Lec. 3 · By. Rofida Awad

Endocrine system

جهاز الغدد الصماء

Endocrinology

- The medical specialty :-

1- studies the anatomy and physiology (الفسيولوجي) of the endocrine system.

2- uses diagnostic tests (الفحوصات الخبرية والأشعات واستخدامها)

3- medical and surgical procedures, and drugs to treat endocrine system diseases. (وكيف نعالج الأمراض اللي بتصيبها سواء بالعلاج او الجراحة)

* Endocrine glands secrete (تفرز) hormones directly into bloodstream. (ومن هنا جاءت التسمية)

* Hormones regulate body activities [general]
  - Metabolic rate (معدل الأيض)
  - Water and mineral balance (توازن).
  - Immune system reactions.
  - Sexual functioning (الوظائف الجنسية)

Organs of the endocrine system

- Adrenal glands [two]
- Gonads [ovaries and testes] [two of each one]
- Hypothalamus
- Pancreas [islets of Langerhans].
- Parathyroid glands [four].
- Pineal gland
- Pituitary gland
- Thymus gland.
- Thyroid gland.

راجع الصور في السلايد

* Hormones are chemicals that act on target organs to increase or decrease target's activity level.

* Responsible for homeostasis [maintenance (وهو معناها) of internal environment stable].

- يحافظ على البيئة الداخلية للجسم ثابتة لا يسمح تغيرها الا general (مهمة رئيسية)

~ Types of glands in the body ~

Exocrine glands

- Release secretions into duct that carries them to outside of body or inside body.
- Ex: sweat glands (الغدد العرقية)
  Pancreas

Endocrine glands

- Release hormones directly into bloodstream. then to targets cell
- Have no ducts (لا يوجد قنوات), referred to as ductless glands.
- Ex: thyroid gland
  Pancreas ← ينطبق عليه الاثنين لأنه ما بفرز هرمونات فقط ويفرز ايضا انزيمات هاضمة تنتقل من البنكرياس عن طريق القناة البنكرياسية وتصب الانزيمات في الاثنا عشر.
  Pituitary
  adrenal glands.

Hypothalamus

* تتحكم في كل هرمونات الجسم بطريقة غير مباشرة من خلال تحكمها في [Pituitary gland]

- shaped like a flattened funnel, size of kidney bean.
- forms floor and walls of third ventricle of the brain.
- Regulates Primitive functions of the body from water balance and thermoregulation to sex drive and childbirth many of its functions carried out by Pituitary gland.
- Composed of two structures with independent origins and separate functions.

A. Adenohypophysis [anterior Pituitary].
B. Neurohypophysis [Posterior pituitary].

under effect hypothalamus (تحت تأثير)

Hypothalamic Hormones

- Eight hormones produced in hypothalamus -

- Six regulate the anterior pituitary.
- Two are released into capillaries in the Posterior Pituitary (oxytocin and antidiuretic hormone).

Six releasing and inhibiting hormones stimulate or inhibit the anterior pituitary.

- Thyrotropin releasing hormone [TRH].
- Corticortropin releasing hormone [CRH].
- Gonadotropin releasing hormone [GnRH].
- growth hormone releasing hormone [GHRH].

- Prolactin inhibiting hormone [PIH] inhibits secretion of prolactin, and Somatostatin inhibits secretion [growth hormone & thyroid stimulating hormone] by the anterior pituitary.

Two other hypothalamic hormones

- Oxytocin hormone [OT].
- Antidiuretic hormone [ADH]

- Both stored and released by Posterior Pituitary.
- Posterior Pituitary does not synthesize them.

Adrenal Glands

- Two glands, one located above each kidney.
- Each gland is composed of two sections

Adrenal cortex

secrets corticosteroids

1) Mineralocorticoids
2) Glucocorticoids
3) Steroid sex hormones.

[Mineralocorticoids]

Ex: aldosterone

- Regulates sodium (Na^+) and Potassium (K^+) levels.

[Glucocorticoids]

Ex: Cortisol

- Regulates carbohydrates.

[Steroid sex hormones]

- Androgens, estrogen, and progesterone.
- Regulates secondary sexual characteristics.

Adrenal medulla

secretes epinephrine [adrenaline] and norephrine [noradrenaline].

1) Critical during emergency situations.
2) Increases blood pressure.
3) Increases heart rate.
4) Increases respiration rate.

Ovaries

- Two ovaries Located in Pelvic cavity of females.
- Secrete female sex hormones, [estrogen and progesterone].

