the eggs against predators.
- The eggs are incubated through the body heat of the parents. In most bird species, it is the female who incubates the eggs.

MENSTRUAL CYCLE AND HORMONAL CONTROL

NOTE

*The menstrual cycle of the female consists of the **ovarian cycle** (see below) and **uterine cycle** (see p. 20) and progresses over a period of about 28 days.*

OVARIAN CYCLE

- There are cyclical changes in the ovary, known as the ovarian cycle. It is divided into the follicular phase (development of the follicle), **ovulation** (release of the ovum) and the luteal phase (development of the corpus luteum).
  - Development of the primary follicles into mature **Graafian follicles** (day 1 – 14)
  - Rupturing of the follicle and release of the immature ovum in **ovulation** (day 14)
  - Formation of the **corpus luteum** (from day 15)

NOTE

See the section through the ovary on p. 20, oogenesis on p. 17 and the summary diagram on p. 22.

- In the ovaries of a **foetus**:
  - The **germinal epithelial cells** (2n) that form the outer layer of the ovary divide by mitosis and form **oogonia** (2n) (singular: oogonium).
  - Each **oogonium** (2n) is surrounded by a granular layer made up of a layer of cells from the germinal epithelium. The oogonium together with its granular layer is known as the **primary follicle**.
  - Inside the primary follicles, the oogonia **grow** into **primary oocytes** (2n).
- At **birth**:
  - There are between 700 000 to 2 million **primary oocytes** (2n) in the primary follicles in a baby girl's ovaries.
  - The **primary oocytes** (2n) remain in a resting phase until puberty.

NOTE

Most of the primary oocytes degenerate during childhood. Approximately 400 000 are present in the ovaries of a girl at puberty.

- At **puberty**:
  - At 10 – 12 years of age, the **hypophysis** starts to secrete the hormone **FSH** (follicle stimulating hormone), which stimulates development of primary follicles into Graafian follicles.
  - Only one follicle develops to full maturity in every cycle. The others degenerate. This mature follicle is known as a **Graafian follicle**.
  - The developing follicles secrete increasing amounts of **oestrogen**, the hormone responsible for the secondary female sexual characteristics as well as the development of the endometrium (lining of the uterus) for the implantation of the embryo.
  - The **primary oocyte** (2n) divides by **meiosis I** into two cells: a larger cell, the **secondary oocyte** (n) and a smaller cell, the **polar body** (n).
  - The mature Graafian follicle moves to the surface of the ovary where it forms a slight protuberance. The follicle increases in size as the production of follicle fluid increases and eventually the wall of the ovary ruptures to release an ovum into the Fallopian tube.

NOTE

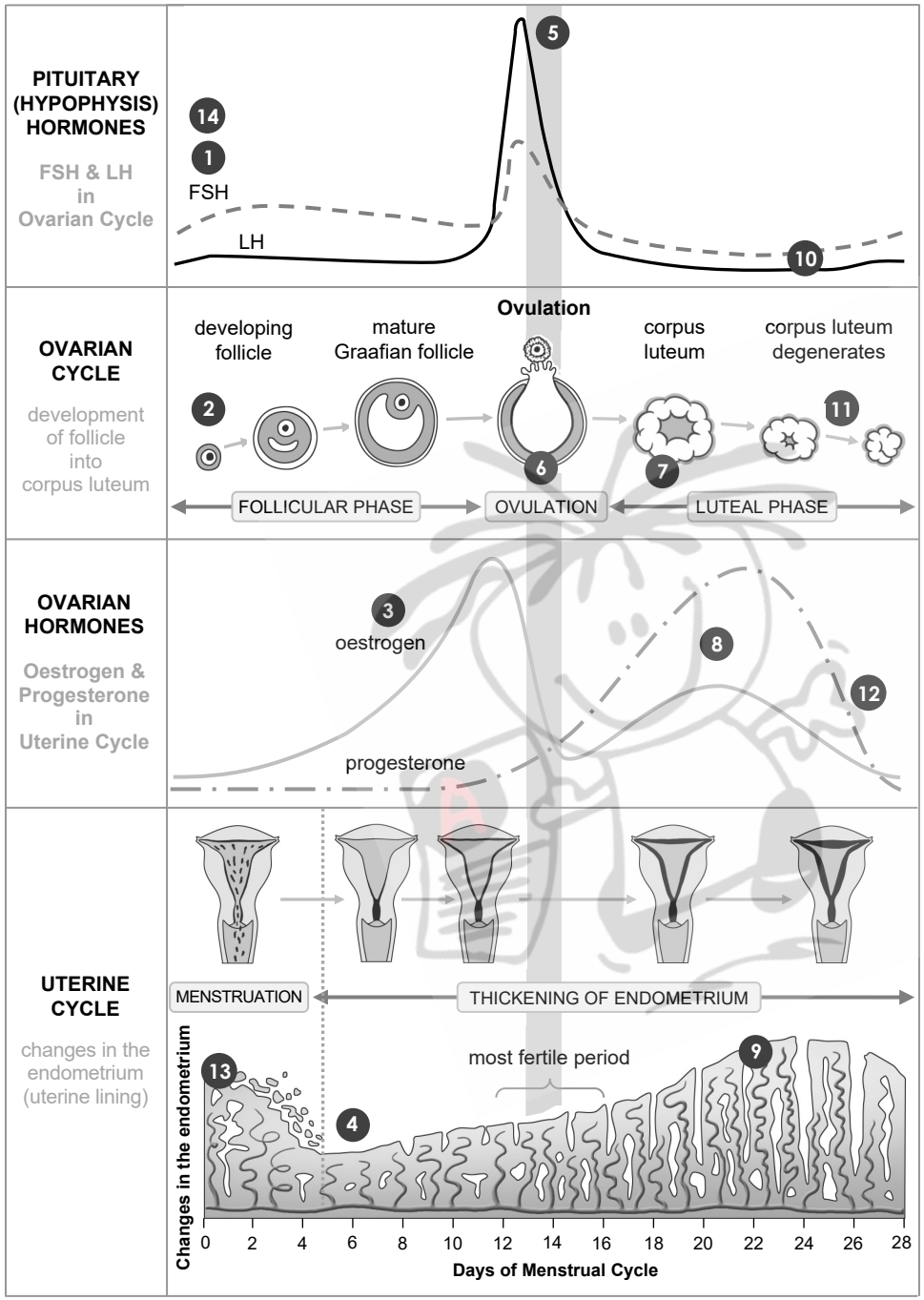
*The remnants of the Graafian follicle will become the **corpus luteum**.*

Graafian follicle before ovulation **Graafian follicle after ovulation**

- This release of an ovum ± every 28 days, is known as **ovulation**.

