THE ENDOCRINE SYSTEM

LESSON PREPARED BY:
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4. ELABORATION OF CONTENT FOR GRADE 12 (CAPS)

A topic-wise elaboration follows, which merely outlines the basic content that needs to be covered. This content can be assessed at all four cognitive levels.

<table>
<thead>
<tr>
<th>HUMAN ENDOCRINE SYSTEM</th>
<th>Term 3</th>
<th>1½ weeks</th>
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</thead>
<tbody>
<tr>
<td>Paper 1: 15 marks</td>
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<table>
<thead>
<tr>
<th>CONTENT</th>
<th>ELABORATION</th>
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<tbody>
<tr>
<td>Introduction</td>
<td>Difference between an endocrine and an exocrine gland</td>
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<td></td>
<td>Definition of a hormone</td>
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<td></td>
<td>Location of each of the following glands, using a diagram, the hormones they secrete and function(s) of each hormone:</td>
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<tr>
<td></td>
<td>• Hypothalamus (ADH)</td>
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<tr>
<td></td>
<td>• Pituitary/Hypophysis (GH, TSH, FSH, LH, prolactin)</td>
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<td></td>
<td>• Thyroid glands (thyroxin)</td>
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<td>• Islets of Langerhans in the pancreas (insulin, glucagon)</td>
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<td>• Adrenal glands (adrenalin, aldosterone)</td>
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<td>• Ovary (oestrogen, progesterone)</td>
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<td></td>
<td>• Testis (testosterone)</td>
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<td>• Negative feedback mechanism involving:</td>
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<td>• TSH and thyroxin (and the result of an imbalance: thyroid disorders)</td>
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<tr>
<td></td>
<td>• Insulin and glucagon (and the result of an imbalance: diabetes mellitus)</td>
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<tr>
<td><strong>ENDOCRINE SYSTEM</strong></td>
<td><strong>NERVOUS SYSTEM</strong></td>
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<td>----------------------</td>
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<tr>
<td>Chemical <strong>messengers</strong></td>
<td>Electro-chemical <strong>impulses</strong></td>
</tr>
<tr>
<td>Chemical is transported in the <strong>blood stream</strong> around the body</td>
<td>Impulse is transmitted along a <strong>nerve fibre</strong></td>
</tr>
<tr>
<td>Stimulates <strong>target organs</strong></td>
<td>Stimulates a <strong>particular organ</strong></td>
</tr>
<tr>
<td>The response is brought about by the <strong>target organ</strong></td>
<td>The response is brought about by the <strong>effector organ</strong></td>
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<tr>
<td><strong>Slow</strong> and <strong>long-term</strong> response</td>
<td><strong>Rapid</strong> and <strong>short-term</strong> response</td>
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**ENDOCRINE GLAND**

Secretions are carried through **bloodstreams**, e.g. **hormones**

**EXOCRINE GLAND**

Secretions are carried through **ducts**, e.g. **salivary glands**
WHAT ARE HORMONES?

- **Hormones** are chemical substances or messengers that enter the blood directly on secretion from endocrine glands.
- **Hormones** are carried to target tissues or organs where they regulate the metabolic reactions.

The Endocrine System

- Hypothalamus
- Pituitary gland
- Pineal gland (epiphysis)
- Thyroid gland
- Parathyroid gland
- Adrenal (suprarenal)
- Pancreas
- Ovaries
- Testicles

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Study the following passage and answer the questions that follow.

Messenger substances are produced in endocrine glands of the human body and then transported to other parts of the body where they are involved in regulating the activity of particular parts. Slow, sustained or on-going responses to these substances complement or support the other more rapid and short-lived responses of the body.

1.1.1 Write a scientific name for each of the following phrases taken from the passage:
(a) Messenger substances (1)
(b) Particular parts whose activities are regulated (1)

1.1.2 Name ONE system in the human body involved in co-ordination. (1)

1.1.3 Tabulate TWO differences between the way in which the systems named in QUESTION 1.1.2 operate. (5)
**ACTIVITY 1 – ANSWERS**

1.1.1 a) Hormones (1)  
  b) Target organs (1)  

1.1.2 Endocrine system/Nervous system (1)

<table>
<thead>
<tr>
<th>Endocrine</th>
<th>Nervous system</th>
</tr>
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<tbody>
<tr>
<td>Operates with bloodstream/</td>
<td>Operates with neurons/</td>
</tr>
<tr>
<td>hormones/chemicals</td>
<td>electrochemical</td>
</tr>
<tr>
<td>Slow responses</td>
<td>Rapid responses</td>
</tr>
<tr>
<td>Response lasts longer</td>
<td>Response short lived</td>
</tr>
<tr>
<td>Effect may be widespread</td>
<td>Localised effect</td>
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</table>

