Chapter 17 The Endocrine System, Part 1

1. An overview of hormones and the endocrine system

2. Describe the structural and functional organization of the hypothalamus and the pituitary and explain their relationship

3. Discuss the locations and structures of the thyroid and parathyroid glands.

4. List the hormones (and their function) produced by these glands.

5. Briefly review some examples of abnormal hormone production
Endocrine System Overview

- **Ductless glands produce hormones**
- Secreted directly into the bloodstream *(endocrine)*
  - Except the thyroid
- Gland may be entire organ:
  - Pituitary, thyroid, parathyroid, pineal, adrenal
- or bits of tissue interspersed within an organ
  - Gonads, kidneys, many others

Fig 17.1
Classes of Hormones (p 516)

- Chemical classification of hormones
  - Amino Acid Derivatives
    - Proteins (longer)
    - Peptides (shorter)
    - Amines (derived from a single amino acid)
  - Steroids (from cholesterol)
    - Glucocorticoids, mineralocorticoids, sex hormones
  - Eicosanoids (from arachidonic acid)
- Target tissues are identified by specific receptors (on target cells). The effects may be stimulatory or inhibitory, depending on the receptors.
Control of Hormone Secretion

- **Humoral**
  - BP and the kidney’s JG apparatus

- **Neural**
  - Recall the adrenal medulla
  - Hypothalamic Releasing Factors

- **Hormonal**
  - Pituitary Releasing Hormones, e.g., FSH
Hypothalamus

Control Center for environment

Regulates nervous and endocrine systems via 3 mechanisms:

1. ANS centers exert nervous control on adrenal medulla
2. ADH and Oxytocin production
3. Regulatory hormone production (RH and IH) controls pituitary gland directly and all other endocrine glands indirectly

1. These regulatory hormones are released from neurons, thus we have neuroendocrine cells.
Pituitary Gland (= Hypophysis) p 518

- **Structure:**
  - Located at the base of the brain, surrounded by the Circle of Willis
  - Infundibulum - connection to hypothalamus
  - In the sella turcica of the sphenoid bone
  - Two parts with separate embryonic origins:
    - Anterior Pituitary
    - Posterior Pituitary
Pituitary Gland (= Hypophysis) p 518

**Anterior Pituitary (= adenohypophysis)**
- AKA pars distalis
- Production of 7 peptide hormones
  - 4 are tropic hormones, stimulating other endocrine glands
- Pars intermedia and pars tuberalis secrete MSH and some gonadotropins.

![Fig 25.3](Image)
Pituitary Gland (= Hypophysis) p 518

- Posterior Pituitary (= neurohypophysis)
  - AKA pars nervosa
  - Storage reservoir for ADH and Oxytocin (produced in ?)
Pituitary Gland (= Hypophysis)

Review
Table 25.1
Anterior Pituitary: Portal System

- **Portal systems**: two capillary networks in serial arrangement
- **Three sites of capillary portal systems**: liver, kidney, and pituitary
- **Portal veins**: blood vessels that link two capillary networks

(a) Relationship between the anterior pituitary and the hypothalamus

1. When appropriately stimulated, hypothalamic neurons secrete releasing and inhibiting hormones into the primary capillary plexus.
2. Hypothalamic hormones travel through the portal veins to the anterior pituitary where they stimulate or inhibit release of hormones from the anterior lobe.
3. Anterior pituitary hormones are secreted into the secondary capillary plexus.
Anterior Pituitary: Control

- Hypothalamus has neurons that produce
  - Releasing, e.g., GnRH, or
  - Inhibiting Hormones
- Into the first capillary plexus
- Down the infundibulum in portal veins
- Into the second capillary plexus
  - Receptors in pituitary
- Hormones then released into the circulation

Fig 17.4 (a)
1. Control of sympathetic output to adrenal medullae

2. Production of ADH and oxytocin

3. Secretion of regulatory hormones to control activity of anterior pituitary

Hypothalamus

Anterior lobe of pituitary

Posterior lobe of pituitary

Adrenal medulla

Preganglionic motor fibers

Adrenal gland

Hormones secreted by anterior pituitary control other endocrine organs

Release of ADH and oxytocin

Secretion of epinephrine and norepinephrine
Neurohypophysis = PP

- Neurons originate in the Supraoptic and Paraventricular Nuclei
- Their axons extend down the infundibulum
- Release Oxytocin and ADH (vasopressin) into the circulation

Fig 17.4 (b)
Anterior pituitary

Pars distalis

Pars intermedia

Posterior pituitary (pars nervosa)

Secretes other anterior pituitary hormones

Secretes MSH

Releases ADH and oxytocin

(b) Anterior and posterior pituitary tissues (LMx77)
Pituitary MRI, contrast enhanced
Thyroid Gland p 523

- Anterior surface of trachea just inferior of thyroid cartilage (or Adam’s apple)
- Two lobes connected by isthmus
More Thyroid

- **Thyroid follicular cells** (simple cuboidal epithelium) produce and store thyroglobulin in thyroid follicles
  - Iodine then added to produce thyroxine ($T_4$) and triiodothyronine ($T_3$) inside the follicles
  - The thyroglobulin is reabsorbed by the follicular cells, cleaved, and the thyroid hormone ($T_3$ and $T_4$) are released into the bloodstream
  - Note that this is the only extracellular storage of hormones

- **C (chief) Cells**: (AKA parafollicular cells) produce calcitonin
  - Interspersed between thyroid follicles
  - Lower blood Calcium
Classic Negative Feedback Loop

- **HOMEOSTASIS DISTURBED**
  - Decreased T₃, T₄ concentration in blood or low body temperature

- **HOMEOSTASIS RESTORED**
  - Increased T₃ and T₄ concentration in the blood

- Hypothalamus releases TRH
  - TRH stimulates the anterior pituitary to release TSH
  - TSH stimulates the thyroid gland to release T₃ and T₄
  - Increased T₃ and T₄ concentrations in the blood
  - Normal T₃ and T₄ concentrations, normal body temperature
C-Cells

Simple cuboidal epithelium
Thyroid Disease

- **Hyper-**
  - Cardiovascular
    - Increased BP
    - Tachycardia
    - Palpitations
  - Neuromuscular
    - Emotional lability
    - Insomnia
    - Weakness
    - Hand Tremor

- **Hypo-**
  - Weakness
  - Dry, coarse Skin
  - Lethargy, Slow Speech
  - Feel cold
  - Less Sweat
  - Eyelid and Facial Edema

Images showing different stages of thyroid disease.
Parathyroid Glands

4 tiny glands embedded in the posterior aspect of the thyroid (superior and inferior)

- **Parathyroid hormone**
  (PTH; sometimes also called parathormone)

- **Function:**
  - raises blood $[\text{Ca}^{2+}]$
  - antagonist to Calcitonin
(b) Thyroid and parathyroid tissues (LM × 116)

(c) Parathyroid gland (LM × 850)

- Connective tissue capsule of parathyroid gland
- Red blood cells in blood vessel
- Principal cells