Methods of examination of the Endocrine System

- The **endocrine system** is a chemical messenger system comprising feedback loops of the hormones released by internal glands of an organism directly into the circulatory system, regulating distant target organs.
- The endocrine system involves many organ systems and hormones, <u>many of which are</u> <u>still being investigated and understood.</u>

- The interaction between the hypothalamus and pituitary (called the hypothalamic-pituitary axis) is a feedback control system.
- The hypothalamus receives input from virtually all other areas of the central nervous system and uses it to provide input to the pituitary. In response, the pituitary releases various hormones that stimulate certain endocrine glands throughout the body.
- Changes in circulating levels of hormones produced by these endocrine glands are detected by the hypothalamus, which then increases or decreases its stimulation of the pituitary to maintain homeostasis.



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Endocrine Organs of the Brain

hypothalamus

pituitary gland

pineal gland

Hypothalamus. The hypothalamus is located at the base of the brain, near the optic chiasm where the optic nerves behind each eye cross and meet.

The hypothalamus secretes hormones that stimulate or suppress the release of hormones in the pituitary gland, in addition to controlling water balance, sleep, temperature, appetite, and blood pressure. Produces **melatonin** (synthesized from seratonin, a derivative of tryptophan)

- High levels at night make us sleepy; low level during day
- Pineal gland is stimulated by darkness and inhibited by light
- Function in regulating circadian
 rhythms (sleep, body temp,

appetite) \rightarrow biological clock



Melatonin

- synchronizes central but also peripheral oscillators (fetal adrenal gland, pancreas, liver, kidney, heart, lung, fat, gut, etc.), allowing temporal organization of biological functions through circadian rhythms (24-hour cycles) in relation to periodic environmental changes and therefore adaptation of the individual to his/her internal and external environment.
- The physiological effects of melatonin: detoxification of free radicals and antioxidant actions, bone formation and protection, reproduction, and cardiovascular, immune or body mass regulation.
- Also, protective and therapeutic effects of melatonin are reported, especially with regard to brain or gastrointestinal protection, psychiatric disorders, cardiovascular diseases and oncostatic effects.

Pituitary gland

-Master gland of body

- Located in the depression of sphenoid bone

-Produces many hormones that affect other glands:

- thyroid stimulating hormone
- Somatotropin- growth hormone
- Lutenizing (LH)- causes ovulation
- ICSH- causes testes to secrete testosterone
- Melanocyte stimulating- distribution of melanin in skin
- ADH- antidiuretic hormone



Posterior Pituitary



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Hormones of the Posterior Pituitary

Antidiuretic Hormone (ADH) Oxytocin (+ feedback)





Anterior Pituitary



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Hormones of the Anterior Pituitary

- Growth Hormone (GH)
- Thyroid Stimulating Hormone (TSH)
- Adrenocorticotropic Hormone (ACTH)
- Gonadotropins (FSH, LH)
- Prolactin (PRL)
- Melanocyte-stimulating Hormone (MSH)

Growth Hormone (GH)

- Acts on the liver, stimulating it to release several polypeptide hormones.
- Stimulates amino acid uptake and protein synthesis in target cells.
- Ultimately stimulates cell growth (cell size and number), especially in muscle and bone.
- Also stimulates fat breakdown.







-**Giantism-** oversecretion of somatotropin before puberty

-Dwarfism-

undersecretion of somatotropin. Cause: tumor, injury, infection, genetics

-**Diabetes insipidus**decreased ADH

Dwarfism

hyposecretion of GH



Kenadie - worlds smallest girl due to primordial dwarfism

Gigantism hypersecretion of GH



Bao Xishun, a 7ft 8.95in herdsman from Inner Mongolia



↑GH





^GH as an adult-acromegaly







^GH as an adult-acromegaly



Thyroid-Stimulating Hormone (TSH)

- Acts on the thyroid gland, stimulating it to release T3 & T4
- These thyroid hormones increase glucose catabolism and body heat production.
- Negative feedback mechanism involved in regulating levels.

Adrenocorticotropic Hormone (ATCH)

- Acts on the adrenal cortex, stimulating it to secrete glucocorticoids (e.g., cortisol).
- Glucocorticoids promote the synthesis of glucose from noncarbohydrate sources such as amino acids, and fatty acids
- Negative feedback mechanism involved in regulating levels.

Thyroid Gland



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Thyroid Hormones

Thyroid gland selectively uptakes iodine to produce T₃ & T₄

- Thyroxine (T_4)
- **Triiodothyronine** (T₃) Both control metabolic rate and cellular oxidation
- Calcitonin (from parafolicular cells)lowers blood Ca ⁺⁺ levels and causes Ca⁺⁺ reabsorption in bone

Thyroid Hormones



Thyroid Hormones

Increased thyroid hormone release causes *hyperthyroidism,* commonly called **Graves'** disease.

- Signs and symptoms:
 - insomnia, fatigue
 - tachycardia
 - hypertension
 - -heat intolerance
 - -weight loss

- Long term hyperthyroidism:
 - Exopthalmos
 - bulging of the
 eyeballs (picture
 Barbara Bush)
 - In severe cases a medical emergency called *thyrotoxicosis* can result.











Inspect the neck: Skin changes - erythema Carse - thyroidectomy Masses - goitre / lymph node







Auscultate each lobe of the thyroid listening for a thyroid bruit (increased vascularity secondary to Graves' disease)

Goiter

Lack of iodine in diet hyposecretion of T3 & T4







Hypothyroidism

Inadequate levels of thyroid hormones = **hypothyroidism**, or **Myxedema**.

Myxedema symptoms:

- Facial bloating
- weakness
- cold intolerance
- lethargy
- altered mental status
- oily skin and hair
- TX: replacement of thyroid hormone.

