

The Endocrine System

“hormone transmitters”

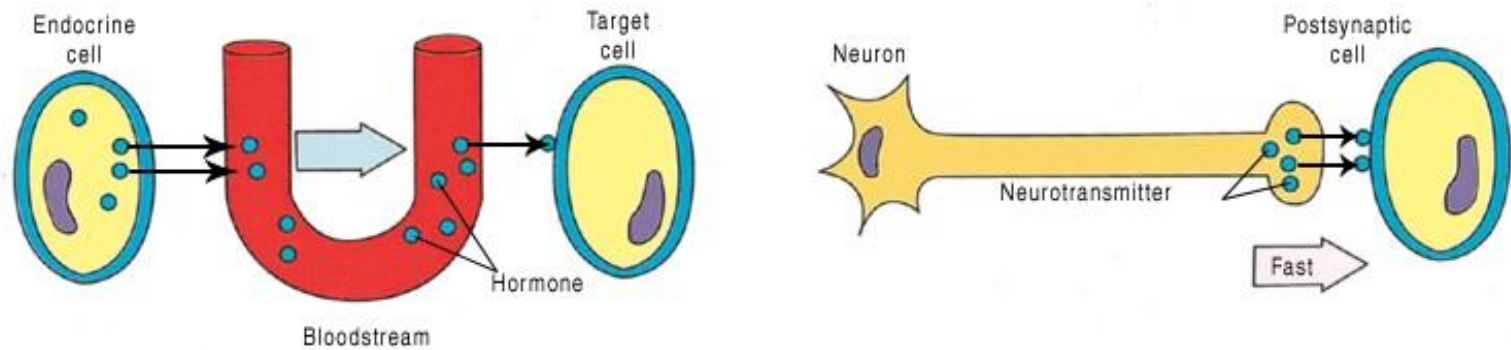
Cushing's Syndrome



Over production of hormone cortisol results in cushing's syndrome.

Endocrine System

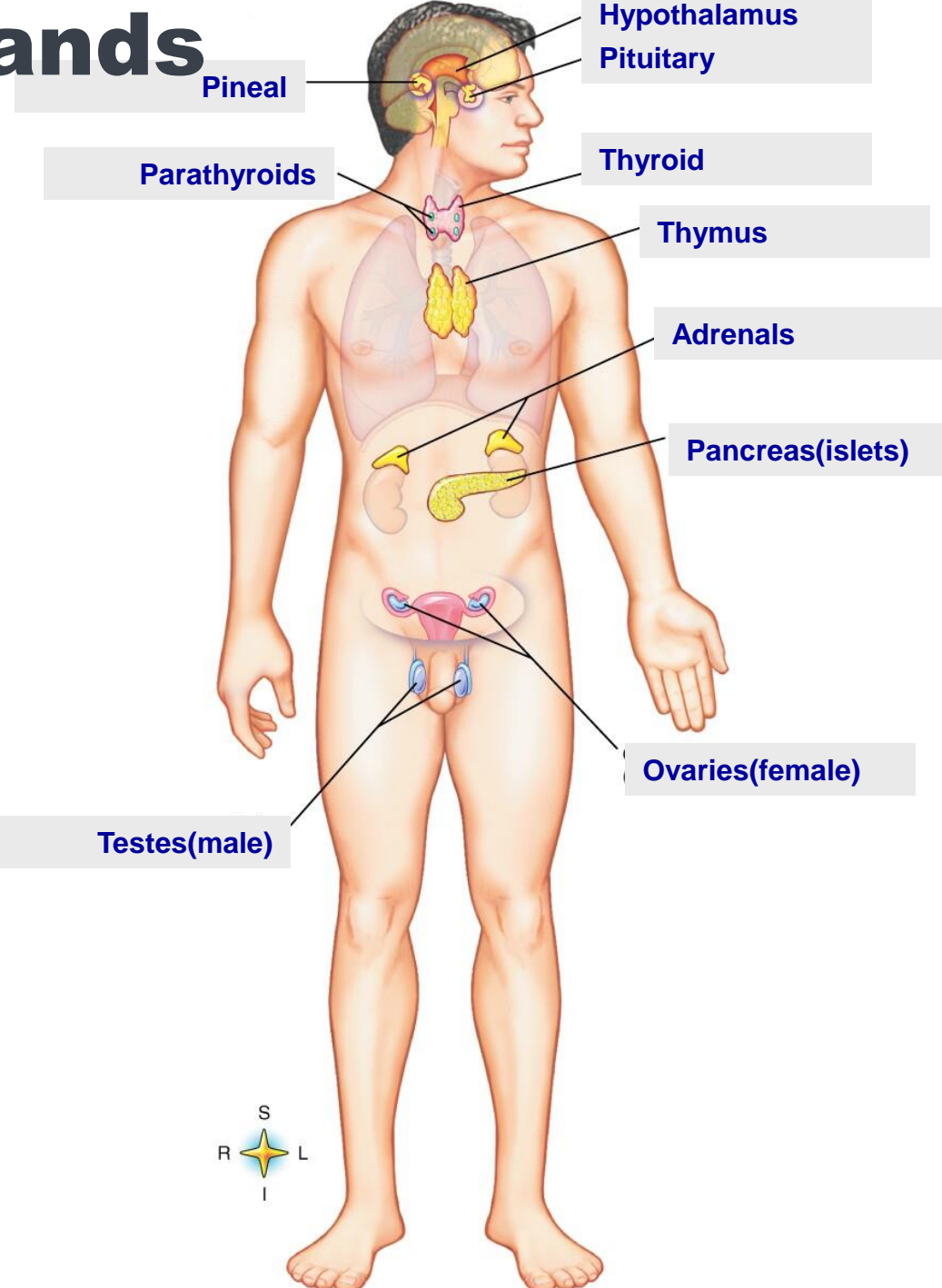
- The endocrine system works with the nervous system to maintain homeostasis.
 - Instead of neurotransmitters it sends hormones to “target cells” in the body
 - Hormones can diffuse in the blood and travel throughout the whole body.
 - The effects are slower than nervous but last longer.



