The Endocrine System

AusDBF - eLearning Modules

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The Endocrine System

Welcome to AusDBF eLearning module – The Endocrine System.

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The Endocrine System – An introduction

The human body uses two types of intercellular communication,

- electrical (the nervous system) and **chemical. (the endocrine system**)

The endocrine system is the collection of glands that produce hormones, that regulate **metabolism**, **growth and development**, and **functions of the body** such as….tissue function, sexual function, reproduction, sleep, mood etc.

The endocrine system is a **chemical messenger system**, that secrete **hormones** as a primary or secondary function. It is typically less specific than neural signalling.

Signals are sent by the endocrine glands, which secrete hormones directly into the extracellular fluid. They are primarily transported via the blood stream, where they bind to receptors to regulate target cells.

The Endocrine System – An introduction

The **hypothalamus & the pituitary gland,** found at the base of the brain, are the neural control centre for all endocrine systems.

In addition to the specialized endocrine glands above, many other organs that are part of other body systems, have **secondary endocrine functions**. For example - bone, kidney, liver, heart and gonads

A number of glands, that signal each other in sequence are usually referred to as **an axis**.
eg. the hypothalamic-pituitary-adrenal axis. - where the the kidney secretes endocrine hormones, such as erythropoietin and renin.

THE STRUCTURES OF THE ENDOCRINE SYSTEM

THE HYPOTHALMUS

The region inferior to the thalmus (towards the base of the brain) that functions in neural and endocrine signaling

The **HYPOTHLAMUS AND PITUITARY COMPLEX**

- can be thought of as the command centre of the endocrine system.

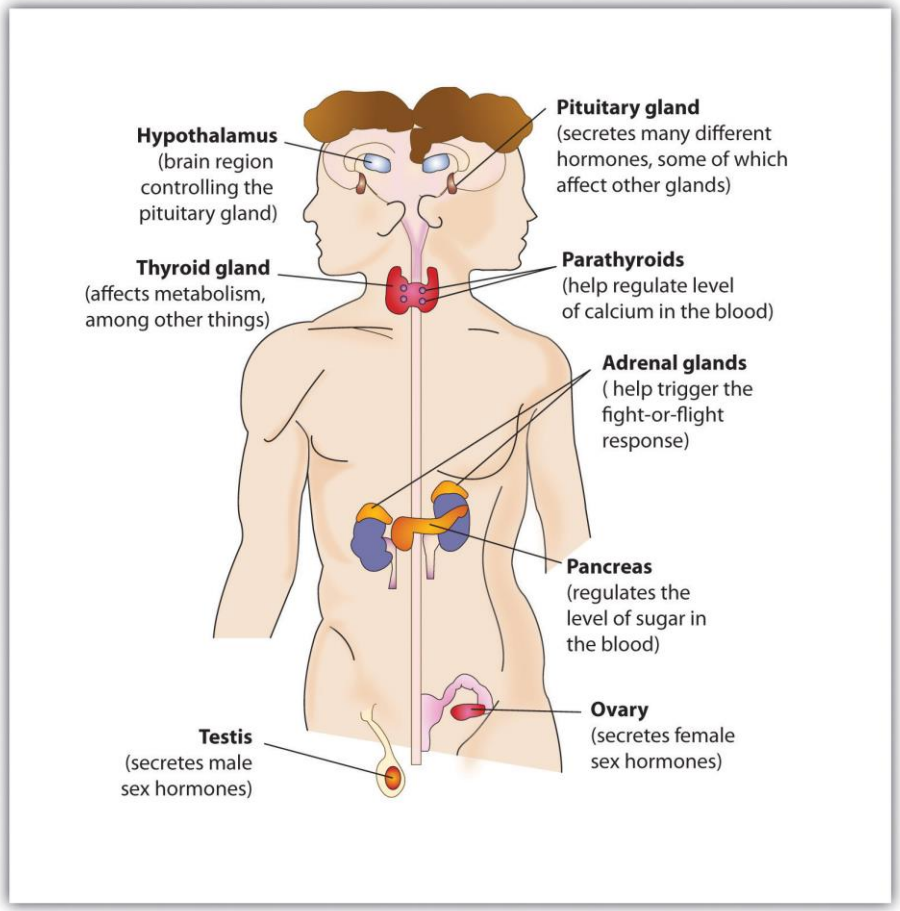
INFUNDIBULIUM

- stalk containing vasculature and neural tissue that connects the pituitary gland to the hypothalmus (also called the pituitary stalk)

THE MAJOR GLANDS OF THE ENDOCRINE SYSTEM INCLUDE THE….

