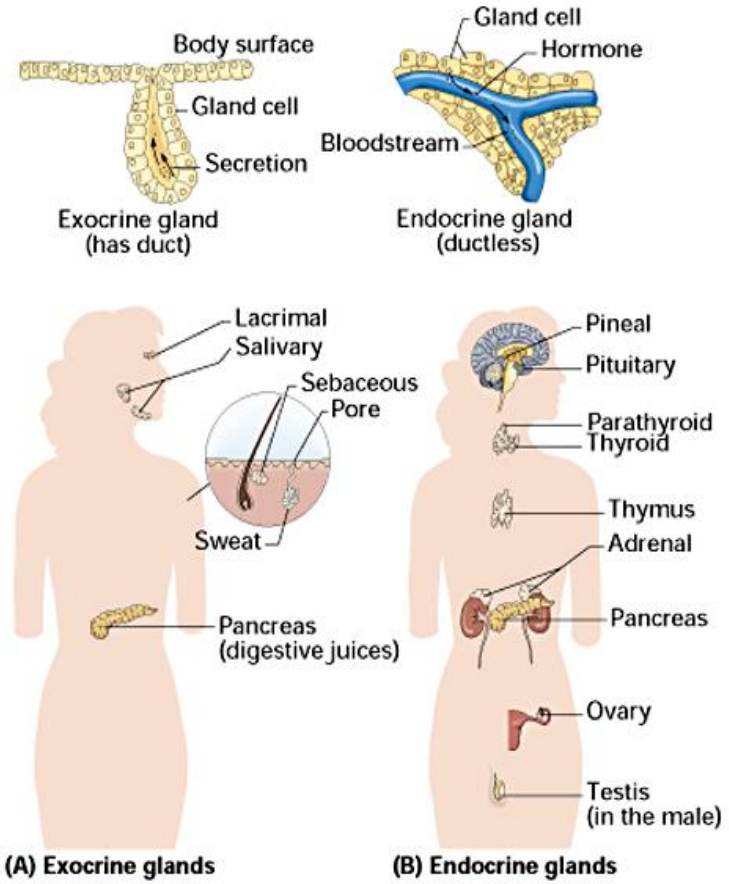
Endocrine System

Introduction

- **Endocrinology**: The medical specialty that studies the anatomy and physiology of the endocrine system and uses diagnostic tests, medical and surgical procedures, and drugs to treat endocrine system diseases.
- **Endocrine System**:
  - Endocrine glands secrete hormones directly into bloodstream
  - Hormones regulate body activities:
    - Metabolic rate
    - Water and mineral balance
    - Immune system reactions
    - Sexual functioning

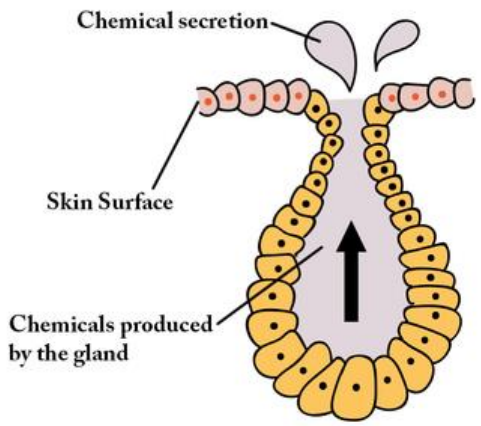
Introduction

- **Organs of the endocrine System**:
  - Adrenal glands (two)
  - Gonads (Ovaries and Testes; two of each one)
  - Hypothalamus
  - Pancreas (islets of Langerhans)
  - Parathyroid glands (four)
  - Pineal gland
  - Pituitary gland
  - Thymus gland
  - Thyroid gland
- Hormones are chemicals that act on target organs to increase or decrease target's activity level
- Responsible for homeostasis (maintenance of internal environment stable).

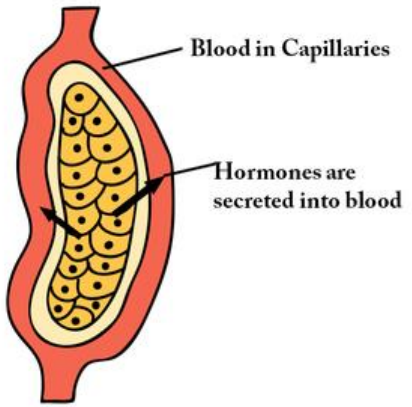


Types of glands in the body

- There are two types of glands
  - Exocrine glands
  - Endocrine glands



Exocrine Gland



Endocrine Gland

Exocrine glands	Endocrine glands
• Release secretions into duct that carries them to outside of body or inside body	• Release hormones directly into bloodstream • Have no ducts, referred to as ductless glands
• **Example**: sweat glands and pancreas	• **Example**: thyroid gland, pancreas, pituitary and adrenal glands

- Some glands have both Exocrine and Endocrine part called **mixed gland**.
- The pancreas is an example of mixed glands.

