

Endocrine System

- I. Introduction
 - A. Hormone - (to arouse or spur on) - defined
 - B. Endocrine vs. exocrine gland
 - C. Difference in this system as compared to others
 - D. Communication system
 - E. Terms: Hypo vs. Hyper
 - F. Blood level - constant (destruction equals production)
 - G. Regulatory action is superimposed on basal genetic metabolic rate
 - H. Chemical nature: steroids and others

- II. Methods of Study
 - A. Gland removal or X-ray
 - B. Clinical observation of disease followed by autopsy and observation
 - C. Hormone injection followed by observation
 - D. Radioisotope tracings
 - E. Chemical analysis of blood
 - F. Electrode stimulation/inhibition of gland

- III. Endocrine glands
 - Pituitary
 - Hypothalamus
 - Pineal
 - Thyroid
 - Parathyroid
 - Adrenals
 - Pancreas
 - Ovaries
 - Testes
 - Placenta
 - Stomach (gastrin)
 - Duodenum (Secretin, cholecystokinin)
 - Kidney (renin)

- IV. Pituitary (hypophysis)
 - A. Introduction
 - 1. Called the "master" gland because it controls other endocrine glands: thyroid, adrenal cortex, gonads
 - 2. Is regulated in turn by hypothalamus by neurosecretions
 - 3. Location: sella turcica
 - 4. Size: 1/2 inch in diameter
 - 5. Embryological origin: anterior lobe - from endoderm in roof of mouth, posterior lobe - from neural ectoderm
 - B. Anterior pituitary (adenohypophysis) controlled by neurosecretions from the hypothalamus, makes neuro-secretory substances or releasing factors

- C. Hormones of anterior pituitary
 - 1. **Growth Hormone** - GH, somatotropin
 - a. Stimulates growth of bone, muscle, organs
 - b. Increase protein synthesis
 - c. Increase fat utilization for energy (keto-genesis)
 - d. (Release of GH under hypothalamic control. SRF (somatotropin releasing factor) via pituitary portal system, stimulus - deletion of cellular proteins)
 - 2. **Thyroid Stimulating Hormone** - TSH, thyrotrophin
 - a. regulates thyroid function
 - b. (TSH controlled by blood level of thyroid hormone and formation of TRF (thyrotrophin releasing factor) of hypothalamus)
 - 3. **Adrenocorticotrophin** - ACTH
 - a. controls growth, secretions of adrenal cortex
 - b. (release of ACTH under control of blood level of cortical hormones, these influence CRF (corticotrophin releasing factors) of hypothalamus)
 - 4. **Gonadotrophins** - control growth and function of gonads
 - a. **FSH** - development / maturation of tubules and follicles in female, maturation of sperm in males
 - b. **LH** (females) and **ICSH** (males) - promotes formation of testosterone in male from interstitial cells, final maturation of follicle in females, ovulation
 - c. **Prolactin** (LTH) - lactogenic hormone
 - 5. **Melanocyte Stimulating Hormone** - MSH
 - a. Controls skin pigmentation (similar action by ACTH)
 - D. Irregular function
 - 1. Hypofunction, dwarfism, hypothyroidism, hypogonadism, adrenal cortical insufficiency (children)
 - 2. Simmond's disease, senility and mental lethargy, weakness, emaciation, hair loss, tooth loss (adults)
 - E. Posterior pituitary (neurohypophysis) under direct nervous control
 - F. Hormones of posterior pituitary
 - 1. None
 - 2. Store ADH and oxytocin produced by hypothalamus
 - a. ADH - increases blood pressure, muscle contractions of vessels
 - b. Reabsorption of water by kidneys
 - c. Oxytocin - uterine contractions during birth, milk letdown
 - G. Irregular function
 - 1. Hypofunction - ADH - excess water loss (vasopressin, pitossin)
 - 2. Hyperfunction - none
- V. Hypothalamus
- A. Controls pituitary via SRF, TRF, and CRF
 - B. Produces: Oxytocin and ADH

VI. Testis

- A. Affected by ICSH or LH (luteinizing hormone)
- B. **Testosterone** - from interstitial cells
- C. Develop and maintain secondary sex characters
- D. Hypofunction:
 - 1. If testis removed or lost or pituitary non-functioning prior to puberty the secondary sex characteristics never develop: voice high, no hair growth, fat deposits in hips, gluteal and pectoral regions, genitalia small, sterile
 - 2. After puberty atrophy of genitalia

VII. Ovaries

- A. Affected by FSH, LH, and LTH of pituitary
- B. Produce **Estrogen** and **Progesterone**
- C. Hypofunction:
 - 1. Prior to puberty - secondary sex characteristics fail to develop, no menses
 - 2. After puberty - uterus, vagina, external genitalia, and breasts atrophy