ESTROGEN

- female sexual characteristics.
- Regulation of menstrual cycle.

PROGESTERONE

- Maintains suitable uterine environment for Pregnancy.

Pancreas

- Located along lower curvature of stomach.
- Only organ that has both endocrine and exocrine functions.
- Exocrine portion :- Releases digestive enzymes through duct into duodenum.
- Endocrine :- Islets of langerhans → Produce [insulin and glucagon]

Insulin

[Produced by β-cells]

* Stimulates glucose uptake from blood stream by cells.
* Lowers blood suger level.
* Occurs after eating ameal and absorbing carbohydrates.

glucagon

[Produced by α-cells]

* Stimulates liver to release stored glucose into blood stream.
* Raises blood suger levels.
* Occurs when body needs more glucose.

Note :- • Somatostain secreted by [δ cells].
• Pencreatic polypeptide secreted by [γ cells.]

- Parathyroid Glands -

- four tiny glands.
- Located on dorsal surface of thyroid gland.
- Secretes parathyroid hormone [PTH].
- Regulates level of calcium in bloodstream.

- If calcium levels in blood fall too low:
- Parathyroid hormone levels in the blood increase.
- Stimulate bone breakdown.
- Releasing more calcium into bloodstream.

Pineal Gland Brain غدة

- Small pine cone - shaped gland.
- Part of thalamus region of brain
- Secretes melatonin.
- Not well understood, but plays role in regulating body's circadian rhythm.
- 24- hour clock that governs periods of wakefulness and sleepiness.

Pituitary Gland

- Small marble- shaped gland.
- Located underneath brain.
- Divided into anterior and posterior lobes.
- Regulated by hypothalamus.

Anterior Pituitary

- Referred to as 'master gland'.
- Secretes hormones that regulate other endocrine glands.
- Thyroid- stimulating hormone [TSH]
- Regulates function of thyroid gland.
- Adrenocorticotropin hormone [ACTH].
- Regulates function of adrenal cortex.

- **Gonadotropins**
  - ✓ follicle - stimulating hormone -FSH-
  - ✓ Luteinizing hormone -LH-

- **FSH**
  - ✓ Responsible for development of ova and sperm.
  - ✓ Also stimulates ovary to secrete estrogen.

- **LH**
  - ✓ Stimulates secretion of sex hormones.
  - ✓ Plays a role in releasing ova in females.
  - ✓ Growth hormone [GH] (somatotropin).
  - ✓ Stimulates cells to grow and divide.

- **Prolactin -PRL-**
  - ✓ Stimulates milk production in breast. العند السنة

- **Melanocyte- stimulating hormone -MSH-** صبغة اميلانين
  - ✓ Stimulates melanocytes to produce more melanin.

Posterior Pituitary ← خزنة الهرمونين

- produced in hypothalamus
- Transported to posterior lobe.
- Releases hormones when hypothalamic neurons are stimulated

- راجع الصورة في السلايد

- Antidiuretic hormone [ADH]
  - Called vasopressin
  - Promotes water reabsorption (عادة وتمتص) by the kidney tubules.

- Oxytocin
  - Stimulates uterine contractions during labor and delivery.
  - After birth stimulates release (إفراز) of milk from breast.

Testis

- Two oval glands located in scrotum
- Secrete testosterone.
  - Produces male secondary sexual characteristics. (الصفات الثانوية للذكر)
  - Regulates sperm production. - عملية انتاج الحيوانات المنوية

* راجع الصورة في السلايد

Thymus gland

- Located in mediastinum. (تقع في منطقة الصدر)
- Part of immune system.
- Also endocrine gland (لها علاقة في جهاز المناعة)
  - Secrets thymosin which is essential for growth and development of (T) cells.
  - Critical part of body's immune system.

- راجع الصورة في السلايد

- Present at birth and grows to largest size during puberty (البلوغ).
- At puberty (عند البلوغ) begins to shrink (تنكمش) and eventually is replaced with connective and adipose tissue. (وتحل محلها)

Thyroid Gland

- Located on either side of trachea (القصبة الهوائية). راجع الصورة في السلايد
- Resembles a butterfly in shape.
- Divided into right and left lobes. [it's one gland but it's consist two lobes].

Thyroid hormones

[needs (iodine) to make hormones]

- Thyroxine (T_4).
- Triiodothyronine (T_3).

[These hormones].

- Regulate energy Production.
- Adjust metabolic rate.

