

MEDAVIE

HealthEd

ÉduSanté



ENDOCRINE SYSTEM

Advanced Care Paramedicine

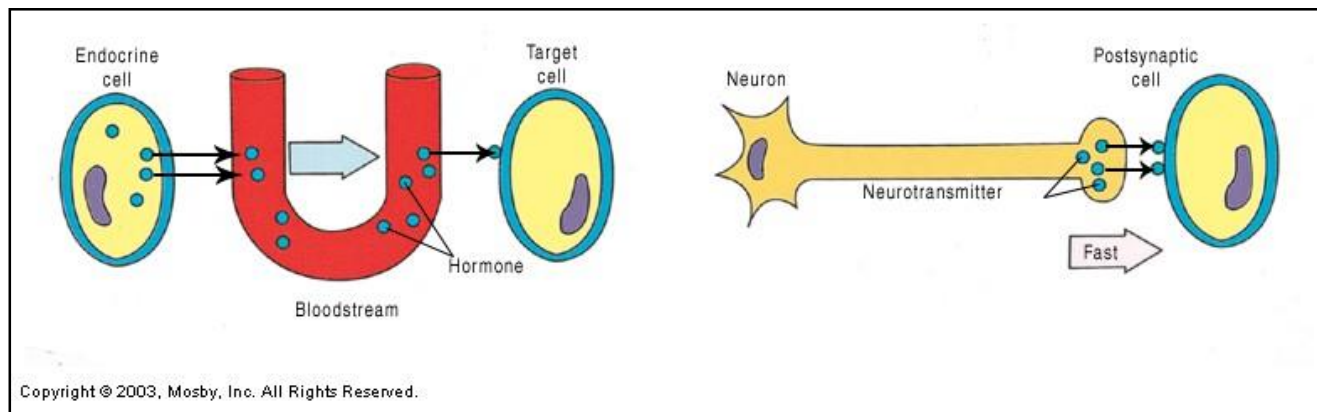
Module: 05

Section: 02



- Communication
- Integration
- Control

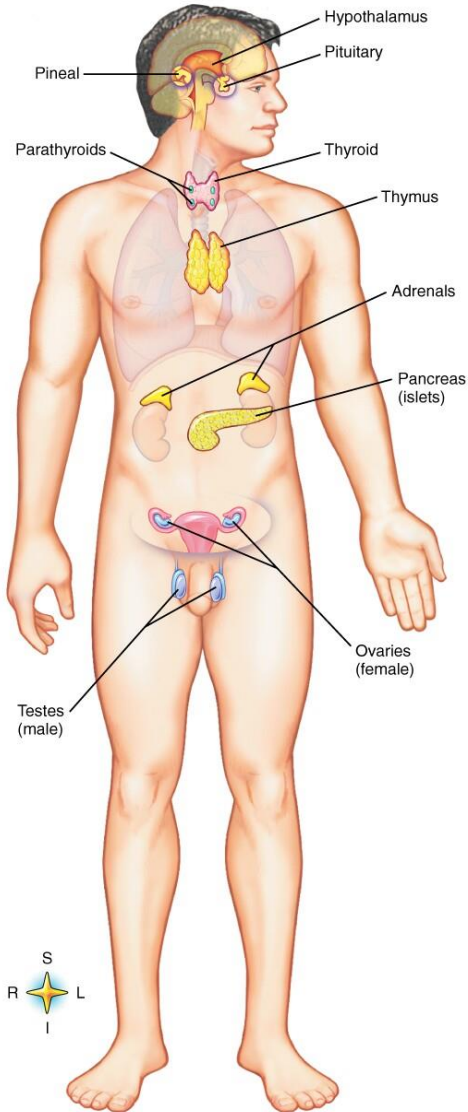
- Functions to regulate the bodies activities
- Works in conjunction with the nervous system
 - Effects are longer acting and are more generalized



- Secreting cells release hormones (Greek for “to excite”)
- Hormones are carried via the bloodstream to target cells somewhere in the body
 - Target tissues
 - Target organs

- Tend to have widespread effects
- Hormones act on distant tissues
 - Specific effect on specific target tissues
 - Some have many targets, some have one
- Important role in the regulation of body functions

Feature	Endocrine	Nervous
Overall Function	Regulation of effectors to maintain homeostasis	Regulation of effectors to maintain homeostasis
Control by regulatory feedback loops	Yes (endocrine reflexes)	Yes (nervous reflexes)
Effector Tissues	Virtually all tissues	Muscles and glands only
Effector Cells	Target Cells (throughout the body)	Postsynaptic cells (in muscles and glands)
Chemical Messenger	Hormone	Neurotransmitter
Cells that secrete the chemical messenger	Glandular epithelial cells or neurosecretory cells (modified neurons)	Neurons
Distance traveled (and method)	Long (bloodstream)	Short
Location of receptor in effector cell	Plasma membrane or within the cell	Plasma membrane
Characteristics of regulatory effects	Slow to appear, long lasting	Appear rapidly, short lived



- Organs of the system are spread throughout the body

- Two major types of glands
 - Exocrine
 - Endocrine

- Ducts carry their secretory product to a surface
 - Sweat
 - Mammary
 - Digestive enzymes