NOTE

The immature ovum released in ovulation is actually a secondary oocyte until meiosis II occurs in fertilisation later.



Hormonal regulation of the ovarian and uterine cycles

1. The hypophysis secretes the hormone **FSH**.
2. **FSH** stimulates the development of primary follicles in the ovary into mature Graafian follicles.
3. Developing follicles secrete increasing amounts of the hormone **oestrogen**.
4. **Oestrogen** stimulates the development of a thickened endometrium, making it more glandular and vascular (more blood capillaries) in preparation for implantation of a fertilised ovum.
5. High levels of **oestrogen** around day 14 stimulate the hypophysis to secrete more **LH** and **FSH** which causes a peak in each hormone.
6. High levels of **LH** stimulate the process of ovulation which normally occurs around day 14. During ovulation, the Graafian follicle ruptures to release the ovum into the Fallopian tube.
7. High levels of **LH** will transform the remnants of the Graafian follicle into a corpus luteum.

NOTE

*Note the peaks in the graphs: **oestrogen** peaks just before ovulation, followed by **FSH** and **LH** peaks to stimulate ovulation.*

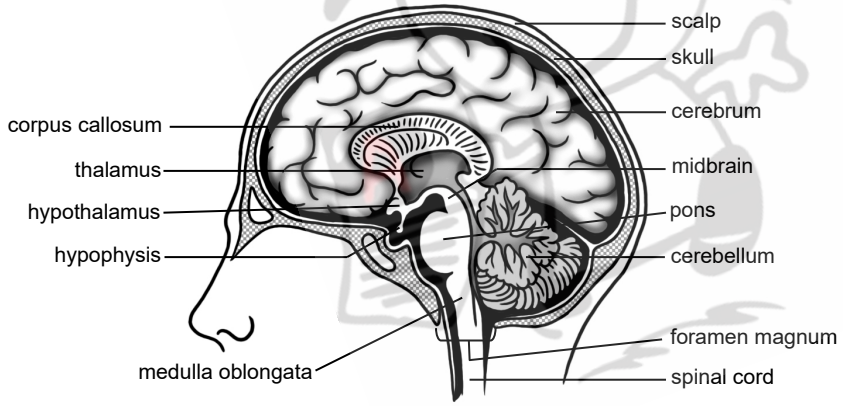
8. The corpus luteum releases large amounts of **progesterone** and small amounts of **oestrogen**.
9. **Progesterone** and **oestrogen** both play a role in the thickening of the endometrium during the second half of the cycle making the endometrium even more glandular and vascular.
10. High levels of **progesterone** and **oestrogen** exert a negative feedback on the pituitary gland and inhibit the release of **FSH** to prevent the development of new follicles and **LH** to prevent ovulation.
11. If fertilisation does not occur, the corpus luteum starts degenerating from day 24 of the cycle.
12. The shrinking corpus luteum secretes less hormones which leads to a drop in the levels of **progesterone** and **oestrogen**.
13. Decreasing levels of **progesterone** and **oestrogen** cannot maintain the endometrium and it is shed, with blood, during menstruation.
14. The drop in progesterone levels eliminates the negative feedback mechanism on the pituitary gland which leads to an increase in the levels of **FSH**. Increasing levels of FSH stimulate the development of a new follicle in the ovary and the entire cycle starts over again.

Brain

- The brain is the enlarged upper part of the central nervous system (CNS) and is divided into the following main parts:
  - **cerebrum**
  - **cerebellum**
  - midbrain
  - thalamus
  - **hypophysis/pituitary gland**
  - **corpus callosum**
  - **medulla oblongata**
  - pons
  - **hypothalamus**

NOTE

*You are only required to know the location and functions of the **cerebrum**, **corpus callosum**, **cerebellum** and **medulla oblongata** in this section. These are discussed in more detail on the following pages. The **hypothalamus** and **hypophysis/pituitary gland** form part of Human Reproduction (Unit 2), Endocrine System (Unit 4) and Homeostasis (Unit 5).*



Longitudinal section of the brain

NOTE

*The **medulla oblongata** is located just above the base of the brain (above the foramen magnum).*

*The **spinal cord** is located below the foramen magnum in the vertebral column.*

REMEMBER

*The opening at the base of the skull through which the spinal cord exits the brain is called the **foramen magnum**.*

Cerebrum

- The cerebrum forms the largest part of the brain.
- The outer layer, consisting of grey matter, is known as the **cerebral cortex**. It has folds (gyri) and grooves (sulci) that enlarge the brain surface.
- White matter occurs on the inside.
- A deep longitudinal fissure (groove) divides the cerebrum into two halves, the left and right **cerebral hemispheres**.
- Each hemisphere is divided into lobes which are associated with various functions of the cerebrum.
- The four lobes are: frontal, temporal, parietal and occipital.
- The two hemispheres are partially connected to each other by a layer of white matter, the **corpus callosum**.

NOTE

The left hemisphere is associated with language and logic while the right hemisphere is linked to creativity and visual processing.

Functions of the cerebrum

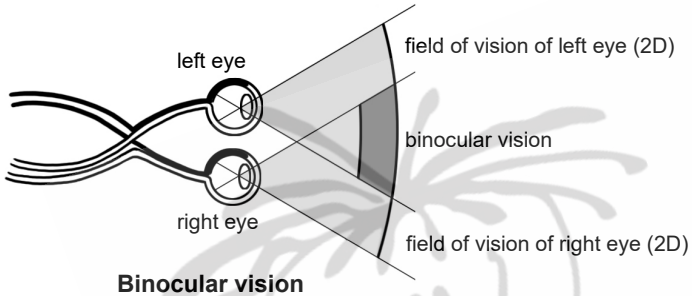
1. Origin of all **voluntary actions**, e.g. walking, jumping, speech.
2. Receives and **interprets nerve impulses from the sense organs** where the **sensations** of sight, sound, smell, taste and touch arise.
3. Seat of **higher mental functions** such as memory, intelligence, imagination, emotions, planning, thought and power of judgement.

Corpus callosum

- The corpus callosum is a C-shaped structure between the two hemispheres of the cerebrum.
- It consists of **white matter**, composed of myelinated **axons**, that connects the two cerebral hemispheres.
- It is the largest bundle of nerve fibres in the brain with over 200 million axons.