* Also secretes calcitonin → - يشتغل عكس شغل ال Parathyroid hormone
  - Regulates level of calcium in bloodstream.
  - If calcium levels in blood rise too high :-
    - Calcitonin levels in blood increase:
    - Increases deposition (ترسيب) of calcium into bone.
    - Lowers levels of calcium in bloodstream.

It's action is opposite of parathyroid hormone

Endocrine functions of other organs

- Skin (غدة): keratinocytes make cholecalciferol using UV from sun.
  → مرحلة من مراحل تكوين Vitamen-D و Vitamen-D بالرغم من أنه Vitamen ولكنه له خصائص الهرمونات يعني فيه صورة من صور Vitamen D وهذه الصورة تعمل كأنها هرمون.
- Liver: involved in the production of at least five hormones
  1. converts cholecalciferol into calcidiol
  2. secrets angiotensinogen (precursor for BP (Blood pressure) regulation).

3- Secretes 15% of erythropoietin (stimulates bone marrow).
4- Hepcidin - promotes intestinal absorption of iron.
5- Source of IGF-I that controls action of growth hormone.

- **Kidneys** :- Play role in production of three hormones

1- Converts calcidiol to calcitriol, the active form of vitamin-D.
2- Secrete renin that converts angiotensinogen to angiotensin I.
3- Produce 85% of erythropoietin.

- **Heart** :- Cardiac muscle secretes atrial natriuretic peptides in response to an increase in blood pressure → ↓ blood pressure.

- **Stomach and Small intestine**: At least ten enteric hormones that coordinate digestive motility and glandular secretion.

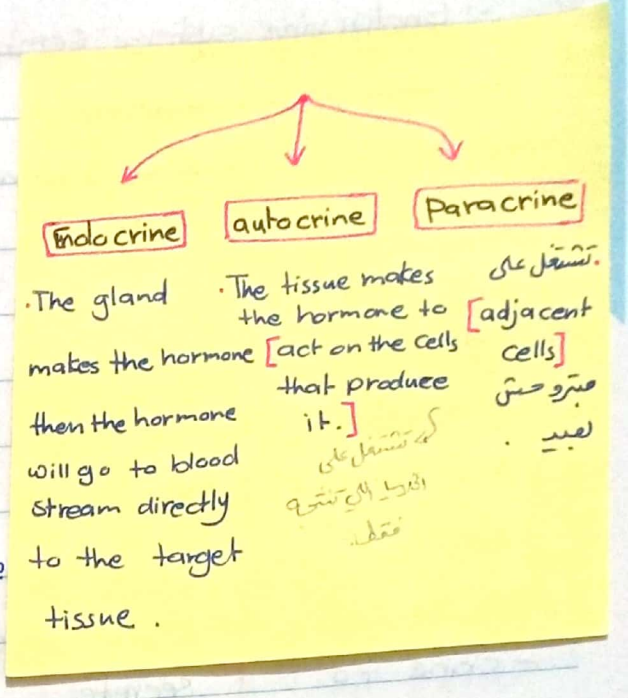
- **Adipose tissue secretes** :- secrets adipocytokines [as leptin] to slow appetite.

- **Osseous tissue** :- Osteocalcin secreted by osteoblasts increases insulin sensitivity of body tissues inhibits weight gain and onset of type II diabetes mellitus.

- **Placenta** :- secretes estrogen, progesterone, HCG and others regulate pregnancy, development of fetus.
  HCG → Human chorionic gonadotrophin.

Paracrine secretions

- Paracrines are chemical messengers that diffuse short distances and stimulate nearby cells.
- unlike neurotransmitters, not produced in neurons.
- unlike hormones, not transported in blood.
- A single chemical can act as a hormone, Paracrine, or even neurotransmitter in different locations.



Histamine from mast cells in connective tissue : causes relaxation of blood vessels.

Nitric oxide from endothelium of blood vessels, causes vasodilatation.

Somatostatin from δ cells of islets of Langerhans to inhibits [α and β cells] secretions.

Catecholamines Diffuse from adrenal medulla to cortex.

Prostaglandins

- Produced by most body tissues.
- Act near site of production
- Blood vessel constriction and dilation.
- Bronchial constriction and dilation
- Intestinal constriction and relaxation [increased and decreased peristalsis].
- Many additional functions that are not fully understood.