Hypothalamus

- Shaped like a flattened funnel, size of kidney bean
  - Forms floor and walls of third ventricle of the brain
  - Regulates primitive functions of the body from water balance and thermoregulation to sex drive and childbirth many of its functions carried out by pituitary gland
  - Composed of two structures with independent origins and separate functions:
    - **Adenohypophysis** (anterior pituitary)
    - **Neurohypophysis** (posterior pituitary)
- **Hypothalamic Hormones**:
- Eight hormones produced in hypothalamus
- Six regulate the anterior pituitary
- Two are released into capillaries in the posterior pituitary (oxytocin and antidiuretic hormone)

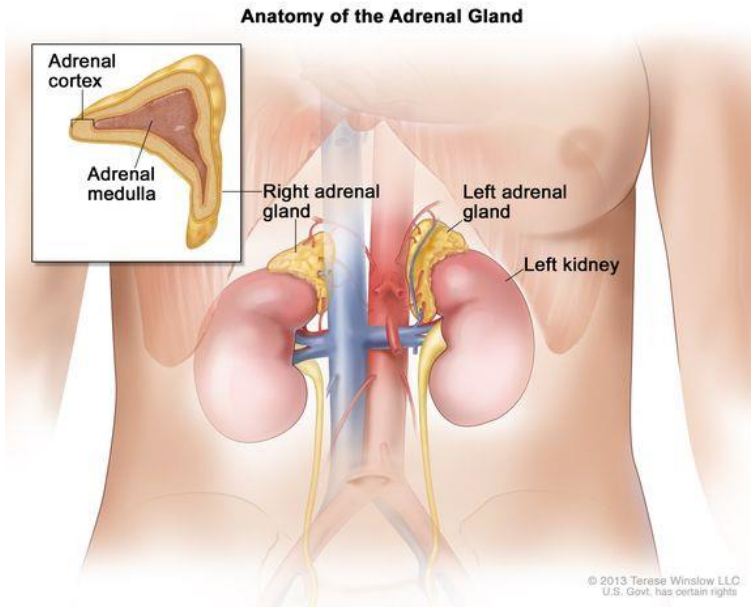
Hypothalamus

❖ **Hypothalamic Hormones**:

- Six releasing and inhibiting hormones stimulate or inhibit the anterior pituitary:
  - Thyrotropin releasing hormone (TRH), Corticotropin releasing hormone (CRH)
  - gonadotropin releasing hormone (GnRH), and growth hormone releasing hormone (GHRH) are **releasing hormones**
- Prolactin inhibiting hormone (PIH) inhibits secretion of prolactin, and somatostatin **inhibits** secretion growth hormone & thyroid stimulating hormone by the anterior pituitary.
- Two other hypothalamic hormones are oxytocin (OT) and antidiuretic hormone (ADH)
  - Both **stored** and **released** by posterior pituitary
  - Posterior pituitary does not synthesize them

Adrenal Glands

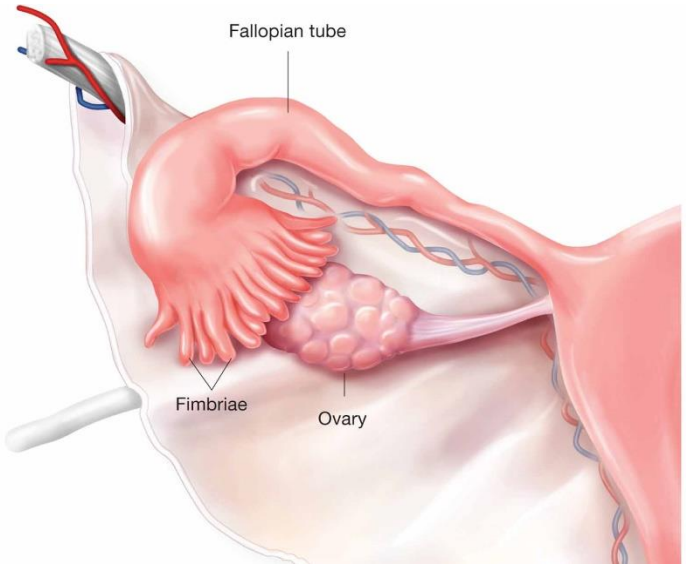
- **Two glands**, one located above each kidney
- Each gland is composed of two sections:
  - **Adrenal cortex** secrets Three different families of corticosteroids:
    - **Mineralocorticoids**: Example; aldosterone: Regulates sodium (Na+) and potassium (K+) levels
    - **Glucocorticoids**: Example; cortisol: Regulates carbohydrates
    - **Steroid sex hormones**: Example; Androgens, estrogen, and progesterone: Regulate secondary sexual characteristics
  - **Adrenal Medulla** secretes epinephrine (adrenaline) and norepinephrine (noradrenaline)
    - Critical during emergency situations: Increases blood pressure, heart rate & respiration rate.



