Endocrine Physiology

Pituitary Gland (master gland)

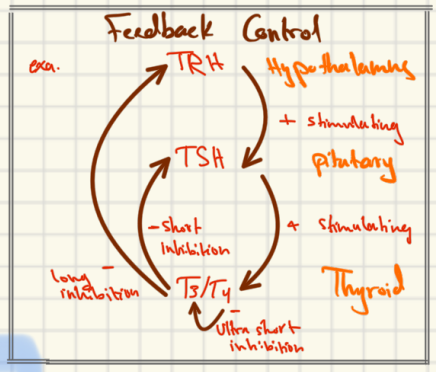
Anterior pituitary Hormones: (5 to)

- GH, somatotropin — Bones and muscles
- PL, prolactin, mammotropin — mammary gland
- TSH, thyrotropin — Thyroid
- ACTH, corticotropin — Adrenal cortex
- Gonadotropic H., GnH, gonadotropin
  - FSH — testes and ovaries
  - LH

Hypothalamic Control

- GHRH
- GHIH → somatostatin
- Dopamine, PIF
- TRH
- CRH
- GnRH

(releasing inhibatory Hormones)



Prolachin Hormone:

In Female:

1. Milk formation
2. Prevent ovulation (FSH↓ and LH↓)
3. Growth of breast with oestrogen and progesterone

In male:

⇒ Has no physiological effect.

Growth Hormone:

Growth functions:

A- Linear growth, increase in the length of the bone — Before epiphysis closure
- Increase in the thickness — After epiphysis closure

B- Growth of skeletal muscles and viscera

Metabolic Functions:

A- Protein ⟶ Anabolic
B- Carbohydrates ⟶ Diabetogenic
C- Fat ⟶ lipolytic

Hypothalamo-pituitary Axis

Posterior Pituitary Hormones:

ADH (Vasopressin):

Antidiuretic effect:

* Water reabsorption in (DCT, CT)
* Urine volume

Vasoconstriction effect:

* Blood pressure increase
* Coronary vasoconstriction
* Myocardial ischemia

Oxytocin Hormone:

Male

* contraction of epididymis and ejaculation of the semen.

Female

* During intercourse: gives orgasm and sperm suction to the uterus
* During labor: Positive Feedback Mechanism: Contraction of the uterus to facilitate labor and prevent post-partum hemorrhage. (تزيد تقلص الرحم)

Lactation: Positive Feedback Mechanism (تزيد افراز الحليب)

* Myo-epithelial cells in mammary glands to eject milk (let-Down reflex).

Thyroid Hormones (T_4 / T_3 / Calcitonin)

T_4:

- ⇒ 90% → can be converted to T_3
- ⇒ long duration ⟶ Strong bound to PP
- ⇒ Less potent ⟶ Weak affinity for receptors

T_3:

- ⇒ 10%
- ⇒ Short duration ⟶ Weak bound to PP
- ⇒ More potent (4times) ⟶ Strong affinity for receptors.

Functions:

Metabolic Function →

1. General Metabolism: BMR = Calorigenic effect
2. Protein
   - Small dose ⟶ Anabolic
   - large dose ⟶ Catabolism
3. Carbohydrates: ↓ blood glucose level
4. Fat: lipolytic

Growth Function:

1. physical growth
2. Mental growth
   - A. Normal fetal (2-3) and neonatal (0-6) brain growth
   - B. Normal CNS: ex. Memory.
3. Sexual Growth

1. Patient with total thyriodectomy:
- Entire thyroid gland is removed.

- Normally, thyroid produces T_3/T_4 Hormones, after removal, T_3/T_4 levels drop very low.

- The pituitary gland senses the low levels of T_3/T_4 and tries to compensate by increasing TSH secretion

- TSH is elevated after total thyrodictomy
(unless the patient is taking thyroid hormone replacement).

2. Patient with thyroid hormone-producing tumor:
- Produce excess T_3/T_4, without needing of TSH stimulation

- High levels of T_3/T_4 make a strong negative feedback to the pituitary.

- The negative feedback suppresses TSH secretion

- TSH low in patients with thyroid hormone-producing tumor.

3. Patient with TSH producing tumor (pituitary adenoma):
- Pituitary tumor secrets too much TSH, without normal regulation

- High TSH stimulates the thyroid gland to make too much T_3/T_4

- TSH + T_3/T_4 are elevated.

- Normally, T_3/T_4 high amount would suppress TSH (via negative feedback), but, because of the tumor is autonomous, TSH remains high despite elevated T_3/T_4.

