Endocrine Glands: Hypothalamus & Pituitary Glands

- Hypothalamus (Master Gland)
- 8 hormones produced in hypothalamus
  - 6 regulate anterior pituitary
    - e.g., TRH, GnRH, GHRH
    - E.g., PIH, Somatostatin (GH TSH)
- Hypothalamus receives info (direction from higher brain areas)

Pituitary Gland (hypophysis)

- Secretes 6 *trophic* hormones
  - Trophic = feed
  - Concentration = hypertrophy
  - Shortened to “tropic” for hormones of Ant. Pit.
  - Ant. Pit. Hormones suffix = “tropin”
- Hypothalamo-hypophyseal portal system releasing/inhibiting hormones released by hypo

Hypothalamic Control of Posterior Pituitary

- Posterior pituitary stores:
  - oxytocin
  - ADH (vasopressin) delivered to post. pit. via hypothalamo-hypophyseal tract

Anterior Pituitary

- *Growth hormone* (GH) (somatotropin) promotes growth, protein synthesis; movement of amino acids into cells
- *Thyroid stimulating hormone* (TSH) (thyrotropin) stimulates thyroid to produce and secrete T<sub>4</sub> and T<sub>3</sub>
- *Adrenocorticotropic hormone* (ACTH) (corticotropin) stimulates adrenal cortex to secrete cortisol, aldosterone
- *Gonadotropic Hormones*
  - Follicle Stimulating Hormone (FSH) Females: follicle maturation; Males: stimulates sperm production
  - Luteinizing Hormone (LH) Females: stimulates ovulation; Males: stimulates androgen secretion
  - *Prolactin* (PRL) stimulates milk production by mammary glands

Anterior Pituitary
Feedback Control of Anterior Pituitary

Adrenal Glands

- Adrenal Medulla synthesizes and secretes 80% Epinephrine and 20% Norepinephrine
  - Controlled by sympathetic division of ANS
  - Recall preganglionic neuron stimulation!

- Adrenal Cortex
  - No neural innervation!!
  - i.e., stimulated by ACTH
  - Releases Steroid hormones (corticosteroids = corticoids)

Adrenal Medulla

- Epi. & Norepi. released in ~ 4:1 ratio
- Innervated by preganglionic Sympathetic fibers
- Activated during "fight or flight" response
- Causes:
  - Increased respiratory rate
  - Increased HR and cardiac output
  - General vasoconstriction which increases venous return
  - Glycogenolysis and lipolysis

Adrenal Glands

- Adrenal Cortex is controlled by ACTH and secretes:
  - Steroid hormones (corticosteroids)
  - 3 functional groups:
    1. Mineralcorticoids (regulate Na+/K+ balance)
       - e.g. aldososterone (Na+ H2O retained/ K+ excreted) increases blood volume & pressure
    2. Glucocorticoids: carb!!!!/protein/fat metabolism
       - e.g. Cortisol (hydrocortisone):
         - stimulates gluconeogenesis (glucose from non-carbs) - inhibit glucose utilization (raises blood glucose)
         - promotes lipolysis (raises free fatty acids in blood)
         - dampen inflammation & immune response!
         - exogenous glucocorticoids (pills, shots, creams)
    3. Sex steroids (weak androgens)

Stress and the Adrenal Gland

Under stress → ACTH
  increases thus adrenal cortex secretes more glucocorticoids
- Stress induces a non-specific response called general adaptation syndrome (GAS)

3 stages in response to stress
1. Alarm reax: adrenal glands activated (epi. & cortisol)
2. Resistance: readjustment occurs (glycogen used, body uses alternative fuels (pro. & fat breakdown for gluconeogenesis but glucose uptake is inhibited - Immune response inhibited
3. Exhaustion

Stress and the Adrenal Gland

- Chronic stress can induce high levels of cortisol that cause a number of negative effects:
  - Atrophy of hippocampus (involved in memory)
  - Reduced sensitivity of tissues to insulin (insulin resistance)
  - Inhibition of vagus nerve activity
  - Suppression of growth hormone, thyroid hormone, and gonadotropins
  - Dampened immune response
Thyroid Gland

- Located just below the larynx
- Secretes:
  - $T_4$ (tetraiodothyronine – aka thyroxine)
  - $T_3$ (triiodothyronine)
- set BMR and needed for growth, development
- Calcitonin: Lowers blood Ca$^+$$^+$

Production of Thyroid Hormones

- Iodide ($I^-$) actively transported into colloid
- oxidized to iodine ($I_2$) and attached thyroglobulin
- MIT & DIT then used to make $T_3$ and $T_4$
- TSH stimulates hormones to be taken in by follicular cells and removed from thyroglobulin

Hyothyroidism:
- Inadequate $T_4$ and $T_3$ levels (hypothyroid) or TSH
- Low BMR, weight gain, lethargic, cold intolerance
- myxedema = puffy face, hands, feet
- Goiter!

