

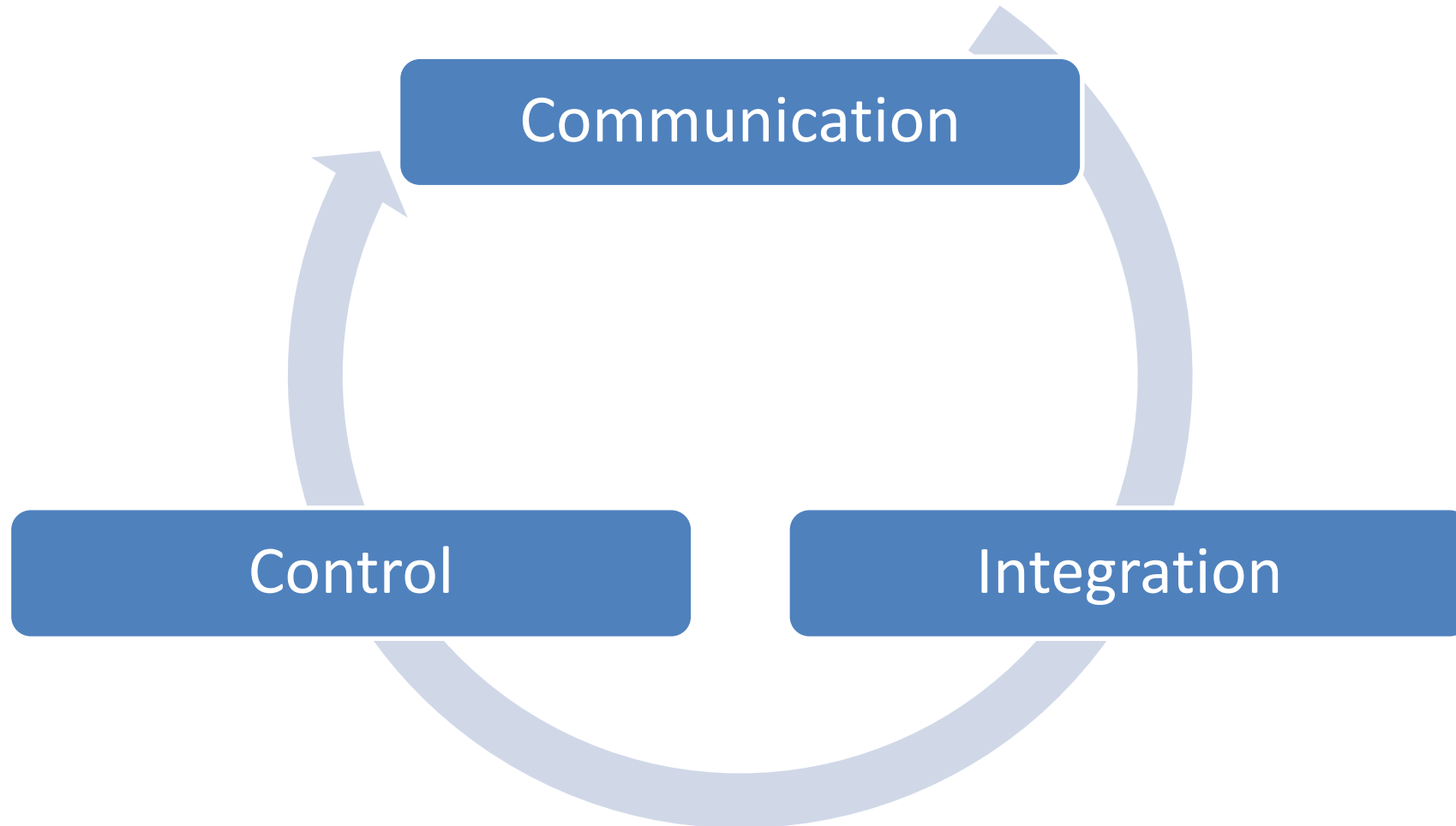
ENDOCRINE SYSTEM

Primary Care Paramedicine

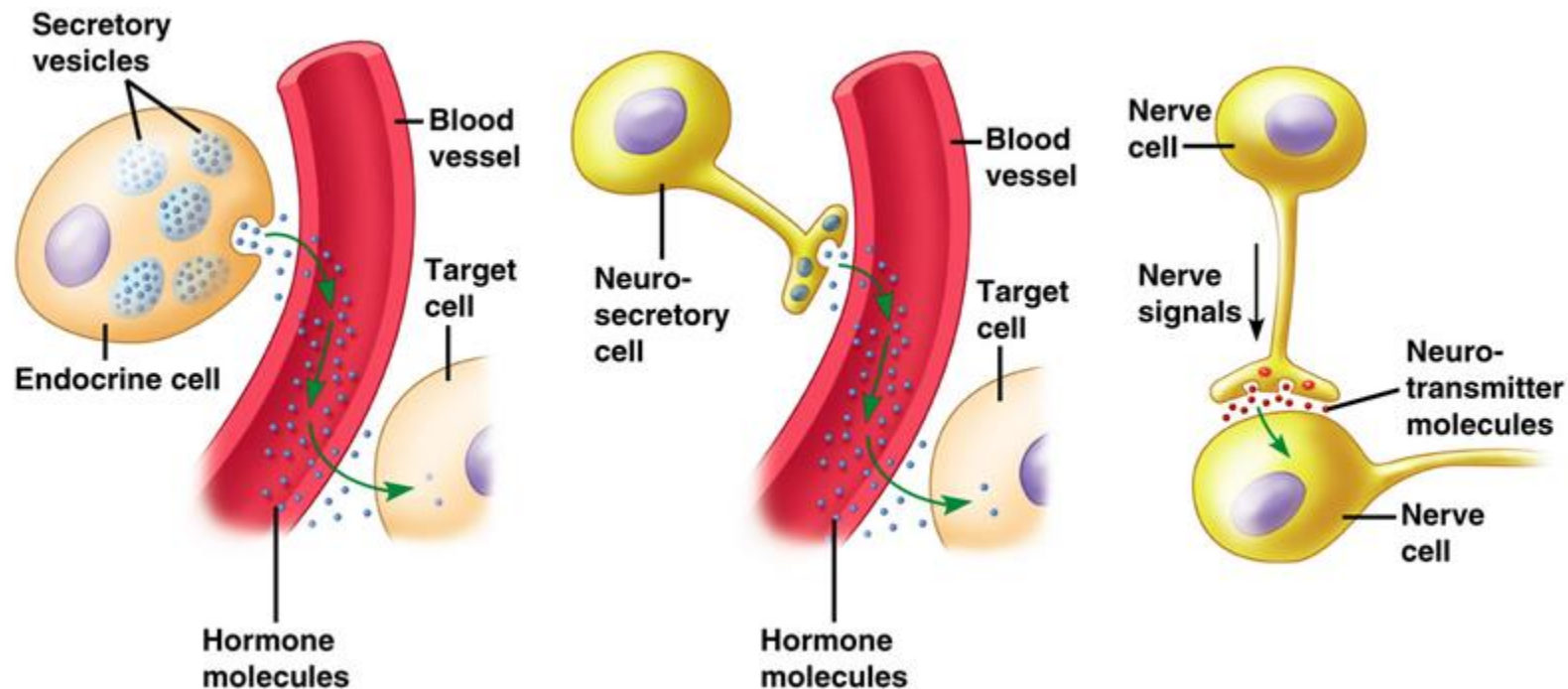
Module: 13

Section: 03





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

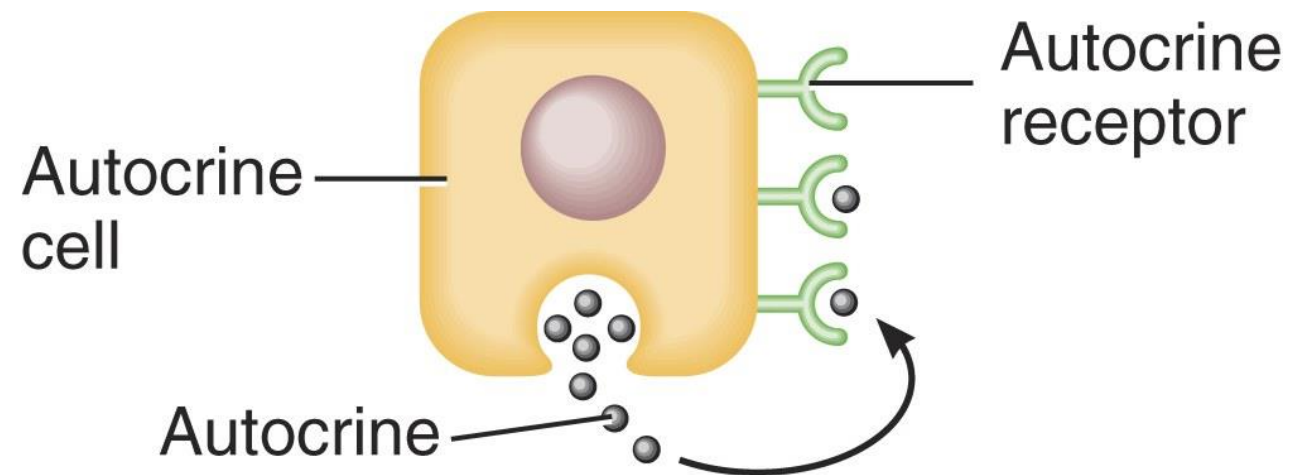


- Secreting cells release hormones
- Hormones are carried via the bloodstream to target cells somewhere in the body
 - Target tissues
 - Target organs

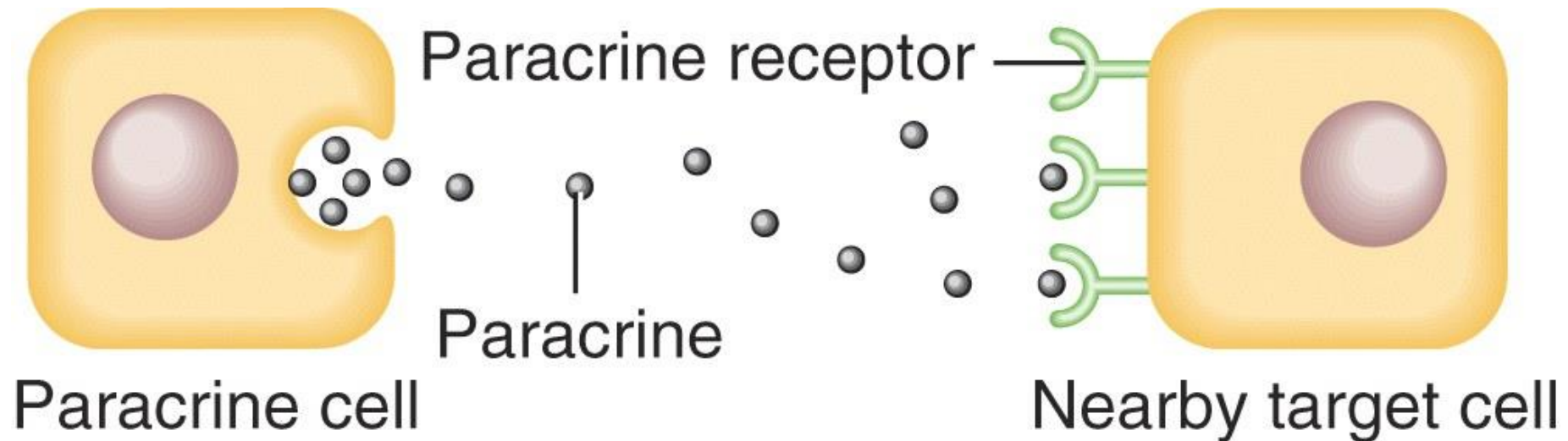
HORMONES

Greek for “to excite”

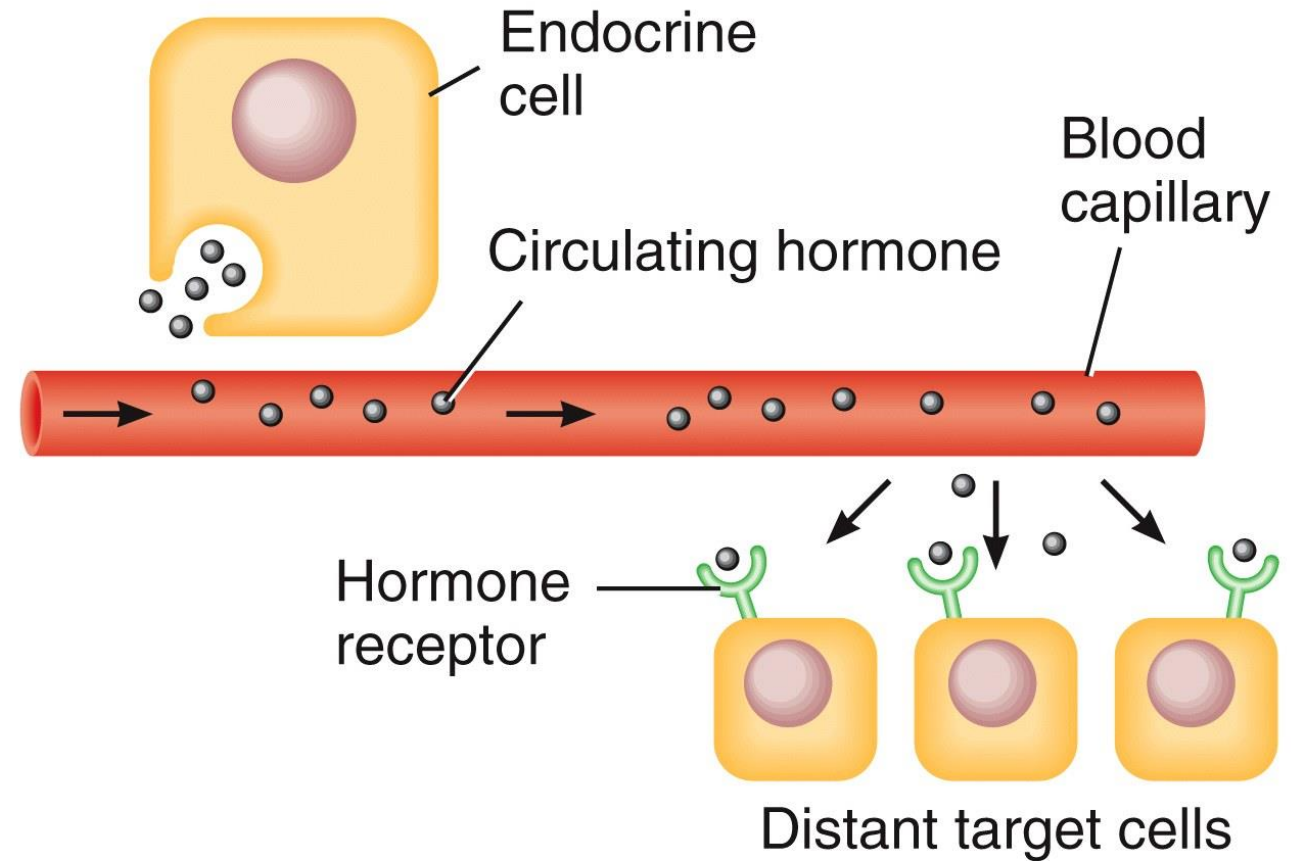
- Hormones are simply mediator molecules that have effects on cells in the local environment, or in a distant part of the body
 - Some hormones, called autocrine hormones are local hormones that are secreted, and bind to the same cell.



- Hormones as mediator molecules ...
 - Paracrine hormones are local hormones that are secreted into interstitial fluid and act on nearby cells



- Mediator molecules
 - Endocrine hormones are secreted into interstitial fluid and then absorbed into the bloodstream to be carried systemically to any cell that displays the appropriate type of receptor



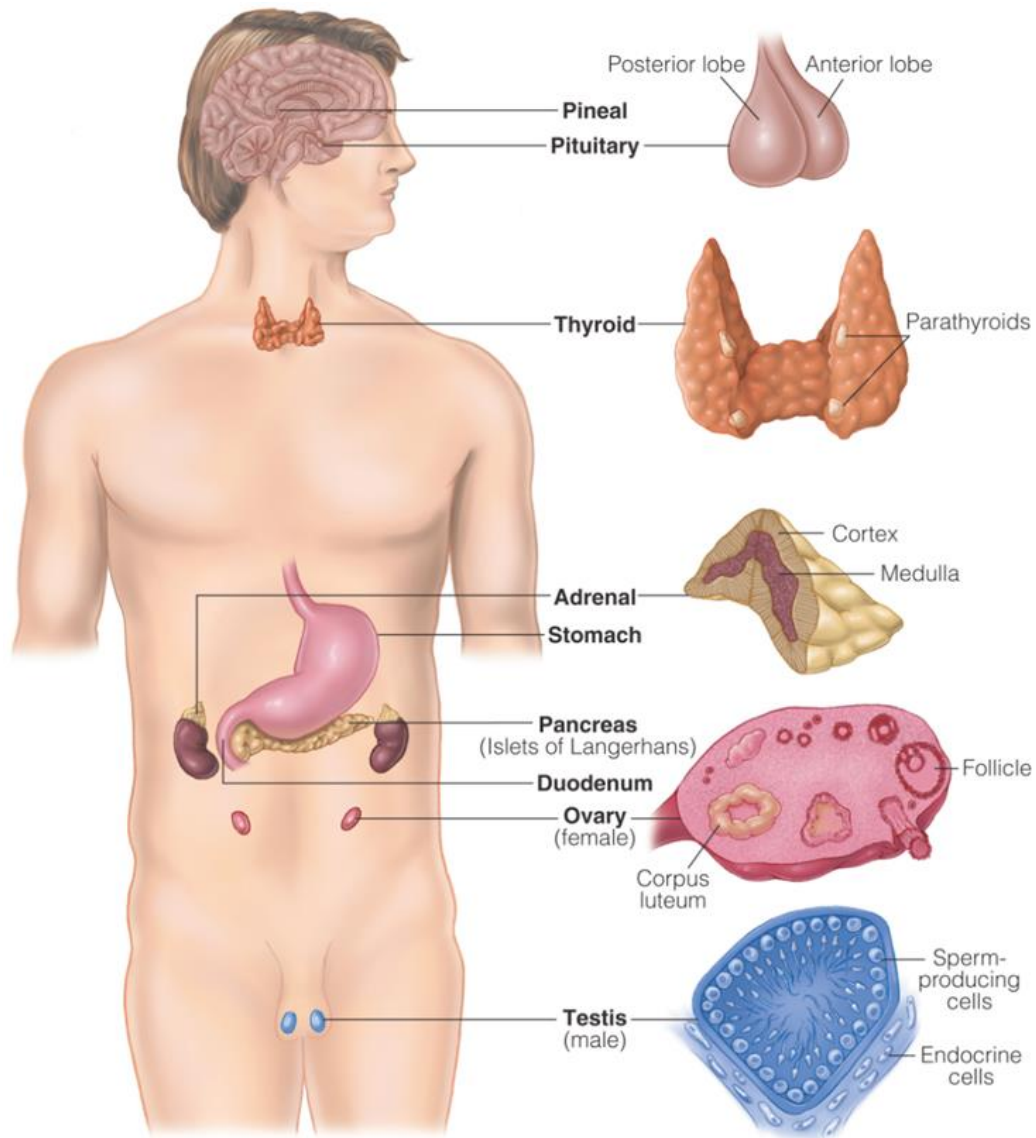
(a) Circulating hormones

- Hormones interact with each other to maintain homeostasis
 - Negative feedback or feedback inhibition
 - Positive feedback

