Endocrine system & Homeostasis

Scope

TOPIC	SUBTOPIC	KEY INFORMATION
HUMAN ENDOCRINE SYSTEM & HOMEOSTASIS IN HUMANS **Mark allocation unsure**	Glands and the hormones they secrete + functions	• Location of each of the following glands, using a diagram, the hormones they secrete and function(s) of each hormone: ✓ Hypothalamus (ADH) ✓ Pituitary (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) • Disorders: Diabetes mellitus & Goitre
	Negative feedback	• Basic explanation of negative feedback when levels of the following are high/low and must return to normal: ✓ Glucose ✓ Thyroxin ✓ Carbon dioxide ✓ Water ✓ Salts
	Thermoregulation	• The role of parts of the skin on hot and cold days • Refer to the role of capillaries in the surface of the skin (vasodilation and vasoconstriction) **Emphasise**: • Blood moves to the skin surface and NOT veins • Heat is released by CAPILLARIES and SWEAT from sweat pores

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Endocrinesystem Notes

The endocrine system is a system responsible for chemical co-ordination and regulation of various activities in the body

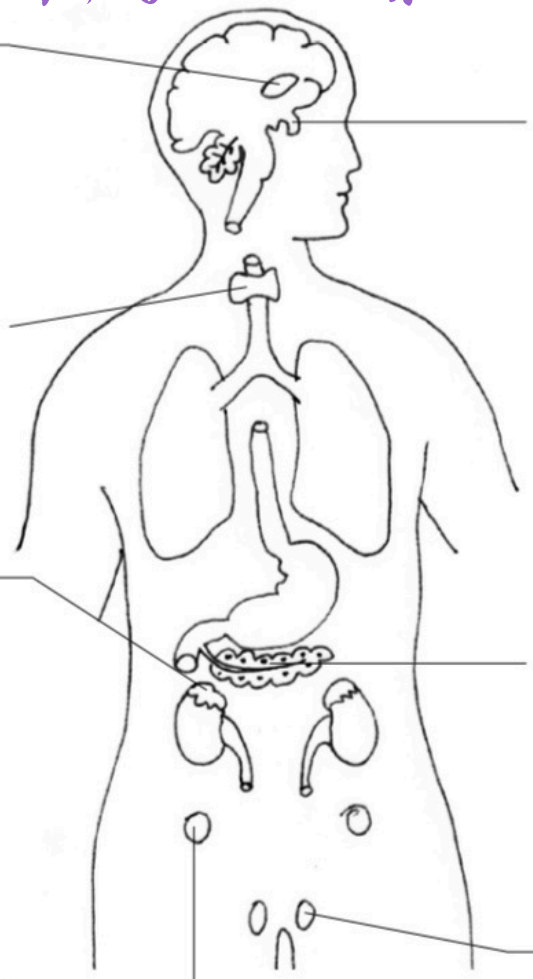
Mammals produce secretions from **exocrine** and **endocrine** glands.

Exocrine glands	Endocrine glands
• have ducts • secretions released into a cavity or on a surface • *Examples*: salivary glands (saliva), sweat glands(sweat)	• ductless • hormones released into the bloodstream • *Examples*: pituitary (ADH), thyroid (TSH), pancreas (insulin)

The pancreas is both an endocrine and an exocrine gland. As an exocrine gland it secretes digestive enzymes into the small intestine. As an endocrine gland it secretes insulin and glucagon into the bloodstream.

Hormones are organic chemical messengers, secreted in one part and work in another.

Endocrine glands, their hormones & their functions



Hypothalamus:
ADH (antidiuretic hormone)
- Target organ: Kidney
- Controls the concentration of water in the blood

Thyroid gland:
Thyroxin
- Controls basic metabolic rate

Adrenal gland:
Adrenalin
Increases:
- heartbeat
- blood pressure
- conversion from glycogen to glucose
- blood supply to the cardiac and skeletal muscles
- skeletal muscle tone
- rate and depth of breathing
- diameter of pupils

Decreases:
- blood flow to the digestive system and skin

Aldosterone
- Target organ: Kidney
- Regulates salt concentration in the blood

Pituitary gland (hypophysis):
GH (growth hormone)
- Controls growth

TSH (thyroid stimulating hormone)
- Stimulates thyroid gland to secrete thyroxin

Reproductive hormones:
FSH, LH and prolactin
- FSH – stimulates the development of the follicle in the ovaries
- LH – stimulates ovulation, and stimulates development of the corpus luteum
- Prolactin – stimulates the mammary glands to secrete milk

Pancreas: Islets of Langerhans
Glucagon
- Stimulates conversion of glycogen to glucose (increases blood glucose levels)

