Endocrine System

**endocrine gland** - gland that secretes *hormones* into interstitial fluid → blood
- no ducts

**hormone** - chemical messenger molecule, carried by blood
- affects specific *target cells*
- protein *receptors* on or in target cells bind to the hormone → response

### Endocrine Glands

1. Separate endocrine organs
   - pituitary gland (= hypophysis)
   - thyroid gland
   - parathyroid glands
   - adrenal glands

2. Endocrine glands contained in other organs
   - pancreas
   - ovaries / testes
   - pineal gland
   - other organs: heart, kidneys, stomach, small intestine, thymus

#### A. Hypothalamus and Pituitary Gland

**hypothalamus** - part of the brain (diencephalon), controls the pituitary gland

**pituitary gland** - “master gland”, located under the hypothalamus
- 2 lobes, anterior and posterior, have different histology and embryonic origin
- *infundibulum* connects the pituitary gland to the hypothalamus

1. **Anterior pituitary gland** (= *adenohypophysis*)
   - circulatory connection to hypothalamus via *hypophyseal portal system*
   - *neurosecretory cells* in hypothalamus secrete *releasing* and *inhibiting hormones* into portal system → regulate secretion of anterior pituitary hormones

<table>
<thead>
<tr>
<th>Anterior pituitary hormones</th>
<th>Target organ or tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSH (thyrotropin)</td>
<td>thyroid gland</td>
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<tr>
<td>ACTH (corticotropin)</td>
<td>adrenal cortex</td>
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<tr>
<td>FSH &amp; LH (gonadotropins)</td>
<td>ovaries/testes</td>
</tr>
<tr>
<td>hGH (somatotropin)</td>
<td>muscle, bone, liver, connective tissues</td>
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<tr>
<td>prolactin</td>
<td>mammary glands (milk production)</td>
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</tbody>
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2. **Posterior pituitary gland** (= *neurohypophysis*, includes infundibulum)
   - direct neural connection to hypothalamus
   - hormones produced by *neurosecretory cells* that originate in the hypothalamus
   - axons pass to posterior pituitary via *hypothalamohypophyseal tract*
   - axon terminals in posterior pituitary secrete hormones

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<th>Posterior pituitary hormones</th>
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<tr>
<td>ADH (vasopressin)</td>
<td>kidneys (function in water balance)</td>
</tr>
<tr>
<td>oxytocin</td>
<td>uterus (labor), mammary glands (milk ejection)</td>
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#### B. Thyroid Gland
- located inferior to the larynx
- right and left lateral lobes and isthmus
- thyroid follicles produce thyroid hormones: T3 (triiodothyronine) and T4 (thyroxine)
  - T3 and T4 stimulate cellular metabolism, increase basal metabolic rate;
    - also promote body growth and development of the nervous system
- parafollicular cells secrete calcitonin → promotes uptake of calcium into bone
C. Parathyroid Glands
- small glands attached to posterior surface of thyroid gland
- secrete parathyroid hormone → promotes bone resorption, increases blood Ca^{2+} levels

D. Adrenal Glands
- located superior to kidneys (suprarenal glands)
- dual gland histologically and functionally
  1. adrenal cortex
     - produces several steroid hormones with diverse functions
     a. zona glomerulosa - secretes mineralocorticoids (e.g., aldosterone)
     b. zona fasciculata - secretes glucocorticoids (e.g., cortisol)
     c. zona reticularis - secretes androgens
  2. adrenal medulla
     - functionally part of the sympathetic division of the ANS
     - chromaffin cells are innervated by sympathetic preganglionic neurons
     - secrete epinephrine (Epi) and norepinephrine (NE)
     - Epi and NE augment the sympathetic “fight of flight” response

E. Pancreas
- mostly an exocrine organ that secretes digestive fluids and enzymes
- pancreatic islets (islets of Langerhans) are clusters of endocrine cells
  - beta cells secrete insulin
    - insulin stimulates glucose uptake into cells
    - insulin promotes conversion of glucose to storage molecules (glycogen in liver, fat in adipose tissue)
    → lowers blood glucose levels
  - alpha cells secrete glucagon
    - glucagon promotes conversion of glycogen to glucose in liver
    → raises blood glucose levels

Diabetes mellitus – insulin deficiency disease
  Type 1 (insulin dependent, “juvenile onset”) - deficiency of insulin secretion
  Type 2 (non-insulin dependent, “adult onset”) - deficiency of insulin receptors

Study Questions
1. Define the following terms:
   • endocrine gland • hormone • receptor • neurosecretory cell
2. Distinguish between the anterior and posterior pituitary gland. List four hormones secreted by the anterior pituitary and two secreted by the posterior pituitary gland.
3. Describe the anatomical relationship between the hypothalamus and anterior pituitary gland. What is the hypophyseal portal system and what is its function?
4. Describe the anatomical relationship between the hypothalamus and posterior pituitary gland. What is the hypothalamohypophyseal tract?
5. Know the location, basic structure, and general functions of the following glands:
   • thyroid gland • adrenal gland • pancreatic islets
6. Distinguish between the adrenal cortex and the adrenal medulla. Identify two hormones secreted by the adrenal cortex and one hormone secreted by the medulla. Which region is associated with the sympathetic division of the ANS?
7. Name two major hormones secreted by the pancreatic islets and contrast their functions in the regulation of blood glucose levels.