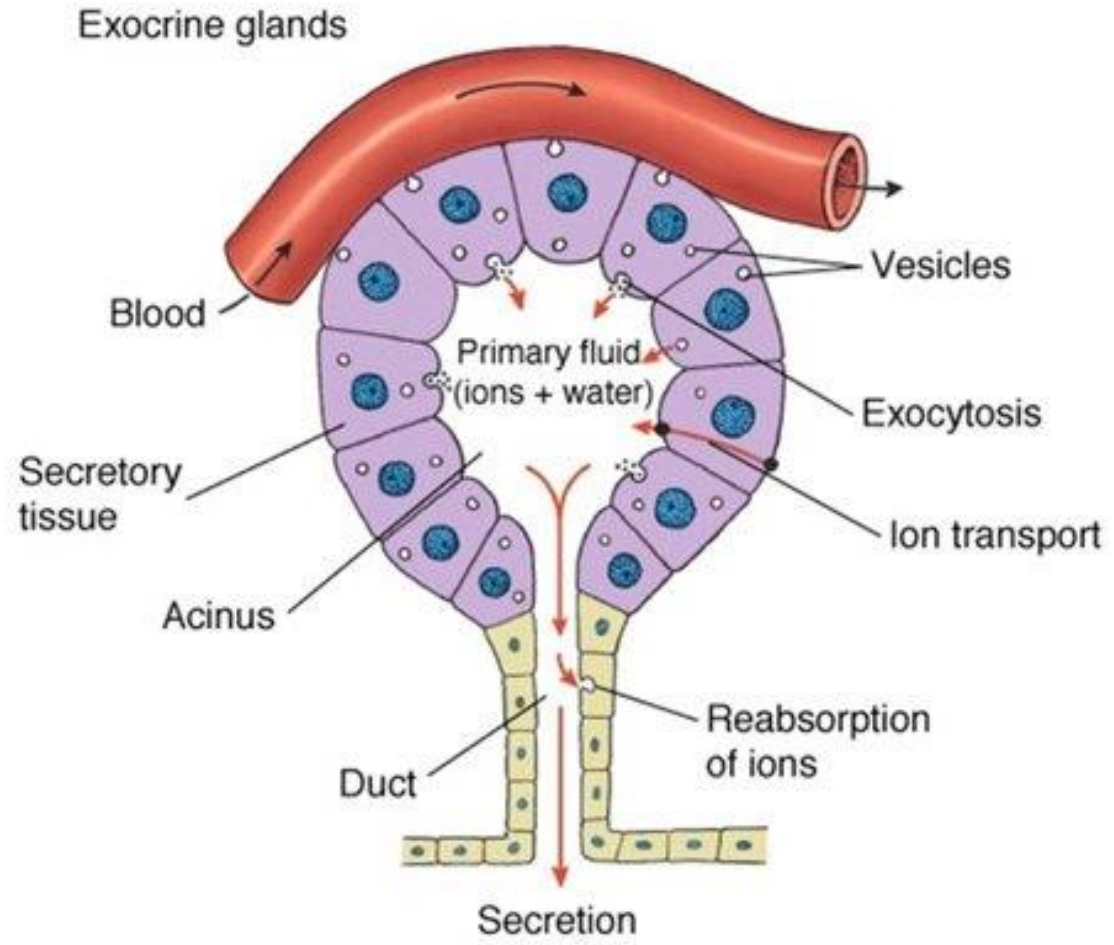
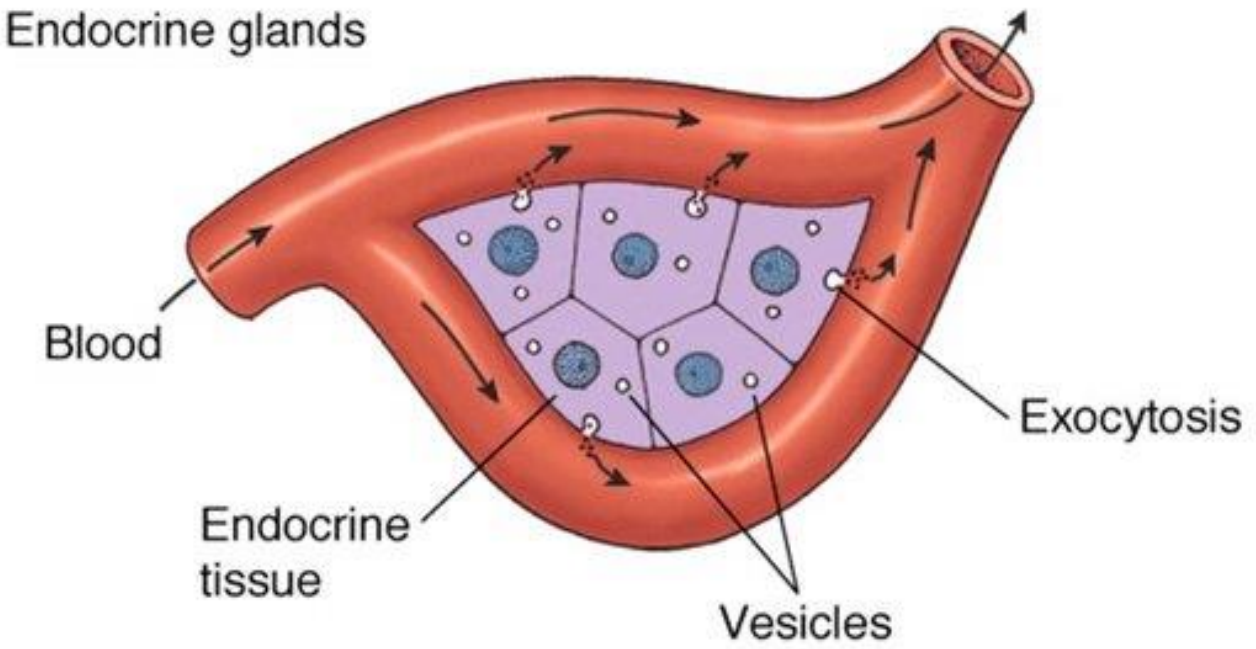
- Endocrine hormones control a variety of physiological processes. Among other things, they:
 - Balance the composition and volume of body fluids
 - Regulate metabolism and energy production
 - Direct the rate and timing of growth and development
 - Exert emergency control during physical and mental stress (trauma, starvation, hemorrhage)
 - Oversee reproductive mechanisms

- 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

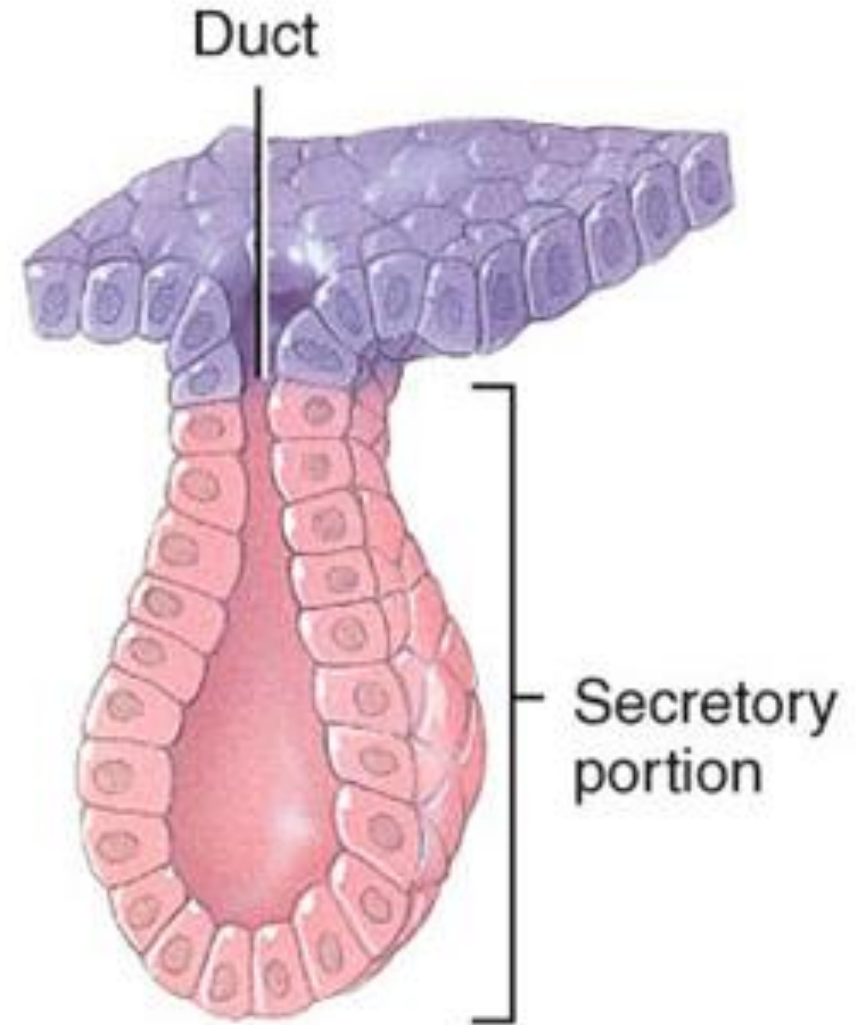
Feature	Endocrine	Nervous
Overall Function	Regulation of effectors to maintain homeostasis	Regulation of effectors to maintain homeostasis
Control by regulatory feedback loops	Yes (endocrine reflexes)	Yes (nervous reflexes)
Effector Tissues	Virtually all tissues	Muscles and glands only
Effector Cells	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



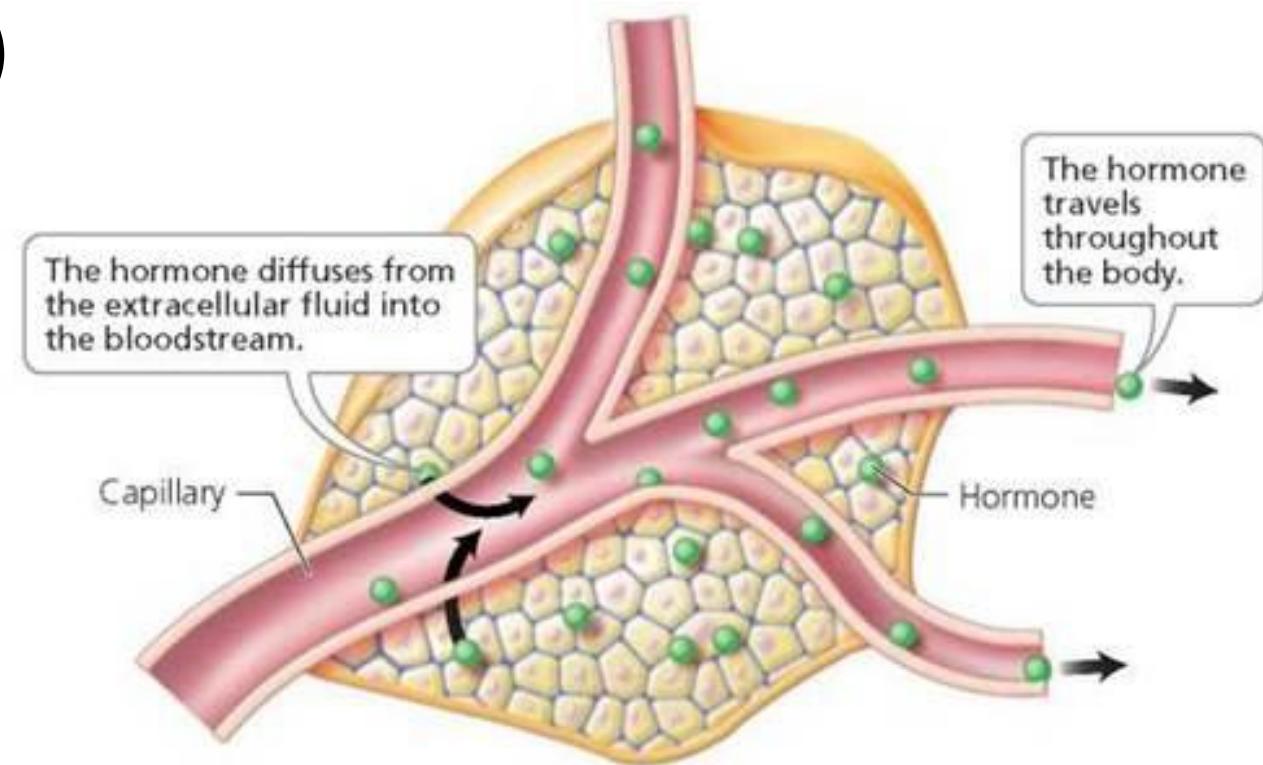
- Organs of the endocrine system are located in many locations of within the body



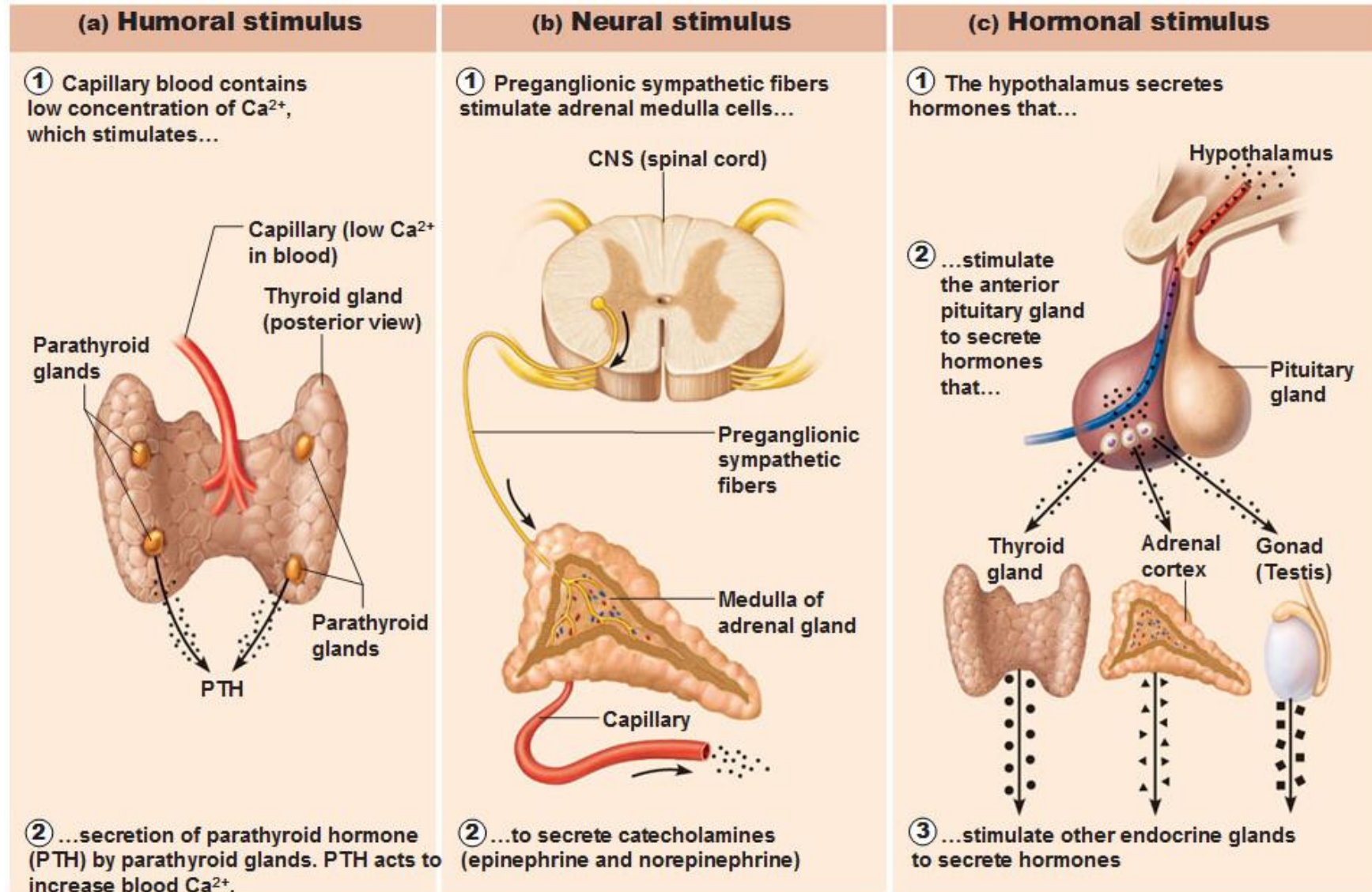
- Ducts carry their secretory product to a surface
 - Sweat
 - Mammary
 - Digestive enzymes



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



- When stimulated, an endocrine gland will release its hormone in frequent bursts, increasing the concentration of the hormone in the blood
 - Hormone secretion is regulated by:
 - Chemical changes in the blood (Humoral)
 - Signals from the nervous system (Neural)
 - Other hormones (Hormonal)
 - Most hormonal regulatory systems work via negative feedback, but a few operate via positive feedback