Glands

- Most glands are made of glandular tissue and secrete hormones directly into the blood.
- Neurosecretory tissue glands are modified neurons which release chemical messengers into the blood.
 - Ex: When norepinephrine

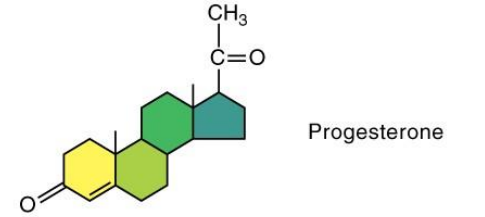
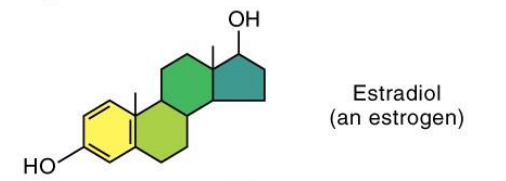
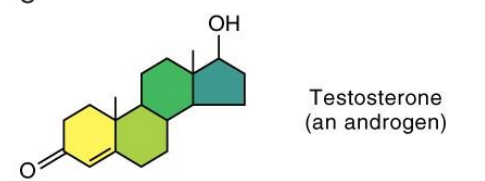
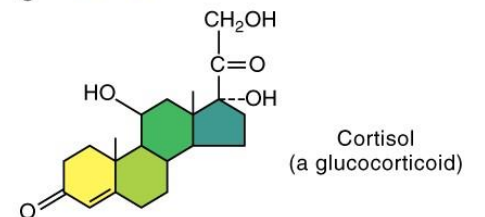
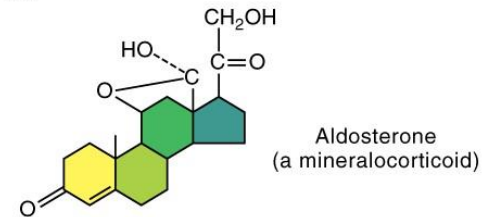
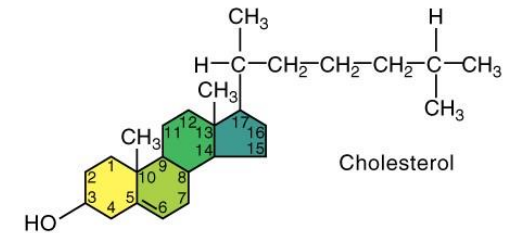
Major Glands