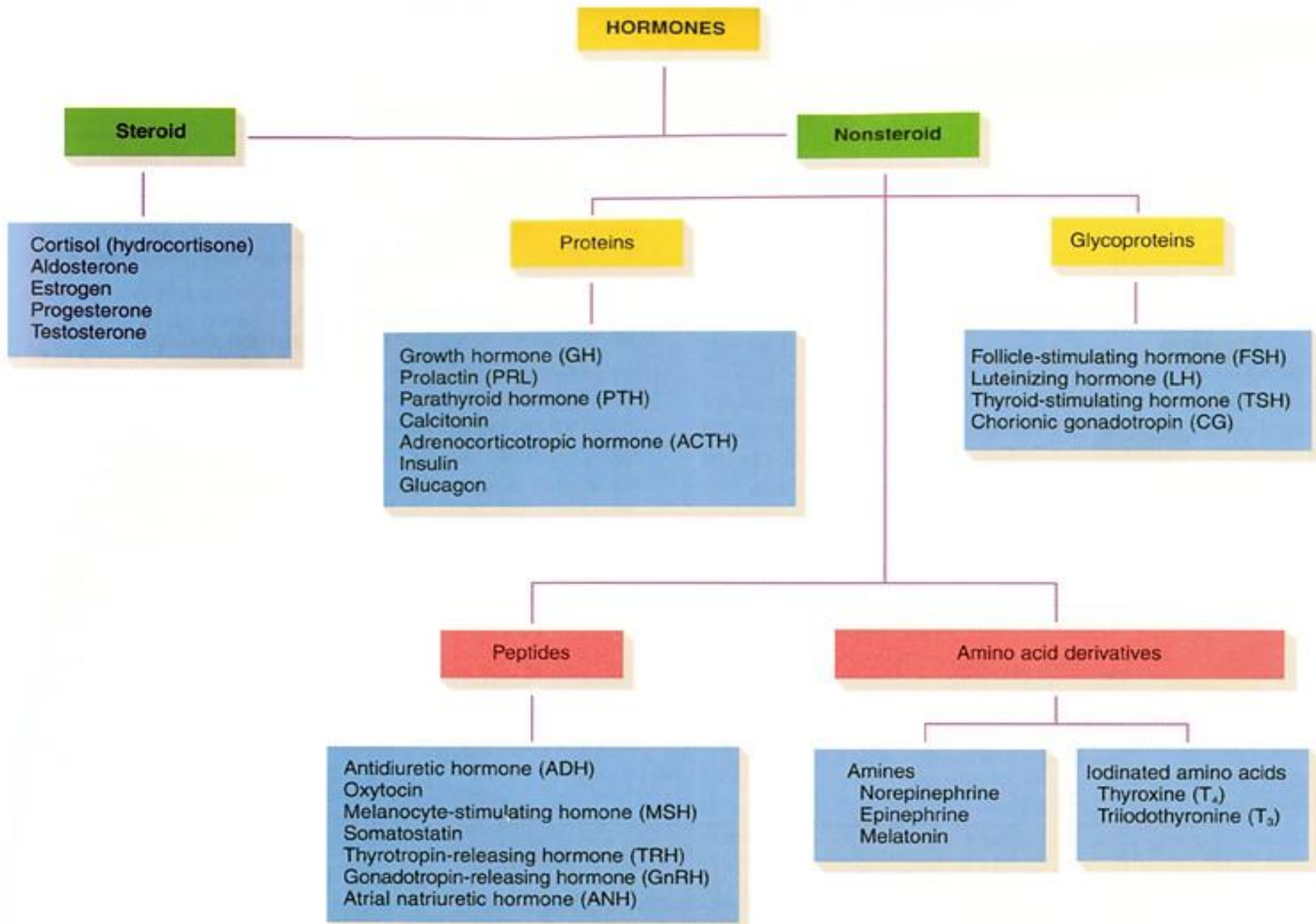
- Are ductless
- Secretory product (hormones) are released directly into the blood
- Blood carries them to their specific receptor sites

- May be classified in many ways
 - Function
 - Chemical Structure

- Function
 - Tropic Hormones
 - Target other endocrine glands and stimulate their growth and secretion
 - Sex Hormones
 - Target reproductive tissue
 - Anabolic Hormones
 - Stimulate anabolism in target cells
 - Many others...

- Chemical Structure
 - Steroid Hormones
 - Manufactured from cholesterol
 - All are chemically similar
 - Are lipid soluble
 - Examples
 - Cortisol
 - Aldosterone
 - Estrogen
 - Progesterone
 - Testosterone

- Chemical Structure
 - Non-Steroid Hormones
 - Synthesized from amino acids
 - Proteins (have long chains of amino acids)
 - Glycoprotein (proteins with carbohydrate group)
 - Peptide (small chains of amino acids)
 - Amino acid derivative (from a single amino acid)
 - » Amines (from tyrosine)
 - » Iodinated amino acids (tyrosine synthesized with iodine)



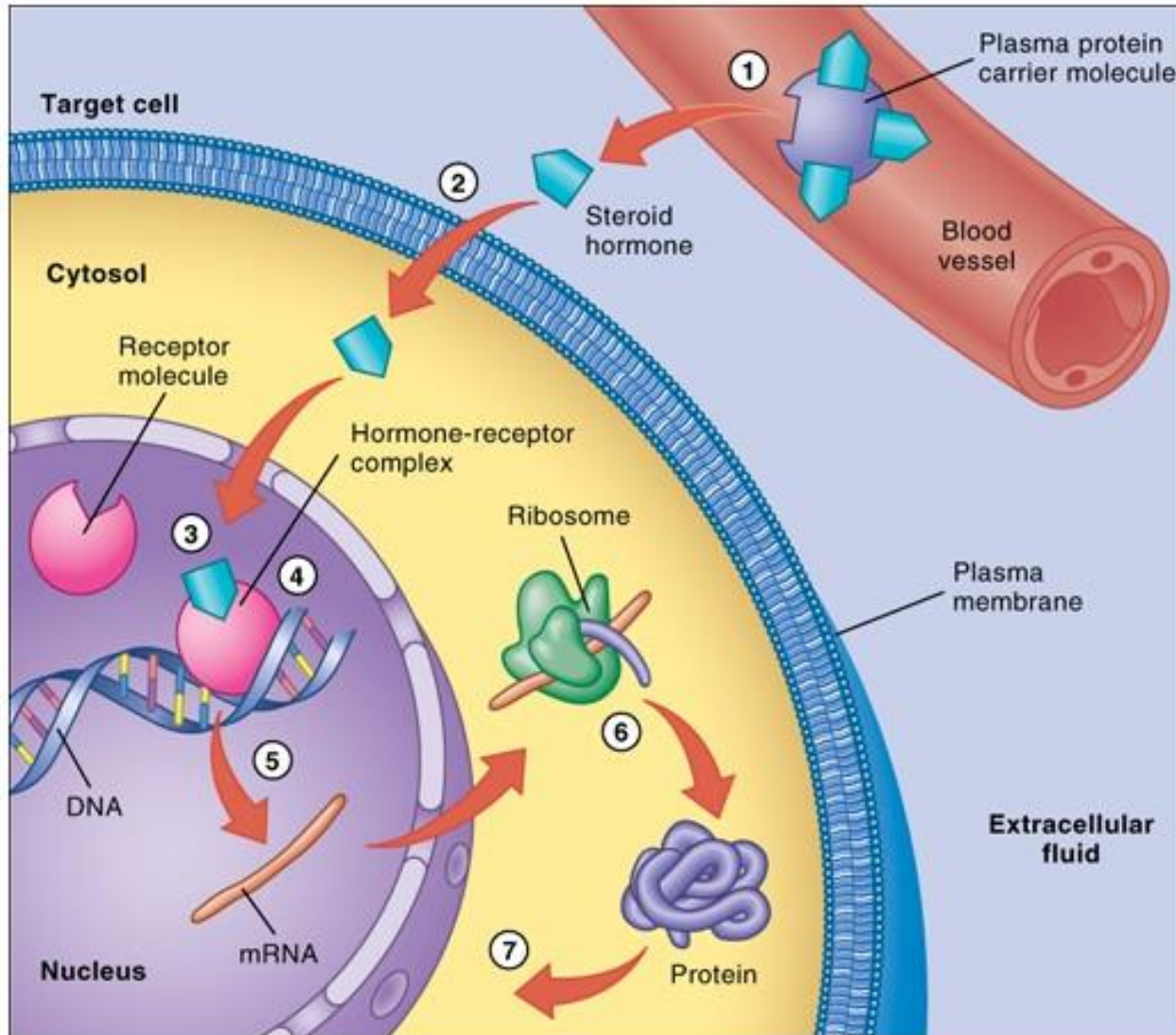
- Most hormones can not be taken orally since they are inactivated by the digestive enzymes
- Steroids are lipid soluble and may be taken orally