- pineal gland,
- pituitary gland,
- pancreas,
- ovaries,
- testes,
- thyroid gland,
- parathyroid gland,
- hypothalamus and
- adrenal glands

The structures of the Endocrine System



The Endocrine System - Male

The Endocrine System - Female

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Structures of the Endocrine System

A GLAND

- is an organ which produces and releases substances that perform a specific function in the body.

ENDOCRINE GLANDS

- have no ducts, are vascular and commonly have intracellular vacuoles or granules that store their hormones

- some glands have both endocrine and non-endocrine functions
  eg. the pancreas contains cells that function in digestion as well as cells that secrete hormones insulin and glucagon to regulate blood glucose levels

HORMONE RECEPTORS

- receives the message from the hormone
- is a protein located either inside the cell or within the cell membrane

Other glands …..

In contrast,

EXOCRINE GLANDS

- secrete hormones to the outside of the body **using ducts**
- tend to be much less vascular and have ducts or a hollow lumen.
- examples of these are - salivary glands, sweat glands, and glands within the gastrointestinal tract

PARACRINE GLANDS

- signal between cells over a relatively short distance
- induces a response in neighbouring cells
- their concentration is often low

  eg. histamine – a paracrine that is released by immune cells, causing bronchi to constrict and narrow the airway

An AUTOCRINE

- as a chemical that elicits a response within the same cell

HORMONES

Hormones are released upon stimulation that is either chemical or neural origin.

Regulation of hormone release is primarily achieved through negative feedback.

THERE ARE THREE MAJOR TYPES OF STIMULI THAT CAUSE THE RELEASE OF HORMONES.

- **Humoral stimuli** - changes in ion or nutrient levels in the blood
- **Hormonal stimuli** - changes in hormone levels that initiate or inhibit the secretion of another hormone
- **Neural Stimulus** - when a nerve impulse prompts the secretion or inhibitions of a hormone

HORMONES

HORMONES

- play a critical role in the regulation of physiological processes because of the target cells they regulate.
- these response contribute to human reproduction, growth and development, of body tissue, digestion, respiration, tissue function, metabolism, fluid and electrolyte balance, excretion, sensory perception, sleep, mood and many other body functions.
- the amount of time it takes for hormones to signal or reach the target cells can vary

For example – when confronted with dangerous or frightening situation - the **“fight or flight” response** – occurs due to the release of **adrenal hormones**, epinephrine and norepinephrine, within seconds

In contrast - it may take up to 48 hours for target cells to respond to certain reproductive hormones

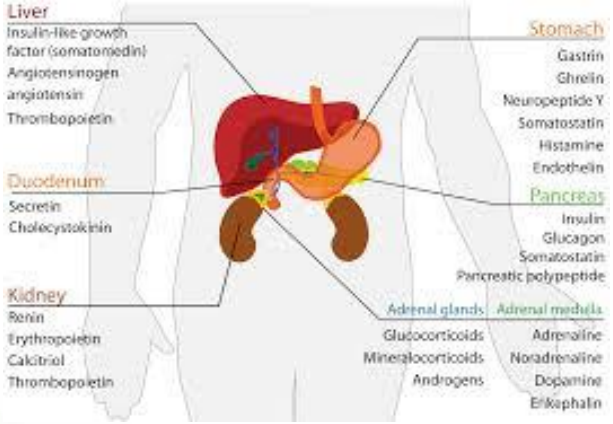
TYPES OF HORMONES

- are divided into two major groups on the basis of their chemical structure

- these chemical groups affect a hormones distribution, the type of receptors it binds to and other aspects of it's function