Classification of Hormones

Steroid

- Derived from cholesterol
- Lipid-soluble (hydrophobic)
 - Cortisol
 - Aldosterone
 - Estrogen
 - Testosterone
 - Progesterone



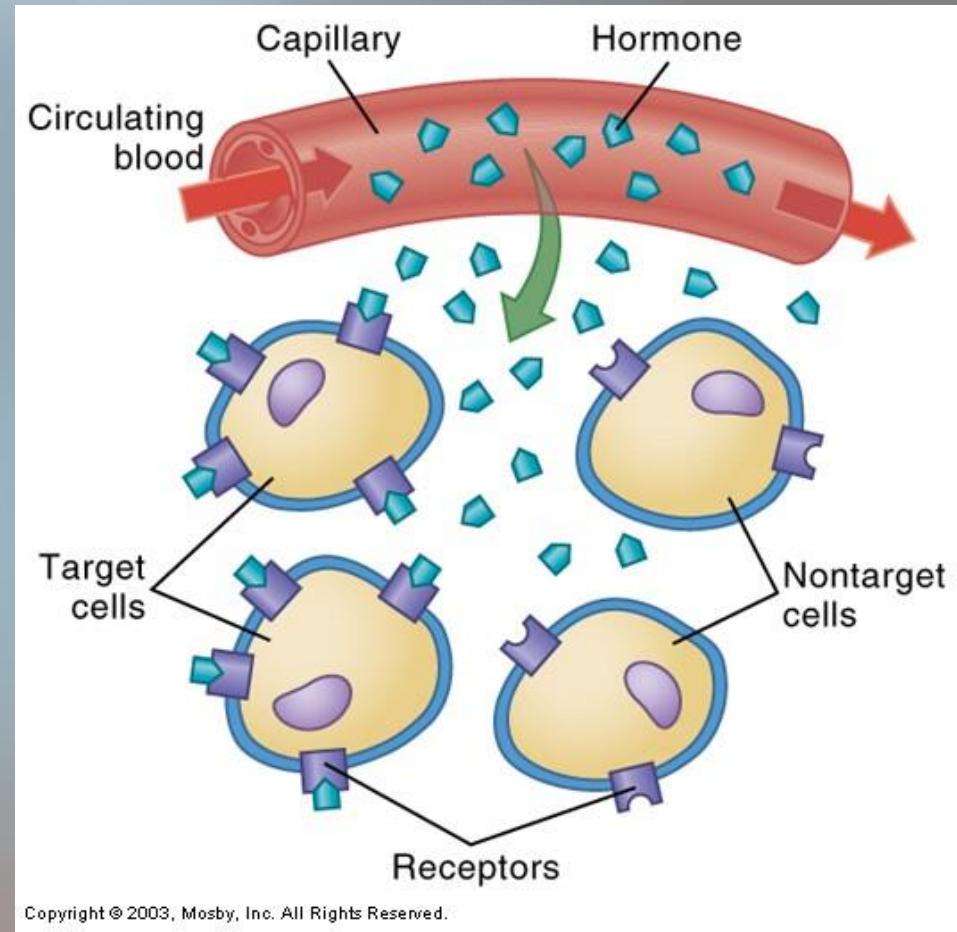
Classification of Hormones

Nonsteroid- derived from amino acids

1. Protein-large folded chains
 - Insulin
 - Parathyroid, calcitonin
 - Glucagon
2. Glycoproteins- have carbohydrate group attached
 - Follicle stimulating hormone(FSH)
 - Luteinizing hormone(LH)
 - Thyroid-stimulating hormone(TSH)
3. Peptides- smaller than proteins
 - Antidiuretic hormone(ADH)
 - Oxytocin
4. Amino Acid derivatives- made from single amino acid, tyrosine
 - Epinephrine
 - Norepinephrine
 - Melatonin