Binocular/stereoscopic vision

- The left and right eyes each form their own image of the object.
- This provides a wider field of vision and is known as **binocular/ stereoscopic vision**.
- The brain combines the two images to form one, three dimensional (3D) combined image.
- This helps immensely with **depth perception** and **judging the distance and size** of an object.



Binocular vision

Visual defects

Irregularities of the lens, cornea or shape of the eye can all cause visual defects.

Presbyopia

A natural part of the ageing process that leads to the **gradual loss** of the eye's **ability to focus on nearby objects**, i.e. accommodation.

Cause and consequence

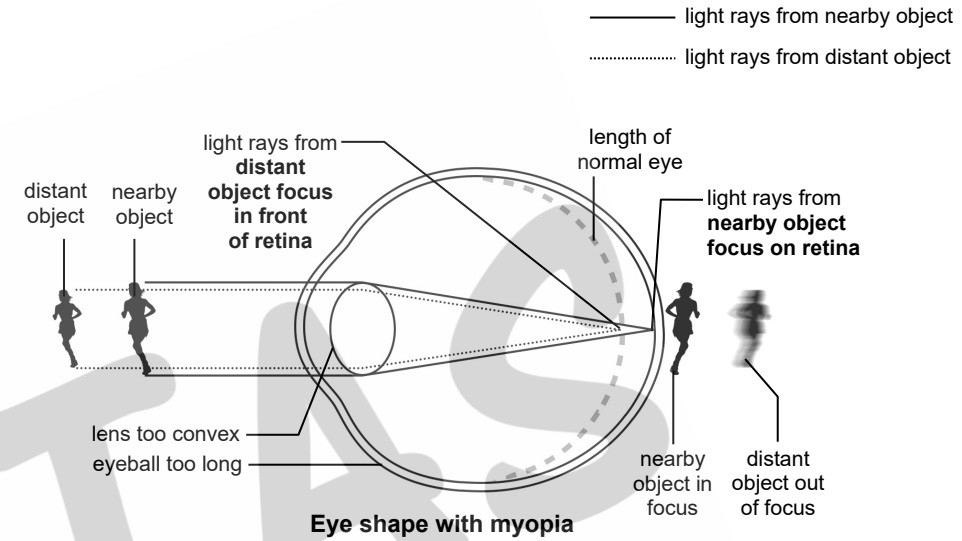
- After the age of 40, the lens loses its elasticity and cannot change its curvature effectively.
- Light rays from nearby objects are no longer refracted correctly to produce a focused image on the retina.

Treatment

- Most people older than 40 years of age need reading glasses to focus on nearby objects.
- Light rays need to be refracted by an additional convex lens (in glasses or contact lenses) to obtain a sharp image on the retina.

Short-sightedness (myopia)

A person can see **nearby objects clearly**, but **distant objects** are unclear and **out of focus**.



Eye shape with myopia

Cause and consequence

- The **eyeball is too long** or the **cornea or lens** is **too convex**.
- Light rays are refracted/bent too much.
- Light rays from nearby objects focus on the retina resulting in a clear image.
- Light rays from distant objects converge (meet) and focus in front of the retina, resulting in a blurred image.

Treatment

- Wear glasses (or contact lenses) with **concave lenses**.
  - A concave lens **diverges** the light rays before they enter the eye to focus on the retina, and a clear image is formed.
- Use **laser surgery** to correct short-sightedness.
  - Laser techniques flatten the cornea to make it less curved (less convex).
  - Light rays are refracted less to focus light rays on the retina.

The middle ear

The middle ear is a small air-filled cavity, lined with a mucous membrane, in the temporal bone of the skull. It consists of: the tympanic membrane, ossicles, oval window, round window and the opening to the Eustachian tube.

Part	Structure	Function
Tympanic membrane (eardrum)	A thin **membrane** that covers the opening between the external auditory canal and the middle ear.	1 Converts **sound waves** into **vibrations** that are transmitted to the first ear ossicle, the **hammer** (malleus).
Ossicles	There are three bony ossicles: › **malleus** (hammer) › **incus** (anvil) › **stapes** (stirrup) Tiny ligaments join the three ossicles so that they can **articulate** freely. ***articulate:*** *form a joint that allows movement* The one end of the malleus is attached to the tympanic membrane and the other end to the incus, which in turn articulates with the stapes. The stapes is attached to the oval window. Together, the three ossicles form an effective **lever system** that connects the outer and inner ear and **amplifies sound**.	1 **Amplify** and **transmit vibrations** to the membrane of the oval window. NOTE *The **difference in size** of the 3 bony ossicles (large malleus to smaller incus and stapes) creates an effective **lever system** that **amplifies** the **vibrations** across the middle ear. (Amplification is also discussed in the functioning of the ear on p. 66.)*
Oval window	An opening covered by a thin **membrane**. It connects the middle ear to the inner ear. The area of the oval window is much smaller than the area of the tympanic membrane.	1 **Transmits vibrations** from the air-filled middle ear to cause **pressure waves** in the fluid-filled inner ear.

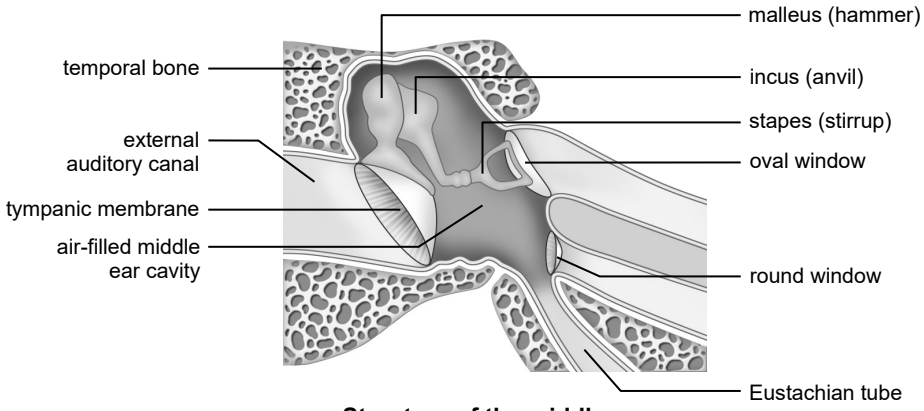
NOTE

*The **difference** in **area** between the **larger tympanic membrane** and the **smaller oval window** (in contact with the smaller stapes ossicle) **amplifies the vibrations** significantly.*

Imagine the greater force when someone steps on your toe with the smaller surface of a stiletto shoe heel compared to the larger surface of a flat shoe heel. (Amplification is also discussed in the functioning of the ear on p. 66.)