Gonads (Ovaries and testes)

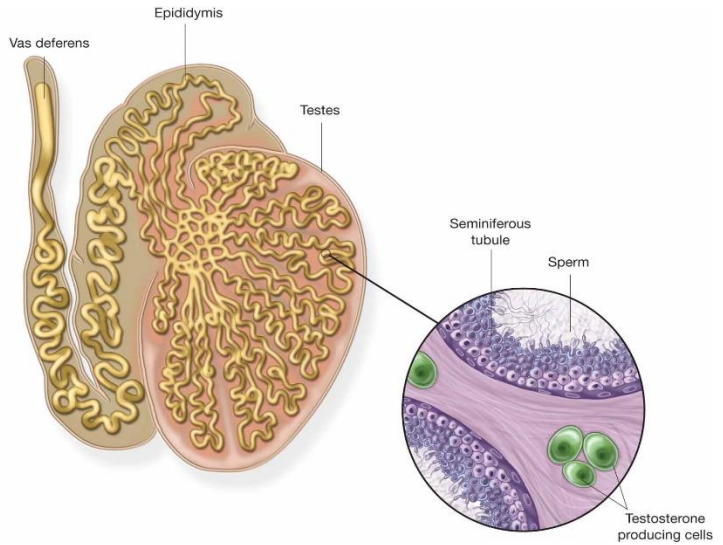
Ovaries

- Two ovaries located in pelvic cavity of **females**
- Secrete female sex hormones, estrogen and progesterone
  - **Estrogen** is responsible for: Female sexual characteristics & regulation of menstrual cycle
  - **Progesterone**: Maintains suitable uterine environment for pregnancy



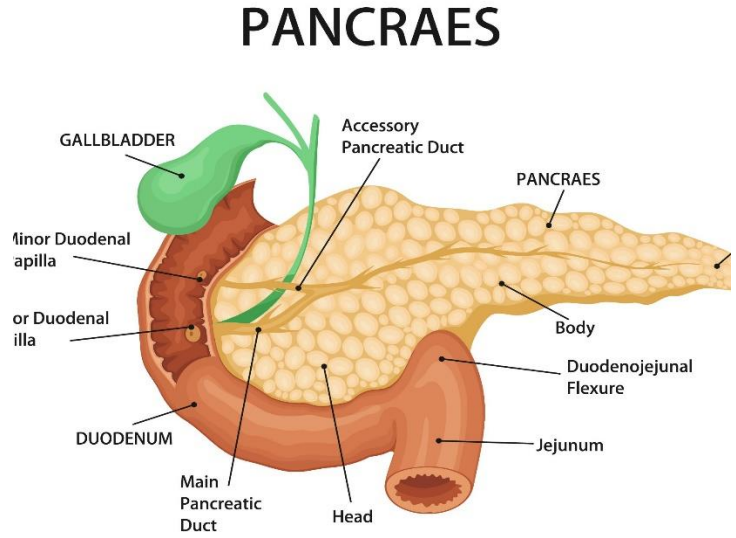
Testis

- Two oval glands located in scrotum of **males**
- Secrete **testosterone** which produces male secondary sexual characteristics & regulates sperm production



