

## Biology Notes

### Topic: Hormones and chemical co-ordination in animals and plants

#### Objectives:

*At the end of this topic the students should be able to:*

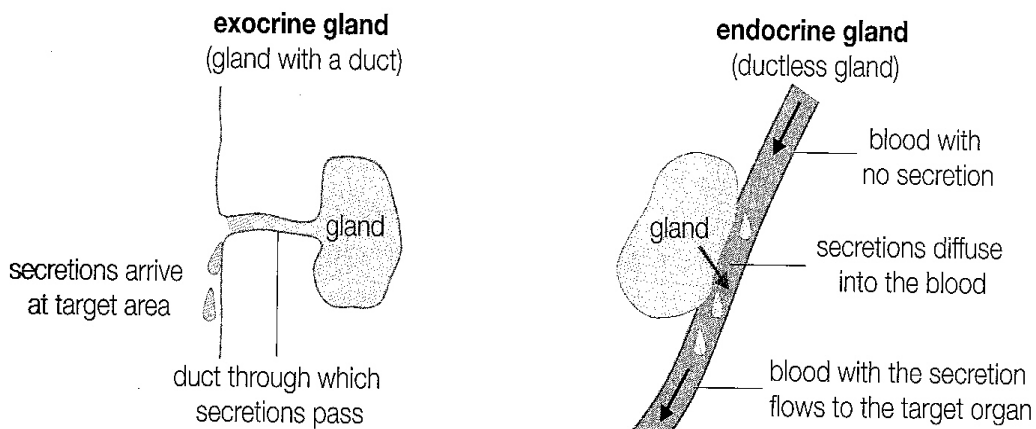
- 1. Define the term hormone.*
- 2. Differentiate between an exocrine gland and an endocrine gland.*
- 3. State the characteristics of enzymes.*
- 4. Describe the chemical control of metabolic activities by insulin and adrenaline.*
- 5. Compare nervous and hormonal control systems.*
- 6. Describe the chemical control of plant growth by auxins.*
- 7. Describe the effects of synthetic plant hormones that are used as weed killers.*

#### **What is a hormone?**

A hormone is a chemical substance which is produced in one part of the body and has an effect in another part. They are known as **chemical messengers**.

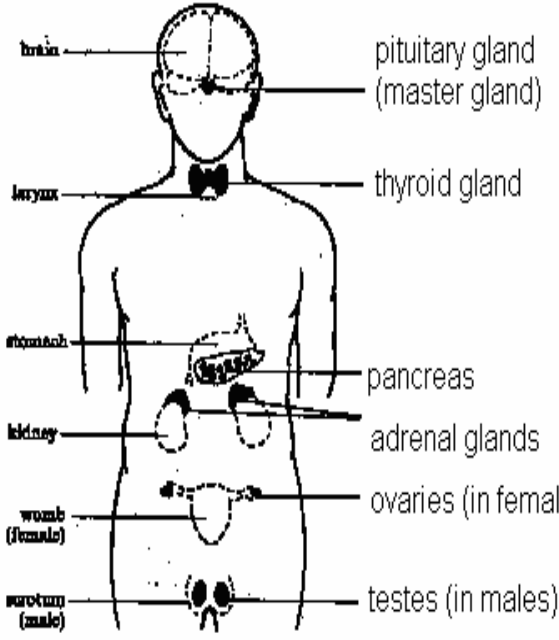
Hormones are produced in special organs called **glands**. There are two types of glands in the human body – glands with duct or tube and glands without duct (ductless). The secretions from glands with duct are transported along the duct to the **target organ** whereas the secretions from ductless glands are deposited directly into the bloodstream and then are transported to the target organ. The diagrams below illustrate the difference between a duct gland and a ductless gland.

**Note:** The target organ is the organ that is affected by the hormone.



Glands with duct are called **exocrine glands** (e.g. salivary gland) and glands without duct are called **endocrine glands**. Hormones are produced by ductless glands.

### Location of the main endocrine glands and their hormones

 <p>The diagram shows a human figure with labels for the following glands and their locations:</p> <ul style="list-style-type: none"> <li><b>brain</b>: pituitary gland (master gland)</li> <li><b>larynx</b>: thyroid gland</li> <li><b>stomach</b>: pancreas</li> <li><b>kidney</b>: adrenal glands</li> <li><b>womb (female)</b>: ovaries (in females)</li> <li><b>scrotum (male)</b>: testes (in males)</li> </ul>	<p>growth hormone – speeds up growth</p> <p>thyroxine – controls the body’s metabolic rate</p> <p>insulin – regulates the amount of sugar in the blood</p> <p>adrenaline – prepares the body for action</p> <p>estrogen- controls female sexual development</p> <p>testosterone- controls male sexual development</p>
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### The chemical control of metabolic activities by insulin and adrenaline

#### Insulin

Insulin is produced by the pancreas and it controls the metabolic activity of regulating the sugar (glucose) level of the blood. Insulin is secreted by the pancreas when the blood-sugar level rises above the normal value i.e.  $90\text{mg}/100\text{cm}^3$  blood.