Part	Structure	Function
Round window	An opening covered by a thin **membrane** situated directly below the oval window. It connects the air-filled middle ear with the fluid-filled inner ear.	1 **Prevents echoes** in the ear as it **absorbs excess pressure waves**. 2 Plays a role in the functioning of the **inner ear: it releases pressure** from the fluid in the cochlear canals during hearing.
Opening to the Eustachian tube	Connects the middle ear to the pharynx (throat cavity).	1 Ensures that the **pressure remains equal** on both sides of the **tympanic membrane** which allows it to vibrate freely.

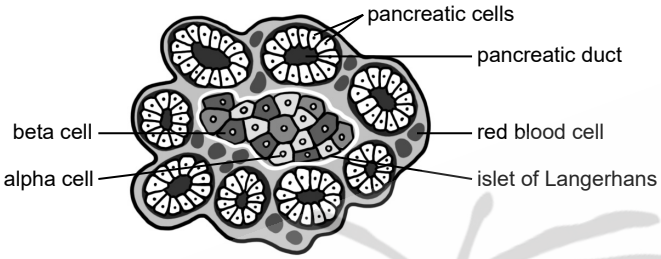
When a person moves to high altitudes (e.g. up a mountain), temporary deafness often occurs. This is relieved when the person swallows or yawns. The decrease in atmospheric pressure with higher altitude means that the pressure in the middle ear is higher than the pressure outside the ear. The tympanic membrane bulges and affects the vibrations of the ossicles. When the person yawns or swallows, air is drawn from the middle ear through the Eustachian tube and the pressure difference on either side of the tympanic membrane is corrected.



Structure of the middle ear

PANCREAS

- The pancreas consists of two types of cells:
  - **exocrine pancreatic cells** – secrete **pancreatic juice** containing enzymes via the pancreatic duct to the small intestine.
  - **endocrine cells in islets of Langerhans** – secretes hormones directly into the bloodstream.



Cells of the pancreas

NOTE

*Therefore, the pancreas functions as an **exocrine** as well as an **endocrine** gland. It secretes substances **via a duct** (exocrine) as well as **directly into blood** (endocrine).*

Hormones of the pancreas

- The islets of Langerhans consist of two types of cells:
  - **alpha cells** (α) produce the hormone **glucagon**
  - **beta cells** (β) produce the hormone **insulin**

Both hormones play a role in the control of the glucose level in the blood. The normal blood glucose level in humans is between 3,5 and 5,5 mmol/litre (80 – 100 mg/cm^3).

Insulin

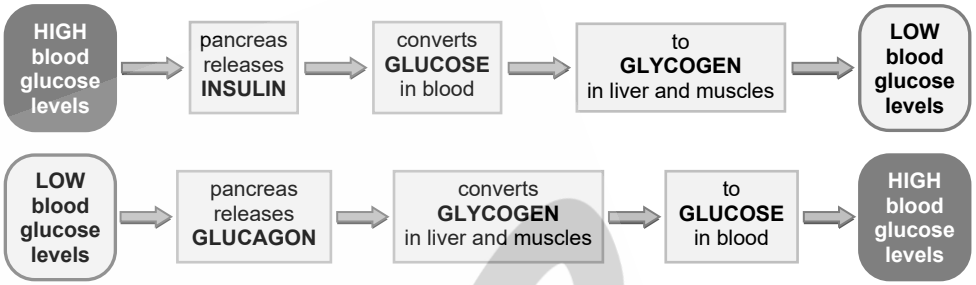
- Insulin is secreted when the blood glucose level rises above normal and it **decreases** the **glucose level**.

Glucagon

- Glucagon is secreted when the blood glucose level drops below normal and it **increases** the **glucose level**.

NOTE

*Insulin and glucagon are **antagonistic hormones** with opposite effects on the body. When one hormone is **stimulated**, the other is **inhibited**.*



Action of hormones insulin and glucagon

Control of glucose concentration in the blood

NOTE

*The control of blood glucose is another example of a **negative feedback mechanism**.*

Increased glucose concentration in blood

- Blood glucose levels **rise above normal** (usually after a carbohydrate-rich meal).
- The pancreas is **stimulated** and beta cells secrete **insulin** into the blood.
- Insulin is transported in blood to the **liver** and skeletal **muscle cells**.
- **Insulin:**
  - stimulates conversion of **excess glucose to glycogen** for storage
  - stimulates **absorption of glucose** from the blood into body cells
- Glucose levels **decrease** in the blood and return to normal.
- The decrease in glucose concentration is detected by the beta cells and insulin secretion is inhibited.

HINT

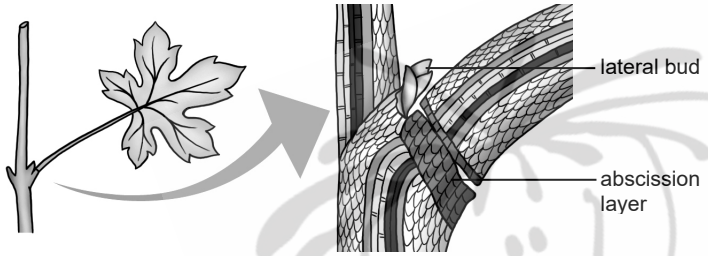
***INsulin INcreases** the uptake and storage of glucose in cells.*

Decreased glucose concentration in blood

- Blood glucose levels **drop below normal** (usually after exercise/fasting).
- The pancreas is **stimulated** and alpha cells secrete glucagon into the blood.

6 Control the abscission of leaves and fruit

- Abscission is the 'cutting off' of fruit and leaves, e.g. when they are ripe (fruit) or in unfavourable conditions (leaves in autumn).
- There is an abscission layer in the leaf/fruit stalk where the cells have thinner cell walls.
- The cell walls suddenly break down and the weight of the leaf/fruit causes it to drop off.
- High auxin concentrations inhibit the formation of the abscission layer in leaves and fruit.
- Lower auxin concentrations stimulate the formation of the abscission layer and the leaves/fruit drop off.



Tropism

- A plant moves by changing its direction of growth towards more favourable conditions.
- Tropism or tropic movement is a **growth movement** of **a part of a plant** in response to an **external stimulus**.
- The direction of growth is directly related to the direction from which the stimulus originates.
- A growth movement towards the stimulus is **positive**, while a growth movement away from the stimulus is **negative**.
- A tropism takes place as a result of the unequal distribution of auxins in the plant.