Pancreas

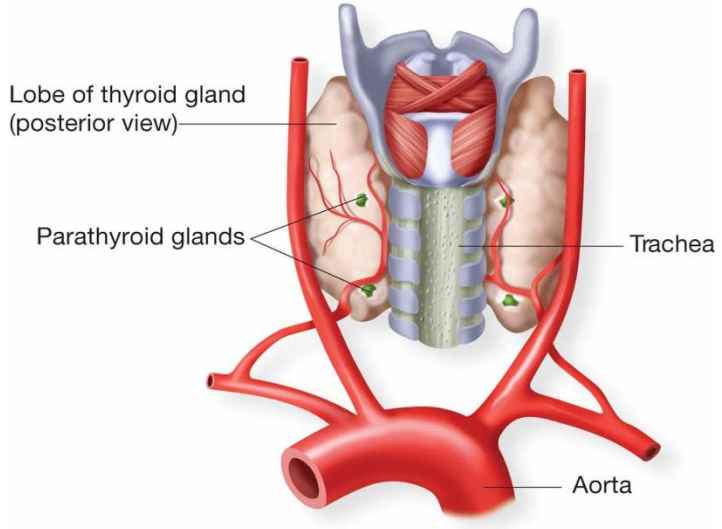
- Located along lower curvature of stomach
- Only organ that has both endocrine and exocrine functions (Mixed gland)
- **Exocrine** portion
  - Releases digestive enzymes through duct into duodenum
- **Endocrine** sections of the pancreas
  - Islets of Langerhans → produce insulin and glucagon
    - **Insulin** (produced by β-cells): Stimulates glucose uptake from bloodstream by cells; Lowers blood sugar level. Occurs after eating a meal and absorbing carbohydrates
    - **Glucagon** (produced by α-cells): Stimulates liver to release stored glucose into bloodstream; Raises blood sugar levels. Occurs when body needs more glucose
  - Also, secrets **somatostatin** secreted by δ (delta) cells and **pancreatic polypeptide** by γ cells



Parathyroid Glands and Pineal Gland

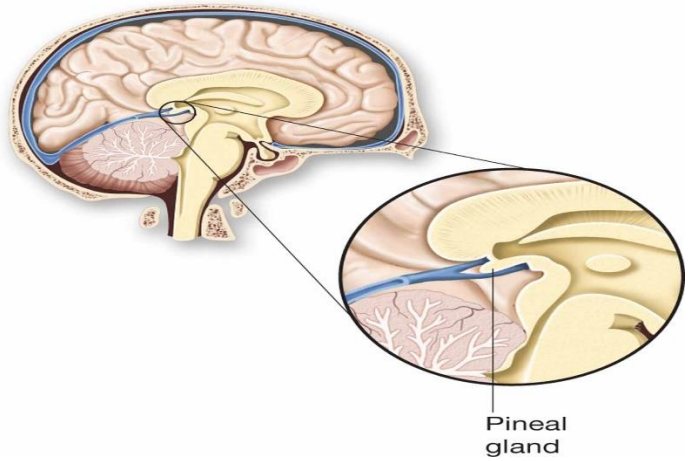
Parathyroid Glands

- Four tiny glands located on dorsal surface of thyroid gland
- Secretes parathyroid hormone (PTH): Regulates level of calcium in bloodstream
- If calcium levels in blood fall too low:
  - Parathyroid hormone levels in the blood increase
  - Stimulate bone breakdown
  - Releasing more calcium into bloodstream



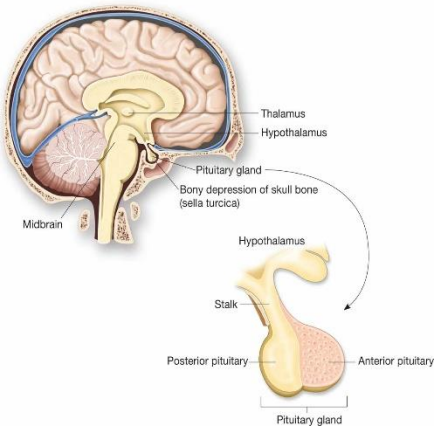
Pineal Gland

- Small pine cone-shaped gland
- Part of thalamus region of brain
- Secretes melatonin; Not well understood, but plays a role in regulating body's circadian rhythm
  - 24-hour clock that governs periods of wakefulness and sleepiness



Pituitary Gland

- Small marble-shaped gland, located underneath brain
- Divided into anterior and posterior lobes
- Regulated by hypothalamus