Insulin
- Stimulates conversion of glucose to glycogen (reduces the blood glucose levels)

Testes (only males):
Reproductive hormone:
Testosterone
- Stimulates the maturation of sperm cells
- Stimulates puberty in males

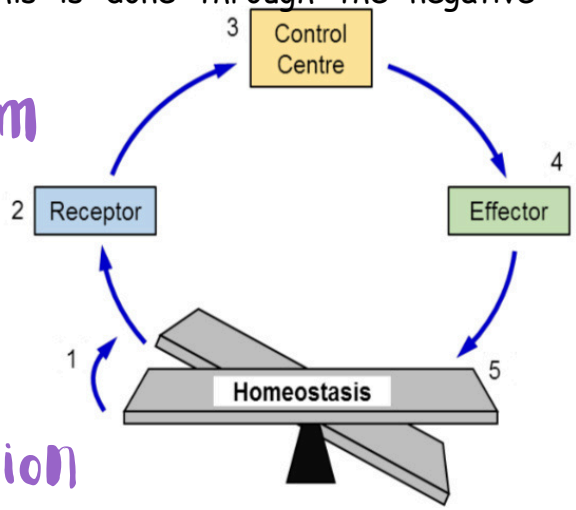
Ovary (only females):
Reproductive hormones:
Oestrogen and ***progesterone***
- Oestrogen – stimulates puberty in females, promotes thickening of the endometrium
- Progesterone – promotes thickening of the endometrium, maintains pregnancy

Homeostasis Notes

Homeostasis is the tendency of an organism or cell to regulate its internal conditions, usually by a system of feedback controls, so as to stabilize health and functioning, regardless of the outside changing conditions. This is done through the negative feedback mechanism.

Negative feedback mechanism

A negative feedback mechanism is an interaction between two hormones in which one hormone stimulates an increase in another hormone which then inhibits the first hormone, thus restoring balance.



Osmoregulation

The homeostatic control of water levels in blood and tissue fluid is carried out in a negative feedback system known as **osmoregulation**.

ADH is produced by hypothalamus and secreted by the pituitary gland.

A – decreased water level	B – increased water level
Dehydration - when the water levels in the blood and tissue fluids are low	**Overhydration** is when water levels in the blood and tissue fluids are high.
May be due to **excessive exercise**, **hot temperatures**, **increased sweating** or **decreased water intake**.	May be due to **cooler temperatures**, **little exercise** with **no sweating** and an **excessive intake of water.**
Low levels of water in the blood and tissue fluid is detected by receptor cells (**osmoreceptors**), in the **hypo-thalamus** of the brain.	Water levels in the blood and tissue fluid are high, and this is detected by the **osmoreceptors** in the **hypo-thalamus**.
Impulses are sent to the **pituitary gland** and **antidiuretic hormone (ADH)** is released.	**Impulses** are sent to the **pituitary gland** and **less anti-diuretic hormone (ADH)** is released.
The hormone is transported in the blood to the **effector organ**, the **kidney**. The **permeability** of the **collecting duct** and the **distal convoluted tubule** is **increased**.	**Collecting ducts** and **distal convoluted tubules** in the **kidney** become **less permeable**.
More water is **reabsorbed** and passed into the **blood**.	**Less water** is **reabsorbed** into the blood.
The **blood** becomes more **dilute** and **concentrated urine** is **excreted**.	More water is lost, **more dilute urine** is **excreted**.

Carbon dioxide regulation

1	High concentrations of CO_2 lead to the formation of carbonic acid. As a result, the pH of the blood will drop (the blood becomes more acidic).
2	Chemoreceptors in the carotid artery are stimulated by the drop in pH.
3	Impulses are sent to the medulla oblongata.
4	Breathing and heart muscles are targeted. Diaphragm and intercostal muscles contract increasing the rate and depth of breathing.
5	Heart rate increases.
6	More CO_2 moves to the lungs to be exhaled therefore blood CO_2 levels return to normal. **Homeostasis** is maintained.

High carbon dioxide levels make the blood acidic

Homeostasis Notes

Regulation of salt

Hypotonic- low salt Hypertonic- high salt

A – low salt level	B – high salt level
Low salt levels in blood and tissue fluids.	When the **salt levels** in the blood and tissue fluids are increased.
Receptor cells in the **kidney** detect decreased sodium ion levels.	**Receptor cells** in the **kidney** will detect an increased presence of sodium ions.
The **adrenal gland** in the kidney secretes the hormone **aldosterone.**	The **adrenal gland** stops releasing **aldosterone**.
Aldosterone stimulates the **reabsorption** of **sodium ions** from the filtrate and back into the blood.	**Sodium ions** will **not** be **reabsorbed.**
Less sodium is excreted in the **urine**.	**More sodium** is excreted in the **urine**.