Adrenal Gland

in the kidney

Adrenal medulla 20%

epinephrine, dopamine, norepinephrine. Catecholamines

Adrenal Cortex & Zona fasciculata (middle 75%)

Glucocorticoids

Function of Cortisol

Metabolic Functions

A- Protein → Catabolic

& Carbohydrates → diabetogenic

C- Fat → lipolytic

Anti-stress Functions

→ Cortisol and catecholamines ↑ FFA and glucose → energy for organs

→ ↓ and A.As ↑ gluconeogenesis and formation of proteins.

Anti-inflammatory Effect

Anti-immunity ↓ lymphocytes

Anti-allergic Function

Adrenal cortex & Zona reticularis (innermost 10%)

Adrenal sex Hormones

Types: DHEA and androstenedione

Control: ACTH Not by GnH

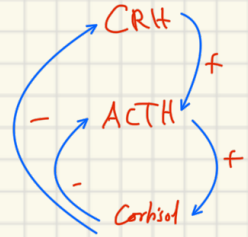
Function:

Males: No physiological effect (testosterone produced by testes)

Females: Normal pubic and axillary hair and RBCs production

Control Mechanism of Glucocorticoids

① ACTH



hypothalamus

pituitary

gland (Adrenal cortex).

② Circadian rhythm

High in early morning and low in evening.

Adrenal Cortex & Zona glomerulosa (outmost 15%)

Mineralocorticoids

Function of aldesterone

Keeping Con. Na^+, K^+, Cl^- and H2O constant in ECF

- Aldesterone → Na^+ reabsorption → exchang K^+ (Na^+ - K^+ pump) → hypokalaemia and H^+ alkalosis in DT and CT
- 2th water reabsorption by osmosis → Na^+ reabsorption ECF ↑ volume.

✳ Aldesterone Control by Angiotensinogen. (most important control)

Na^+ - K^+ Serum levels ← most potent factor

→ K^+ most potent (negative feedback) | 1mEq/L

→ Na^+ ↓ 20 mEq/L plasma.

* K^+ stimulates the Zona glomerulosa
* Na^+ low levels stimulate these cells through formation of angiotensin II.

PANCREAS

* Pancreatic Acini (exocrine) 80%
  Secrete digestive fluids in the duodenum
* Islets of Langerhans (endocrine) 20%
  Secrete 4 types of Hormones (D 10% somatostatin, F 5% pancreatic and polypeptide)

Insuline (B cells 60%)

Metabolic Function
A- Carbohydrates → Hypoglycemic (uptake glucose GLUT4)
B- Fat → lipogenic and fat sparer Hormon
C- protein → Anabolic
Growth Function

Glucagon (α Cells 25%)

1- Carbohydrates → Diabetogenic
2- Fat → lipolytic and ketogenic
3- Protein → Catabolic.

Regulation of blood glucose levels

* By the liver (hepatic glucostate).
  increase → glucose converted into glycogen stored in liver
  Decreased → glycogen, fat and protein converted into glucose
* By Hormones (insulin and glucagon)

Diabetes Mellitus

Type 1 & Insulin dependent diabetes mellitus (IDDM)
* Before 40 years, autoimmune destruction of β cells ↓ insulin secretion

Type 2 & Non-Insulin dependent diabetes Mellitus (NIDDM)
* After 40 years and obese, Insulin resistance (↓ insulin) ↑ plasma glucose
  ↑ Insulin secretion till β cell reserve is exhausted

Factors: Hereditary (type 2DM) + Obesity

DM: Polyuria, polydipsia, polyphagia, weight gain or lose.
DIABETES INSIPIDUS (↓ADH): ↓, ↑, Dehydration, Nocturia

Category	Hormones
Hypoglycemic (low con. of glucose in the blood)	Insulin
Hyperglycemic (high con. of glucose in the blood)	Glucagon, Cortisol, GH, Adrenaline, T3/T4
Lipolytic +Ketogenic	Glucagon, Adrenaline, GH, Cortisol (Fat → Fatty acids → Ketone bodies → acidosis)
Lipogenic +Antiketogenic	Insulin (fat sparer)
Growth-Promoting +Anabolic	GH, Testosterone, estrogen, Insulin, T3/T4 (in small doses)
Calorigenic	T3/T4, Adrenaline
Catabolic	Glucagon, Adrenaline, Cortisol (T3/T4 in large doses)

Hormone Group	Hormones
Mineralocorticoid Hormones	Aldosterone
Glucocorticoid Hormones	Cortisol, Corticosterone
Gonadotropic Hormones	Follicle-stimulating hormone (FSH), Luteinizing hormone (LH)
Lactogenic Hormone	Prolactin
Stress Hormones	Epinephrine, Norepinephrine, Cortisol, Growth hormone, Glucagon
Androgens	Testosterone, Dihydrepiandrostrone (DHEA), Androstenedione
Catecholamines (Adrenal medulla 20%)	Epinephrine (Adrenaline), Norepinephrine (Noradrenaline), Dopamine