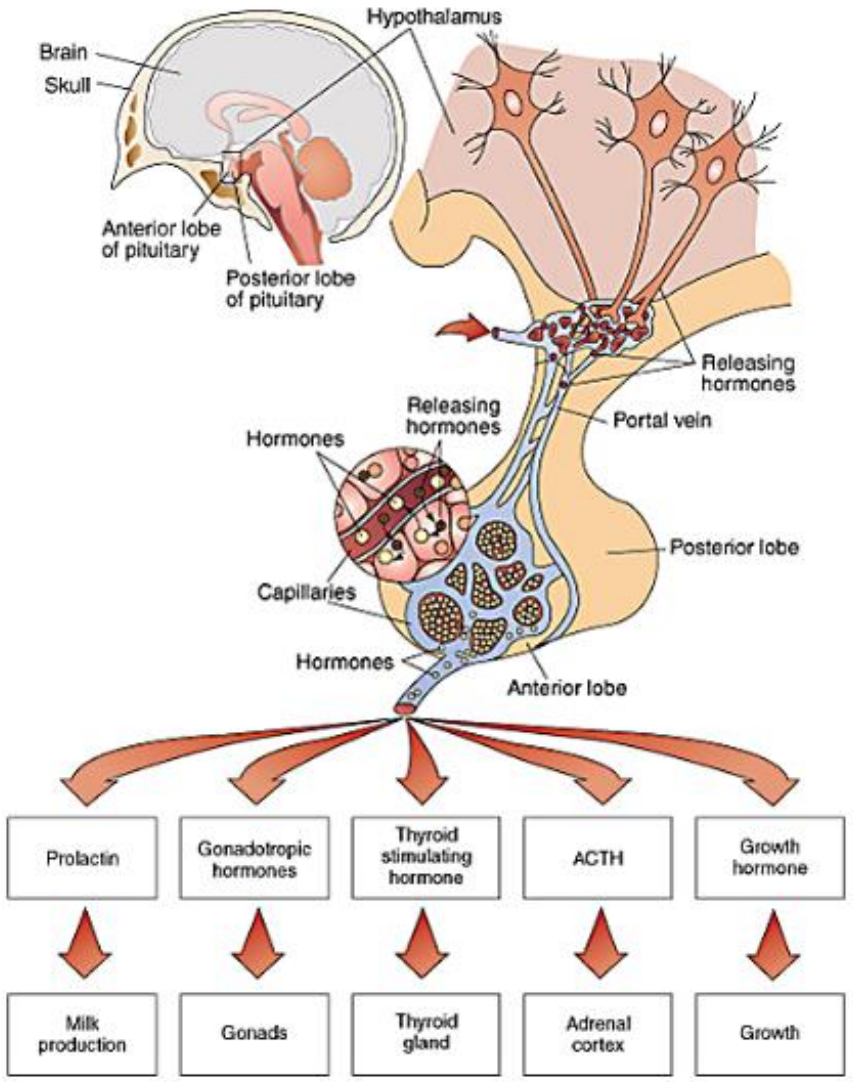
Anterior Pituitary

- Referred to as "master gland"
- Secretes hormones that regulate other endocrine glands
  - **Thyroid-stimulating hormone** (**TSH**): Regulates function of thyroid gland
  - **Adrenocorticotropin hormone** (**ACTH**): Regulates function of adrenal cortex
  - **Gonadotropins**:
    - **Follicle-stimulating hormone** (**FSH**): Responsible for development of ova and sperm & Also stimulates ovary to secrete estrogen
    - **Luteinizing hormone** (**LH**): Stimulates secretion of sex hormones; Plays a role in releasing ova in females
  - **Growth hormone** (**GH**) (somatotropin): Stimulates cells to grow and divide
  - **Prolactin** (**PRL**): Stimulates milk production in breast
  - **Melanocyte-stimulating hormone** (**MSH**): Stimulates melanocytes to produce more melanin