• The **hypothalamus** is located at the base of the brain
• The **hypothalamus** secrete **ADH** (Anti-diuretic hormone)
• **ADH** controls the levels of water in the body
• **ADH** makes the **collecting ducts** more permeable for the re-absorption of water
The Pituitary & Hypothalamus

- Cerebrum
- Hypothalamus
- Pituitary
- Cerebellum
- Brain stem
The **pituitary gland** is located at the base of the **brain** just below the hypothalamus.

The **pituitary gland** is the most important part in the **endocrine system**.

The **pituitary gland** secrete hormones on the basis of the emotional and seasonal changes.
**Hormones Secreted by Hypophysis**

- **Growth Hormone**: To stimulate the growth of the bones and tissues.
- **Prolactin**: To activate the production of milk in lactating mothers.
- **Follicle Stimulating Hormone**: Stimulates the development of the follicle.
- **Luteinising Hormone**: Stimulates ovulation and development of the corpus luteum.
- **Thyroid Stimulating Hormone**: Stimulates the thyroid gland to secrete thyroxin.
• Secretes the hormone **thyroxin** which controls the basic metabolism rate
• Affects growth by maintaining the GH content of the **pituitary gland / hypophysis**
• Affects the functioning of the **heart** and **nervous system**
THYROID DISORDERS

Hyperthyroidism (overproduction)
Increases the above actions and 
exophthalmia (protruding eyeballs) 
can occur

Hypothyroidism (underproduction)
In children produces cretinism 
(failure to grow, low intelligence and 
failure to mature sexually)
In adults it causes myxoedema 
(slowing down reactions, increase in 
sub epidermal tissue and low 
metabolic rate).
NEGATIVE FEEDBACK MECHANISM
ACTIVITY 2

2.1 Name the endocrine gland which secretes each of the following:
   (a) TSH  
   (b) Adrenalin  
   (c) Thyroxin  
   (d) Growth hormone

2.2 It was found that the thyroxin concentration of a healthy adult remained very low for a period of three months.
   (a) Will the person gain or lose weight if he continued with his normal diet during this period?
   (b) Explain your answer in QUESTION 2.2 (a).
2.1.1   (a) Hypophysis/pituitary gland (1)
(b) Adrenal glands (1)
(c) Thyroid (1)
(d) Hypophysis/pituitary gland (1)

2.1.2   a) Gain (1)
b) Thyroxin controls metabolic rate
   - Low metabolic rate because of low thyroxin concentration
   - Less food oxidised (broken down)
   - Less glycogen converted to glucose
   - Excess food accumulates as fat any (3)

[8]
There are two types of cells making up the Islets of Langerhans namely:
- Alpha cells (α) and
- Beta cells (β)

The alpha cells secrete the hormone glucagon and the beta cells secrete the hormone insulin.
• Insulin reduces the blood glucose level and is stimulated by a high blood sugar level
• Stimulates the conversion of glucose into glycogen in the liver and muscles and inhibits the reverse reaction
• Promotes the absorption of glucose from the blood into the cells
• Increases the use of glucose by the liver and muscles
• **Glucagon** secretion is stimulated by a **low blood sugar level** and raises the blood sugar level
• It converts stored **glycogen**, from the **liver** or **muscles**, into **glucose**
• The actions of **insulin** and **glucagon** can be summarised by the following **equation**
**NEGATIVE FEEDBACK MECHANISM**

1. **STIMULUS:** Blood glucose level rises.
   - Insulin
   - Beta cells of pancreas release insulin into the blood.
   - Liver takes up glucose and stores it as glycogen.
   - Blood glucose level declines.

2. **STIMULUS:** Blood glucose level falls.
   - Glucagon
   - Alpha cells of pancreas release glucagon.
   - Liver breaks down glycogen and releases glucose.
   - Blood glucose level rises.