Cretinism

hyposecretion of T3 & T4





Myxedema hyposecretion of T3 & T4



Exophthalmos-hyperthyroidism





Hypersecretion of TSH or TH





(b) Exophthalmos



(c) Goiter

Parathyroid Glands

parathyroid glands

• thyroid

esophagus

trachea

Parathyroid Glands

- small, pea-shaped glands, located in the neck near the thyroid
- usually 4 number can vary
- regulate the level of calcium in the body
- produce *parathyroid hormone* 1 level of calcium in blood
- Hypocalcemia can result if parathyroids are removed or destroyed.

Parathyroid Hormone (PTH)

- 1) stimulates osteoclasts
- enhances reabsorption of Ca⁺⁺ by kidneys
- 3) increases absorption of Ca⁺⁺ by intestinal mucosal cells



- <u>Hyperparathyroidism</u>- too much Ca⁺⁺ drawn out of bone; could be due to tumor
- Hypoparathyroidism most often follow parathyroid gland trauma or after removal of thyroid--- tetany, muscle twitches, convulsions; if untreated → respiratory paralysis and death



100 At 110 At 110

- a key gland located in the folds of the duodenum
- has both endocrine and exocrine functions
- secretes several key digestive enzymes
- **Islets of Langerhans**
 - specialized tissues in which the endocrine functions of the pancreas occurs
 - include 3 types of cells:
 - alpha (α)
 - beta (β)
 - delta (∂)
 - each secretes an important hormone.



- -Alpha (α) cells release *glucagon*, essential for controlling blood glucose levels.
- -When blood glucose levels fall, α cells $\ \uparrow$ the amount of glucagon in the blood .
- -The surge of glucagon stimulates the liver to release glucose stores (from glycogen and additional storage sites)
- glucagon stimulates the liver to manufacture glucose gluconeogenesis.

- -Beta Cells (β) release *insulin* (antagonistic to glucagon).
- -Insulin 1 the rate at which various body cells take up glucose. Thus, insulin lowers the blood glucose level.
- -Insulin is rapidly broken down by the liver and must be secreted constantly.
- -Delta Cells (∂) produce *somatostatin*, which inhibits both glucagon and insulin

- Regulates glucose uptake by cells
- Controlled via negative feedback: insulin & glucagon
- N. blood sugar level: 60-99 mg/dL (3.3-5.5 mmol/l in the blood sample collected from the finger; up to 6.5 mmol/l-in the blood sample collected from the vein
- Conversion factor: mg/dl x 0.0555 = mmol / L

Insulin

- Produced by the β cells of the Islets of Langerhan
- Catalyze oxidation of glucose for ATP production
- Lowers blood glucose levels by promoting transport of glucose into cells.
- Stimulates glucose uptake by the liver and muscle cells.
- Stimulates glycogen synthesis in the liver and muscle cells (*glycogenesis*).
- Stimulates amino acid uptake and protein synthesis
- Stimulate lipogenesis
- Decreases glycogenolysis
- Decreases gluconeogenesis

Glucagon

- Produced by the α cells of the Islets of Langerhans
- Stimulates change of glycogen to glucose in the liver (*glycogenolysis*).
- Synthesis of glucose from lactic acid and non carbohydrate molecules such as fatty acids and amino acids (*gluconeogenesis*)
- Causes 1 in blood glucose concentration

hypoglycemic- low blood sugar[↑]; deficient in glucagon

Regulation of Blood Sugar Levels



Symptoms of DM:

- Hypergylcemia
- Glucosauria
- Polyuria
- Polydipsia
- Polyphagia
- Ketoacidosis

Complications of DM:

- Arteriosclerosis
- Cardiovascular problems
- Gangrene
- Eye problems
- Kidney damage







Carlyn Iverson

ADRENAL CORTEX releases: glucocorticoids e.g. cortisol mineralocorticoids

e.g. aldosterone

sex hormones

e.g. testosterone

ADRENAL MEDULLA releases:

epinephrine

norepinephrine

kidney





Hormones of the Adrenal Medulla

- Adrenalin (epinephrine): converts glycogen to glucose in liver
- Noradrenalin (norepinephrine): increases blood pressure (sympathetic nervous system)
- Corticosteroids:
 [↑] glucose levels)

Hormones of the Adrenal Cortex

Glucocorticoids- cortisol

- 1. Decrease protein synthesis
- 2. Increase release and use of fatty acids
- 3. Stimulates the liver to produce glucose from non carb's

Mineralcorticoids- aldosterone

- 1. Stimulates cells in kidney to reabsorb Na+ from filtrate
- 2. Increases water reabsorption in kidneys
- 3. Increases blood pressure

Sex Steroids- small amts (androgens)

- 1. Onset of puberty
- 2 Sex drive

Cushing's Syndrome

Hypersecretion of cortisone; may be caused by an ACTH releasing tumor in pituitary

Symptoms: trunkal obesity and moon face, emotional instability









(b) Pendulous abdomen with striae

Hypersecretion of Adrenal Cortex





Addison's Disease

Hyposecretion of glucocorticoids and mineral corticoids;

Symptoms- weight loss, fatigue, dizziness, changes in mood and personality, low levels of plasma glucose and Na+ levels, high levels of K+





Too many steroids







Thymus



Located anterior to the heart

Produces- thymopoetin and thymosin→ helps direct maturation and specialization of T-lymphocytes (immunity)

Gonads

<u>**Ovaries</u>**- produce estrogen and progesterone \rightarrow responsible for maturation of the reproductive organs and 2ndary sex characteristics in girls at puberty</u>





Female Reproductive System



Gonads

<u>**Testes</u>**- produce sperm and testosterone (initiates maturation of male repro organs and 2ndary sex characteristics in boys at puberty)</u>