Pituitary Gland

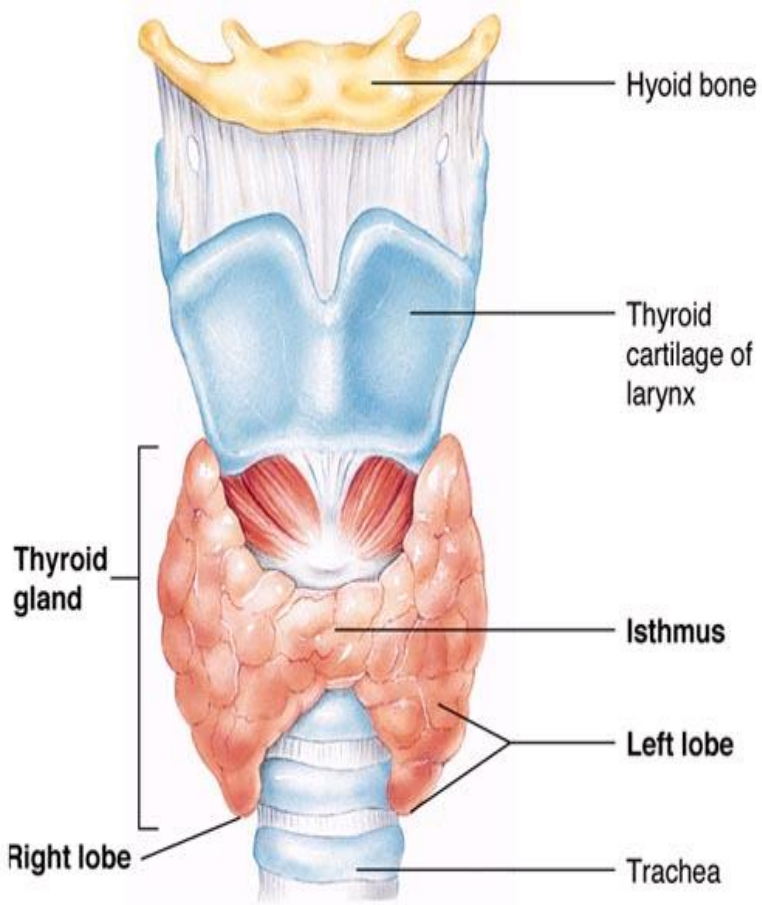
Posterior Pituitary

- Produced in hypothalamus Transported to posterior lobe
- Releases hormones when hypothalamic neurons are stimulated
  - **Antidiuretic hormone** (ADH): Called vasopressin
    - Promotes water reabsorption by the kidney tubules
  - **Oxytocin**:
    - Stimulates uterine contractions during labor and delivery
    - After birth stimulates release of milk from breast



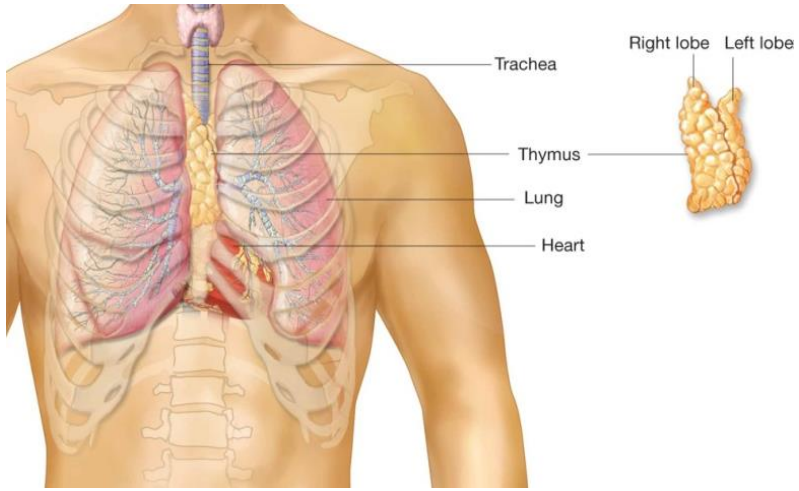
Thyroid Gland

- Located on either side of trachea
- Resembles a butterfly in shape
- Divided into right and left lobes
- **Thyroid hormones**
  - **Thyroxine** (T4) & **Triiodothyronine** (T3)
  - Needs iodine to make hormones
  - These hormones:
    - Regulate energy production
    - Adjust metabolic rate
- Also secretes **calcitonin**: Regulates level of calcium in bloodstream
  - If calcium levels in blood rise too high: Calcitonin levels in blood increase
  - Increases deposition of calcium into bone
  - Lowers levels of calcium in bloodstream
  - Its action is opposite of parathyroid hormone



Thymus Gland

- Located in mediastinum
- Part of immune system
- Also, endocrine gland
  - Secretes **thymosin** which is essential for growth and development of T cells
  - Critical part of body's immune system
- Present at birth and grows to largest size during puberty
- **At puberty** begins to shrink and eventually is replaced with connective and adipose tissue



Endocrine Functions of Other Organs

❖ **Skin**

- keratinocytes make cholecalciferol using UV from sun

❖ **Liver**

- involved in the production of at least five hormones
  - 1- Converts cholecalciferol into calcidiol
  - 2- Secretes angiotensinogen (precursor for BP regulation)
  - 3- Secretes 15% of erythropoietin (stimulates bone marrow)
  - 4- Hepcidin – promotes intestinal absorption of iron
  - 5- Source of IGF-I that controls action of growth hormone

Endocrine Functions of Other Organs

- **Kidneys**:
  - Play role in production of three hormones
    1. Converts **calcidiol** to **calcitriol**, the active form of vitamin D
    2. Secrete **renin** that converts angiotensinogen to angiotensin I
    3. Produce 85% of **erythropoietin**
- **Heart**:
  - Cardiac muscle secretes atrial natriuretic peptides in response to an increase in blood pressure → ↓ blood pressure
- **Stomach and small intestine**:
  - At least ten enteric hormones that coordinate digestive motility and glandular secretion
- **Adipose tissue**:
  - secrets **adipocytokines** (as leptin) to slow appetite
- **Osseous tissue**:
  - **Osteocalcin** secreted by osteoblasts increases insulin sensitivity of body tissues inhibits weight gain and onset of type II diabetes mellitus
- **Placenta**:
  - Secretes **estrogen**, **progesterone**, **HCG** and others regulate pregnancy, development of fetus