- Hormones find specific receptor sites in the target tissue
- Tissues may have many different types of receptor cells
- Target tissue may be localized or may be diffuse throughout the body
 - Hormones may work together to produce synergistic effects (1 + 1 = 3)
 - Some combinations produce **permissiveness**
 - Small amount of one hormone allows another to have full effect

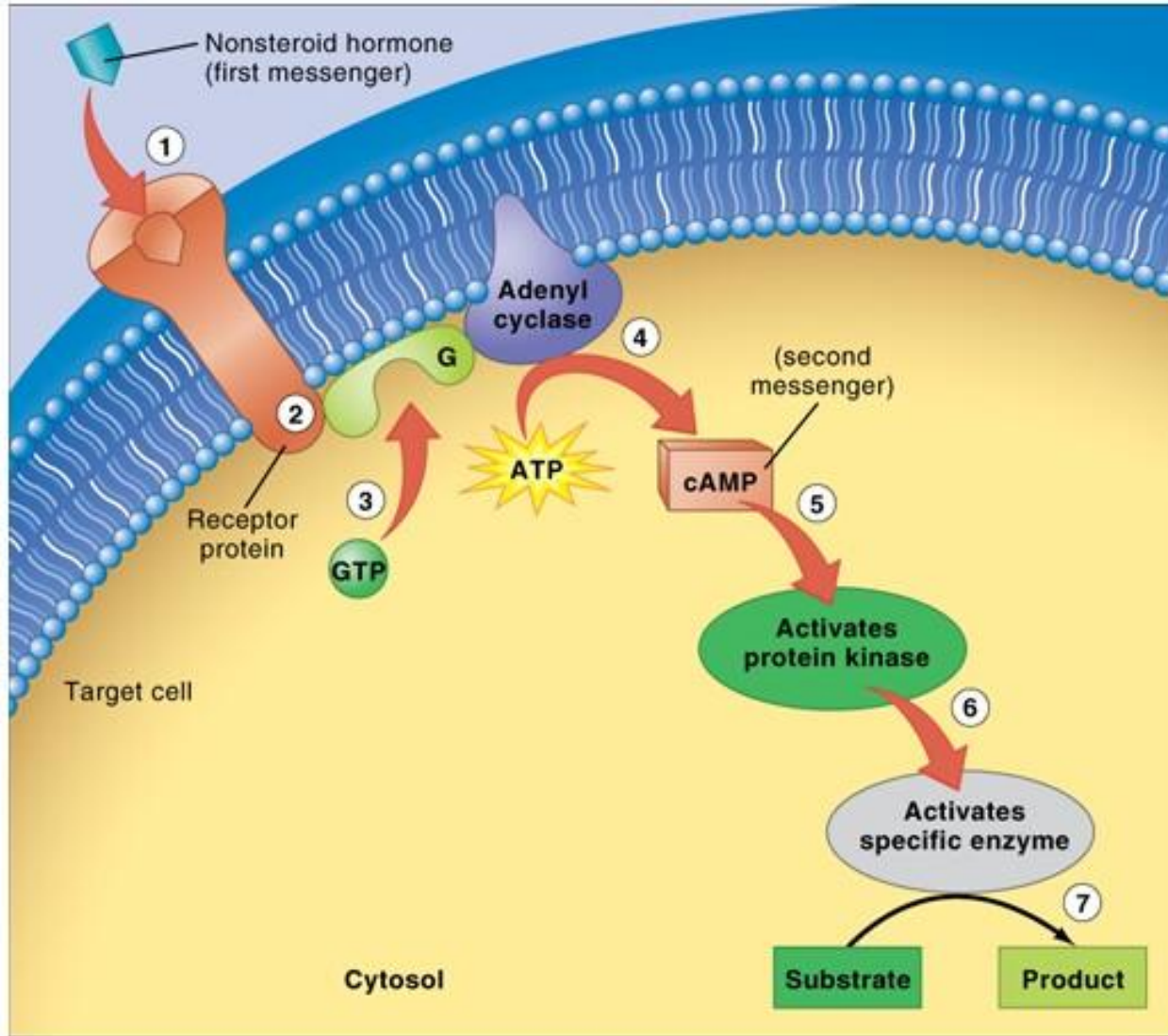
- Endocrine system typically produces more hormones than actually hit the target tissue
- Some are carried by plasma proteins
 - Must be released from protein first
- Unused hormones are either excreted by kidneys or broken down by metabolism

