

BIOL 1030 – TOPIC 18 LECTURE NOTES

Topic 18: Hormones and the Endocrine System (Ch. 45)

- I. function
 - A. coordination and regulation of body functions
 - B. via regulatory molecules (chemical signals are easy to send in the bloodstream and can have target specificity)
- II. types of regulatory molecules
 - A. neurotransmitters (wait for nervous system)
 - B. **hormones** – secreted by endocrine glands, carried in blood, only target cells respond
 - C. **autocrine** regulators – not transported in blood, acts within an organ on cells similar to the secretory cells
 - D. **paracrine** regulators – same as autocrine, but acts on cells of a different tissue type from secretory cells
 - E. **pheromones** affect other individuals of the same species; often used for sexual attraction or signaling, but also for control; typically produced by exocrine glands
 - F. there is some overlap; definition based on how transported and used, not chemical identity
- III. autocrine and paracrine regulation
 - A. many types
 - B. common autocrine: **cytokines** in immune system (actually travel in the blood)
 - C. paracrine examples
 1. **growth factors** (stimulate cell division and proliferation)
 2. **prostaglandins**
 - modified lipids
 - many functions, including promoting pain and fever in inflammation and stimulating smooth muscle contraction
 - NSAIDS inhibit (includes aspirin) by inhibiting making of prostaglandins
- IV. how hormones work
 - A. lipid-soluble hormones enter target cells
 1. includes **steroid** hormones and **thyroxine**
 2. travel in blood attached to protein carriers
 3. steroids
 - derived from cholesterol
 - bind to receptor proteins in the cytoplasm or nucleus of the target cell
 - complex binds to specific DNA region, activating or enhancing gene transcription
 - examples: cortisone, testosterone, estrogen, progesterone
 4. **thyroxine** – the thyroid hormone
 - modified form of tyrosine produced by the thyroid gland
 - contains 4 or 3 iodine atoms (most made with 4)
 - within target cells, all converted to 3-iodine form
 - bind with receptors in the nucleus
 - initiates growth-promoting mRNA synthesis
 - stimulates oxidative respiration
 - B. water-soluble hormones do not enter target cells
 1. peptide, glycoprotein, and catecholamine hormones
 2. bind to receptors in the target cell plasma membrane (example: G proteins)
 3. binding often brief and reversible (one hormone molecule can affect many cells)
 4. second messengers needed to transmit signal inside
 - examples are cyclic AMP (cAMP), inositol trisphosphate (IP₃), Ca⁺⁺
 - different cells may respond differently to the same second messenger
 - many intermediate messengers may be involved (signaling pathways)
 - may or may not involve transcriptional activation
- V. major endocrine glands and their hormones (focus on humans)
 - A. pituitary gland
 1. two-part gland below hypothalamus of brain: anterior and posterior
 2. controlled by hypothalamus
 3. produces 9 major hormones
 4. many of these hormones affect other hormone-producing glands; thus, pituitary often called the "master gland"
 5. **posterior pituitary**
 - actually formed from neural tissue
 - hormones actually made in hypothalamus but secreted by pituitary
 - **antidiuretic hormone** (ADH, or vasopressin)
 - stimulates water retention in kidneys
 - damage or alcohol inhibition leads to excessive urination

BIOL 1030 - TOPIC 18 LECTURE NOTES

- **oxytocin**
 - stimulates uterine contraction during childbirth
 - initiates milk release with nipple stimulation
 - major signaling molecule in female orgasm
- 6. **anterior pituitary**
 - develops from epithelial cells from roof of mouth
 - makes its own hormones
 - many stimulate growth (**tropic hormones**)
 - **growth hormone (GH)** or somatotropin – stimulates growth of muscle, bone, some other tissues
 - **adrenocorticotropic hormone (ACTH)** or corticotropin – stimulates production of corticosteroids in adrenal cortex
 - **thyroid-stimulating hormone (TSH)** or thyrotropin – stimulates production of thyroxine in thyroid
 - **luteinizing hormone (LH)** – stimulates testosterone production, ovulation, and corpus luteum formation; a gonadotropin
 - **follicle-stimulating hormone (FSH)** – another gonadotropin; required for spermatogenesis and development of ovarian follicles
 - **prolactin (PRL)** – stimulates breasts to produce milk
 - **melanocyte-stimulating hormone (MSH)** – stimulates synthesis and dispersion of melanin; no known function in mammals
- B. **thyroid** – a metabolic thermostat
 1. located in front of the neck
 2. produces
 - **thyroxine**: increases metabolic rate, promotes growth; promotes metamorphosis in amphibians
 - **calcitonin**: stimulates Ca^{++} uptake into bones
 3. **goiter**: enlarged thyroid due to insufficient iodine in diet
- C. **parathyroid**: builders of bones
 1. four small glands attached to the thyroid
 2. produces **parathyroid hormone (PTH)**
 - one of only two hormones absolutely essential for survival
 - stimulates osteoclasts to dissolve calcium phosphate in bone, leading to increase in blood Ca^{++} level
 - stimulates reabsorption of Ca^{++} in kidneys
 - activates vitamin D to absorb Ca^{++} from food in intestine
- D. **adrenal glands**
 1. two glands, one above each kidney
 2. inner and outer portions
 3. inner – **adrenal medulla**: emergency warning siren
 - activate "fight or flight" response to stressors
 - releases **epinephrine (adrenalin)** and **norepinephrine**
 - stimulates rapid deployment of body fuel: faster heartbeat, increased blood pressure, increased blood sugar (in pancreas, inhibited insulin production and stimulated glucagon production), dilated blood vessels, dilated bronchioles, increased blood flow to the heart and lungs, decreased blood flow to the skin and digestive organs
 4. outer – **adrenal cortex**: mineral and glucose balance
 - make steroid hormones
 - produces **aldosterone**
 - a mineralocorticoid (regulates mineral balance)
 - second hormone absolutely essential for survival
 - stimulates kidneys to reabsorb Na^+ – essential for normal blood volume maintenance (remember how most water is reabsorbed from the kidneys)
 - stimulates kidneys to secrete K^+ into the urine
 - produces **cortisol** (hydrocortisone)
 - a glucocorticoid (regulates glucose balance)
 - stimulates conversion of protein from muscles to glucose in liver
 - also anti-inflammatory; used to treat rheumatoid arthritis
- E. **pancreas**: the body's dietician
 1. located behind the stomach
 2. also an exocrine gland that secretes digestive enzymes
 3. two antagonistic hormones, insulin and glucagon, produced in cell clusters called islets of Langerhans
 4. **insulin** lowers blood glucose level by activating uptake of glucose by cells and conversion of glucose to glycogen or fat

BIOL 1030 – TOPIC 18 LECTURE NOTES

5. **glucagon** raises blood glucose and fatty acid level by promoting hydrolysis of glycogen in the liver and fat in adipose tissue
- F. gonads (ovaries and testes): produce steroid sex hormones
- G. **pineal gland**
 1. pea-sized gland; "third eye" in some fish and reptiles, deep in brain in other vertebrates
 2. secretes **melatonin**, responsible for daily sleep/wake rhythms in many vertebrates (humans too?)
 3. light appears to lead to decrease in melatonin level