Paracrine Secretions

- **Paracrines**: are chemical messengers that diffuse short distances and stimulate nearby cells
  - Unlike neurotransmitters, not produced in neurons
  - Unlike hormones, not transported in blood
  - A single chemical can act as a hormone, paracrine, or even neurotransmitter in different locations
  - **Histamine**: From mast cells in connective tissue, causes relaxation of blood vessels
  - **Nitric oxide**: From endothelium of blood vessels, causes vasodilatation
  - **Somatostatin**: From Delta cells of islets of Langerhans to inhibits α and cells β cells secretions
  - **Catecholamines**: Diffuse from adrenal medulla to cortex
  - **Prostaglandins**: Produced by most body tissues, act near site of production
    - Blood vessel constriction and dilation
    - Bronchial constriction and dilation
    - Intestinal constriction and relaxation (increased and decreased peristalsis)
    - Many additional functions that are not fully understood

Endocrine System Combining Forms

acr/o	Extremities	**adren/o**	Adrenal glands
adrenal/o	adrenal glands	**andr/o**	Male
calc/o	Calcium	**crin/o**	Secrete
estr/o	Female	**glyc/o**	Sugar
glycos/o	Sugar	**ophthalm/o**	Eye
gonad/o	Sex glands	**home/o**	Sameness
pancreat/o	Pancreas	**pituitar/o**	Pituitary gland
pineal/o	Pineal gland	**thyr/o**	Thyroid gland
thyroid/o	Thyroid gland	**toxic/o**	Poison
–crine to	Secrete	**–dipsia**	Thirst
–prandial	Relating to a meal	**–tropin**	Stimulate
kal/i	Potassium	**natr/o**	Sodium

Endocrine System Terminology

Word Building with adren/o & adrenal/o		
-al	Adrenal	Pertaining to adrenal gland
-megaly	Adrenomegaly	Enlarged adrenal gland
-pathy	Adrenopathy	Adrenal gland disease
-ectomy	Adrenalectomy	Eemoval of adrenal gland
-itis	Adrenalitis	Inflammation of adrenal gland
Word Building with calc/o & crin/o		
hyper- **-emia**	Hypercalcemia	Excessive calcium in blood
hypo- **-emia**	Hypocalcemia	Low calcium in blood
endo- **-ologist**	Endocrinologist	Specialist in endocrine system
endo- **-pathy**	Endocrinopathy	Endocrine system disease

Endocrine System Terminology

Word Building with glyc/o, kal/i, & natr/o		
hyper- -emia	Hyperglycemia	Excessive sugar in blood
hypo- -emia	Hypoglycemia	Low sugar in blood
hyper- -emia	Hyperkalemia	Excessive potassium in blood
hypo- -emia	Hyponatremia	Low sodium in blood
Word Building with parathyroid/o & pancreat/o		
-al	Parathyroidal	Pertaining to parathyroid
-ectomy	Parathyroidectomy	Removal of parathyroid
hyper- -ism	Hyperparathyroidism	State of excessive parathyroid
hypo- -ism	Hypoparathyroidism	State of insufficient parathyroid
-ic	Pancreatic	Pertaining to pancreas

Endocrine System Terminology

Word Building with pituitar/o & thym/o		
-ary	Pituitary	Pertaining to pituitary
hypo- -ism	Hypopituitarism	State of low pituitary
hyper- -ism	Hyperpituitarism	State of excessive pituitary
-ic	Thymic	Pertaining to thymus
-ectomy	Thymectomy	Eemoval of thymus
-it is	Thymitis	Inflammation of thymus
-oma	Thymoma	Thymus tumor
Word Building with thyr/o & thyroid/o		
-al	Thyroidal	Pertaining to thyroid
-ectomy	Thyroidectomy	Removal of thyroid
hyper- -ism	Hyperthyroidism	State of excessive thyroid
hypo- -ism	Hypothyroidism	State of low thyroid
-megaly	thyromegaly	Enlarged thyroid