- Receptor sites
 - Plasma membrane
 - Interior of the cell
- Steroid hormones
 - Lipid soluble
- Non-steroid
 - do not easily cross the membrane so typically find receptor sites on the surface

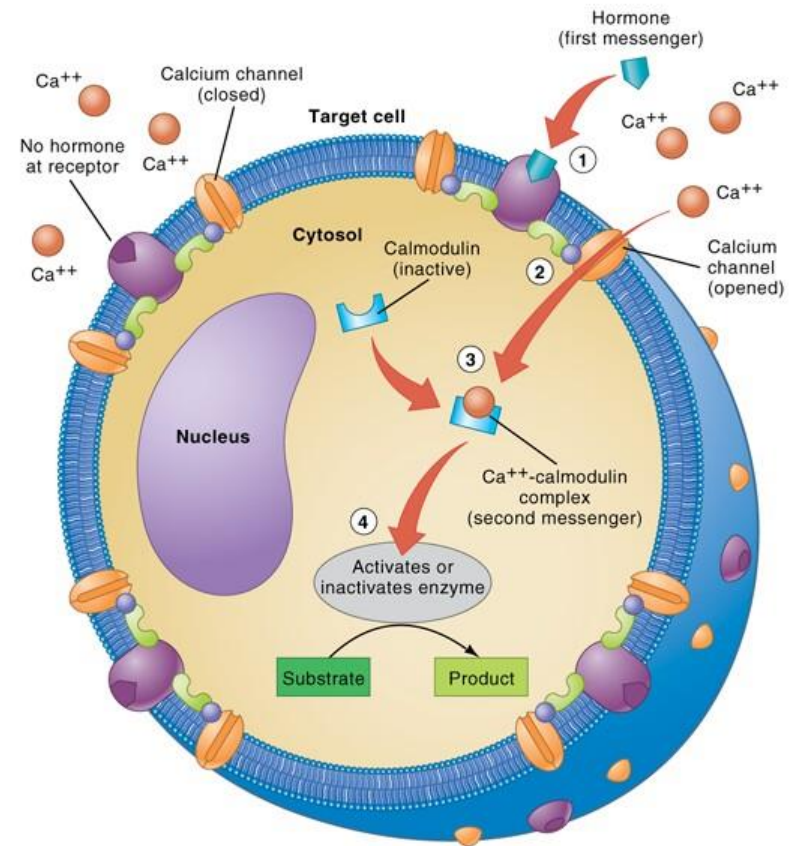
- Usually carried by plasma proteins
- Steroids diffuse into the cell and react with receptor sites on the cells interior
- This hormone-receptor complex enters the nucleus where it effects specific genes in the DNA
- The genes act as templates in the production of messenger RNA (mRNA) which diffuses into the cytoplasm
- mRNA directs synthesis of proteins at the ribosomes
- The proteins are the cell's response of the hormone
- This is relatively slow since everything has to be synthesized (45 minutes – days)



- Hormone attaches to receptor protein (**first messenger**)
- Activates a G protein (membrane protein) to react with a nucleotide (GTP – guanosine triphosphate)
- This activates another membrane protein (adenyl cyclase)
- Adenyl cyclase reacts with ATP and removes 2P to create cyclic adenosine monophosphate (cyclic AMP)
- cAMP is called the **second messenger**
- This produces the changes in cellular activity sought by the hormone
- Is relatively fast since most items involved only need to be stimulated (Seconds to minutes)

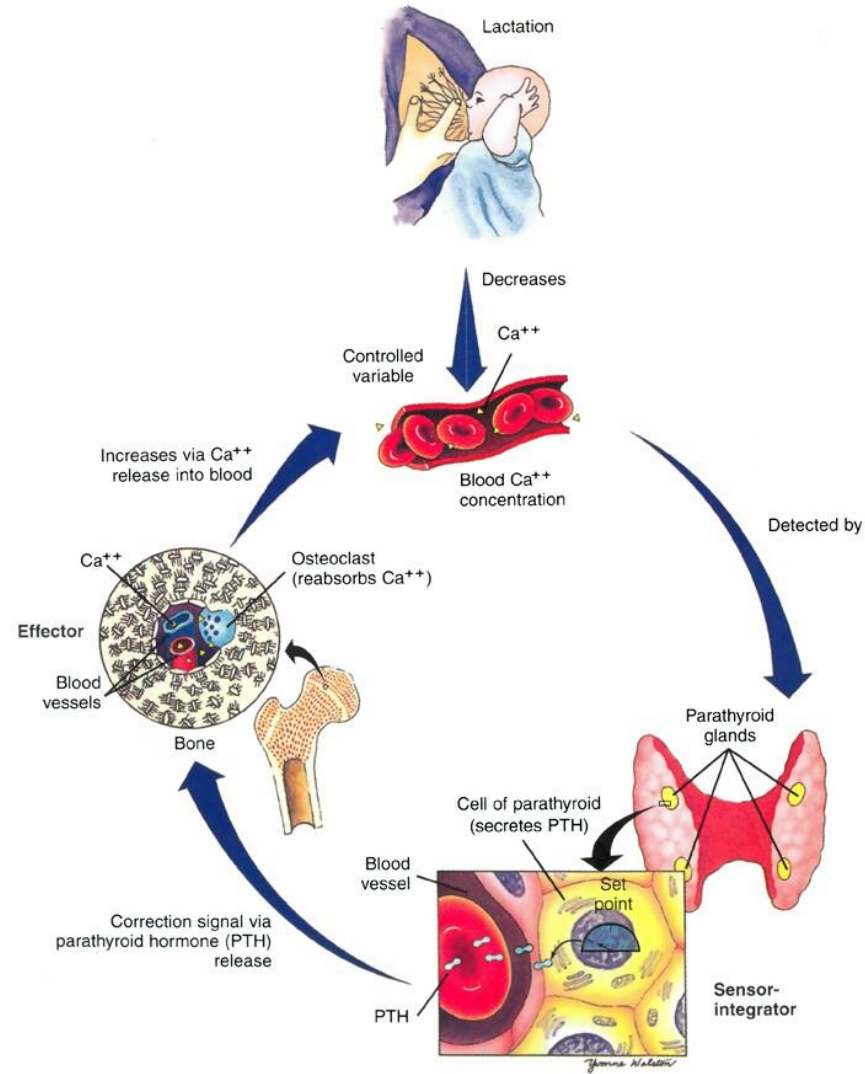


- Most non-steroids use cAMP as its secondary messenger
- Others may use
 - inositol triphosphate (IP_3)
 - Cyclic guanosine monophosphate (GMP)
- Also possible to trigger effects by opening Ca channels