~ Endocrine system combining forms ~

acr/o	extremities	adren/o	adrenal glands
adrenal/o	adrenal glands	andr/o	male
calc/o	calcium	crin/o	secrete
estr/o	female	glyc/o	sugar
glycos/o	sugar	ophthalm/o	eye
gonad/o	sex glands	home/o	sameness
Pancreat/o	Pancreas	pituitar/o	Pituitary gland
Pineal/o	Pineal gland	thyr/o	thyroid gland
thyroid/o	thyroid gland	toxic/o	Poison
-crine to	secrete	-dipsia	thirst
-prandial	relating to ameal	-tropin	stimulate.
kal/i	Potassium	natr/o	Sodium.

~ Word Building with adren/o & adrenal/o ~

-al	adrenal	Pertaining to adrenal gland.
-megaly	adrenomegaly	enlarged adrenal gland.
-pathy	adrenopathy	adrenal gland disease.
-ectomy	adrenalectomy	removal of adrenal gland.
-itis	adrenalitis	inflammation of adrenal gland.

~ Word Building with calc/o & crin/o ~

hyper-	-emia	hypercalcemia	excessive calcium in blood.
hypo-	-emia	hypocalcemia	low calcium in blood
endo-	-ologist	endocrinologist	specialist in endocrine system.
endo-	-pathy	endocrinopathy	endocrine system disease.

Word Building with glyc/o, kal/i & natr/o

hyper-	-emia	hyperglycemia	excessive sugar in blood.
hypo-	-emia	hypoglycemia	low sugar in blood.
hyper-	-emia	hyperkalemia	excessive potassium in blood.
hypo-	-emia	hyponatremia	low sodium in blood.

Word Building with Parathyroid/o & Pancreat/o

-al		Parathyroidal	Pertaining to parathyroid
-ectomy		Parathyroidectomy	removal of parathyroid.
hyper-	-ism	hyperparathyroidism	state of excessive parathyroid
hypo-	-ism	hypoparathyroidism	state of insufficient parathyroid
-ic		Pancreatic	Pertaining to pancreas.

Word Building with pituitar/o & thym/o

-ary		Pituitary	Pertaining to pituitary.
hypo-	-ism	hypopituitarism	state of low pituitary.
hyper-	-ism	hyperpituitarism	state of excessive pituitary.
-ic		thymic	Pertaining to thymus.
-ectomy		thymectomy	removal of thymus
-itis		thymitis	inflammation of thymus
-oma		thymoma	thymus tumor

~ Word Building with thyr/o & thyroid/o ~

-al	thyroidal	Pertaining to thyroid.
-ectomy	thyroidectomy	removal of thyroid.
hyper- -ism	hyperthyroidism	state of excessive thyroid.
hypo- -ism	hypothyroidism	state of low thyroid.
-megaly	thyromegaly	enlarged thyroid.

[Endocrine system Vocabulary]

edema	-excessive acidity of body fluids.	ورم وتجمع السوائل
endocrinology	- excessive fluid in body tissue.	-studing anatomy and physiology -using the medical procedure -treatment disease in Endocrine gland.
exophthalmos	- diagnosis and treatment of conditions of endocrine glands.	
gynecomastia	-development of breast tissue in males.	حالة مرضية
hirsutism	- excessive amount of hair	غالبًا على الـ female وحالة مرضية
hypersecretion	-excessive hormone production by endocrine gland.	
hyposecretion	-insufficient (غير كافٍ) hormone production by endocrine gland.	
obesity السمنة	-having abnormal amount of fat	
syndrome متلازمة	-group of symptoms and signs that combine to present a clinical picture of disease or condition.	

* PH in the blood [7.35 → 7.45]

قيمة القاعدية ليش ؟! بسبب Buffers

[Adrenal Gland Pathology]

Addison's disease (عكس Cushing's syndrome)	hyposecretion (نقص في افراز) of adrenal cortex; symptoms include generalized weakness and weight loss.
Adrenal feminization (عكس Adrenal virilism)	hypersecretion (زيادة افراز) of estrogen by adrenal cortex in males; develops female secondary sexual characteristics like gynecomastia. (يظهر عنده تضخم في الثدي)
Adrenal virilism	hypersecretion of testosterone by adrenal cortex in females; develops male secondary sexual characteristics. (يظهر عندها بعض ملامح الذكورة)
Cushing's syndrome	hypersecretion of adrenal cortex; symptoms include weakness, edema, excess hair growth, and osteoporosis (هشاشة العظام).
Pheochromocytoma	hypersecretion of epinephrine by adrenal medulla tumor; usually benign; symptoms include anxiety (القلق), heart palpitations (خفقان في القلب), dyspnea (صعوبة التنفس), and headache (صداع).