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

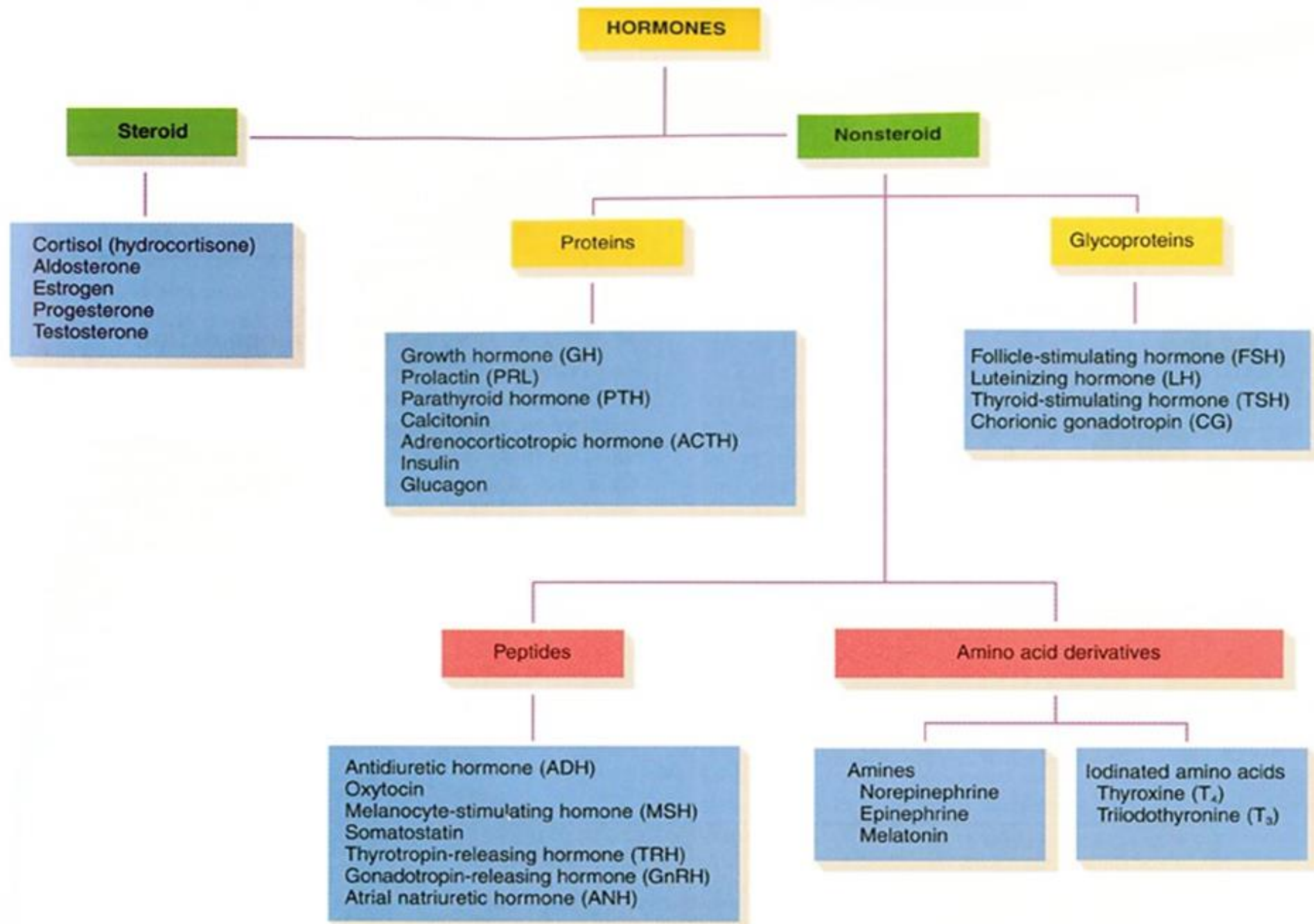
- Function
 - Tropic Hormones
 - Target other endocrine glands and stimulate their growth and secretion
 - Sex Hormones
 - Target reproductive tissue
 - Anabolic Hormones
 - Stimulate anabolism in target cells
 - Many others...

Steroid Hormones

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

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)



HORMONES

Steroid

Cortisol (hydrocortisone)
Aldosterone
Estrogen
Progesterone
Testosterone

Nonsteroid

Proteins

Growth hormone (GH)
Prolactin (PRL)
Parathyroid hormone (PTH)
Calcitonin
Adrenocorticotrophic hormone (ACTH)
Insulin
Glucagon

Glycoproteins

Follicle-stimulating hormone (FSH)
Luteinizing hormone (LH)
Thyroid-stimulating hormone (TSH)
Chorionic gonadotropin (CG)

Peptides

Antidiuretic hormone (ADH)
Oxytocin
Melanocyte-stimulating hormone (MSH)
Somatostatin
Thyrotropin-releasing hormone (TRH)
Gonadotropin-releasing hormone (GnRH)
Atrial natriuretic hormone (ANH)

Amino acid derivatives

Amines
Norepinephrine
Epinephrine
Melatonin

Iodinated amino acids
Thyroxine (T₄)
Triiodothyronine (T₃)

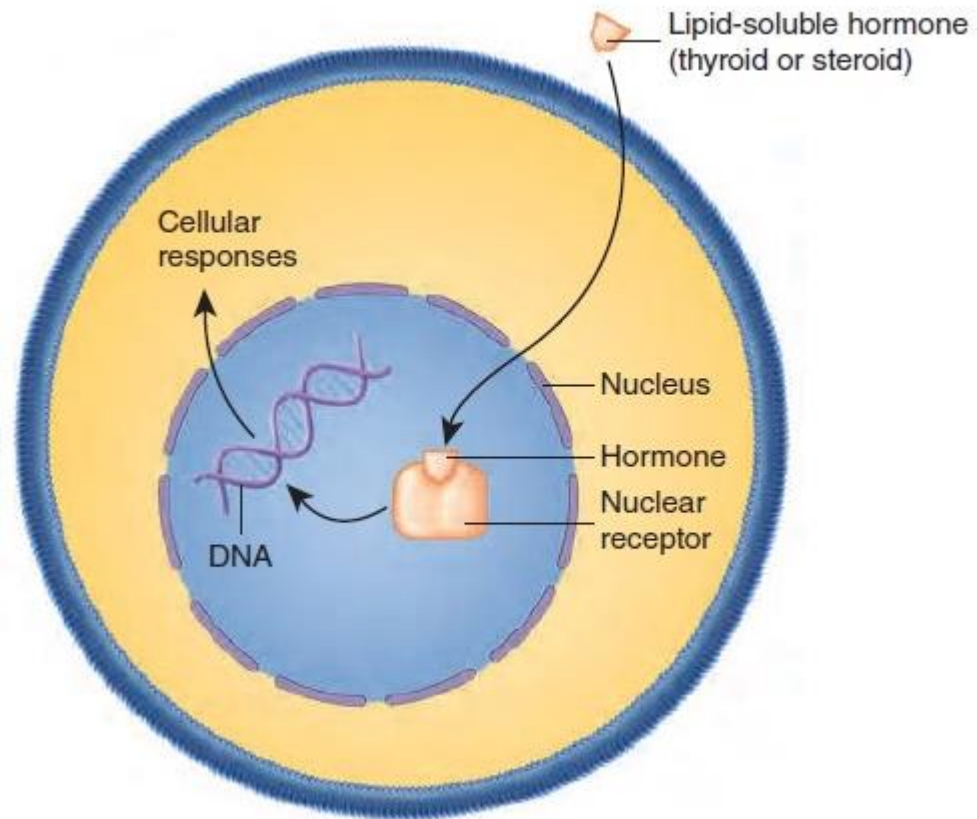
- Hormones find specific receptor sites in the target tissue
- Tissues may have many different types of receptor cells
- Target tissue may be localized or may be diffuse throughout the body
 - Hormones may work together to produce synergistic effects (**1 + 1 = 3**)
 - Some combinations produce permissiveness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

- Endocrine system typically produces excessive amounts of hormones, more than actually needed by 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

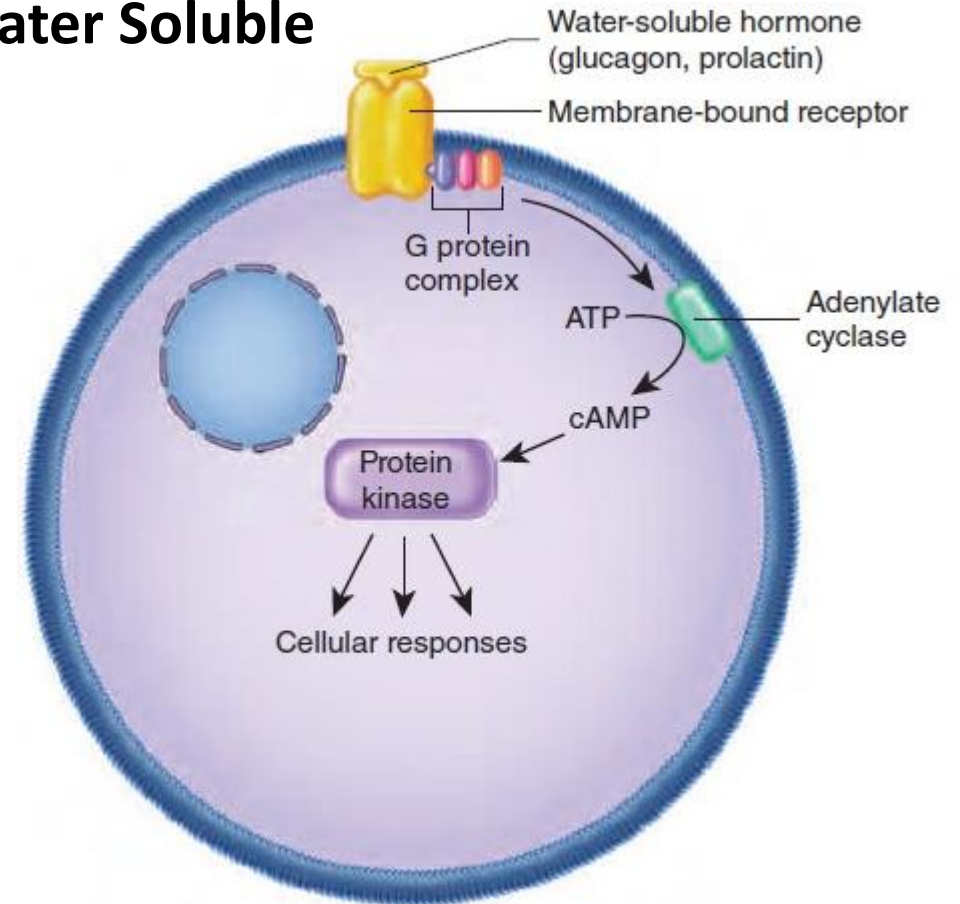
- Receptor sites
 - Plasma membrane
 - Interior of the cell
- Steroid hormones
 - Lipid soluble
- Non-steroid
 - Do not easily cross the membrane so typically find receptor sites on the surface