Endocrine System Vocabulary

Acidosis	Excessive acidity of body fluids
Edema	Excessive fluid in body tissues
Endocrinology	Diagnosis and treatment of conditions of endocrine glands
Exophthalmos	Protruding eyeballs
Gynecomastia	Development of breast tissue in males
Hirsutism	Excessive amount of hair
Hypersecretion	Excessive hormone production by endocrine gland
Hyposecretion	Insufficient hormone production by endocrine gland
Obesity	Having abnormal amount of fat
Syndrome	Group of symptoms and signs that combine to present a clinical picture of disease or condition
Addison's disease	Hyposecretion of adrenal cortex; symptoms include generalized weakness and weight loss

Endocrine System Vocabulary

Adrenal feminization	Hypersecretion of estrogen by adrenal cortex in males; develops female secondary sexual characteristics like gynecomastia
Adrenal virilism	Hypersecretion of testosterone by adrenal cortex in females; develops male secondary sexual characteristics
Cushing's syndrome	Hypersecretion of adrenal cortex; symptoms include weakness, edema, excess hair growth, and osteoporosis
pheochromocytoma	Hypersecretion of epinephrine by adrenal medulla tumor; usually benign; symptoms include anxiety, heart palpitations, dyspnea, and headache
Parathyroid Gland Pathology	
Tetany	Nerve irritability and painful muscle cramps due to hypocalcemia; may be caused by hypoparathyroidism
Recklinghausen disease	Hypersecretion of parathyroid hormone; causes degeneration of bones

Endocrine System Vocabulary

Pancreas Pathology	
diabetes mellitus (DM)	Chronic disorder of carbohydrate metabolism Results in hyperglycemia and glycosuria Two very distinct types: • Insulin-dependent (IDDM) & Non-insulin-dependent (NIDDM)
diabetic retinopathy	Accumulation of damage to retina; complication of diabetes mellitus
ketoacidosis	Acidosis due to excess of acidic ketone bodies; serious complication of diabetes mellitus
Peripheral neuropathy	Damage to nerves in lower legs and hands as a result of diabetes mellitus
insulinoma	islet of Langerhans tumor; secretes excessive amount of insulin
Endocrine Gland Pathology	
Adenocarcinoma	cancerous tumor in gland that produces hormones secreted by that gland; results in hypersecretion pathologies

Endocrine System Vocabulary

Pituitary Gland Pathology	
Acromegaly	Chronic hypersecretion of growth hormone in adults; causes enlargement of bones of head and extremities
Diabetes insipidus (DI)	Hyposecretion of antidiuretic hormone; symptoms include polyuria and polydipsia
Dwarfism	Hyposecretion of growth hormone in children; causes short stature
Gigantism	Hypersecretion of growth hormone in child; results in very tall adult
Panhypopituitarism	Hyposecretion of all pituitary hormones; results in problems with the glands controlled by pituitary gland

Endocrine System Vocabulary

Thyroid Gland Pathology	
Cretinism	Congenital hyposecretion of thyroid; results in poor physical and mental development
Goiter	Enlarged thyroid gland
Graves' disease	Hypersecretion of thyroid; symptoms include exophthalmos and goiter
Hashimoto's disease	Autoimmune destruction of thyroid; results in hyposecretion disorder
Myxedema	Hyposecretion disorder in adult; symptoms include anemia, edema, and mental lethargy
Thyrotoxicosis	Marked hypersecretion; symptoms include rapid heart rate, tremors, thyromegaly, and weight loss

Endocrine System Vocabulary

Thyroid Gland Pathology	
Blood serum test	Measures level of substances, such as calcium, glucose, or hormones, in blood
Total calcium	Measures calcium in blood; used to diagnose parathyroid or bone disorders
Radioimmunoassay (RIA)	Measures levels of hormones in blood
Fasting blood sugar (FSB)	Measures glucose in bloodstream after 12-hour fast
Glucose tolerance test (GTT)	Measures blood sugar level over several hours after person drinks large dose of glucose
Two-hour postprandial glucose tolerance test	Measures blood glucose level two hours after a meal
Protein bound iodine test (PBI)	Measures T_4 blood level; iodine in the hormone becomes bound to blood proteins
Thyroid function test (TFT)	Measures levels of T_3, T_4, and TSH in blood

Endocrine System Vocabulary

Diagnostic Imaging	
Thyroid echogram	Ultrasound image of thyroid gland
Thyroid scan	Nuclear medicine image based on accumulation of radioactive iodine in thyroid gland
Medical Treatments	
Chemical thyroidectomy	Large dose of radioactive iodine is given to kill a portion of the thyroid gland; avoids surgery
Hormone replacement therapy	Administering replacement hormones; treats hyposecretion disorders
Laparoscopic adrenalectomy	Removal of adrenal gland through small abdominal laparoscopic incision
Lobectomy	Removal of a lobe of thyroid gland