Thyroxin regulation

Two glands are involved in the control of thyroxin levels:
- **pituitary gland** - which releases thyroid stimulating hormone (TSH)
- **thyroid gland** - which releases thyroxin

A – low thyroxin level	B – high thyroxin level
When levels of thyroxin that fall **below normal**, this is detected by the **pituitary** gland.	When levels of thyroxin increase above normal, this is detected by the **pituitary** gland which is then inhibited.
This causes the pituitary gland to **secrete** more **TSH**.	**Less TSH** is secreted from the pituitary gland.
TSH is **transported** via the bloodstream to the **thyroid gland** which stimulates **increased** secretion of **thyroxin.**	**Lower** secretions of **TSH** result in the thyroid gland releasing **less thyroxin**.
The level of thyroxin is increased back to normal.	The level of thyroxin is decreased back to normal.

Glucose regulation

A – high blood glucose	B – low blood glucose
Increased blood glucose levels are detected by the Islets of Langerhans in the pancreas.	**Decreased blood glucose** levels are detected by the Islets of Langerhans in the pancreas.
The Islets of Langerhans respond by secreting **insulin** into the bloodstream.	**Glucagon** is secreted by the Islets of Langerhans into the blood-stream.
Insulin is transported to the **liver** which is the **effector** organ.	Glucagon is transported to the **effector** organ, the **liver.**
Enzymes in the liver catalyse the conversion of excess **glucose into glycogen.** Glycogen is a **storage** carbohydrate.	Glycogen is **broken down** into **free glucose.** Glucose is released into the bloodstream.
Glucose **levels** in the blood return to **normal.**	**Glucose levels** are **increased** to **normal** levels.

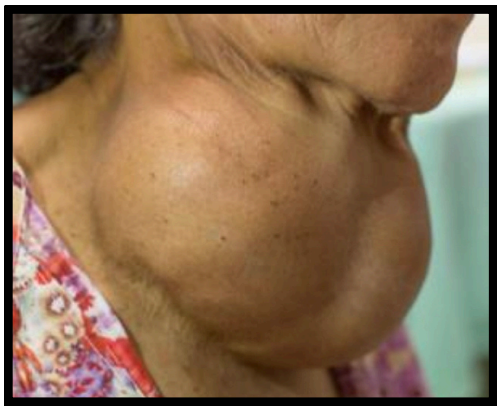
The two hormones are secreted by islets of Langerhans in the pancreas

Homeostasis Disorders

Homeostasis is the tendency of an organism or cell to regulate its internal conditions, usually by a system of feedback controls, so as to stabilize health and functioning, regardless of the outside changing conditions. This is done through the negative feedback mechanism.

Hyperthyroidism

Overstimulation of the thyroid leads to goitre.



Overstimulation of the thyroid is due to lack of iodine - needed to produce thyroxin.

Symptoms:
- increased metabolic rate
- increased cardio-vascular activity
- increased anxiety
- swollen thyroid gland in neck

Hypothyroidism

Understimulation of the thyroid leads to Myxoedema - In adults

Symptoms:
- mental, physical tiredness
- low metabolic rate
- increase in dermal fat
- roughening of skin

Understimulation of the thyroid leads to Cretinism - In children

Symptoms:
- physical, mental retardation

Pituitary disorders

	Acromegaly	Dwarfism	Gigantism (Figure 15)
	hypersecretion of GH	**hypo**secretion of GH	**hyper**secretion of GH
Cause	too much GH secreted **after puberty**	too little GH produced during childhood	too much GH secreted during childhood
Symptoms	• enlargement of the hands and feet • additionally: enlargement of the forehead, jaw and nose	• well-proportioned but of short stature • retarded growth and delayed puberty.	• long bones and connective tissue grow very fast • person may grow up to 2,1 to 2,5 m tall • heart and other organs also enlarge, causing high blood pressure

The continued production of too much thyroxin is known as hyperthyroidism (hyper = high). Continued low levels of thyroxin leads to hypothyroidism (hypo=low).

Diabetes

Diabetes mellitus is a disease associated with high blood glucose levels.