- Not all non-steroid hormones use the second messenger model
- Iodinated amino acids enter the target cells and bind to receptor sites in the DNA
- Produce enzymes similar to steroids

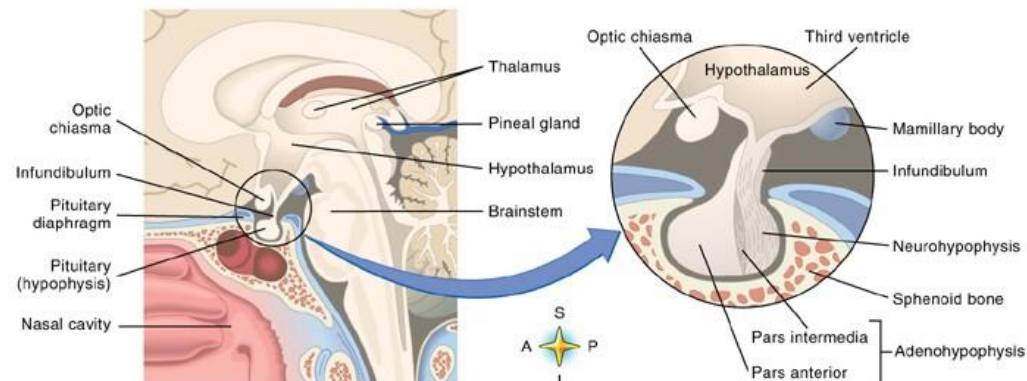
- Hormones are very potent
- This demands very narrow limits to maintain homeostasis
- Most are controlled by negative feedback mechanisms (feedback loops)
 - Pancreas releases Insulin if too much glucose
- Some endocrine glands release hormones in response to other hormones
 - TSH from anterior pituitary causes thyroid to release thyroxin
- Nervous stimulation
 - The release of epinephrine from the adrenal cortex



Organs of the Endocrine System

Pituitary Gland (Hypophysis)

- Is the size of a pea that rest on the sphenoid bone of the skull
- Is connected to the hypothalamus by a slender stalk called the infundibrium
- Has 2 distinct regions
 - Anterior pituitary (Adenohypophysis)
 - Posterior pituitary (Neurohypophysis)



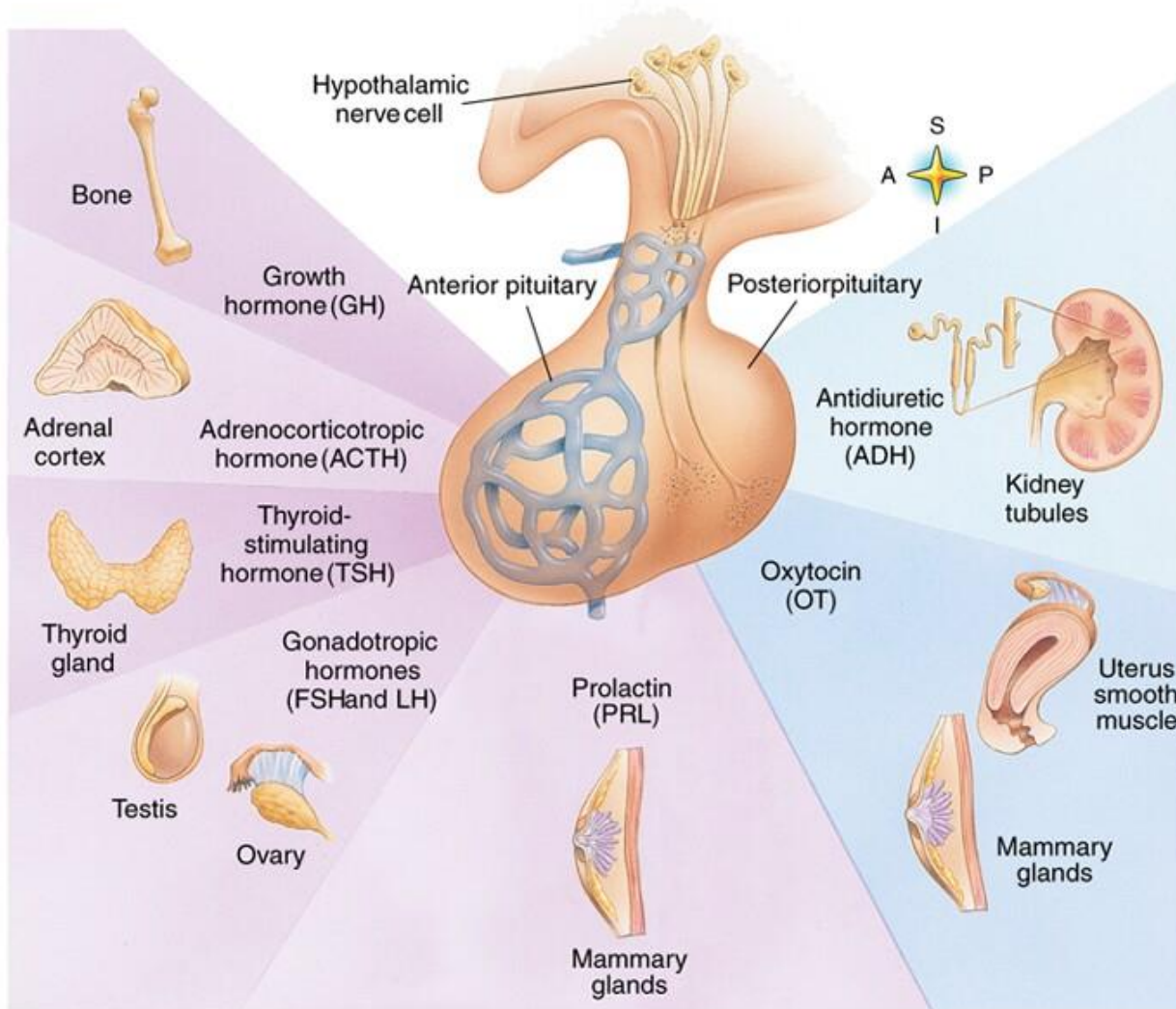
- Anterior pituitary
 - Growth Hormone (GH)
 - Promotes growth by stimulating the liver to release growth factors
 - These factors accelerate amino acid transport into the cells promoting protein anabolism
 - Prolactin (PRL)
 - Promotes development of breasts during pregnancy
 - Stimulates the secretion of milk to mammary glands