Insulin regulates the blood-sugar level by the following mechanisms:

1. It promotes the uptake of excess glucose in the blood to the liver and muscles where the glucose is converted to glycogen and stored.
2. It stimulates the increased oxidation of glucose by the cells of the body to produce energy.
3. It promotes any additional excess glucose in the blood to be converted to fat and stored underneath the skin

The result of the above activities is the lowering of the blood-sugar level to its normal value.

#### Adrenaline

Adrenaline is produced by the adrenal glands. It is generally called the ‘fight or flight’ hormone because it prepares the body for action during an emergency. In other words, the body is prepared to put up a good fight or to flee successfully from a dangerous situation.

In an emergency, the body must act quickly to protect itself. Adrenaline prepares the body by promoting the conversion of glycogen to glucose to produce more energy. The heart rate and the breathing rate also increase to help facilitate this process. Blood flow to less important organs such as the alimentary canal are diverted to more important organs such as the muscles and the brain. This allows the muscles to produce energy at an optimum rate and the mental awareness of the brain to be improved so appropriate decisions can be taken quickly. Additionally the pupils dilate (widen) to allow the animal to 'see' better.

These effects prepare the body to handle dangerous situations. A lot of energy is made available for the muscles, which can then perform feats not normally seen, such as running 'extra' fast or being 'extra' strong.

The production of adrenaline, although quick and fast acting, cannot be sustained for a long period of time. A surge of energy is provided to escape a predator or handle a life-threatening situation. The effects are drastic on the body and sometimes they can result in death. An older person with a 'weak' heart or high blood pressure, faced with a traumatic situation, may not be able to survive the sudden increase in heart rate.

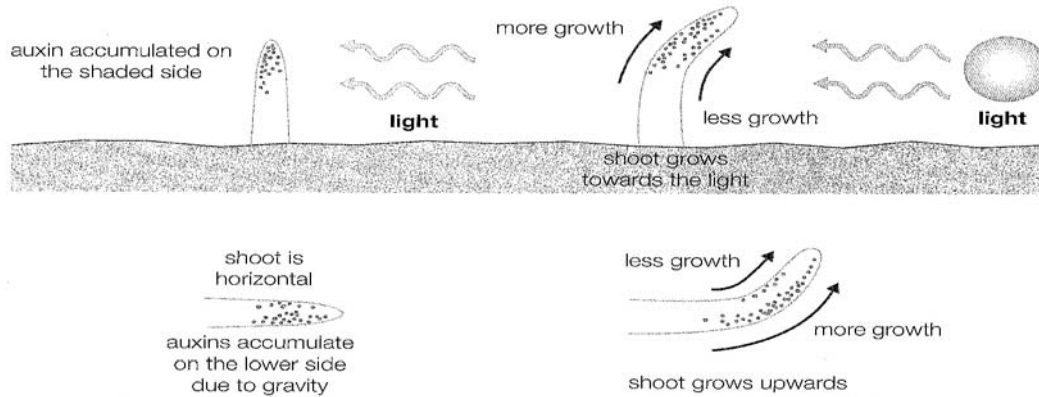
### Comparison of nervous and hormonal control systems

FEATURE	NERVOUS SYSTEM	ENDOCRINE SYSTEM
<i>Nature of message</i>	electrical impulses	chemicals
<i>Transmission of message</i>	along nerves	in the bloodstream
<i>Speed</i>	rapid	slow
<i>Destination</i>	specific regions of the body	all parts of the body but only produce a reaction in target cells
<i>Effect on the body</i>	immediate and short lasting	slower effect and long lasting

### The chemical control of plant growth by auxins

Plants are also affected by hormones. The most important group of plant hormones are called auxins. Auxin is made in the tips of roots and shoots which are the growing parts of the plant. It diffuses to the region just behind the tip and there it causes growth. Light and gravity are examples of external factors that affect growth in plants. The shoots of plants respond to light by growing towards it. When a shoot is lit from one side, auxin breaks down on the light side and accumulates on the shaded side. This results in more growth on the shaded side so that the shoot bends towards the light.

(Refer to following diagram.)



**Figure 13.3** Shoots always grow towards light and upwards or against gravity.

### The effects of synthetic plant hormones used as weed killers

Synthetic plant hormones are man-made hormones. They can be used as weed killers (herbicides). When synthetic plant hormones, such as auxin, are used as herbicides and they are present in higher concentration than the naturally produced auxin, they can disrupt plant growth and kill the plants. 2, 4 -D and 2,4,5-T is an example of a selective herbicide which kills broad-leaved plants. It stimulates auxin production in the plants. The weedkiller causes dicotyledons to grow so fast that they cannot sustain their own growth and they die.

Some herbicides work because they are translocated throughout a plant. They are called **systemic herbicides**. They are translocated from the leaves where they were applied, to the roots, where they interfere with root function. The root dies resulting in the death of the whole plant.

### Assignment question

1 (a) Define the terms:

- |                     |                       |                      |
|---------------------|-----------------------|----------------------|
| (i) hormone         | (iii) endocrine gland | (v) endocrine system |
| (ii) exocrine gland | (iv) target organ     | (5)                  |

(b) Describe the changes that take place in the blood after a meal rich in sugar in a normal person. (5)

(c) A boy is able to jump a high fence when confronted by an angry dog. The same fence he was unable to jump before.

Explain how the effects on the boy's body by the hormone produced by the adrenal glands caused him to jump the fence. (5)