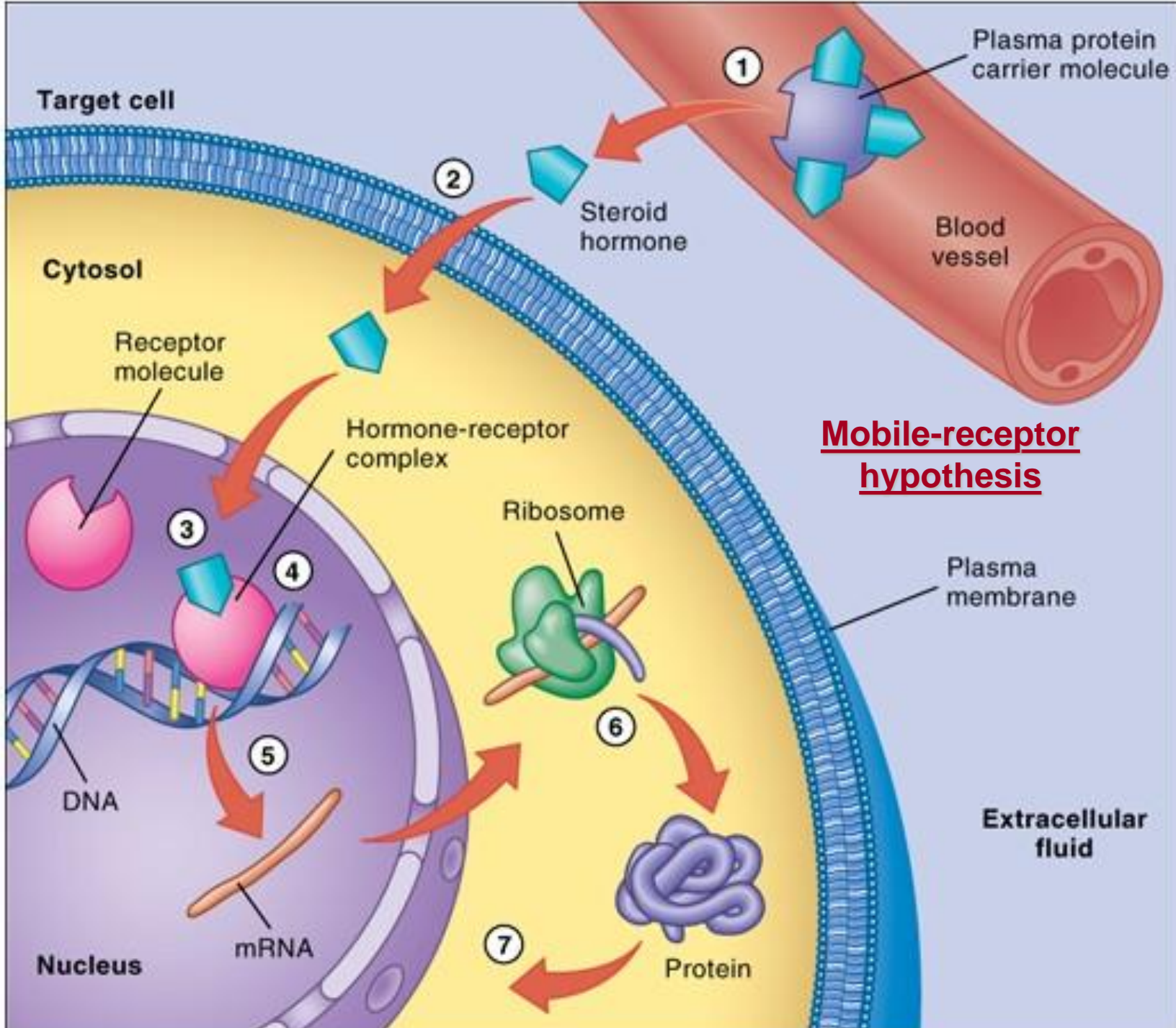
Hormone Action

- Hormones function with “lock-and-key” mechanisms and only affect their target cells
- **Synergism** is when hormones act together therefore creating a greater effect than the sum of the two separately.
- **Permissiveness**- first hormone allows a second one to have a greater effect
- **Antagonism**- hormones that have opposite effect so that result is fine tuned.