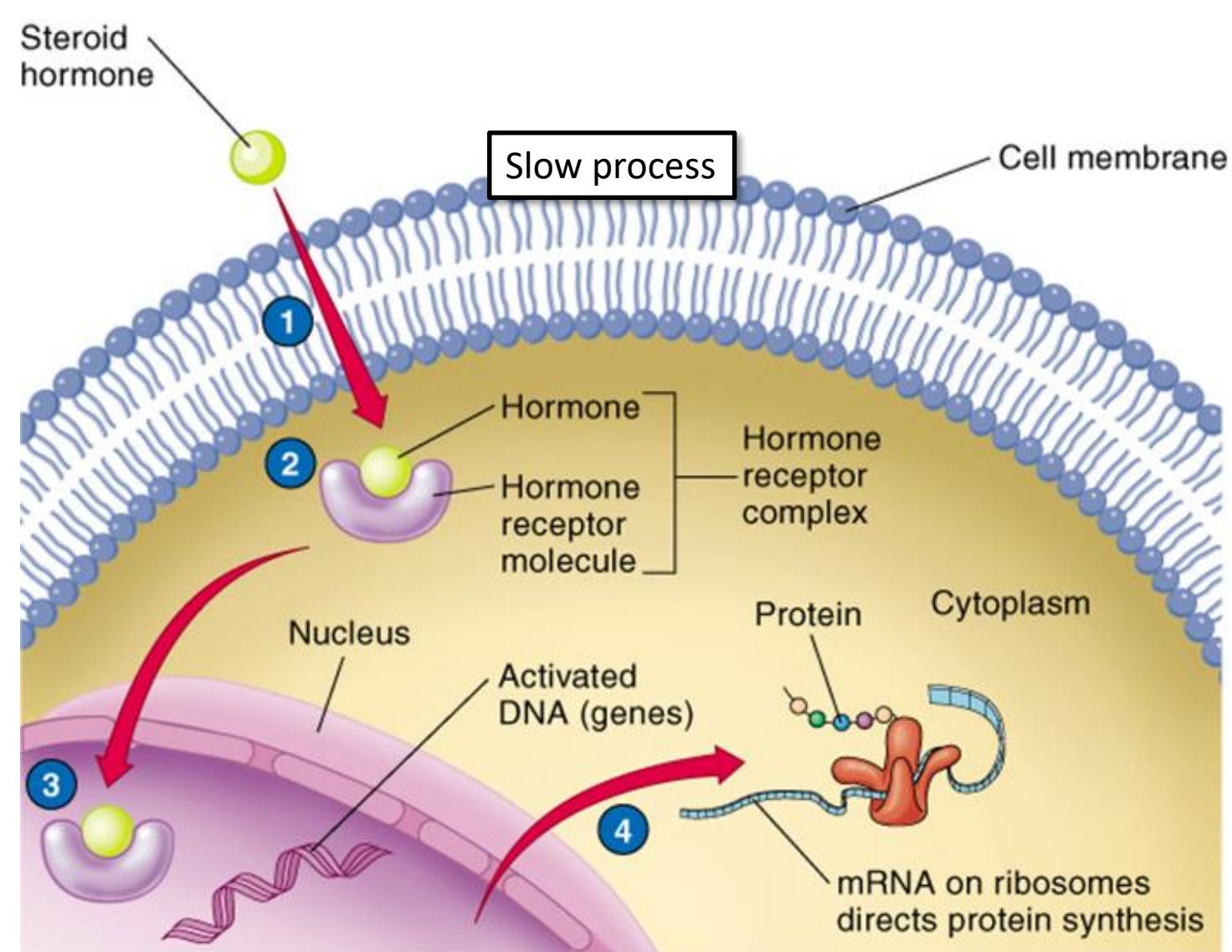
Solubility of Hormones

Lipid Soluble

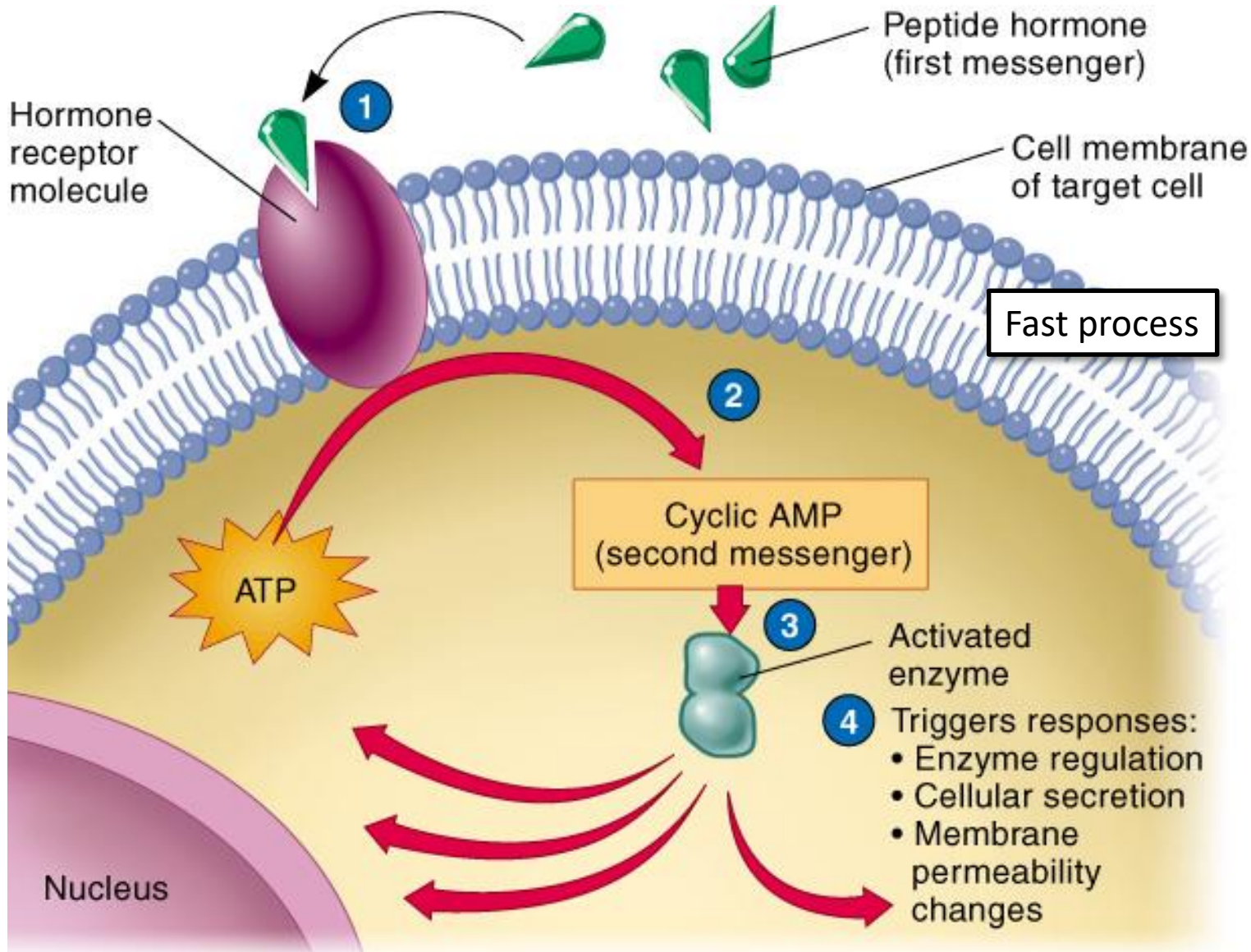


Water Soluble

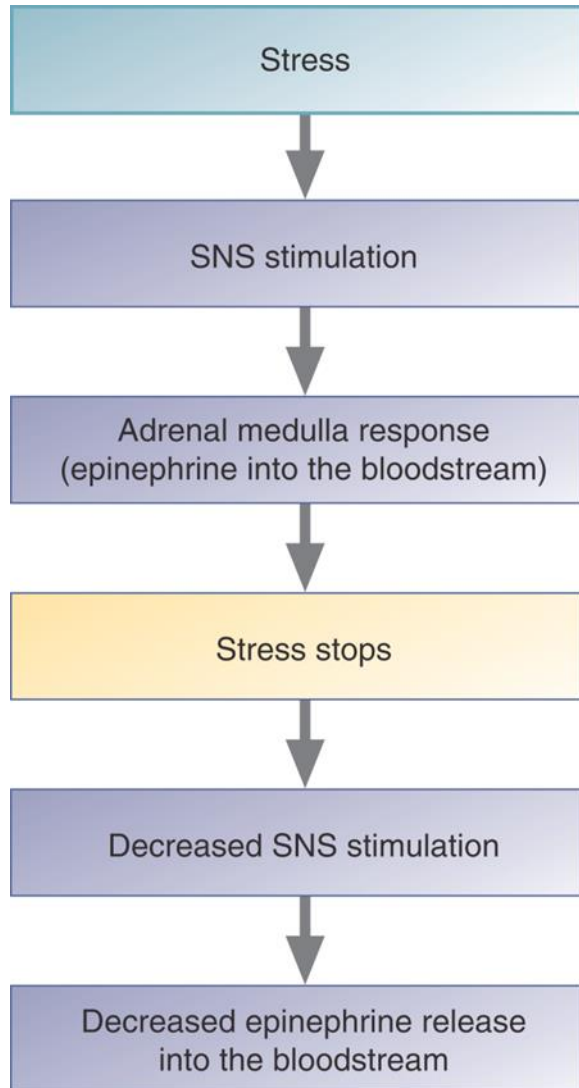




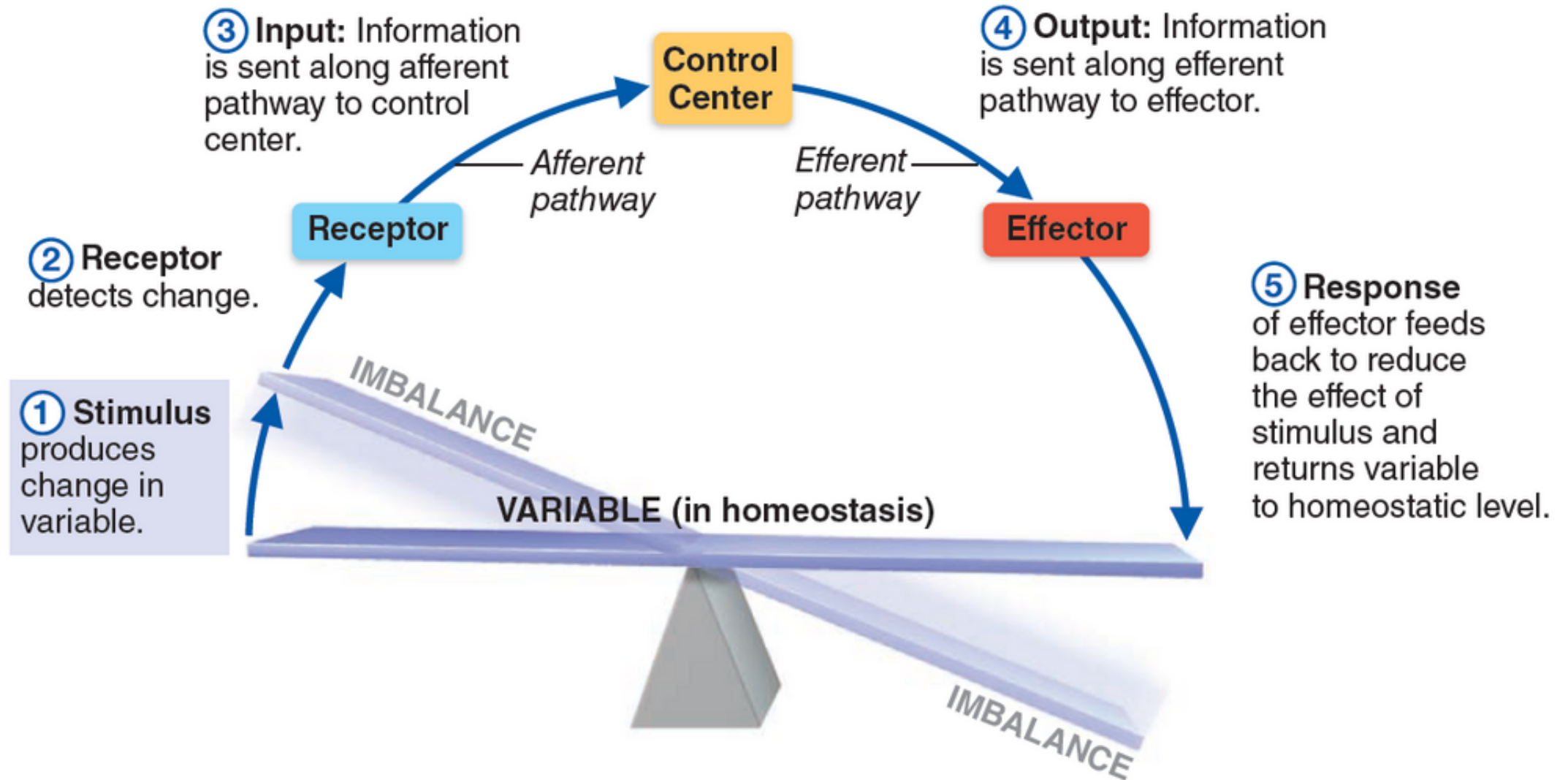
1. Steroids diffuse into the cell
2. React with receptor sites on the cells interior
3. Enters the nucleus where it effects specific genes in the DNA
4. Production of messenger RNA (mRNA) which diffuses into the cytoplasm
5. mRNA directs synthesis of proteins at the ribosomes

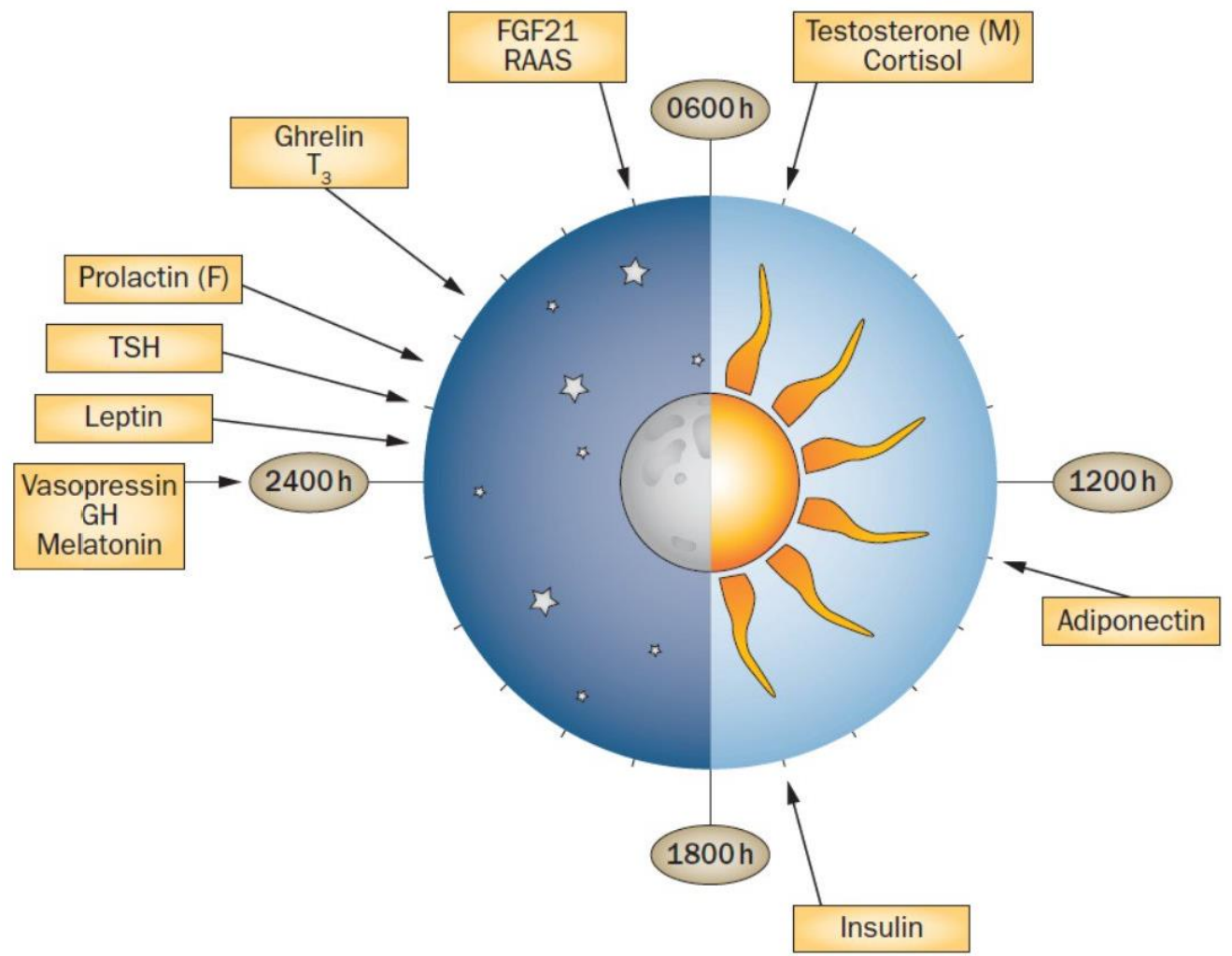
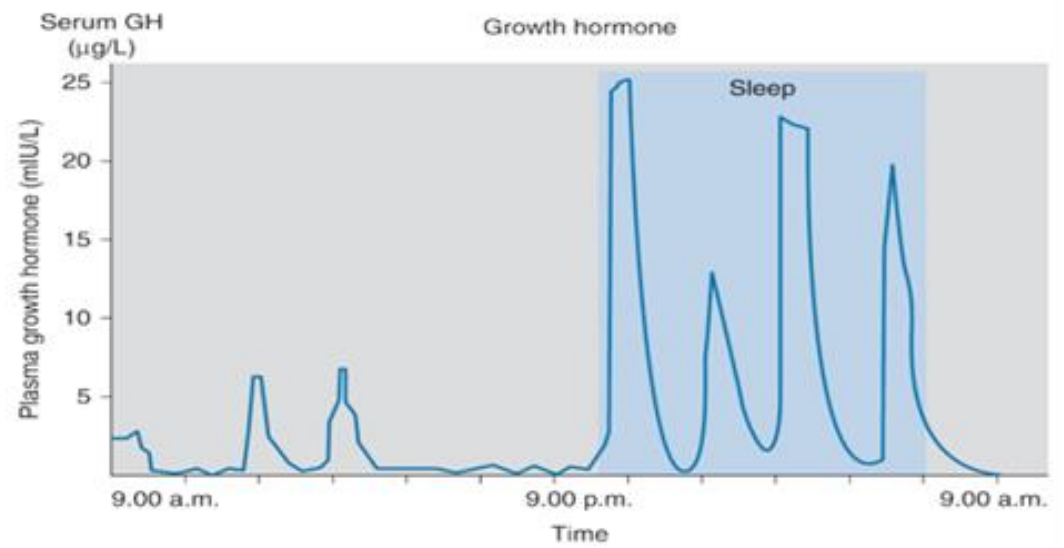
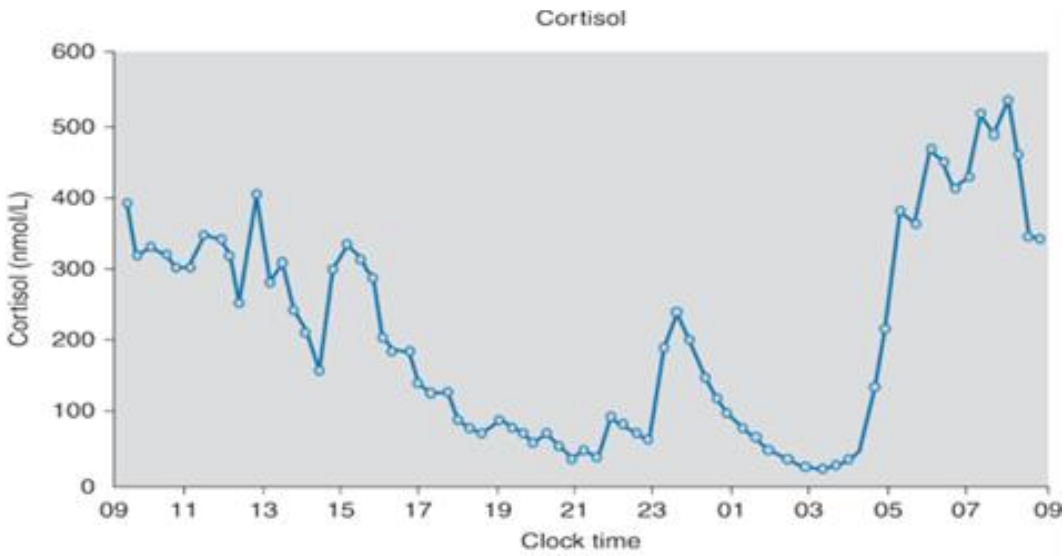


1. Hormone attaches to receptor protein (**First messenger**)
2. This activates another membrane protein (adenyl cyclase)
3. Adenyl cyclase reacts with ATP and removes 2P to create cyclic adenosine monophosphate (cyclic AMP) - **Second messenger**
4. This produces the changes in cellular activity sought by the hormone



- Hormones are very potent
- This demands very narrow limits to maintain homeostasis
- Control
 - Feedback loops (most are controlled by negative feedback mechanisms)
 - Some endocrine glands release hormones in response to other hormones
 - Nervous stimulation to support system