NOTE

Roots and stems differ in their sensitivity to auxins.
Roots are more sensitive to auxins than stems:

- *A **high concentration** of auxins **in stems stimulates growth**.*
- *A low concentration of auxins in stems inhibits growth.*
- *A high concentration of auxins in roots inhibits growth.*
- *A **low concentration** of auxins **in roots stimulates growth**.*

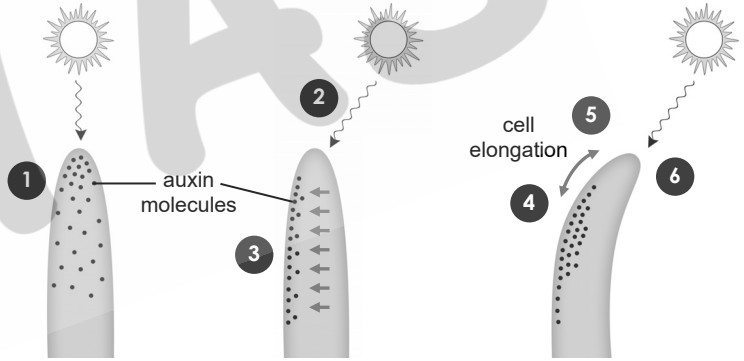
Phototropism

- Phototropism is the growth movement of part of a plant in response to a unilateral **light stimulus**.

unilateral light: *light from one direction only*
uniform light: *light of the same quality from all directions,*
e.g. movement of the sun during the day provides uniform light to a stem

- Stems and leaves usually grow towards the light to absorb the maximum amount of sunlight for photosynthesis and are therefore **positively phototropic**.
- Roots usually grow away from the light, underground and towards water and minerals and therefore roots are **negatively phototropic**.

Phototropism in stems



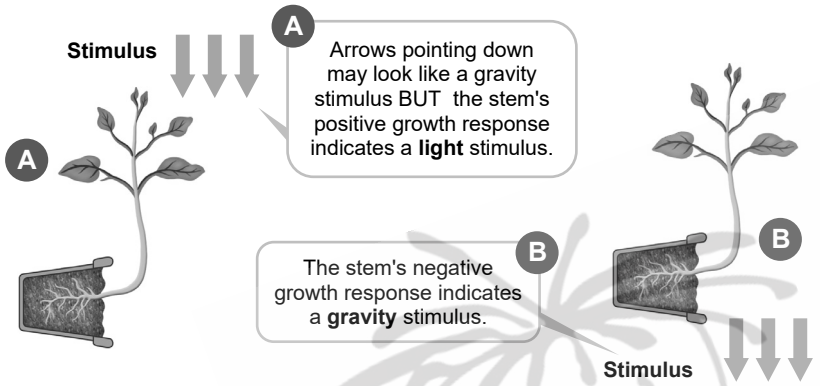
Phototropism in stems

1. Auxins are light-sensitive hormones that move away from light.
2. When the growing tip of a stem receives unilateral light, the auxins move away from the light source and accumulate on the shaded side of the stem.
3. There is a higher concentration of auxins on the shaded side of the stem.
4. More cell division and elongation will occur on the shaded side of the stem as **high concentrations of auxins** in stems **stimulate growth**.
5. There is uneven growth and the stem bends towards the light (stimulus).
6. Stems are thus **positively phototropic**.

EXAM TIP

Exam questions may use arrows only to indicate a stimulus without identifying the type of stimulus.

Focus on the **response of the part of the plant** (stem or root) **to the stimulus** to determine the type of stimulus (light or gravity).



GIBBERELLINS

Gibberellins are one of the largest groups of plant hormones and are mainly produced in the terminal buds of stems and roots, in young leaves and in embryos.

Functions of gibberellins

1. **Stimulate main stem elongation** (by lengthening the internodes)
2. **Stimulate the germination of seeds**
3. **Stimulate root growth**
4. **Promote flowering**
5. **Promote the growth of lateral buds**

ABSCISIC ACID

Abscisic acid is a growth inhibitor that counteracts the functioning of auxins. It plays a role in helping the plant to cope under stressful conditions. It is produced in leaves, stems and unripe fruit.

Functions of abscisic acid

1. **Causes dormancy** (inactivity) **of terminal buds and lateral buds in winter.**
2. **Contributes to the dormancy of seeds by inhibiting germination.**
3. **Promotes the abscission of leaves and fruit.**
4. **Causes the closing of stoma when the plant wilts** (plant loses more water through transpiration than it absorbs from the soil).

NOTE

Both auxins and gibberellins are growth stimulators while abscisic acid is a growth inhibitor that helps the plant to survive unfavourable conditions, e.g. winter.

THE USE OF PLANT HORMONES IN AGRICULTURE

Plant hormones are used extensively in the production of food crops:

- **Root formation in cuttings**
  - Auxins stimulate the development of adventitious roots.
  - Cuttings develop bigger root systems by dipping them into auxin-containing hormone powder.
  - Plants are cloned cheaply and quickly.
- **Production of seedless fruit**
  - Growth hormones are sprayed onto unpollinated flowers, stimulating the development of ovaries into fruit.
  - No fertilisation takes place, no seeds are formed and thus seedless fruit develop.
- **Ripening of fruit**
  - Some plant hormones (e.g. ethylene) are sprayed onto fruit to stimulate ripening, so that all the fruit ripen at the same time and they can be harvested simultaneously.

NOTE

Bananas are harvested before they are ripe. This prevents damage during transport. They are sprayed with ethylene afterwards to cause ripening.

- **Prevention of premature abscission of fruit**
  - High auxin concentrations prevent the formation of the abscission layer in fruit stalks.
  - Therefore, spraying with auxins delays abscission.
  - Harvesting dates can then be manipulated accordingly for simultaneous harvesting.

QUESTION 6

Illustrations of young animals **A** – **D**.