HORMONES DERIVED FROM AMINO ACIDS INCLUDE

- ✓ amines –eg. norepinephrine
- ✓ peptides eg. oxytocin
- ✓ proteins – human growth hormone
  - are all water soluble hormones
  - act on the surface of target cells



HORMONES DERIVED FROM LIPIDS INCLUDE

- ✓ steroids eg. testosterone & progesterone
  - are lipid soluble
  - move through the plasma membranes of target cells to act within their nuclei

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HORMONES OF THE PITUITARY GLAND

GROWTH HORMONE *(somatotropin)*
- regulates the growth of the human body, protein synthesis and cellular replication

THYROID-STIMULATING HORMONE (TSH) *(thyrotropin)*
- regulates the thyroid gland
- released in response to **THYROTROPIN-RELEASING HORMONE (TRH)** – a negative feedback loop

ANTIDIURETIC HORMONE (ADH)
- enables the regulation of water absorption, to maintain the blood's osmolarity, causing a change in urine production

ADRENOCORTICOTROPIC HORMONE (ACTH)
- stimulates the adrenal cortex
- a variety of stressors influence it's release

OXYTOCIN
- stimulates uterine contractions & dilation of the cervix

HORMONES OF THE PITUITARY GLAND…..

MELANOCYTE-STIMULATING HORMONE

- responsible for the production of melanin production in response to UV light exposure and the darkening of the skin

FOLLICLE STIMULATING HORMONE (FSH)

- stimulates the production and maturation of the sex cells - ova and sperm

LUTEINIZING HORMONE (LH)

- triggers ovulation, productions of estrogens, progesterone by the ovaries and testosterone by the male testes

PROLACTIN (PRL) – promotes lactation in women

HORMONES OF THE THYROID & PARATHYROID GLAND

THYROID HORMONES – T3 & T4

- secreted in response to thyroid-stimulating hormone (TSH)
- influences the body's basal metabolic rate
- bind to receptors on the mitochondria and cause an increase in nutrient breakdown and the use of oxygen to produce ATP
- dietary iodine deficiency can result in impaired ability to synthesize T3 & T4, resulting in colloid accumulation – a *goiter* is a visible sign of an enlarged thyroid gland

CALCITONIN

- released from the thyroid gland in response to a rise in blood calcium levels

PARATHYROID HORMONE (PTH)

- released from the parathyroid gland for the the regulation of blood calcium levels
- stimulates the conversion of Vitamin D & calcium absorption in the GI tract.

HORMONES OF THE ADRENAL GLANDS

EPINEPHRINE (*adrenalin)* & NONEPINEPHRINE *(nor epinephrine)*

- controlled by a neural pathway that originates in the hypothalmus in response to danger or stress
- signals lower and skeletal muscle cells to convert glycogen into glucose, resulting in increased blood glucose levels
- Increases the heart rate, pulse and blood pressure to prepare the body to to fight a perceived threat or flee from it
- prompts **vasodilation** and increases the oxygenation of important organs
  eg. lungs, brain, heart and skeletal muscles
- prompts **vasoconstriction** to less essential organs
  eg. gastro intestinal tract, kidney, skin

GLUCOCORTICOIDS – including **CORTISOL** – plays an important role in glucose metabolism

HORMONES OF THE ADRENAL GLANDS……

MINERALOCORTICOIDS

- a collective of hormones secreted by the adrenal gland
- essential for fluid and electrolyte balance, particularly sodium and potassium

ALDOSTERONE

- a major mineralocorticoid hormone
- regulation of the concentration of sodium and potassium ions in urine, sweat and saliva

HORMONES OF THE PINEAL GLAND

MELATONIN

- released by the pineal gland, in response to low light levels
- high blood levels of melatonin induces drowsiness

Note – JETLAG occurs because melatonin synthesis takes several days to readjust to the light-dark pattern in the new environment

HORMONES AFFECTING THE DEVELOPMENT OF THE REPRODUCTIVE SYSTEM

TESTOSTERONE

- steroid hormone important in the development of of the male reproductive system – including deeper voice, body hair and increased muscle mass