- Anterior pituitary
 - Thyroid stimulating hormone (TSH)
 - Promotes and maintains the growth and development of the thyroid
 - Cause the thyroid to release its hormones
 - Adrenocorticotrophic hormone (ACTH)
 - Growth and development of the adrenal cortex
 - Causes release of adrenal cortex hormones

- Anterior pituitary
 - Follicle-stimulating hormone (FSH)
 - Females
 - Promotes maturity of follicles in the ovaries
 - Secretion of estrogen
 - Males
 - Development of seminiferous tubules of the testes
 - Maintains spermatogenesis

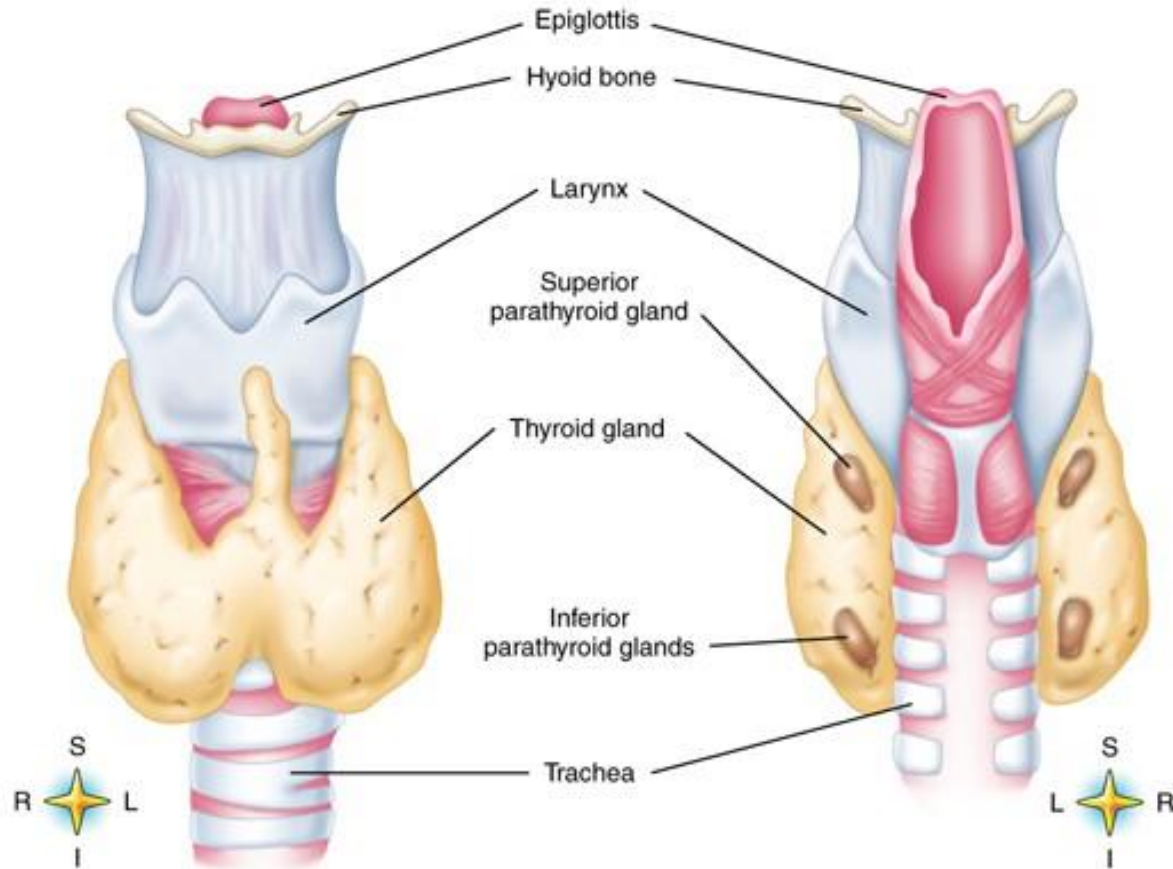
- Anterior pituitary
 - Luteinizing hormone (LH)
 - Females
 - Formation of corpus luteum in the tissue left behind when a follicle ruptures
 - Secretion of progesterone and estrogen
 - Supports FSH
 - Males
 - Stimulates interstitial cells in the testes to develop
 - Secretion of testosterone

- Posterior pituitary
 - Antidiuretic hormone (ADH)
 - Oxytocin (OT)
 - Contraction of the uterus
 - Ejection of milk from breasts