A

B

C

D

6.1 Identify the developmental strategy exhibited by each of the animals labelled **A** to **D** respectively.

6.2 What type of bird has chicks that, when hatched, will display the developmental stage indicated by:

6.2.1 chick **A** 6.2.2 chick **B**

6.3 Compare, in table form, the developmental strategies as represented by chicks labelled **A** and **B** respectively by referring to:

6.3.1 incubation period 6.3.2 structure of eggs

6.3.3 hatched chicks 6.3.4 parental care

6.4 Tabulate the developmental strategies as represented by the mammal species labelled **C** and **D** respectively by referring to:

6.4.1 examples of animal species that exhibit this development strategy

6.4.2 the gestation period

6.4.3 the young after birth

6.5 Compare the young of precocial and altricial animals with respect to their chances of survival to reproductive age.

QUESTION 7

7.1.1 Define the concept *parental care*.

7.1.2 Discuss the energy input that is associated with parental care.

7.2 Name FIVE examples of parental care.

7.3 Which group of vertebrates exhibit

7.3.1 the least, if any, parental care

7.3.2 the greatest measure of parental care

7.4 'In humans parental care includes far more than simply the physical rearing of the child.' Briefly explain this statement.

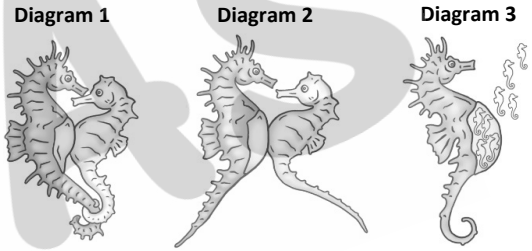
QUESTION 8

The extract below refers to the reproduction of seahorses.

Seahorses have a unique life cycle. During the mating ritual, the male and female first dance with each other (Diagram **1**), after which the female deposits her eggs in the male's brood pouch (Diagram **2**). The male then releases his sperm into the same pouch. Fertilisation occurs inside the brood pouch.

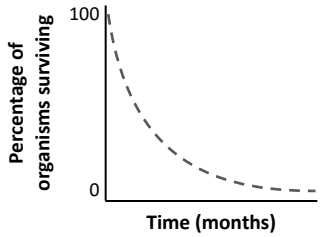
It takes between 10 to 25 days (depending on the species) for the eggs to fully mature and as many as 2 000 eggs can grow inside the brood pouch at one time. The male cares for the developing eggs and protects them inside the brood pouch. When the young seahorses are ready to be born, the male contracts muscles in his abdomen to expel the fully developed offspring into the water (Diagram **3**).

The newborn seahorses must immediately be able to fend for themselves and can easily be caught by predators or swept away from their nutrient-rich ecosystems by ocean currents. Less than 5 seahorses per 1 000 survive to adulthood.



Life cycle of a seahorse

The graph below shows the percentage survivors in a population of seahorses over a certain period.



8.1 What type of fertilisation is exhibited by seahorses?

8.2 Are seahorses oviparous, ovoviviparous, or viviparous?

8.3 Give a reason for your answer in QUESTION 8.2.

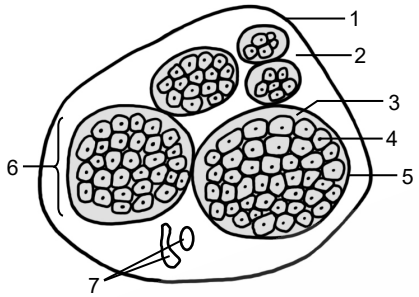
8.4 The shape of the graph would be different if there was parental care.

8.4.1 Describe how the shape of the graph would differ is there was parental care.

8.4.2 Explain your answer in QUESTION 8.4.1

QUESTION 5

Study the representation of a cross-section through a typical nerve below and answer the following questions.



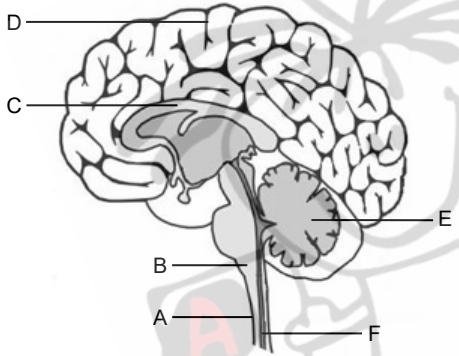
5.1 Identify the parts numbered **1** to **7**.

5.2 Describe the structure of a nerve with reference to the drawing.

5.3 The average number of synapses in a neuron of a newborn baby is 2 500. This increases up to 15 000 in a three-year-old. Calculate the percentage increase in synapses from birth until three years of age. Show ALL calculations.

QUESTION 6

Study the diagram of a part of the human brain and answer the following questions.



6.1 Identify the parts labelled **B**, **C** and **E** respectively.

6.2 What do we call the part of the nervous system shown in the diagram?

6.3 Name and describe the meninges that surround the brain.

6.4 Give ONE function of the fluid that is found in part **F**.

6.5 A haemorrhage (excessive bleeding due to rupture of a blood vessel) at part **D** can cause permanent dysfunction. State THREE possible consequences for a patient who has suffered damage to part **D**.

6.6 Give the functions of the parts labelled **C** and **E** respectively.

6.7 Concussion is a type of traumatic brain injury caused by a blow to the head. This can lead to impaired vision, confusion and loss of consciousness.

6.7.1 Give the LETTER of the part of the brain that will be affected by concussion.

6.7.2 Explain why concussion does not influence the heartbeat.

6.8 Identify part **A**.

6.9 Besides the liquid in **F**, name another way in which part **A** is protected.

6.10 If part **A** was damaged during an accident, explain:

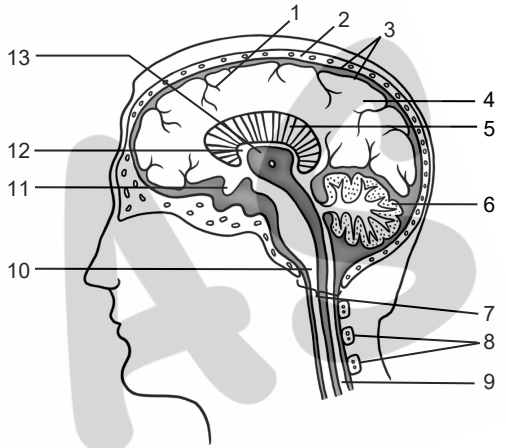
6.10.1 how a person can still see, taste, speak and hear

6.10.2 how the pituitary gland can still control the functioning of other endocrine glands

6.10.3 why it would lead to the sudden death

QUESTION 7

Study the drawing below of a section through a part of the human central nervous system and answer the questions that follow.