ESTROGENS

- important in the development of the female reproductive system, including regulation of the menstrual cycle, increased adipose tissue and breast tissue development

PROGESTERONE

- ovarian hormone important in regulating menstrual cycle and in preparing body for pregnancy

HORMONES OF THE PANCREAS

GLUCAGON

- leads to an increase of blood glucose levels
- stimulates liver to convert its stores of glycogen back into glucose, and stimulates lipolysis (the breakdown of stored triglycerides into free fatty acids and glycerol)

INSULIN

- facilitates the uptake of glucose into the body cells
- a dysfunction of insulin production and secretion leads to diabetes mellitus

Type 1 Diabetes (mellitus)

- an auto immune disease, where insulin is not produced. Hence insulin is often injected

Type 2 Diabetes

- acquired by range of lifestyle factors such as diet, inactivity, genetic disposition
- commonly treated through lifestyle changes

SYNTHETIC HORMONES

Many synthetic hormones have been developed, to be used in a variety of medical situations. Some are of interest to the athlete – however strict WADA/ASADA guidelines prohibit athletes from their use. Some that are often discussed are shown below -

ANABOLIC STEROIDS

- used to mimic of the male sex hormone testosterone,
- are used predominantly to build muscle mass (eg. for added strength)

SYNTHETIC VERSION OF GROWTH HORMONE

- to aid in the build up of muscle mass

ERYTHROPOIETIN (EPO)

- naturally produced by the kidneys, yet is also available as a pharmaceutical
- stimulates the production of red blood cells in the bone marrow and regulates the concentration of RBC and **haemoglobin in the blood**
- of value to athletes with AEROBIC based events as it enables them to transport more O2 to the muscle cells for effective energy production

HORMONES DECREASE WITH AGE

The production of some hormones, such as human growth hormones, cortisol, alderstone, sex hormones and thyroid hormones all decrease with age.

DISEASES OF THE ENDOCRINE SYSTEM

Diseases of the endocrine system are common, and can include conditions, such as diabetes mellitus, thyroid disease, and obesity.

ENDOCRINE DISEASE IS CHARACTERIZED BY

- a mis- regulated hormone release - a productive pituitary adenoma
- inappropriate response to signalling - hypothyroidism
- structural enlargement in a critical site, eg. thyroid - toxic multinodular goitre.
- lack of a gland – pancreas - diabetes mellitus type 1,
- diminished erythropoiesis - chronic kidney failure

DISEASES OF THE ENDOCRINE SYSTEM

HYPOFUNCTION OF ENDOCRINE GLANDS can occur as a result of

- loss of reserve,
- hyposecretion,
- agenesis,
- atrophy, or
- active destruction.

HYPERFUNCTION OF ENDOCRINE GLANDS can occur as a result of

- hypersecretion,
- loss of suppression,
- hyperplastic or neoplastic change, or
- hyperstimulation.

DYSFUNCTION OF THE THYROID, AND HORMONES ….
have been implicated in wrongly signalling distant tissues to proliferate, eg. the estrogen receptor has been shown to be involved in certain breast cancers.

OTHER COMMON DISEASES OF THE ENDOCRINE SYSTEM

CUSHING'S DISEASE

- dysfunction of the Adrenal Gland
- due to hypercortisolism, characterized by the hypersecretion of the adrenocorticotropic hormone (ACTH)
- clinical signs can include include obesity, moon face

ADDISON'S DISEASE

- dysfunction of the Adrenal Gland
- due to hypocortisolism
- causing a decreased ability to maintain blood pressure and blood sugar

GRAVES DISEASE

- involves the hyperactivity of the thyroid gland which produces the T3 and T4 hormones.
- the effects range from excess sweating, fatigue, heat intolerance and high blood pressure, redness, puffiness of the eyes

Please **turn up your volume** then
click on the URL link below to
view a short video of the Endocrine system.
When the video is completed please return and go to
the next slide in this presentation.

https://youtu.be/DFMjjF1drRA