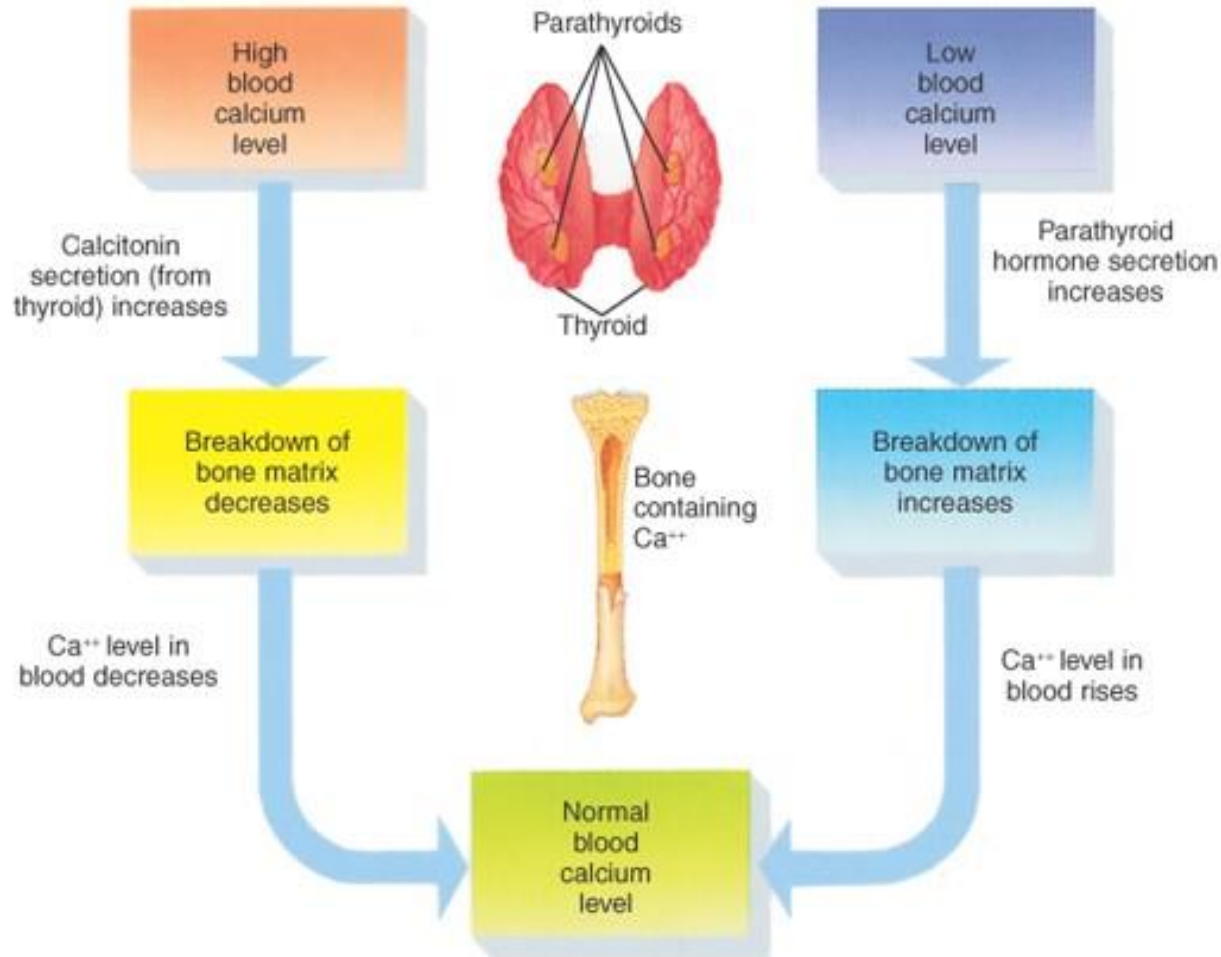


- Small cone shaped organ posterior to the 3rd ventricle of the brain
- Part of both systems
 - Nervous (receives visual nerve stimuli)
 - Endocrine (secretes hormone)
- Functions as ‘biological clock’
 - Hunger, sleep, reproduction and behavior
- Secretes Melatonin
 - Induces sleep
 - Secretion inhibited by sunlight
 - Excessive amounts produce mood-altering effects

- Very vascular organ found in the neck
- Consists of two lobes (with one on each side of the trachea)
- Hormones released
 - Thyroid Hormone (may actually be stored for later use)
 - Thyroxin and triiodothyronine
 - Regulate metabolic rates, growth processes and cell differentiation
 - Calcitonin
 - Influences the processing of Ca by bones
 - Can inhibit osteoclasts from breaking down bone (in cases of high Ca in blood)
 - Can promote osteoblasts to break down bone (to little Ca in blood)
 - Influences reabsorption of Ca in tubules
 - ↑ calcitonin inhibits reabsorption
 - ↓ calcitonin promotes reabsorption

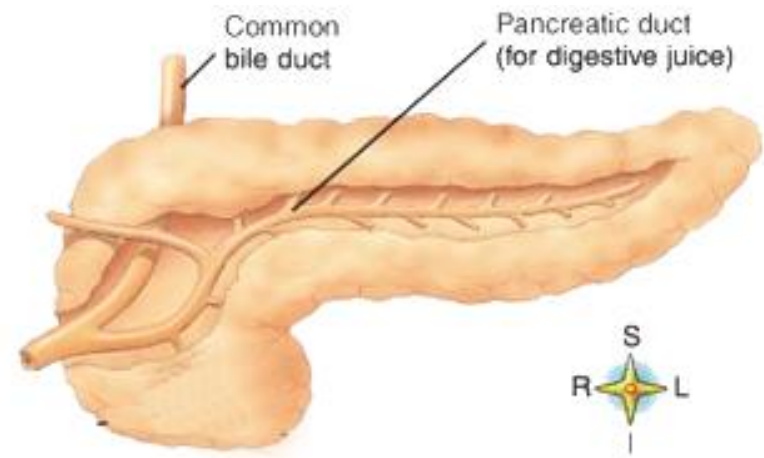


- Found on posterior surface of thyroid
- Releases parathyroid hormone
 - Antagonizes calcitonin
 - Acts on bone and kidney cells to release Ca into the blood