7.1 Identify the parts numbered **1** to **13**.

7.2 What is the function of part number **1**?

7.3 Write down the NUMBER of the part responsible for:

7.3.1 the control of the permeability of the renal collecting ducts

7.3.2 the connection between the two cerebral hemispheres

7.3.3 serving as a pathway for nerve impulses to and from the brain

7.3.4 control of heart rate

7.3.5 the ability to play chess

7.3.6 peristaltic control

7.3.7 maintenance of muscle tone and balance

7.3.8 protective reflexes

7.4 In a lumbar puncture, fluid is extracted from the central canal of the spinal cord, e.g. when a doctor confirms meningitis in a patient. What is this fluid called?

7.5 Apart from the central canal, name TWO other locations in the nervous system where the fluid mentioned in QUESTION 7.4 may occur.

7.6 Write down the NUMBERS of TWO parts where grey matter appears on the outside and white matter on the inside.

9.1 Draw a histogram using the data in the table.

9.2 Name the hormone that results in diabetes mellitus when it is deficient.

9.3 Name the organ that secretes the hormone mentioned in QUESTION 9.2.

9.4 State TWO other hormones (except the one mentioned in QUESTION 9.2) that influence the glucose level of the blood.

QUESTION 10

Answer the following questions about the male gonads (testes) of humans.

10.1 Describe the location of the testes.

10.2 What is the name of the male hormone secreted by the testes?

10.3 Which cells secrete the hormone mentioned in QUESTION 10.2?

10.4 List THREE functions of the hormone mentioned in QUESTION 10.2.

QUESTION 11

Answer the following questions about the female gonads (ovaries) of humans.

11.1 Describe the location of the ovaries.

11.2 Which structure in the ovaries is responsible for the secretion of oestrogen?

11.3 List the functions of oestrogen.

11.4 Which structure in the ovaries is responsible for the secretion of progesterone?

11.5 List the functions of progesterone.

QUESTION 12

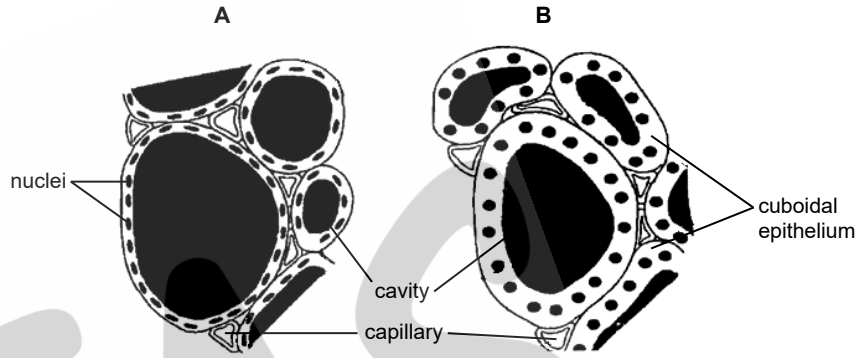
The nervous and endocrine systems help to protect the human body. Use suitable examples and describe how this occurs by means of a reflex action and the hormone adrenaline.

QUESTION 13

Tabulate the differences between the nervous and endocrine systems of humans.

QUESTION 14

A tissue sample was taken from the thyroid gland of a sick cat and a section (**A**) was examined under a microscope. It was compared to a similar section (**B**) taken from a healthy cat. The sick cat suffers from hyperthyroidism. The drawings below show differences between sections **A** and **B**.



Tissue samples of thyroid gland with numerous blood capillaries

14.1 What is meant by *hypothyroidism*?

14.2 Give ONE symptom (not visible in the diagrams) that might be associated with hypothyroidism.

14.3 Describe TWO differences (visible in the diagrams) between the sick and healthy cat.

14.4 Explain why there are many capillaries in the thyroid tissue.

14.5 The investigator thought that the cat with tissue sample **A** might be sick due to a lack of iodine in its diet. Why is this element needed for the normal functioning of the thyroid gland?

QUESTION 15

Anaphylactic shock is a rare, but serious allergic reaction that can be fatal if not treated immediately. It is commonly caused by an allergy to certain foods, insect bites or medication. One of the most characteristic symptoms of such an attack is a tight feeling on the chest and the closure of the airways. The best treatment is an intravenous (into the bloodstream) injection of adrenalin. Adrenalin is normally naturally secreted during stressful situations.

15.1 Why is adrenalin administered during anaphylactic shock?

15.2 Which part of the nervous system works with adrenalin?

15.3 Name the endocrine gland that secretes adrenalin.

15.4 Explain why adrenalin is administered intravenously instead of orally.

3.3 The lateral branches will curve in the direction of the light source. The main shoot (without auxin) will continue to grow straight.

- when the lateral branches receive light unilaterally, the light-sensitive auxins move to the shaded side
- a higher auxin concentration accumulates on the shaded side
- cell elongation is stimulated on the shaded side and those cells grow faster
- the lateral branches curve in the direction of the light

3.4 positive phototropism

3.5 Plants position their leaf-bearing branches to absorb the maximum amount of sunlight for photosynthesis.

QUESTION 4

4.1 An auxin concentration between 10^{-4} and 10^{-3} ppm is optimum for root development. Up to approximately 10^{-2} ppm stimulates root development, but if it increases beyond that, it inhibits root development; a lower auxin concentration stimulates root development.

4.2 Auxin concentrations of up to and including 10 parts per million stimulate cell elongation in stems.

4.3 An increase in auxin concentration from 10^{-5} to 10^{-3} stimulates growth in lateral buds. Auxin concentrations between 10^{-3} and 10^{-1} have less of a stimulating effect. Auxin concentrations above 10^{-1} inhibit the growth of lateral buds.

4.4 apical dominance

4.5 stems

4.6.1 10^{-3} parts per million

4.6.2 1 part per million

QUESTION 5

5.1 Cell elongation in the coleoptile will increase/decrease/remain the same/differ as the auxin concentration increases/decreases/differs.

5.2 It removes the effect of auxins produced at the tip as there can be varying concentrations produced by each plant.

5.3

- same type of soil
- same amount of water
- same light intensity
- same temperature
- same size of the pot
- same environmental conditions

5.4 Increasing the concentration of auxin results in an increase in cell elongation up to an optimum concentration; then it starts inhibiting/decreasing the cell elongation.

QUESTION 6

6.1 phototropism 6.2 clinostat

6.3 Stationary. If the clinostat was wound up, the disc with the pot plant would rotate, and the plant would grow upright, as the light would be received equally from all sides (uniform lighting).

6.4 I would set it up exactly the same as in the experiment, but I would wind up the clinostat (apparatus marked A), so that the plant receives light from all sides instead of unilaterally.

