

Primary Endocrine Organs

• **Hypothalamus**: secretes hormones that affect the pituitary gland

- posterior lobe of pituitary gland has neural tissue of axon terminals of neurons that originated in the hypothalamus → hormones are released when neurons receive a signal → a neuroendocrine reflex
- hypothalamus and anterior lobe are connected by the hypothalamic-pituitary portal system → specialized arrangement of blood vessels (two capillaries arranged in series) → hypothalamus secretes tropic hormones (regulate secretion of other hormones) travel to anterior pituitary gland

Tropic Hormones

- Prolactin releasing hormone (PRH): stimulates mammary gland development + milk secretion
 - Prolactin inhibiting hormone (PIH): dopamine inhibits the release of prolactin
 - Thyrotropin releasing hormone (TRH): stimulates thyroid stimulating hormone → secretion of thyroid hormones → regulate metabolism
 - Corticotropin: stimulates release of adrenocorticotropic hormone (ACTH) → stimulates secretion of glucocorticoids from adrenal cortex (ex: cortisol → regulates metabolism when the body is stressed)
 - Growth hormone RH: stimulates secretion of growth hormone → growth, energy metabolism, insulin-like growth factors
 - Growth hormone inhibiting hormone: somatostatin
 - Gonadotropic RH (GnRH): release of gonadotropins, follicle stimulating hormone, luteinizing hormones → LH stimulates ovulation and sex hormones (estrogen/progesterone in females, androgens in males) by gonads, FSH promotes development of egg + sperm cells
- ↳ Short loop negative feedback: inhibition by the anterior pituitary tropic hormone, long loop: inhibition at endocrine gland

• **Pineal Gland**: secretes melatonin, regulated by input from suprachiasmatic nucleus (based off circadian rhythms)

• **Thyroid**: located on ventral surface of trachea, thyroid hormones regulate metabolism, calcitonin decreases blood calcium levels

↳ 4 parathyroid glands regulate blood calcium levels by acting on bones, intestines, + kidneys

• **Thymus**: close to the heart, secretes thymosin → regulates T-cell function (T-cells: essential for effective immune responses)

• **Adrenal Glands**: located above the kidney.

↳ Adrenal cortex → epithelial tissue, secretes adrenocorticoid hormones (3-types)

- mineralocorticoids: secreted by cells in the zona glomerulosa (outer layer) → regulates sodium reabsorption + potassium secretion in the kidneys → primarily aldosterone
- Glucocorticoids: secreted in zona reticularis (inner layer) → primarily cortisol
- Sex hormones: secreted in zona fasciculata + zona reticularis (middle + inner layers) → primarily androgens
- ↳ Adrenal medulla: contains chromaffin cells, secretes catecholamines → 80% epinephrine (adrenaline) 20% norepinephrine ~1% dopamine
- **Pancreas**: exocrine pancreas → secrete enzymes + fluids to gastrointestinal tract, endocrine pancreas → consist of islets of Langerhans
- islets of Langerhans: source of insulin (secreted by beta cells) and glucagon (alpha cells), somatostatin (delta cells) → regulate digestion
- **Gonads**: ovaries/testes, produce gametes (sperm + oocytes)

Secondary Endocrine Organs

- **Heart**: secretes atrial natriuretic peptide (ANP) → regulates sodium reabsorption in kidneys
- **Kidneys**: secrete erythropoietin → stimulates production of red blood cells by bone marrow
- **Gastrointestinal tract**: secretes gastrin (stomach) → stimulates acid secretion, small intestine secretes secretin, cholecystokinin, glucose-dependent insulinotropic peptide → regulates exocrine secretion by liver + pancreas
- **Liver**: secretes insulin-like growth factors → promote bone + soft tissue growth
- **Skin, liver, kidney**: involved in 1,25-dihydroxy vitamin D₃ production → regulates blood calcium levels

Hormone Actions

- Control of hormone levels in the blood
 - rate of hormone secretion: altered in response to
 - neural signals → directly through the hypothalamus (tropic hormones), posterior pituitary gland (ADH and oxytocin) and adrenal medulla (epinephrine)
 - humoral (bloodborne) signals → hormones, ions, and metabolites
- Transport of hormones: bound to carrier proteins → only the concentration of unbound hormones affect the binding of hormones to receptor. Carrier proteins increase the half-life of a hormone

- Rate of hormone metabolism: hydrophobic hormones metabolize slower → bind to carrier proteins + can be stored in fatty tissue

Abnormal secretion

- hypersecretion: excess of hormones (acromegaly → excess growth hormones)
- hyposecretion: too little of a hormone
 - ↳ in a primary secretion disorder, abnormality originates in the endocrine gland → in hypersecretion, blood levels of tropic hormones are lower b/c increased negative feedback
 - ↳ Secondary secretion disorder: abnormalities originate in endocrine cells of either anterior pituitary or hypothalamus

Hormone Interactions

- Antagonism: hormone effects opposing each other
- two or more hormones producing same response can be additive (net effect → sum of ind effects) or synergistic (net effect → greater than the sum of the ind. effects)
- Permissiveness: when presence of one hormone is needed for another to exert actions