Parathyroid Glands

- 4 glands: posterior lateral lobes of thyroid gland
- Secrete Parathyroid hormone (PTH)
- Raises blood Ca$^{2+}$ levels

Parathyroid Hormone

- Stimulated by decreased blood Ca$^{2+}$
- Acts on bones, kidney, and intestines
- Bones: increases osteoclast activity
- Kidney: Ca$^+$ reabsorption
- Intestines: increased Ca$^+$ absorption
- ALL increase blood Ca$^+$
**Correction for Hypercalcemia**

- Blood \(Ca^{2+}\) excess
- Calcitonin secretion
  - Thyroid Gland
- Reduced osteoclast activity
- Increased osteoblast activity
- Less bone resorption
- More bone deposition
- Blood \(Ca^{2+}\) returns to normal

**Correction for Hypocalcemia**

- Blood \(Ca^{2+}\) deficiency
- Parathyroid hormone secretion
- Reduced osteoclast activity
- More bone resorption
- Less bone deposition
- Prevention of hydroxyapatite formation
- Less urinary calcium excretion
- Conservation of calcium

**Pancreas**

- Islets of Langerhans
- Scattered clusters of endocrine cells in pancreas
  - *alpha* and *beta* cells
- Alpha cells secrete horomone glucagon in response to low blood glucose
  - Stimulates *glycogenolysis* and *lipolysis*
  - Increases blood glucose

**Islets of Langerhans**

- Beta cells secrete *insulin* in response to high blood glucose
  1. Promotes entry of glucose into cells
  2. Conversion of glucose into glycogen and fat
  3. Both decrease blood glucose

**Diabetes mellitus:**

- Type 1 insulin-dependent:
  - Beta cells don't secrete insulin
- Type 2 non insulin-dependent (more common):
  - Tissue loses sensitivity for insulin
  - i.e., need more for normal effect

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**Figure 7.18b**

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Pineal Gland

- Located epithalamus
- Secretes \textit{melatonin} in response to activity of \textit{suprachiasmatic nucleus} of hypothalamus
- Daylight inhibits SCN reducing sympathetic stimulation of Pineal gland.

GI Tract

- A number of GI organs produce hormones:
  - Stomach
  - Small intestine
    - Act on GI tract itself, gallbladder, and pancreas
    - Act in concert with ANS to coordinate regions of GI tract and pancreatic juice and bile

Sex and Reproductive Hormones

- \textit{Gonads (testes} and \textit{ovaries} \textit{secrete} sex steroid hormones:
  - Androgens (testosterone)
    - semineferous tubules = spermies
    - leydig cells = testosterone
  - Estrogens & Progesterone
    - Estrogens
    - \textit{Placenta} secretions: estrogen, progesterone, hCG, and somatomammotropin

Autocrine and Paracrine Regulation

- \textbf{Autocrine regulators}: Chemicals produced in a cell and have an effect on same cell
  - All autocrines control gene expression in target cells
- \textbf{Paracrine regulators} produced by tissue of an organ and act on different cells of the same organ

A chemical can function as both
- Autocrines and paracrines include:
  - \textit{Cytokines} \textit{(lymphokines, interleukins)}
    - stimulate (regulate), proliferation of cells of immune system
  - \textit{Growth factors} \textit{(promote growth and cell division)}
  - \textit{Neutrophins} \textit{(provides trophic support for neurons)}

Autocrine Regulators: Prostaglandins (PGs)

- Produced in almost every organ
- \textit{Belong to eicosanoid family -- all derived from arachidonic acid of plasma membrane}
  - Hormones or other agents stimulate release of arachidonic acid from membrane
  - PGs have wide variety of functions
    - Different PGs may exert antagonistic effects in tissues
      - Some promote smooth muscle contraction and some relaxation
      - Some promote clotting; some inhibit
    - Promotes \textit{inflammatory process} of immune system
    - Plays role in ovulation
    - Inhibits gastric secretion in digestive system
Autocrine Regulators: Prostaglandins (PGs)

- **Cyclooxygenase (COX)** needed for PG synthesis

Prostaglandin inhibitors: non-steroidal anti-inflammatory drugs (NSAIDs) inhibit COX; i.e., drugs inhibit inflammation!!!!!!!!!!!!!!