**Homeostasis:**
- Blood glucose level (about 90 mg/100 mL)
ACTIVITY 3

3.4 Study the graph below showing the changes in the glucagon concentration during exercise.

![Graph showing changes in blood glucagon concentration over time]

3.4.1 Describe the trend for the changes in the glucagon level over time. (3)

3.4.2 Explain the changes in the level of glucagon from 0 to 10 minutes. (3)

3.4.3 Taking into account the pattern for glucagon concentration from 0 to 10 minutes in the graph above, what will you expect to happen to the insulin concentration for the same period? (1)

3.4.4 Explain why people with diabetes mellitus have very little glycogen in their liver and muscle cells. (3)
| 3.4  | 3.4.1          | - The blood glucagon levels increase✓/from 100 to 210 (picograms/ml)  |
|      |                | - from 0 to 20 min✓                                                  |
|      |                | - and become constant✓ thereafter                                    |

| 3.4  | 3.4.2          | - during exercise more energy is needed✓                             |
|      |                | - therefore the rate of cellular respiration increased✓              |
|      |                | - Increased cellular respiration requires more glucose✓             |
|      |                | - hence more glucagon is secreted✓                                  |
|      |                | - to stimulate the conversion of glycogen to glucose✓                |

| 3.4  | 3.4.3          | Decrease✓                                                            |

| 3.4  | 3.4.4          | - The lack of insulin✓/defective insulin                             |
|      |                | - decreases the conversion✓                                         |
|      |                | - of glucose to glycogen✓                                           |

(3)   Any
(1)   (10)
**Adrenal glands**: On each of the two kidneys, there are two triangular adrenal glands situated.

**Adrenal gland** is divided into two parts:
- **Adrenal medulla** – secrete Adrenalin
- **Adrenal cortex** – secrete Aldosterone
Adrenal glands secretes the hormones adrenalin and aldosterone.

Aldosterone
• Regulates the amount of salts in the blood
• Works with ADH to bring about water balance
ADRENALIN

• **Increases** the heartbeat
• **Raises** blood pressure
• Speeds up the **conversion** from glycogen to glucose
• Causes pupils to **dilate**
• **Increases** the blood supply to the cardiac and skeletal muscles
• **Increases** skeletal muscle tone
• **Increases** rate and depth of breathing
• Causes the **blood vessels** of the digestive system and skin to **constrict**
The **gonads** are present in **males and females** and are the main organs producing **sex hormones**.

In men, the **gonads** are **testes**. The most important **hormone** for men **testosterone** is secreted from the **testes**.

In women, **ovaries** are the **gonads** that are located in the **pelvis region**.
It secretes the **female hormone Oestrogen**

- **development of girls** into **sexually mature** individuals (breasts, soft skin, feminine voice)
- Influences the **menstrual cycle**

**Progesterone**

- **Implantation** of the **fertilised egg** onto the wall of the uterus and ensure it stays in position for the entire period of pregnancy
• It secretes the **male hormone** testosterone.
• Development and functioning of the **male reproductive system** and features e.g. deep voice, more body hair, etc.
NEGATIVE FEEDBACK MECHANISM

Suckling sends impulses to hypothalamus.

Hypothalamus signals posterior pituitary to release oxytocin.

Stimulus: baby suckles at nipple

Baby feeds and continues suckling (positive feedback)

Milk is released and the baby continues to feed.

Oxytocin released into bloodstream stimulates milk ejection from mammary gland.

(b) Positive feedback
VASODILATION & VASOCONSTRICTION

Parasympathetic stimulation causes circular muscles to contract.

Sympathetic stimulation causes radial muscles to contract.
HORMONE ACTION STIMULATES SWEAT GLANDS

1. Muscular activity increases body heat
2. Heat stimulates hypothalamus
3. Hypothalamus stimulates sweat glands to secrete fluid
4. Evaporation of fluid cools body
ACTIVITY 4

Discuss the concept of homeostasis by referring to the role played by the pituitary gland, the thyroid gland and the autonomic nervous system in regulating the metabolic rate of the body.

Content: (17)

Synthesis: (3)
Homeostasis is the maintenance of a relative constant internal environment.

When the metabolic rate is low because of low thyroxin concentration, the pituitary gland is stimulated to secrete TSH which is transported by the blood to the thyroid gland which is stimulated to secrete more thyroxin which is transported to cells to increase the metabolic rate.

If the metabolic rate increases above the normal level, the pituitary gland is inhibited, therefore less TSH and therefore less thyroxin is secreted. The metabolic rate is lowered to normal.

The autonomic nervous system also influences the metabolic rate through double innervation which functions antagonistically. One section is stimulatory while the other section is inhibitory.

A constant internal environment is thus maintained through negative feedback.

any (17)
Thank you.

Siyabonga

Baie dankie

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