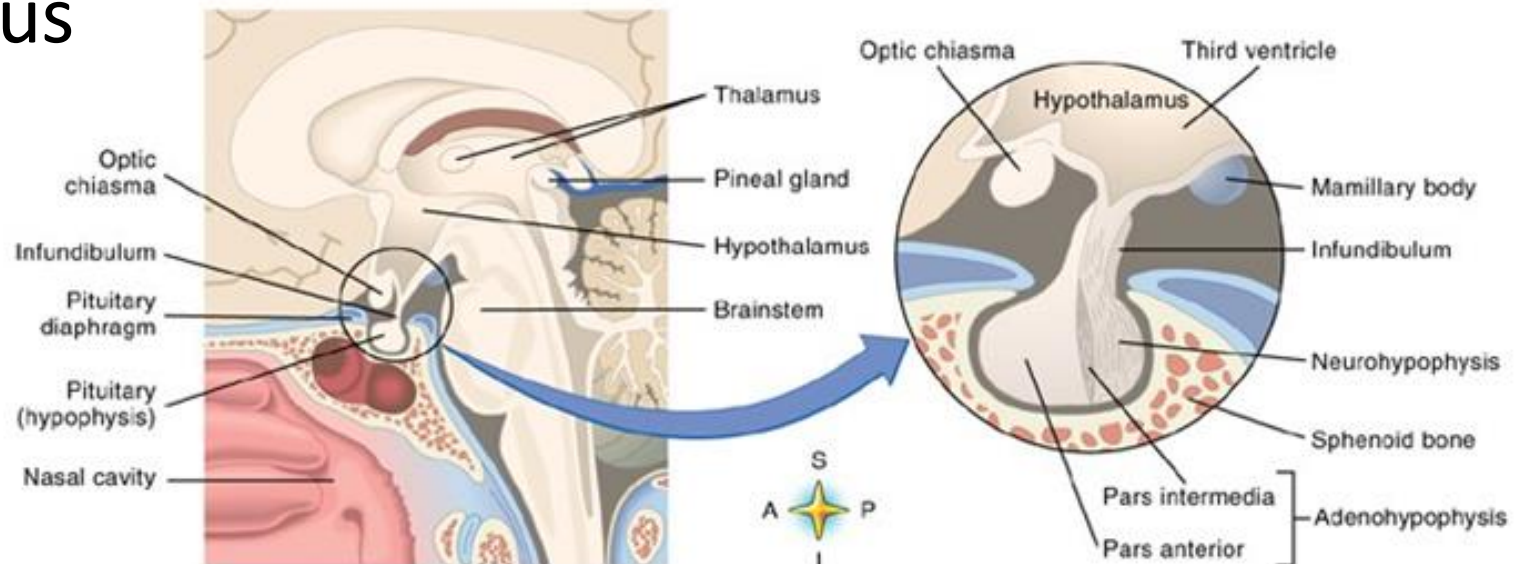


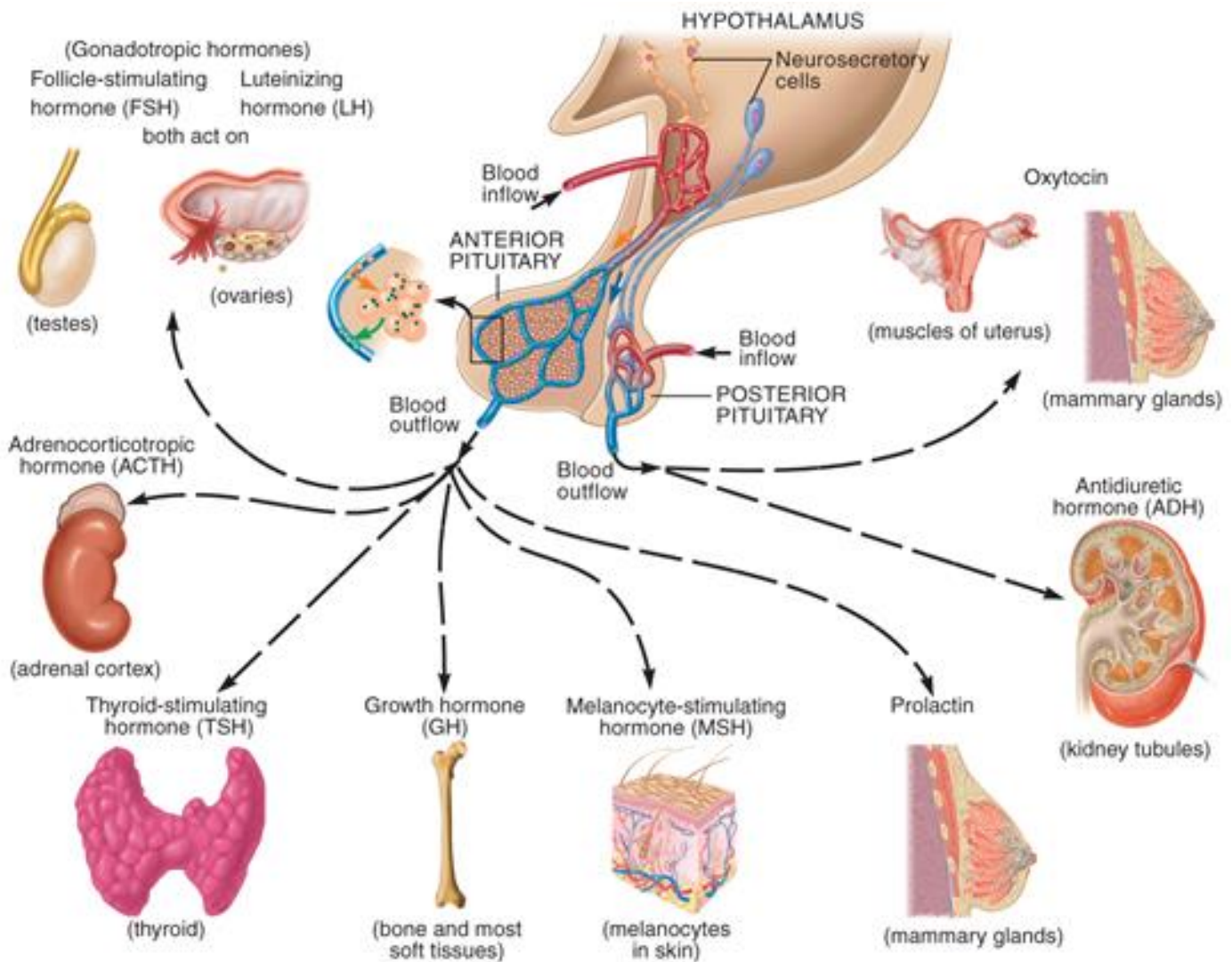
Endocrine System

ORGANS OF THE ENDOCRINE SYSTEM

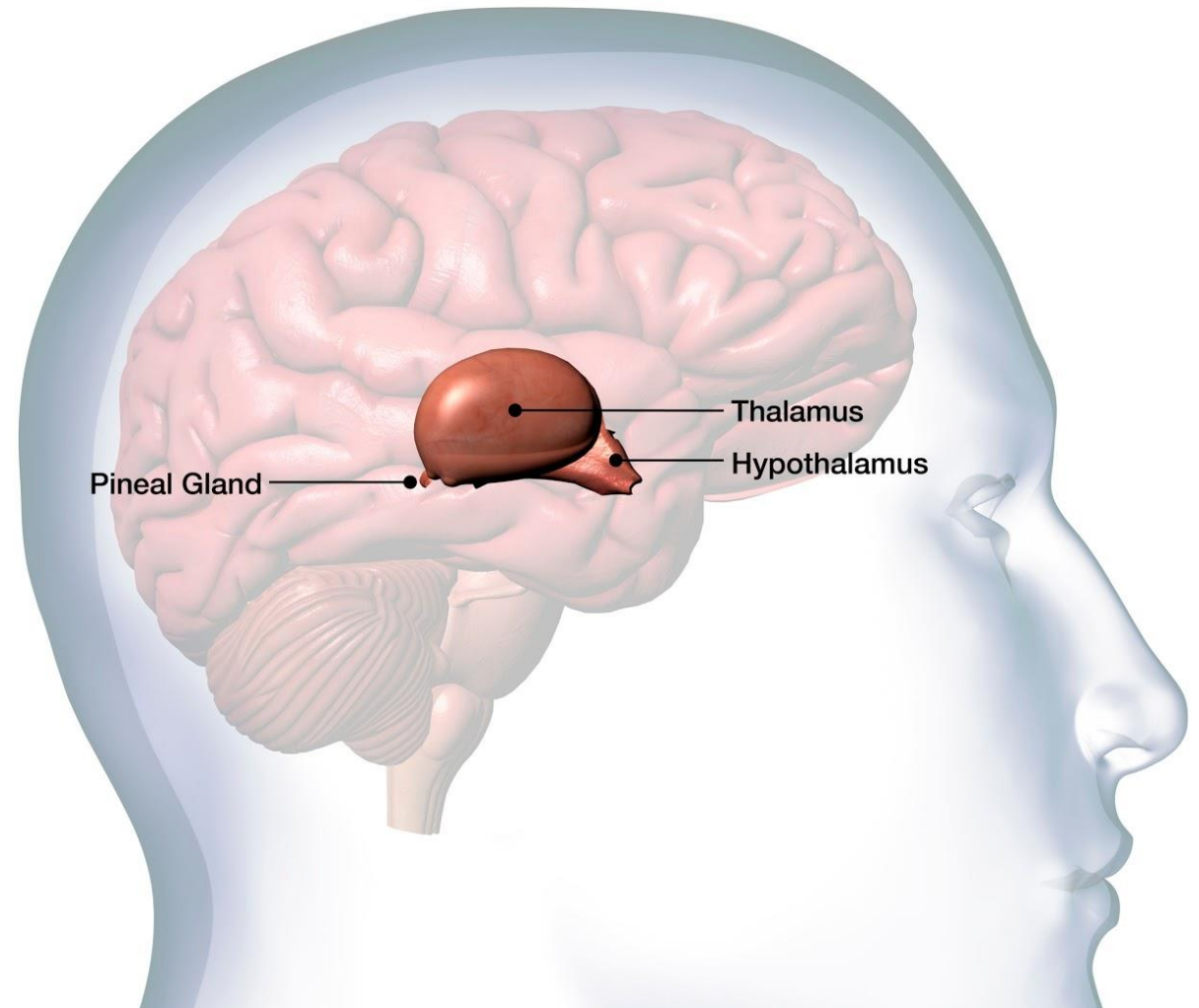
Pituitary Gland (Hypophysis)

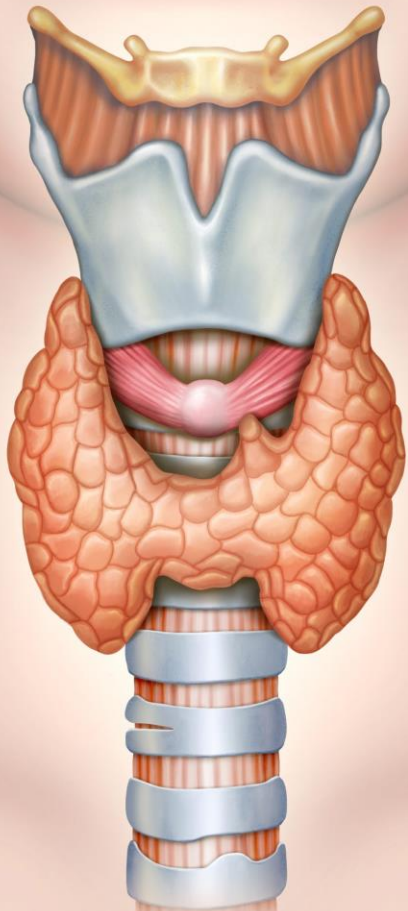
- Known as the master gland
- Secretes hormones that regulate the function of many other glands in the body
- Located at the base of the brain in the cranial cavity located below the hypothalamus