6.5 The plant would grow straight up, because, due to the rotating clinostat, the external light stimulus would be uniform (from all sides) instead of unilateral.

6.6 The stem of the plant is positively phototropic.

6.7 The stem of the plant curves in the direction of the light so that the leaves, the plant's main photosynthesising organs, can absorb the maximum amount of sunlight for photosynthesis.

6.8

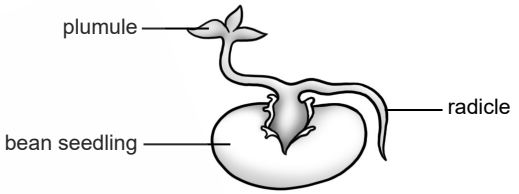
- when the growing tip of a stem receives unilateral light, the light-sensitive auxins move away from the light to the shaded side
- auxins accumulate on the shaded side
- cell elongation is stimulated on the shaded side
- the shaded side thus grows faster
- the stem curves in the direction of the light
- the stem is thus positively phototropic

6.9 As there is now no longer an external, unilateral light stimulus, the plant will grow upright in an attempt to reach the light.

QUESTION 7

7.1 Geotropism. The seedling was placed in a dark box and therefore light could not play a role as a stimulus.

7.2



7.3.1

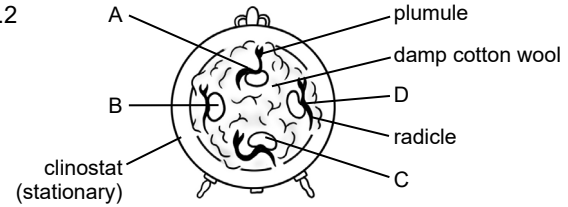
- when a young seedling is placed horizontally, the radicle will curve downwards
- the auxins accumulate on the lower side of the root under the influence of gravity
- the high auxin concentration on the lower side of the root inhibits cell elongation in this area
- cells on the upper side grow faster due to the lower auxin concentration that is closer to the optimal auxin concentration
- the radicle curves downward and is positively geotropic

7.3.2

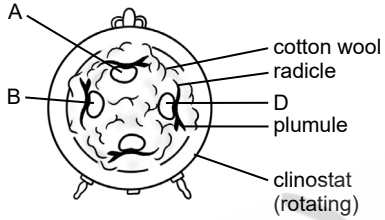
- when a young seedling is placed horizontally, the plumule will curve upwards
- the auxins accumulate on the lower side of the stem under the influence of gravity
- the higher auxin concentration on the lower side of the stem stimulates cell elongation in this area
- the plumule curves upward and is negatively geotropic

7.4.1 Use an unwound clinostat set in vertical position for the experiment. Pin four germinating bean seeds on damp cotton wool onto the cork disc, with the micropyles respectively at the top (A), to the left (B), at the bottom (C) and to the right (D). Arrange an identical setup for the control, but wind up the motor of the clinostat. Place both clinostats in a dark cupboard/box for a few days.

7.4.2



Experiment



Control

NOTE

In the drawings of the results, make sure that:

- *the bean seeds are placed with their micropyles in the positions as mentioned in QUESTION 7.4.1 for both the experiment and the control.*
- *the plumules in the experiment are drawn facing upward and all the radicles facing downward.*
- *the plumules and radicles in the control are pointing in the same direction as in the beginning when pinned to the cork disc.*

QUESTION 8

8.1.1 0,2 mg/mol 8.1.2 0,43 mg/mol

8.1.3 0,6 mg/mol

8.2 auxins

8.3 Higher auxin concentrations stimulate stem development, but inhibit root development.

8.4.1 See p. 94 in the notes under the heading '*Functions of gibberellins*'.

8.4.2 See p. 94 in the notes under the heading '*Functions of abscisic acid*'.

QUESTION 9

9.1 See p. 94 in the notes under the heading '*Root formation in cuttings*'.

9.2 See p. 94 in the notes under the heading '*Production of seedless fruit*'.

9.3 See p. 94 in the notes under the heading '*Ripening of fruit*'.

9.4 See p. 94 in the notes under the heading '*Prevention of premature abscission of fruit*'.

9.5 See p. 95 in the notes under the heading '*Increase in fruit size*'.

9.6 See p. 95 in the notes under the heading '*Stimulation of germination*'.

9.7 See p. 95 in the notes under the heading '*Weed control*'.

QUESTION 10

10.1 Gibberellins promote the growth of lateral buds which leads to the growth of lateral branches / cell elongation of internodes.

10.2 120 – 80 = 40 mm

10.3
- use more plants per group
- use the same quantity of paste

10.4 Initially, a high concentration of auxins diffuse from the paste into the stem, inhibiting growth of the lateral branches (Days 1 – 9). Once all the auxins in the paste are depleted, the growth of lateral branches is not inhibited by the low auxin concentration and the average length of the branches increases (Day 9 – 12).

QUESTION 11

11.1 Plants also have enemies, such as insects, pathogens, microorganisms and herbivores, and have to defend themselves against these, as well as excessive water loss.

11.2 mechanical; chemical

11.3 See p. 95 in the notes under the heading '*Mechanical defence mechanisms*'.

11.4
- repellent
- poisonous
- influence digestibility of plant material

11.5.1 tannins 11.5.2 alkaloids

11.5.3 lignin/silica 11.5.4 terpenoids

QUESTION 12

12.1 phototropism

12.2
- the same plant species was used for each apparatus
- identical clinostats were used for each apparatus
- the same time frame / 5 weeks for each apparatus was used
- each apparatus was placed in a box with one opening
- the opening in each box was in the same area / same size / allowed the same amount of light to enter

NOTE

*If an exam question asks for **two** factors, only the **first two** answers will be marked.*

12.3 The investigation was only conducted once / was not repeated
OR
Only one plant was used in each apparatus / the sample size was too small

NOTE

*Only the **first answer** will be marked.*

12.4.1 B 12.4.2 A

12.5 The clinostat was stationary (unwound) and the stem showed negative geotropism.

12.6.1 To allow enough time for the auxin to diffuse and spread through the agar block.

12.6.2
- the auxins diffuse downwards
- most of the auxin will move down the right-hand side of the stem, where the agar block is in direct contact with the stem
- there will be a higher concentration of auxin on the right-hand side of the stem compared to the left-hand side
- a high concentration of auxin stimulates cell elongation in stems
- therefore, the right-hand side of the stem will grow faster than the left-hand side of the stem / uneven growth occurs
- the stem bends towards the left-hand side/away from the contact with the agar block, even in the absence of light