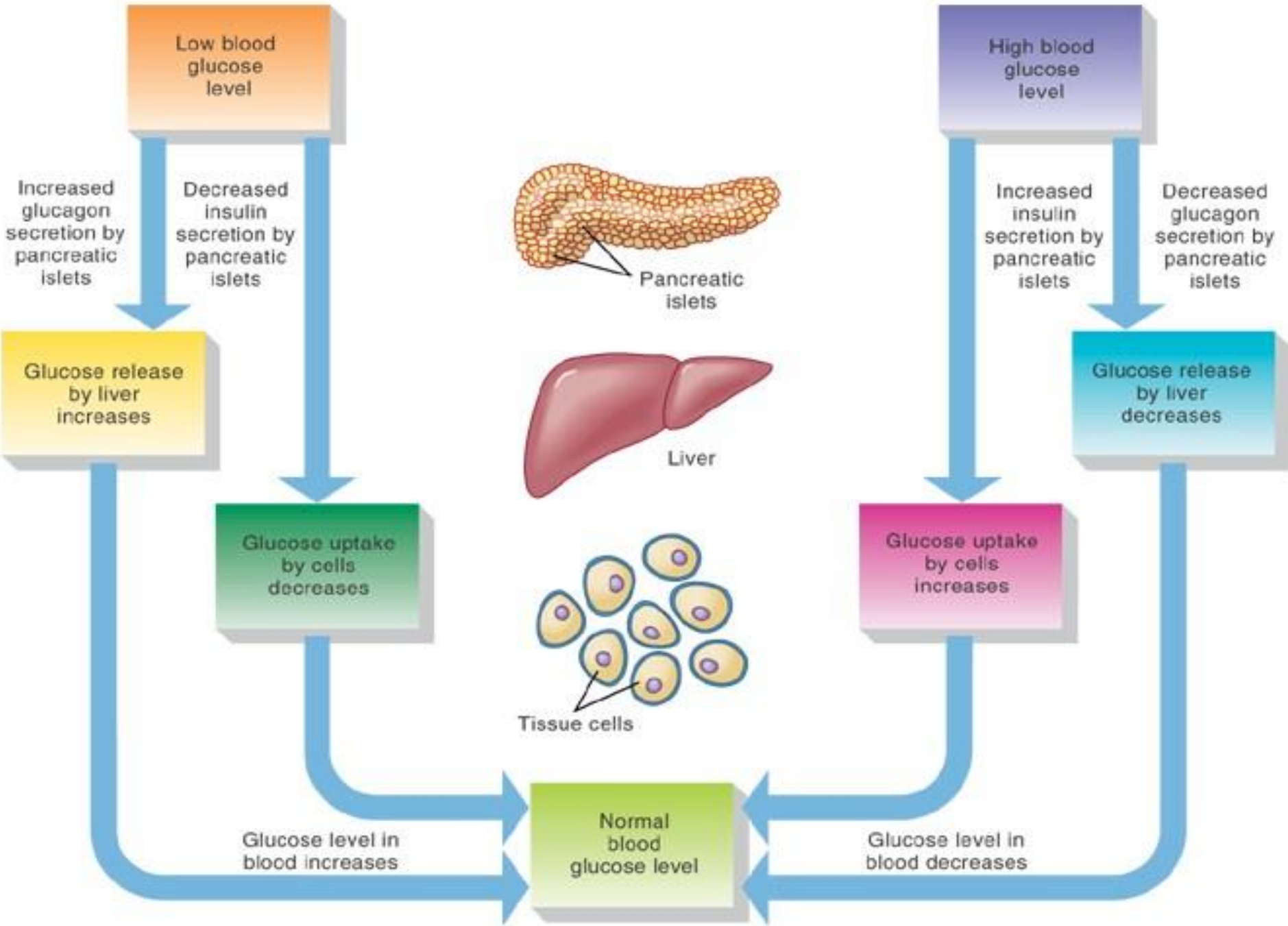


- Located on top of the kidneys
- Is divided into
 - Outer region (adrenal cortex)
 - Mineralocorticoids (aldosterone)
 - Aids in Na concentrations in the blood by increasing reabsorption
 - Glucocorticoids (cortisol)
 - Gonadocorticoids (androgens and estrogens)
 - Inner region (adrenal medulla)
 - Norepinephrine (20%)
 - Epinephrine (80%)

- Found along the posterior wall of the abdomen
- Has exocrine and endocrine properties
- Exocrine
 - Releases digestive enzymes into the duodenum
- Endocrine
 - Releases hormones into the blood



- Endocrine
 - Consists of over a million pancreatic islet cells (**Islets of Langerhans**)
 - 2 – 3% of total mass of pancreas
 - Alpha cells (A Cells)
 - glucagon
 - Beta cells (B Cells)
 - insulin
 - Delta cells (D Cells)
 - Somatostatin
 - regulates secretion of pancreatic hormones
 - Pancreatic polypeptide cells
 - pancreatic polypeptide
 - influences absorption in GI tract



- Exocrine
 - Acini cells
 - Surround hormone producing cells
 - Secrete serous fluid containing digestive enzymes into digestive system

- Testes
 - Androgens (testosterone)
 - Male characteristics and sperm production
- Ovaries
 - Estrogen
 - Female characteristics and aid other hormones in the sequence of pregnancy
 - Progesterone
 - Secreted by the corpus luteum to help maintain the lining of the uterus for pregnancy

- Produces Human Chorionic Gonadotropin (hCG)
 - High levels released during pregnancy signal the gonads to maintain the uterus lining
 - Used as indicator in pregnancy tests
 - Production decreases after 3rd month
- Produces estrogen and progesterone after 3rd month

- Found in the thoracic cavity (mediastinum)
- Large in children and atrophies in puberty
- Secretes thymosin and thymopoietin
 - Promote the production of T-Cells for immune system

- Cells can produce endocrine or exocrine secretions
 - Ghrelin
 - boosts appetite
 - Gastrin
 - Stimulates gastric glands to produce gastric juice
 - Secretin
 - regulates acid secretion
 - Cholecystikin-pancreozymin (CCK)
 - Triggers gallbladder to release more bile

- Atrial natriuretic hormone (ANH)
 - Secreted by the atrium
 - Increased secretion due to increase in stretching of atrium wall
 - ANH promotes Na secretion thus depleting blood volume by removal of water