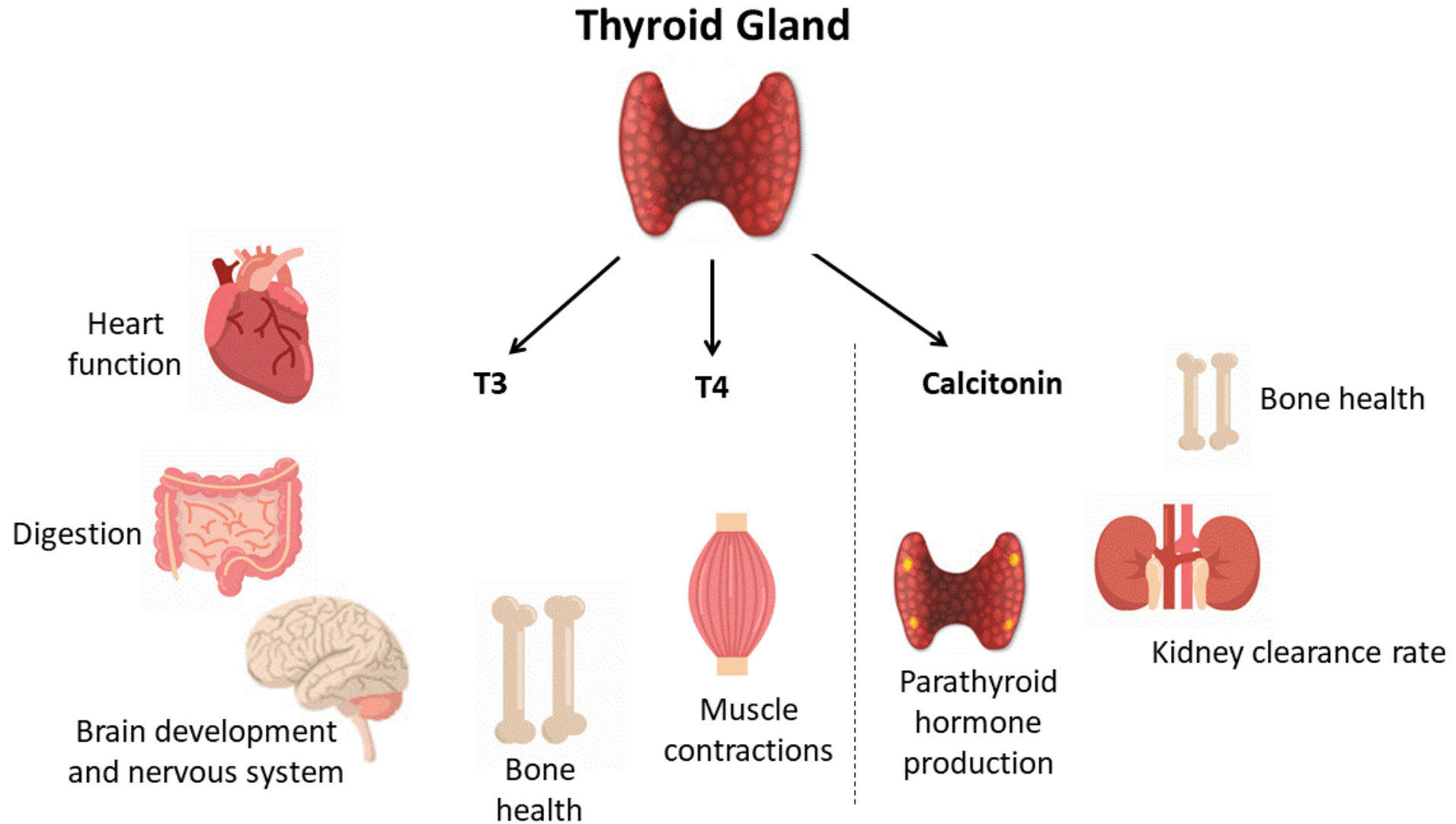


- Part of both systems
- Functions as 'biological clock'
- Secretes Melatonin

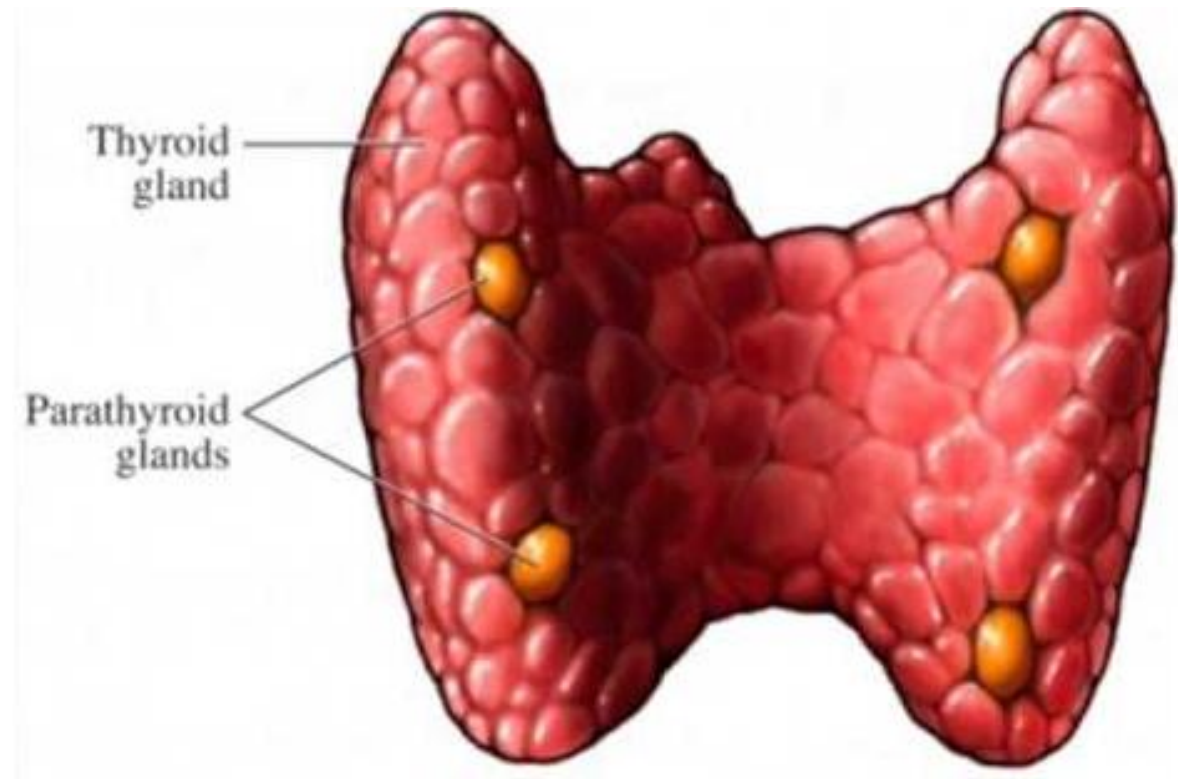


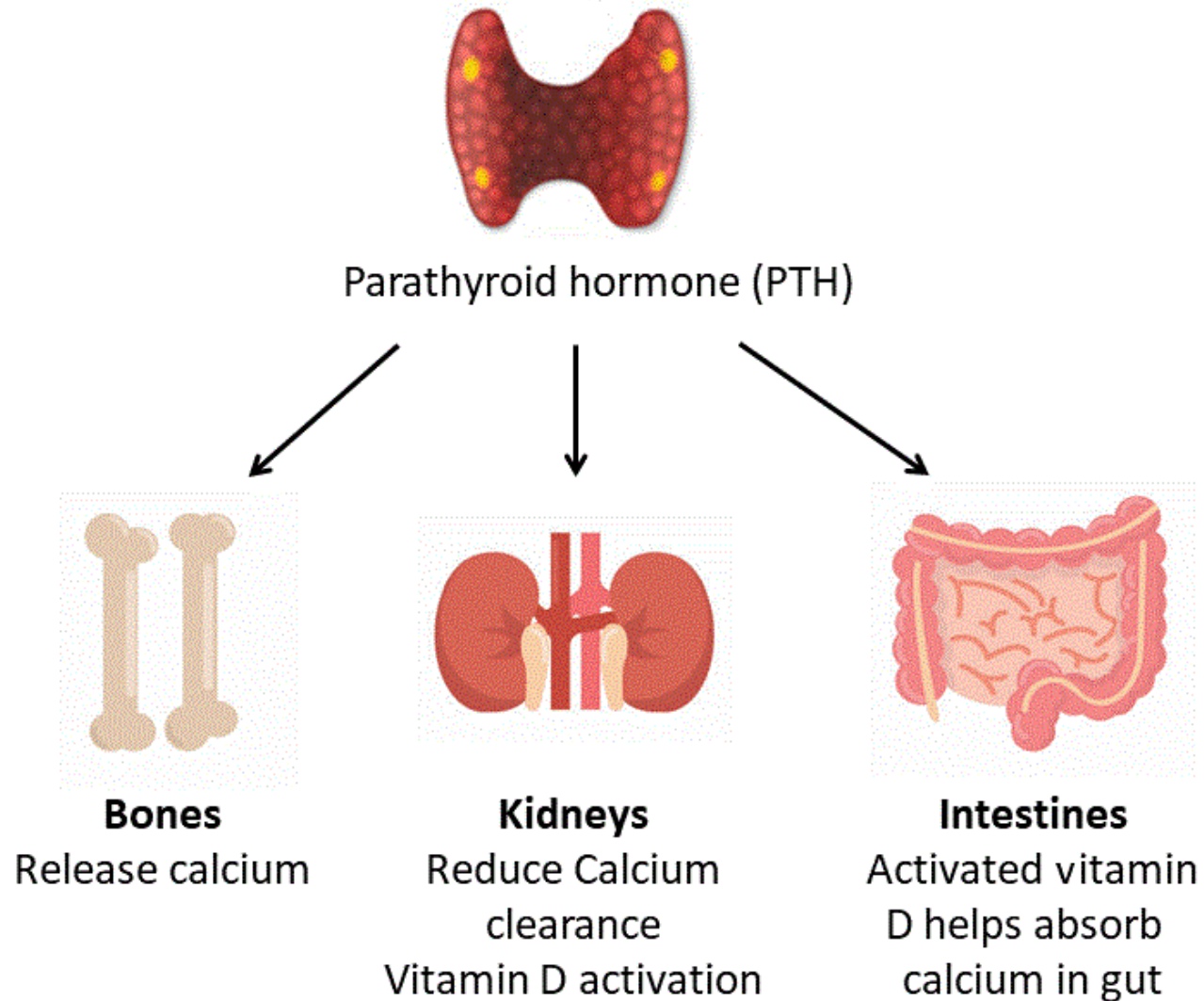


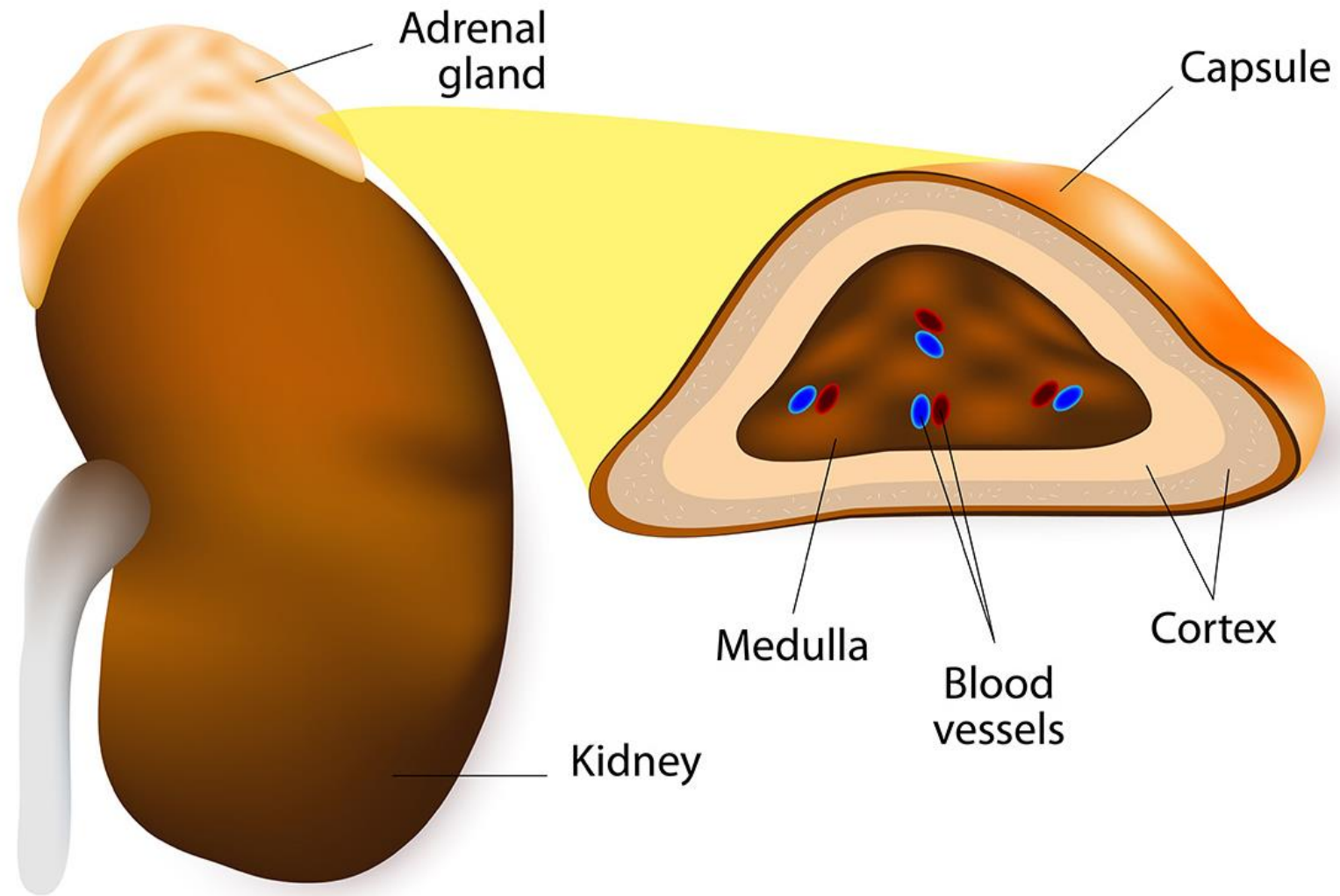
- Very vascular organ found in the neck
- Consists of two lobes (with one on each side of the trachea)
- Hormones released
 - Thyroid Hormone (may actually be stored for later use)
 - Calcitonin



- Found on posterior surface of thyroid
- Releases parathyroid hormone







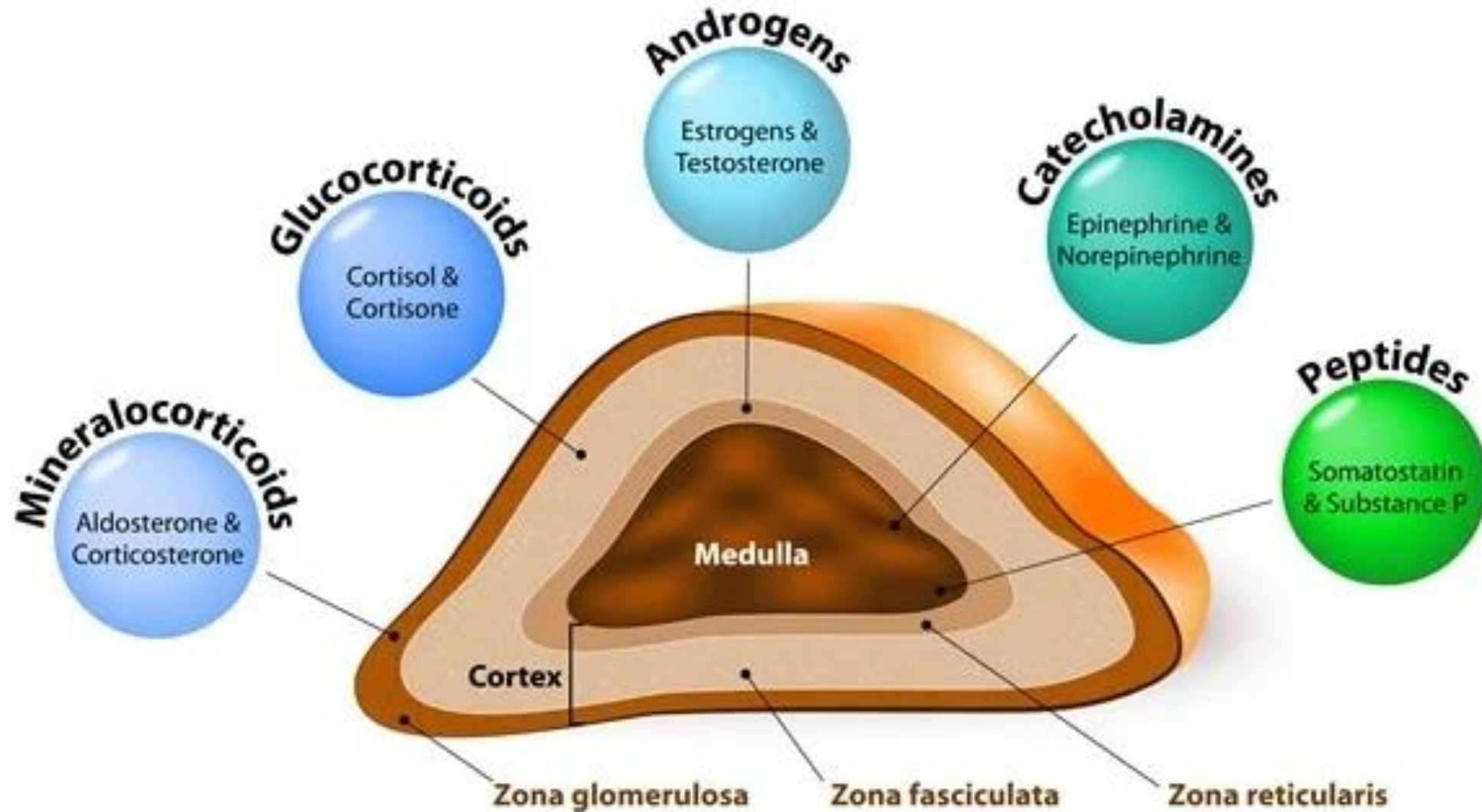
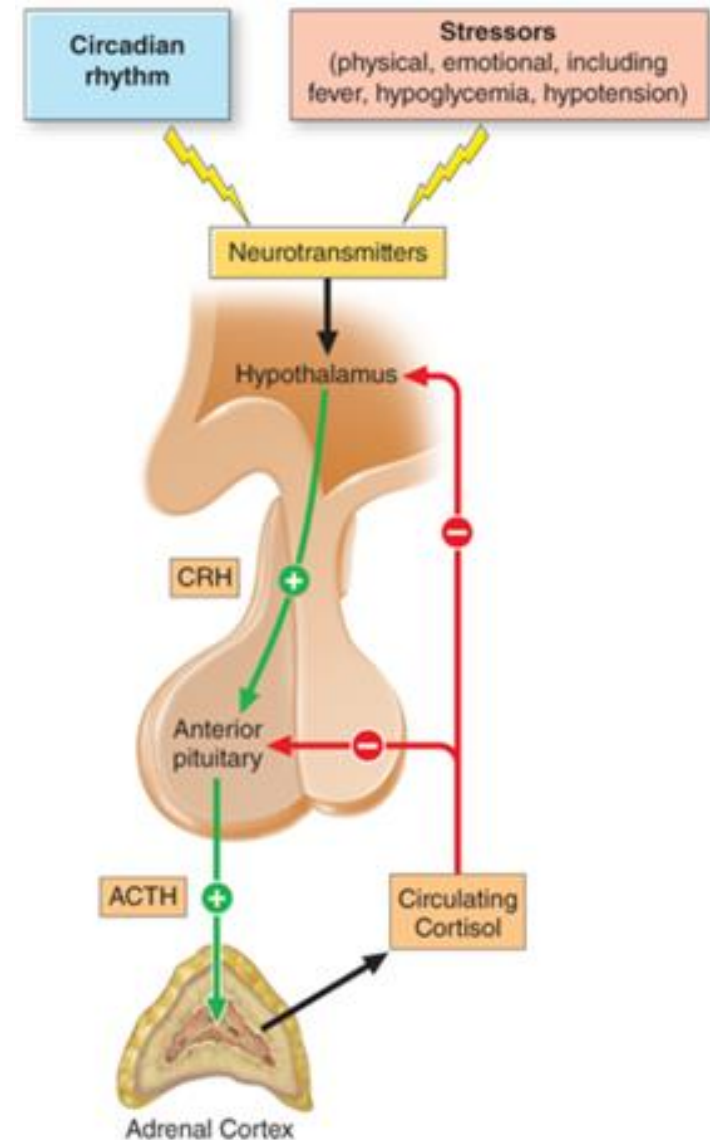
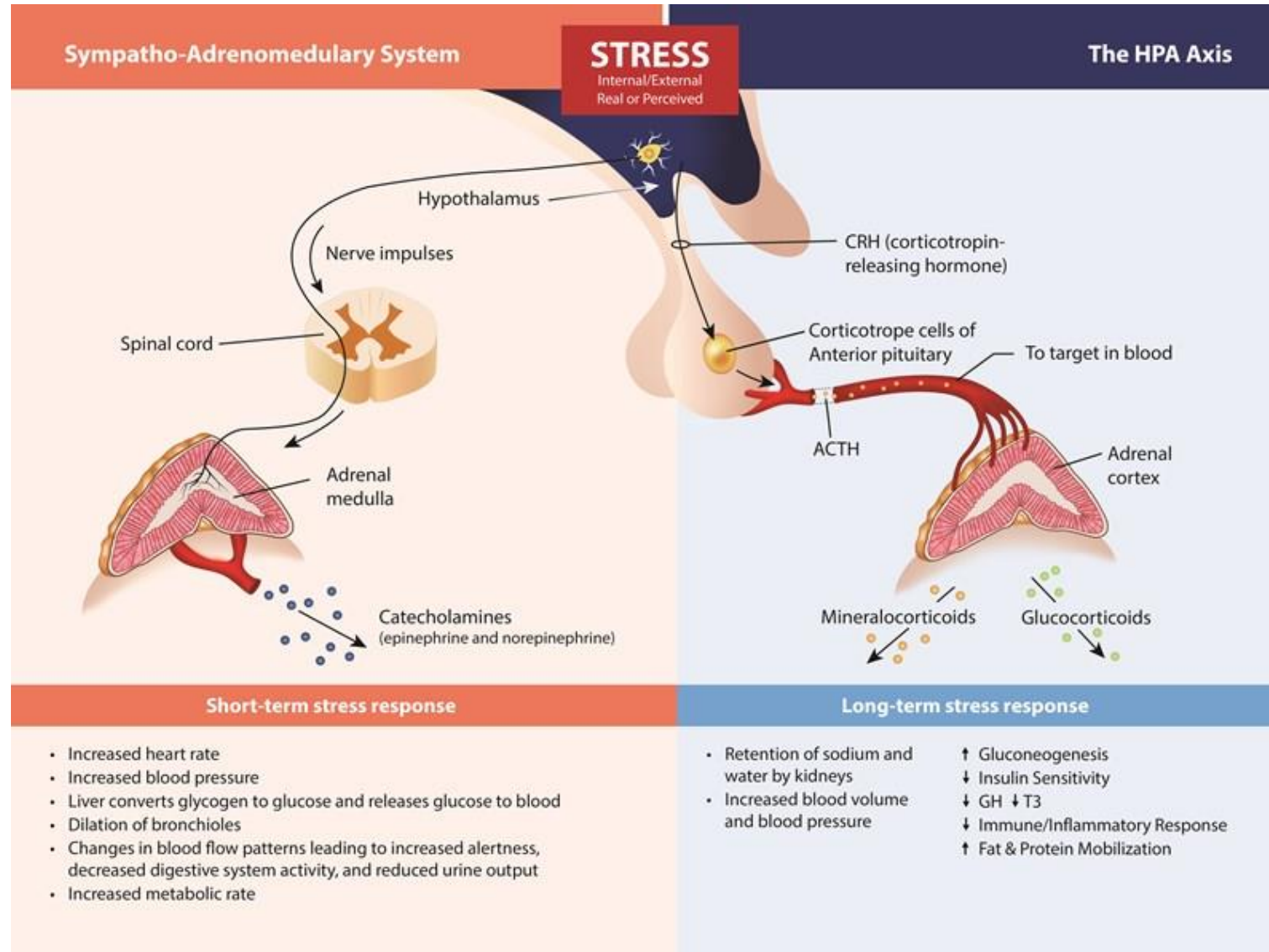


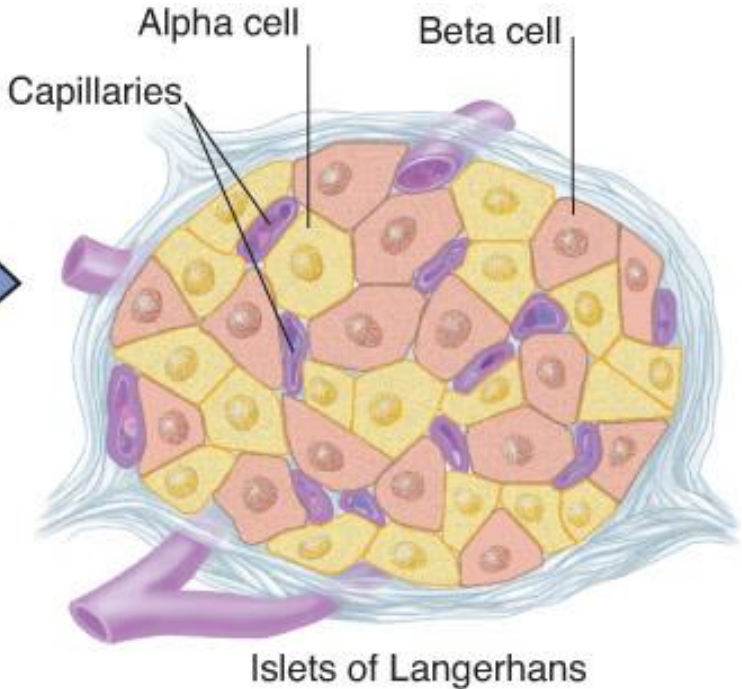
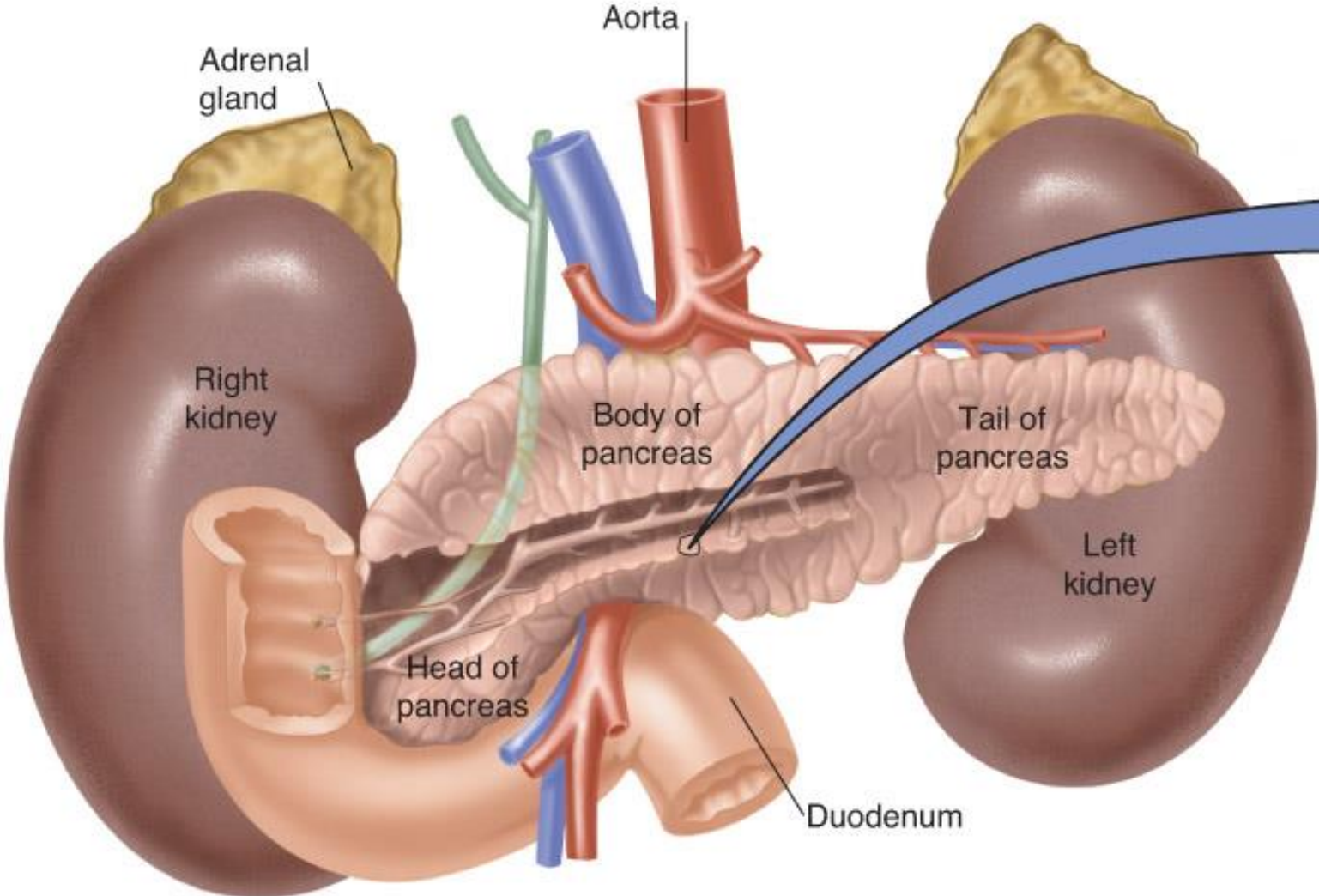
Table 32-2 Hormones of the Adrenal Gland		
Hormone	Target Site	Effect
Adrenal Gland, Cortex		
Cortisol (glucocorticoid)	Most cells	Stimulates release of amino acids from skeletal muscles, lipids from adipose tissue, and glucose and glycogen from liver (mimics effects of glucagon); antiinflammatory effects
Aldosterone (mineralocorticoid)	Kidneys, blood	Increases renal absorption of sodium and water (more so in the presence of antidiuretic hormone) and increases urinary loss of potassium; net increase in blood volume
Estrogen	Most cells	Stimulates development of secondary sexual characteristics
Progesterone	Uterus	Stimulates uterine changes in preparation for gestation
Testosterone	Most cells	Stimulates development of secondary sexual characteristics
Adrenal Gland, Medulla		
Epinephrine/ norepinephrine	Muscle, liver, cardiovascular system	Stimulates cardiac activity; increases vasoconstriction; stimulates glycogenolysis; raises blood glucose levels
Norepinephrine	Muscle, liver, cardiovascular system	Stimulates vasoconstriction