* التنبي مع بعض يرفعوا ضغط الدم.

[Pancreas Pathology]

diabetes mellitus (DM) داء السكري

* Three very important symptoms for any diabetic patient ?!
1- Polyuria يزيد ادرار البول
2- Polydipsia العطش الشديد
3- Polyphagia زيادة في الشعور بالجوع.

- Chronic disorder of carbohydrate metabolism. - زيادة مستوى ال glucose في الدم ويبدأ glucose ينزل في البول
- Results in hyperglycemia and glycosuria
- Two very distinct types

[IDDM] → Insulin-dependent. (في عمر الشباب)

[NIDDM] → non-insulin-dependent (في عمر متقدم)

→ تم تسميتهم هيك لأن العلاج هو الذي يحدد

diabetic retinopathy	accumulation of damage to retina ; complication of diabetes mellitus.
keto acidosis	acidosis due to excess of acidic ketone bodies ; serious complication of diabetes mellitus.
Peripheral neuropathy	damage to nerves in lower legs and hands as aresult of diabetes mellitus.
insulinoma	islet of Langerhans tumor ; secretes excessive amount of insulin.

[Parathyroid gland Pathology]

tetany	nerve irritability and painful muscle cramps due to hypocalcemia ; may be caused by hypoparathyroidism.
Recklinghausen disease	hypersecretion of parathyroid hormone ; causes degeneration of bones.

[Pituitary gland Pathology]

acromegaly	chronic hypersecretion of growth hormone in adults ; causes enlargement of bones of head and extremities.
diabetes insipidus 'DI'	hyposecretion of antidiuretic hormone ; symptoms include 1- polyuria and 2- polydipsia.
dwarfism	hyposecretion of growth hormone in children ; causes short stature.

gigantism	hypersecretion of growth hormone in child; results in very tall adult.
Panhypopituitarism	hyposecretion of all pituitary hormones; results in problems with the glands controlled by pituitary gland. ← يؤثر على كل الغدد

Thyroid gland Pathology

Cretinism	congenital hyposecretion of thyroid; results in Poor physical and mental development. (تأخر عقلي)
goiter	enlarged thyroid gland.
Graves' disease	hypersecretion of thyroid; symptoms include exophthalmos and goiter.
Hashimoto's disease	auto immune destruction of thyroid; results in hyposecretion disorder. - من أمراض المناعة الذاتية - more common in female.
myxedema	hyposecretion disorder in adult; symptoms include anemia, edema, and mental lethargy.
thyrotoxicosis	marked hypersecretion (زيادة كبيرة جدًا); symptoms include repid heart rate, tremors (رعشة), thyromegaly (تضخم في thyroid gland), and weight loss. - يشعر دائمًا بسخونة

[Endocrine gland pathology]

adenocarcinoma	cancerous tumor in gland that produces hormones secreted by that gland; resutls in hypersecretion pathologies.

Clinical Lab tests

blood serum test	measures level of substances, such as calcium, glucose, or hormones, in blood.
total calcium	measures calcium in blood; used to diagnose parathyroid or bone disorders.
radioimmunoassay [RIA]	measures levels of hormones in blood.
fasting blood sugar [FSB]	measures glucose in bloodstream after 12-hour fast. (يصوم)
glucose tolerance test [GTT]	measures blood sugar level over several hours often person drinks large dose of glucose.
two-hour postprandial glucose tolerance test	measures blood glucose level two hours after a meal.
Protein bound iodine test [PBI]	measures (T4) blood level; iodine in the hormone becomes bound to blood proteins. (tetraiodothyronin)
thyroid function test [TFT]	measures levels of (T3), (T4), and [TSH] in blood. (triiodothyronin)

Diagnostic Imaging (خاصة بالأشعة)

thyroid echogram	ultrasound (موجات فوق صوتية) image of thyroid gland.
thyroid scan	nuclear medicine (الطب النووي) image based on accumulation (تشبع) of radioactive iodine in thyroid gland.

~ Medical treatments ~

chemical thyroidectomy	large dose of radioactive iodine is given to kill aportion of the thyroid gland; avoids surgery.
hormone replacement therapy	administering replacement hormones; treats hyposecretion disorders.
laparoscopic adrenalectomy	removal of adrenal gland thrugh small abdominal laparoscopic incision.
lobectomy	removal of alobe of thyroid gland.