VIII. Adrenal gland (suprarenal) cortex and medulla

- A. Adrenal cortex (under control of ACTH from pituitary)
 - 1. **Aldosterone** - mineral corticoids and desoxycorticosterone - absorption of sodium and water and the excretion of potassium
 - 2. **Glucocorticoids** - sugar hormones
 - a. **Cortisol** - hydrocortisone or compound F and **Cortisone** - corticosterone
 - b. Cortisol and cortisone affect the metabolism of carbohydrates, fats and proteins by trying to maintain the body's carbohydrate reserve
 - c. Catabolic effect on protein, cause the breakdown of amino acids with conversion to glucose, cause the deposition of glycogen in the liver, mobilization and oxidation of fat in the liver
 - d. Have an anti-inflammatory effect by inhibiting lysosomes, used to reduce swelling of arthritis, athletic injuries and antiallergic effect
 - e. production is under the control of ACTH
 - 3. Sex hormones: small quantities of male and female hormones produced
- B. Adrenal cortex dysfunction
 - 1. Hypofunction - Addison's disease (swelling, tissue water loss, diarrhea, low blood sugar, low glycogen content within cells, muscle weakness, GI disturbances, vomiting, depressed sexual function)
 - 2. Hyperfunction - Cushing's disease (fat deposition in facial area and upper back, muscle wasting, high blood glucose level)
- C. Adrenal Medulla
 - 1. **Epinephrine** (adrenalin)
 - a. Constriction of arterioles except in heart and skeletal muscle
 - b. increase rate/force of heart beat and rise in systolic pressure
 - c. diabetes bronchiolus - relaxes smooth muscle
 - d. increases blood sugar and glycogen breakdown in liver causing hyperglycemia

2. Associated with super feats of strength, epinephrine compliments the sympathetic division of the autonomic nervous system
 3. Clinically: bronchial asthma, cardiac failure, constricts blood vessels, causes blood to clot faster
 4. **Norepinephrine** - increases systolic and diastolic pressure, constriction of arterioles in skeletal and heart muscle, relaxes smooth muscle of the digestive tract, and causes the spleen to contract releasing erythrocytes to the C.V.S.
- D. Hyperfunction of adrenal medulla
1. Hypertension, high blood pressure

IX. Thyroid

- A. Location and description
1. immediately below larynx, 2 lobes connected by isthmus
 2. separated into irregular lobes by septa
- B. Microstructure - follicles contain a colloid of glycoproteins and thyroglobulin+iodine complex
- C. Hormones
1. **Thyroxin** (95%)
 2. **Thriiodothyron** (5%)
 3. **Thyrocalcitonin**
- D. Control wide range of metabolic activities
1. regulate metabolic and oxidative rates in cells of body
 2. increase glucose absorption by small intestine
 3. increase rate glucose utilized by cells
 4. liver increases conversion glycogen to glucose
 5. liver increases gluconeogenesis
 6. increases protein synthesis in cells
 7. influences physical and mental development in children
 8. stimulates mental process in adults
- E. Simple goiter (colloid goiter)
1. not enough iodine in diet
 2. thyroid - enlarges, cell numbers and sizes increase
 3. enough cells to trap enough iodine that hypothyroidism does not occur
- F. Hyperthyroidism
1. enlargement, but not goiter proportions
 2. Grave's disease or exophthalmic goiter
 3. Symptoms: bug eyes, epithelial surface irritated, infected, rapid heartbeat (tachycardia), rapid respiration, high BMR, appetite tremendous, high body temperature, sweating
- G. Hypothyroidism (cretinism in children)
1. skeletal growth ceases, dwarfism, bones thicken
 2. mental retardation, low mental ability, lethargic
 3. ill proportioned - large head, abdomens, slow speed
 4. no secondary sex characteristics
 5. low BMR, heart beat, blood pressure, heart enlarged

- H. Other hormones
 - 1. **Parahormone** - increase blood calcium levels, absorption in intestine, mobilization from bones, kidney to excrete phosphate and conserve calcium
 - 2. **Calcitonin** - decrease blood calcium levels

- X. Pancreas
 - A. Endocrine - Islets of Langerhans, exocrine - acinar cells
 - B. Hormones
 - 1. **Insulin**
 - a. lowers blood sugar
 - b. storage of sugar by liver
 - c. decrease glyconeogenesis
 - d. fat manufactured from sugar
 - C. Diabetes is associated with
 - 1. high blood sugar level
 - 2. alters fat and protein metabolism
 - 3. lesions in kidney, retina, ulcers, cardiovascular damage, poor circulation
 - 4. insulin injections
 - D. Hyper activity
 - 1. insulin shock
 - 2. not enough glucose
 - 3. weakness, trembling, perspiration

- XI. Parathyroids
 - A. Location: posterior surface or buried in thyroid, approximately 4
 - B. Function
 - 1. **Parahormone** - same as above
 - 2. **Calcitonin** - same as above (thyrocalcitonin promotes uptake in bones)
 - 3. Calcium affects - clotting mechanism, cell membrane permeability, neuromuscular irritability and bone salts
 - C. Hypofunction of parahormone
 - 1. Hypocalcemia
 - 2. Blood calcium levels down, irritability increases and results in spasms and tetanus, respiratory paralysis and convulsions
 - D. Hyperfunction of parahormone
 - 1. Hypercalcemia
 - 2. Decalcification of bone and greater fracture potential, kidney stones

- XII. Thymus - site of antibody formation
 - A. Size and location - relatively large at birth, increases during adolescence, then undergoes atrophy in size as adult
 - B. Function of antibody formation
 - 1. Attach gamma globulin - protein recognizes antigens
 - 2. Thymic factor- (thymosin) promote lymph tissue growth in body to produce antibodies

3. Produces lymphocytes - these populate other lymph tissue of the body and perpetuate growth of lymphocytes

XIII. Pineal Gland - biological clock

- A. Location
- B. Function: regulates maturation of sex glands
- C. Hormone **melatonin** - delays onset of puberty
- D. Hyperfunction - tumor, puberty delayed
- E. Hypofunction - destroyed or damaged, precocious puberty