Hypothalamic-Pituitary-Adrenal Axis

- A complex set of direct influence and feedback mechanisms among the three endocrine glands
 - Hypothalamus
 - Pituitary gland
 - Adrenal glands
- Controls reactions to stress and helps regulate other processes

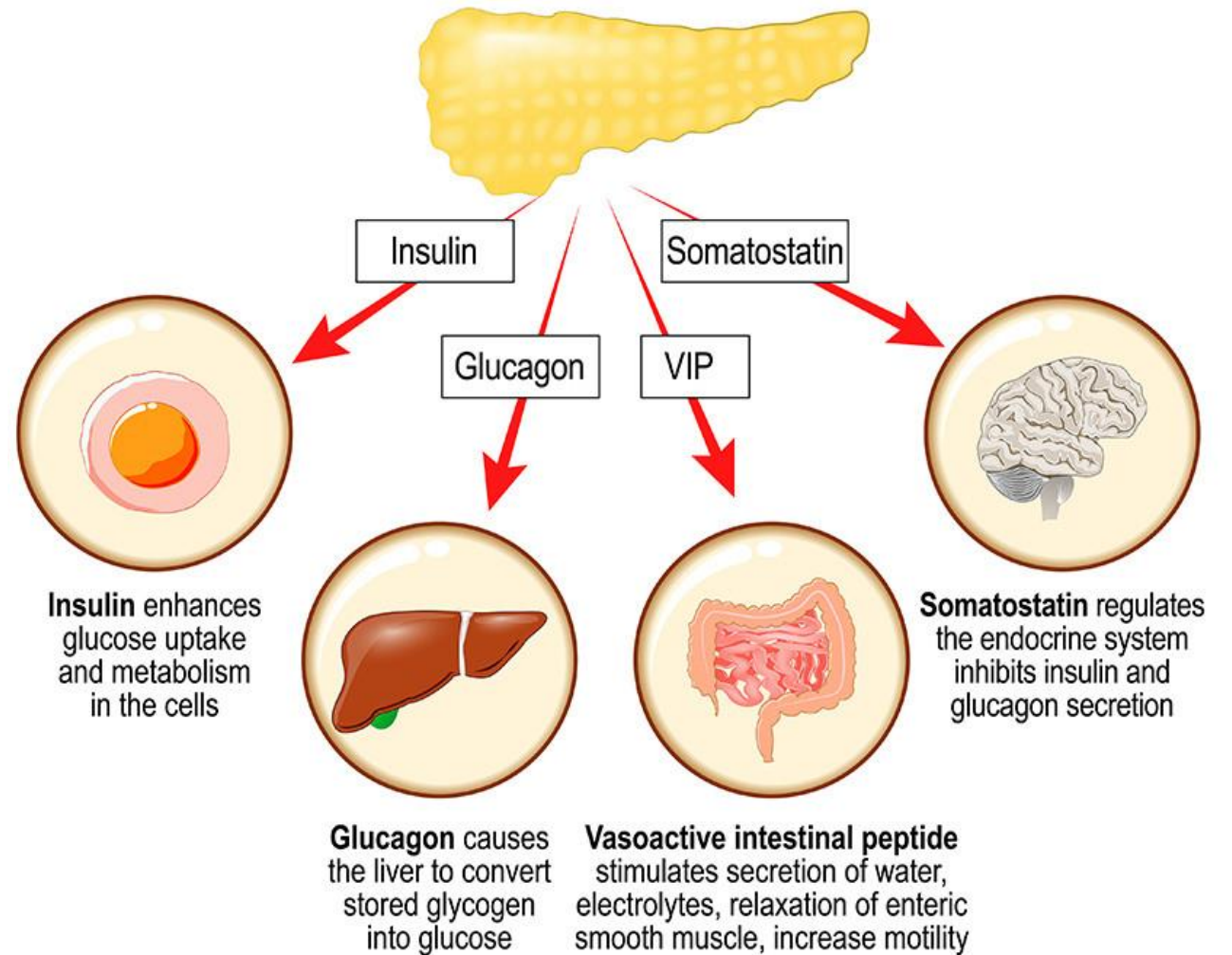






Endocrine Cells

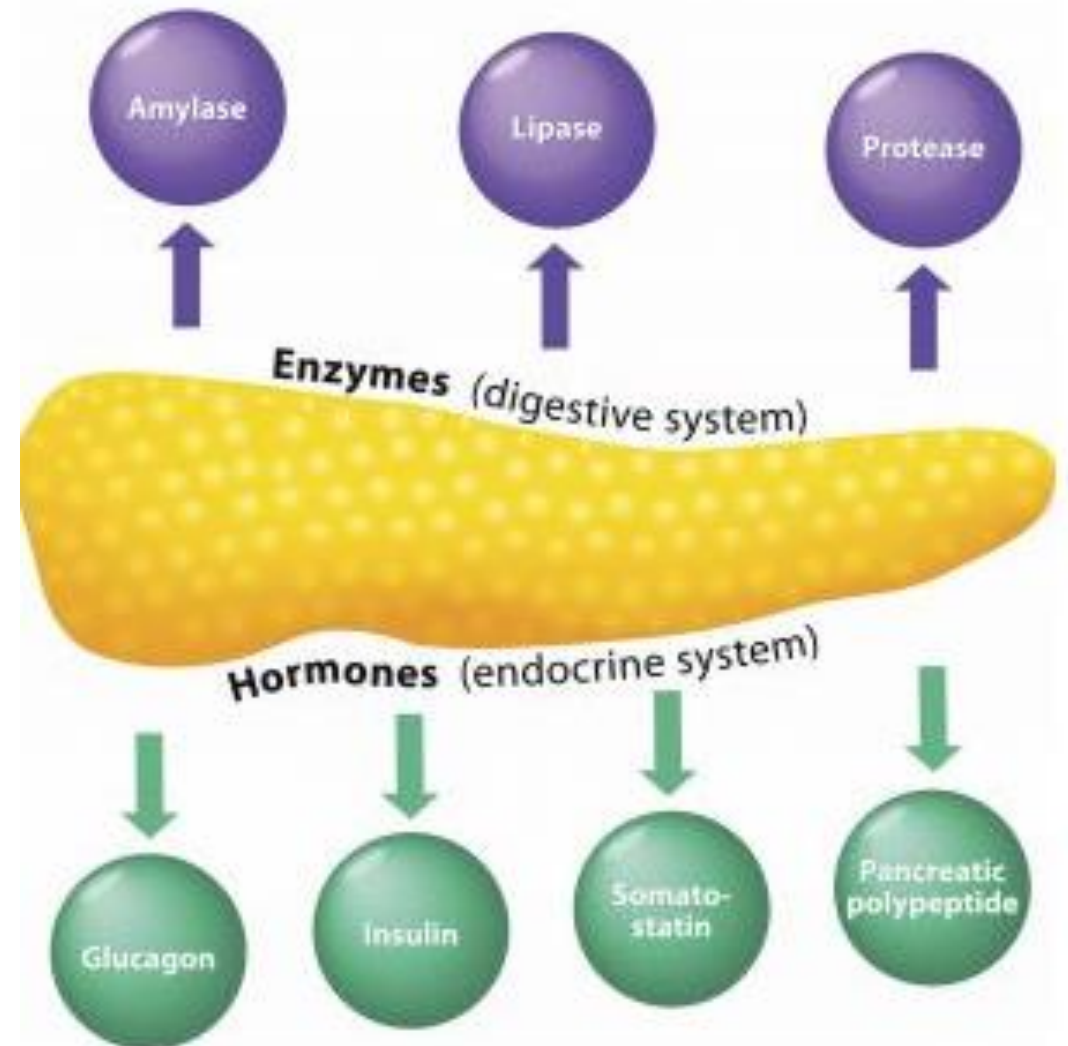
Cell	Hormone
Alpha cells (A Cells)	Glucagon
Beta cells (B Cells)	Insulin
Delta cells (D Cells)	Somatostatin
PP Cell	Pancreatic Polypeptide

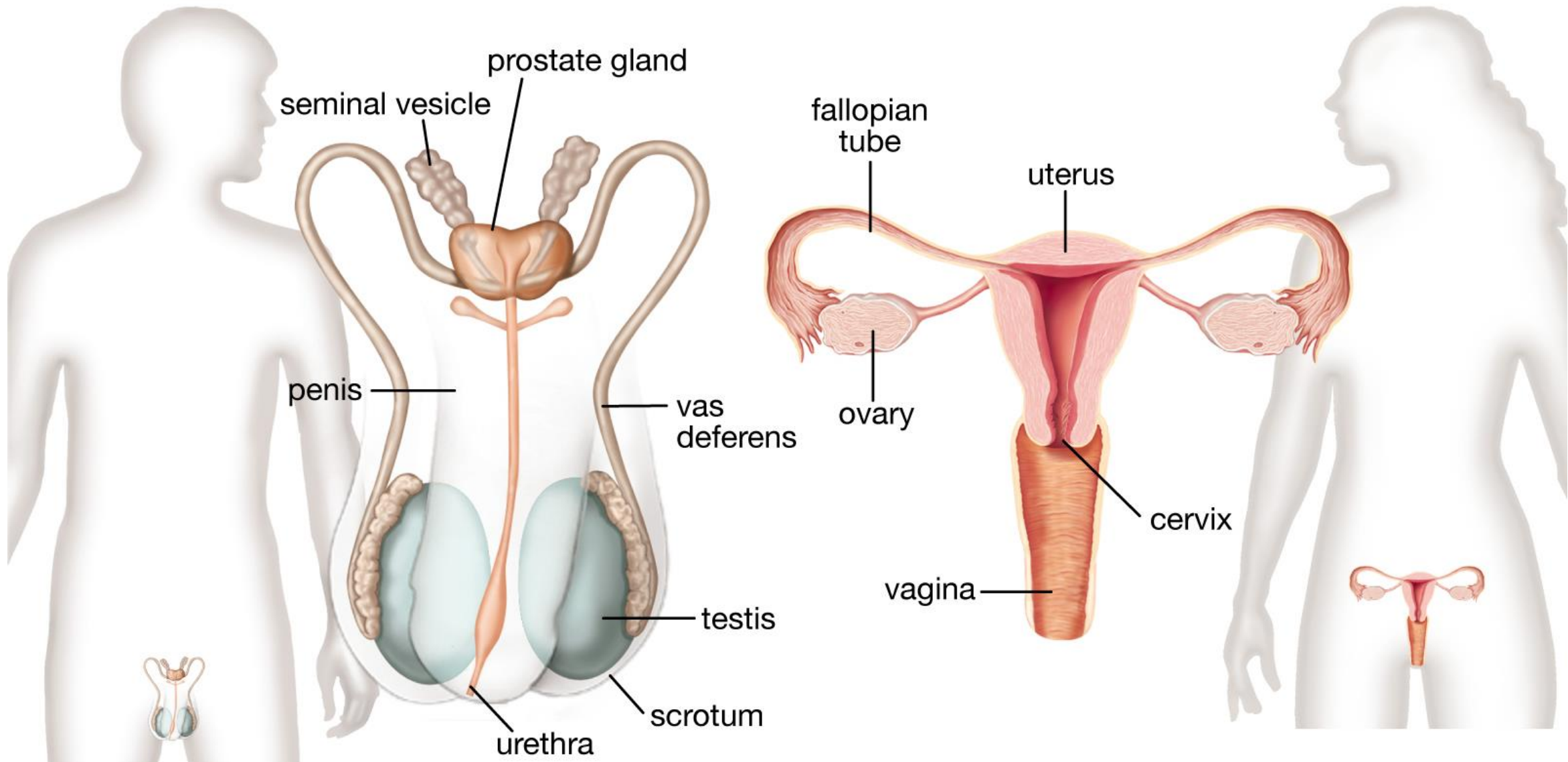


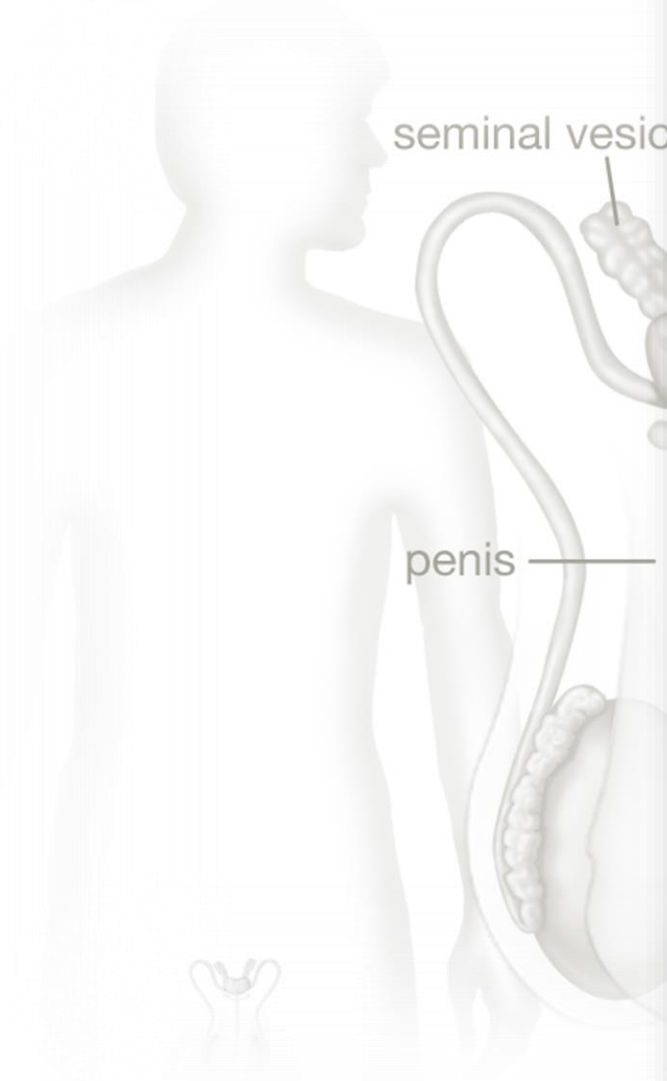
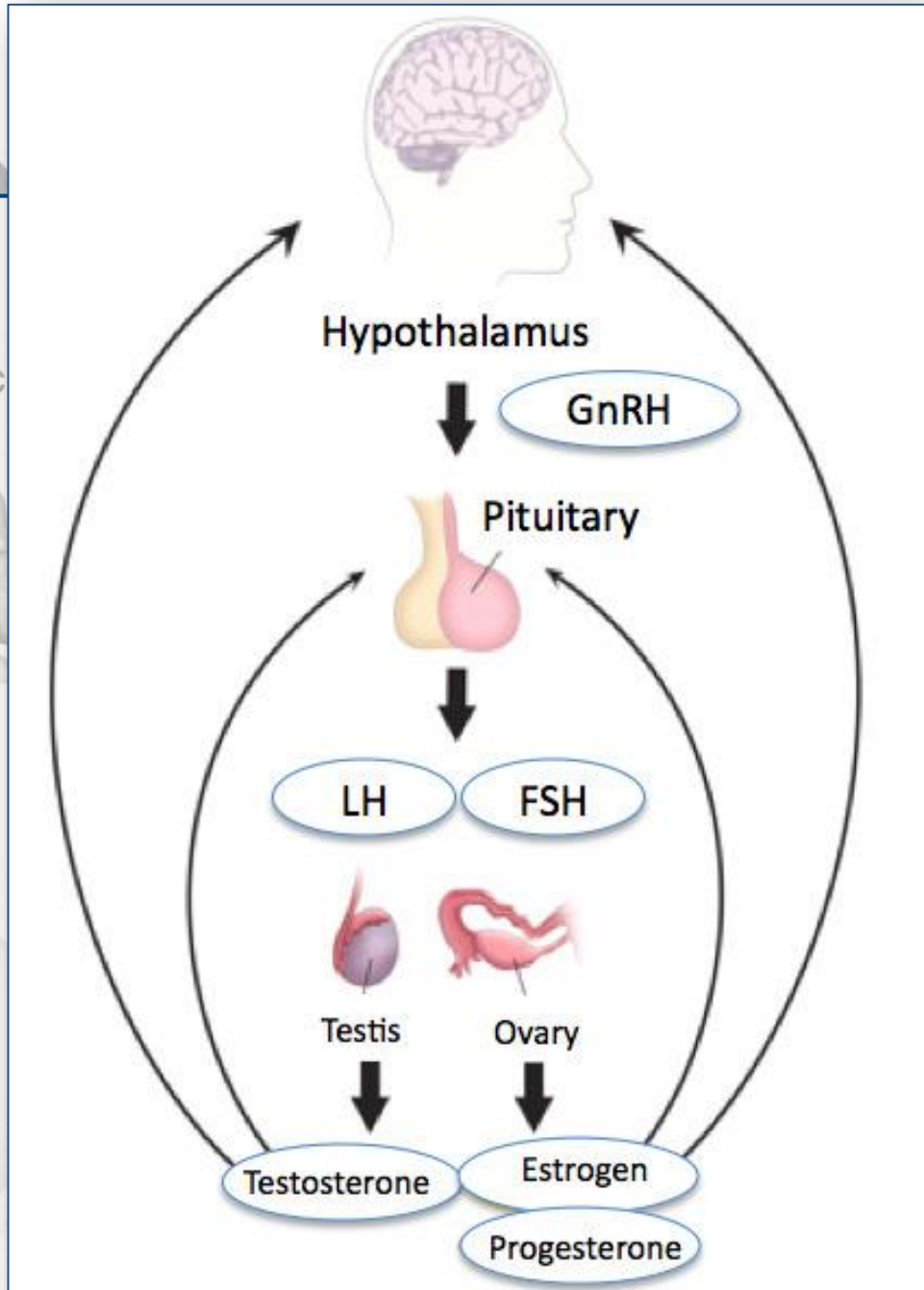
Exocrine Cells