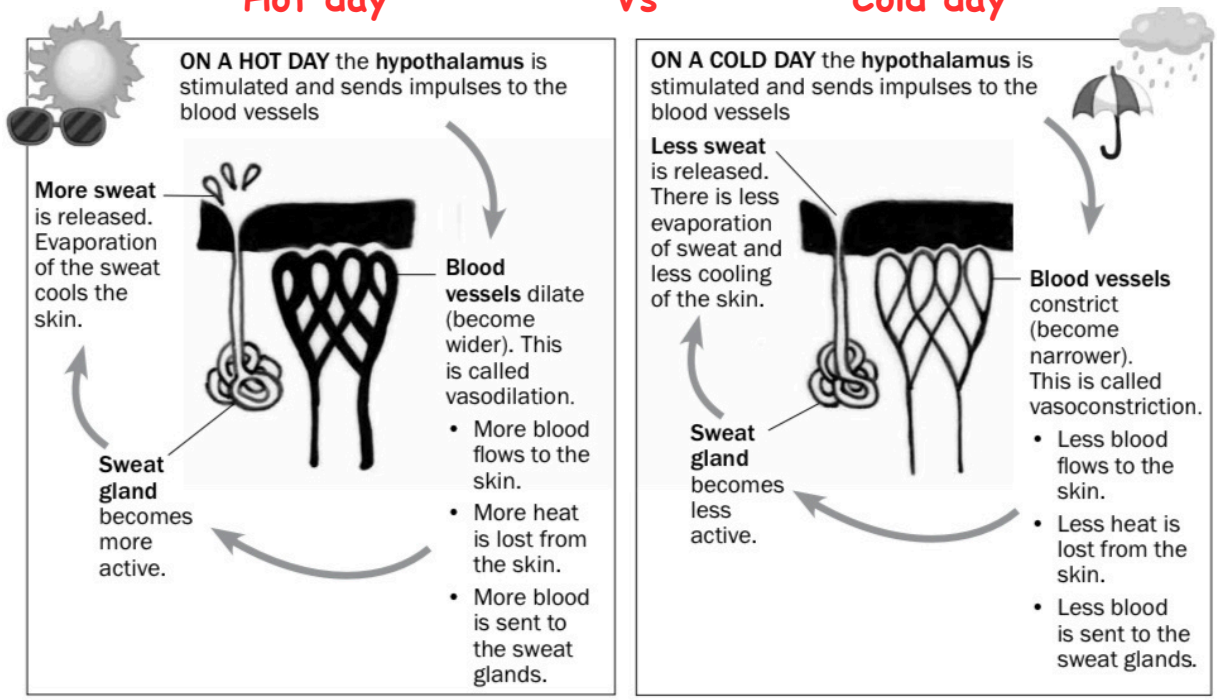
Non-diabetic	Type 1 Diabetic	Type 2 Diabetic
Normal blood glucose levels: 80-100 mg/ml of blood	**Type 1** diabetes – pancreas **not producing** the hormone, **insulin**, necessary for controlling the glucose levels in humans	**Type 2** diabetes – insulin is available, but the body is unable to control the glucose levels

Thermoregulation Notes

The way in which the body manages to control its internal core temperature when external environmental conditions change is called **thermoregulation**.

The human skin is well adapted for thermoregulation. It is the largest organ in the body and has thermoreceptors which respond to either hot (Ruffini's corpuscles) or cold (Krause's end bulb).

Hot day Vs Cold day



Hot environment	Cold environment
• body temperature **increases** • warmed blood passes through the hypothalamus • impulses are sent to blood vessels in the skin and to sweat glands	• body temperature **decreases** • slightly colder blood passes through the hypothalamus • impulses are sent to blood vessels in the skin and to sweat glands
• **vasodilation** – blood vessels dilate and more blood flows closer to surface of the skin	• **vasoconstriction** – blood vessels become narrow and less blood flows close to surface of the skin
• more heat lost to outside air by **radiation** and **conduction**	• less heat is lost to outside air

Heat can be lost from the body by evaporation, radiation, conduction and convection. sweat pore

Endocrine system Terminology

Biological term	Description
Endocrine glands	Ductless glands secreting hormones directly into bloodstream.
Exocrine glands	Secrete substances into **ducts** that lead **into cavities** in the body or lead directly to the external environment. (Examples: sweat glands, mammary glands, the liver, salivary glands and the pancreas.)
Hormones	Organic chemical messengers secreted directly into the blood by an endocrine gland.
Homeostasis	It is the process of **maintaining a constant internal environment** within narrow limits, despite changes that take place internally and externally.
Negative feedback mechanism	When there is an increase from normal, a corrective mechanism causes a decrease and vice versa to maintain a balanced system.

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Negative feedback mechanism	When there is an increase from normal, a corrective mechanism causes a decrease and vice versa to maintain a balanced system.
Vasoconstriction	The narrowing of the blood vessels in the skin that decreases the amount of blood flowing to the skin in humans when the environmental temperature is low
Vasodilation	The widening of the blood vessels in the skin that increases the amount of blood flowing to the skin in humans when the environmental temperature is high