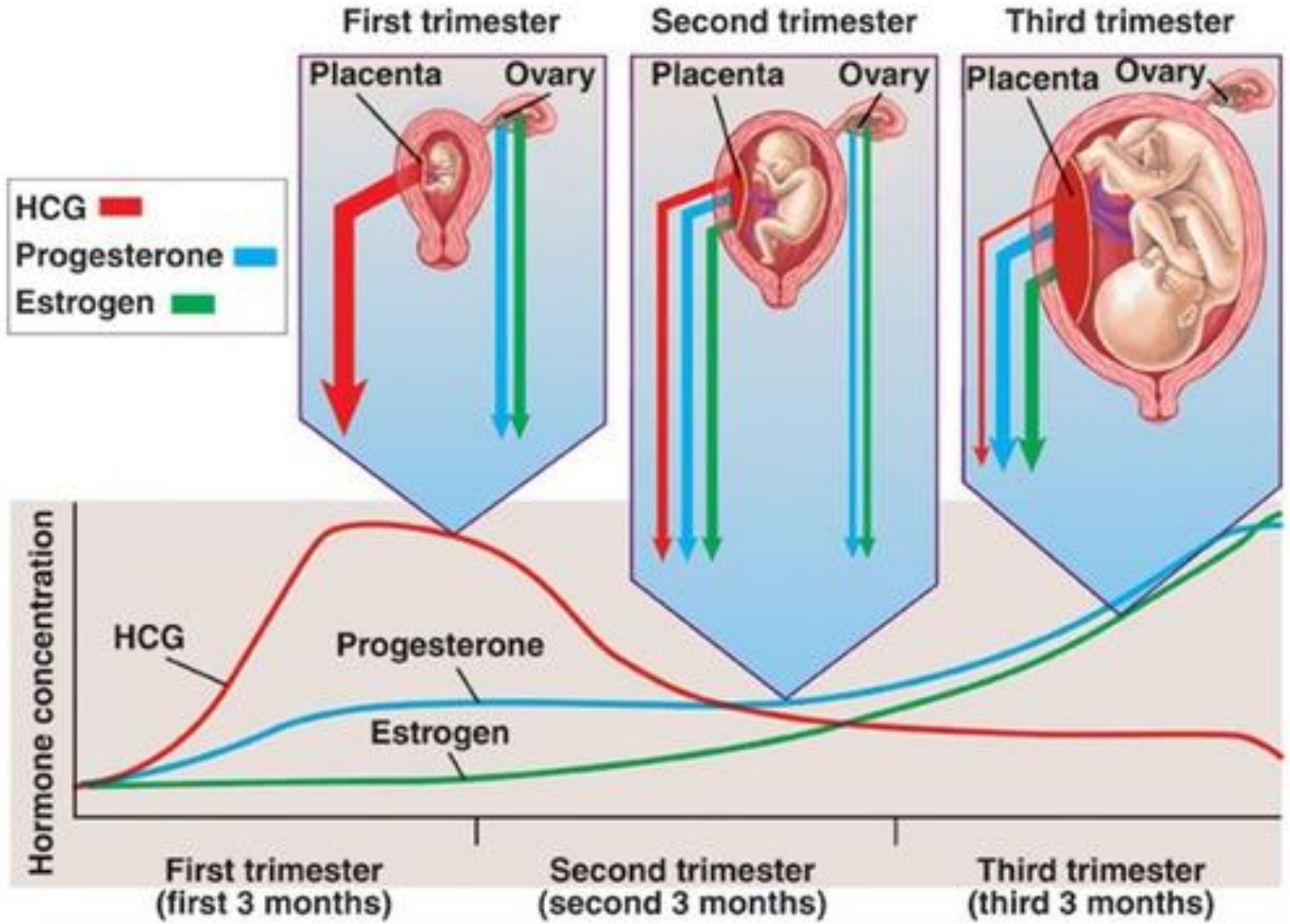
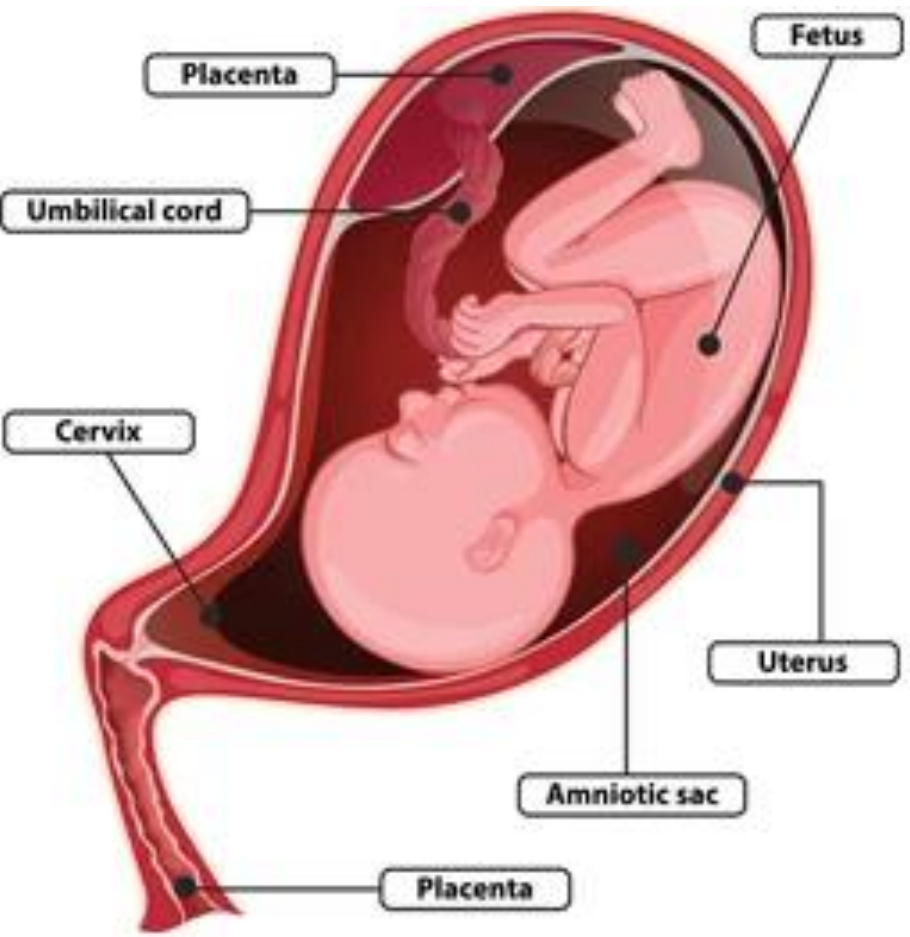
- Acini cells
 - Serous fluid containing digestive enzymes into digestive system

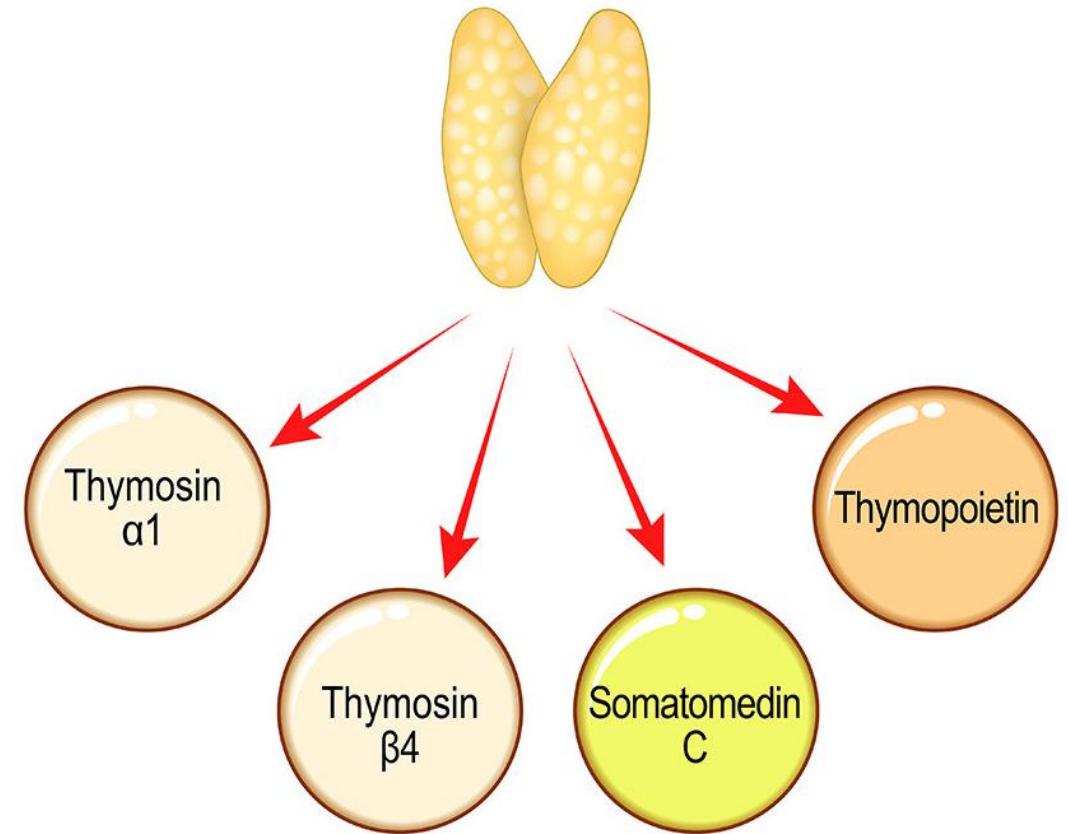
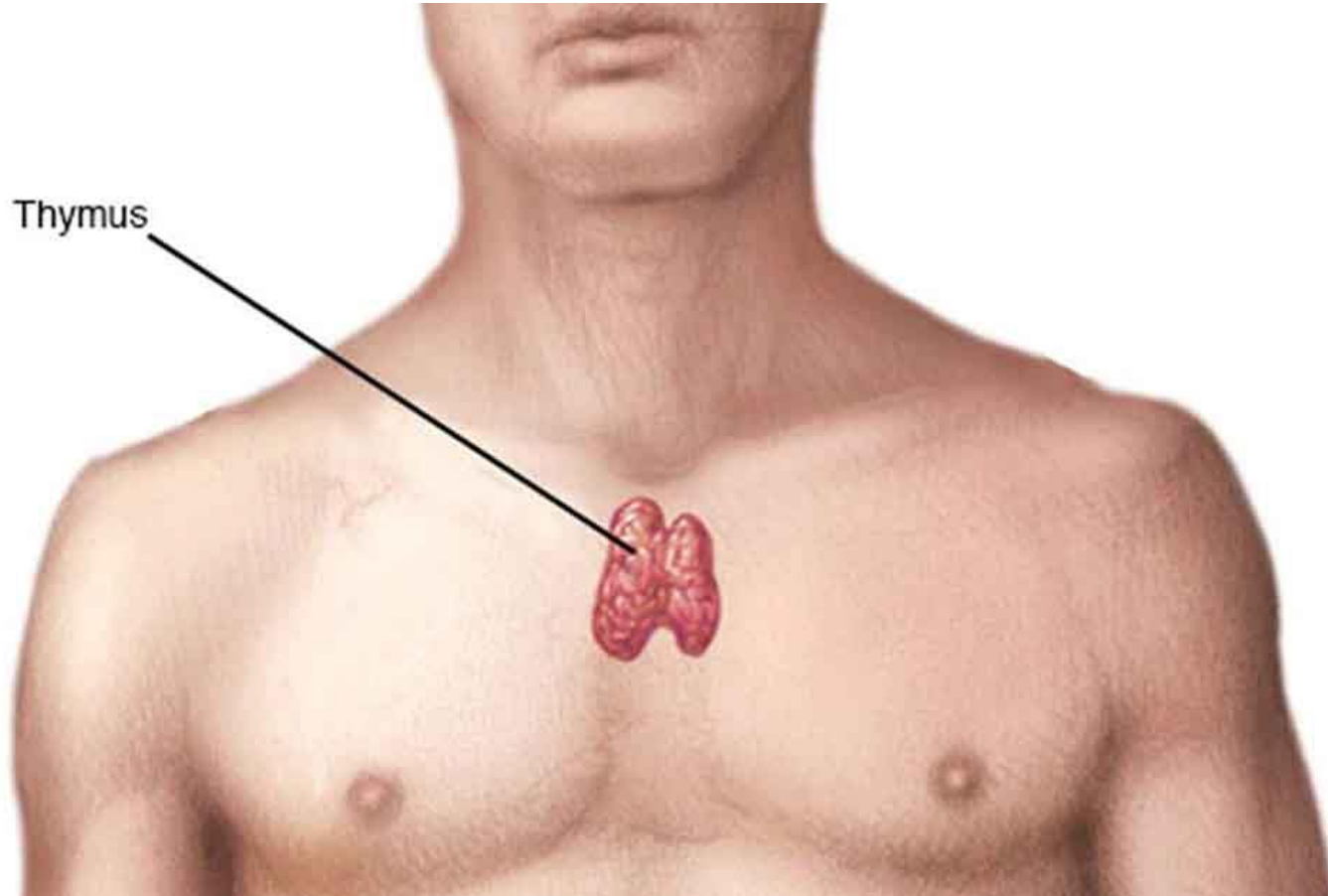
Endocrine Cells





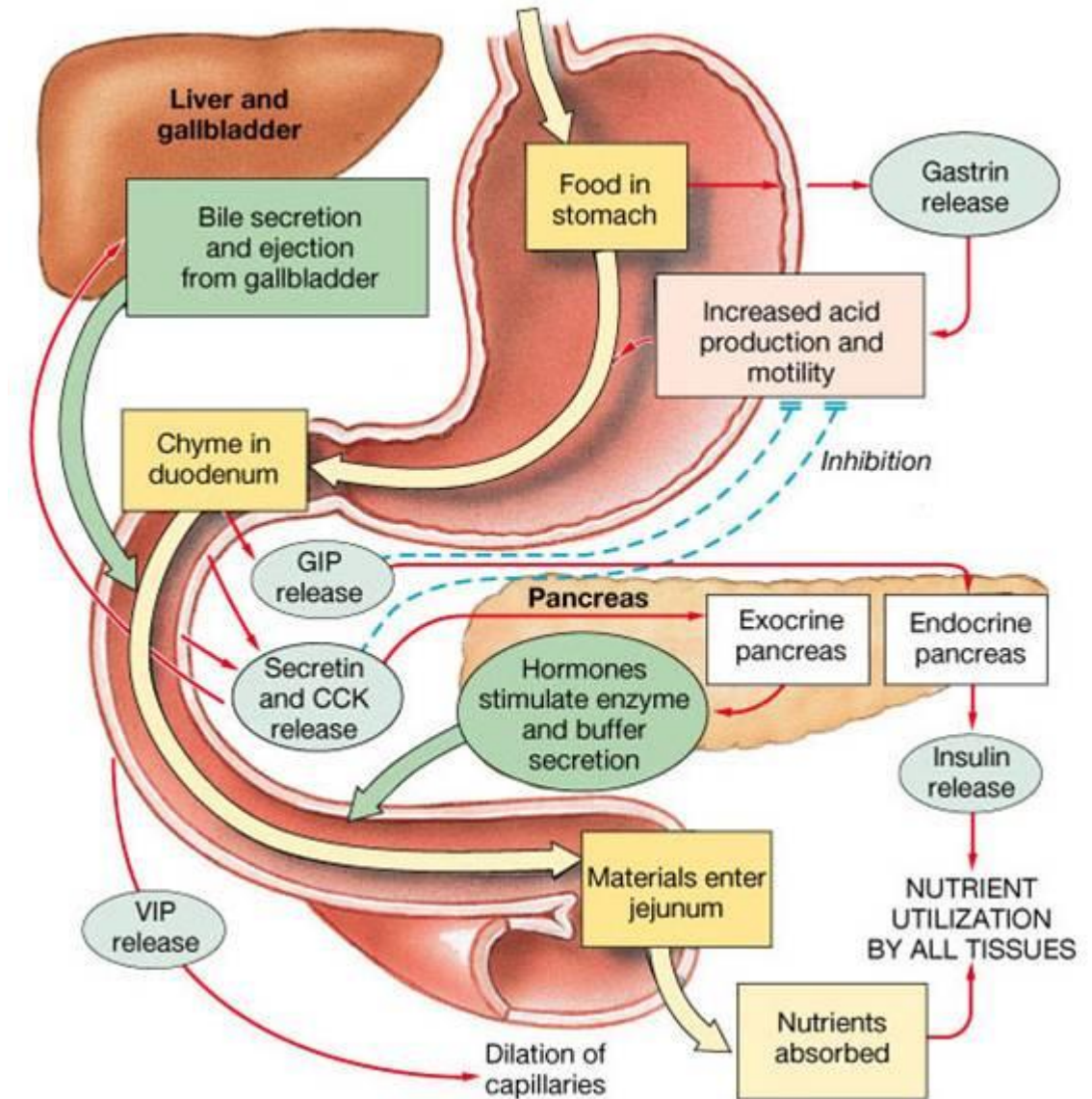






Gastric and Intestinal Mucosa

- Ghrelin
- Gastrin
- Secretin
- Cholecystokinin-pancreozymin (CCK)



- Atrial natriuretic hormone (ANH)
 - Also known as ANP (Peptide)
 - Promotes Na^+ secretion