Steroid Hormone Action

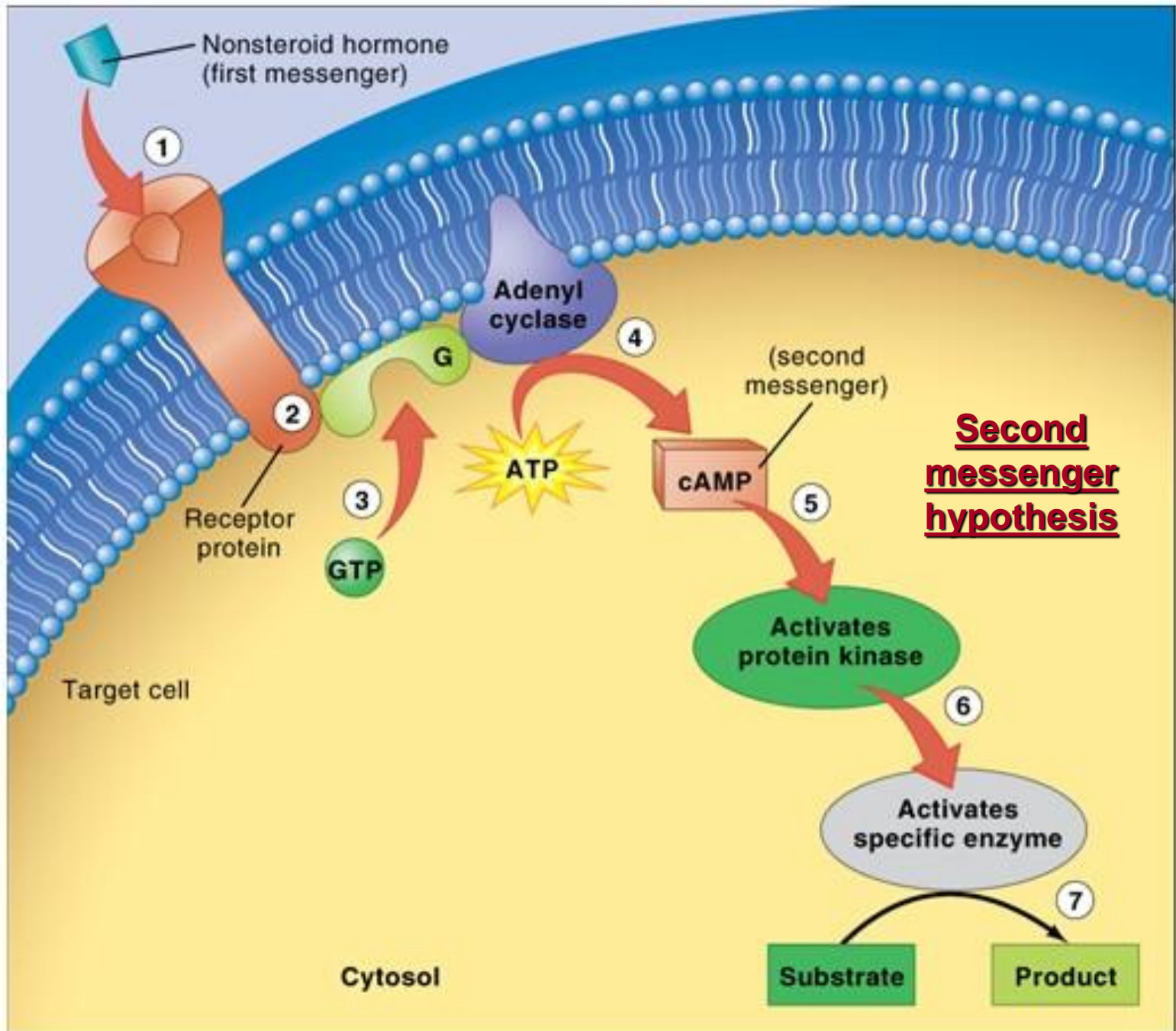
- Target receptors are found inside the cell
- Steroid forms hormone-receptor complex inside the nucleus and binds to DNA
- This results in production of RNA then proteins
- The amount of steroids determines how many HRCs can be formed thus how much protein is made.
- Steroids are slow acting in their affect
- **Mobile-receptor hypothesis**



Mobile-receptor hypothesis

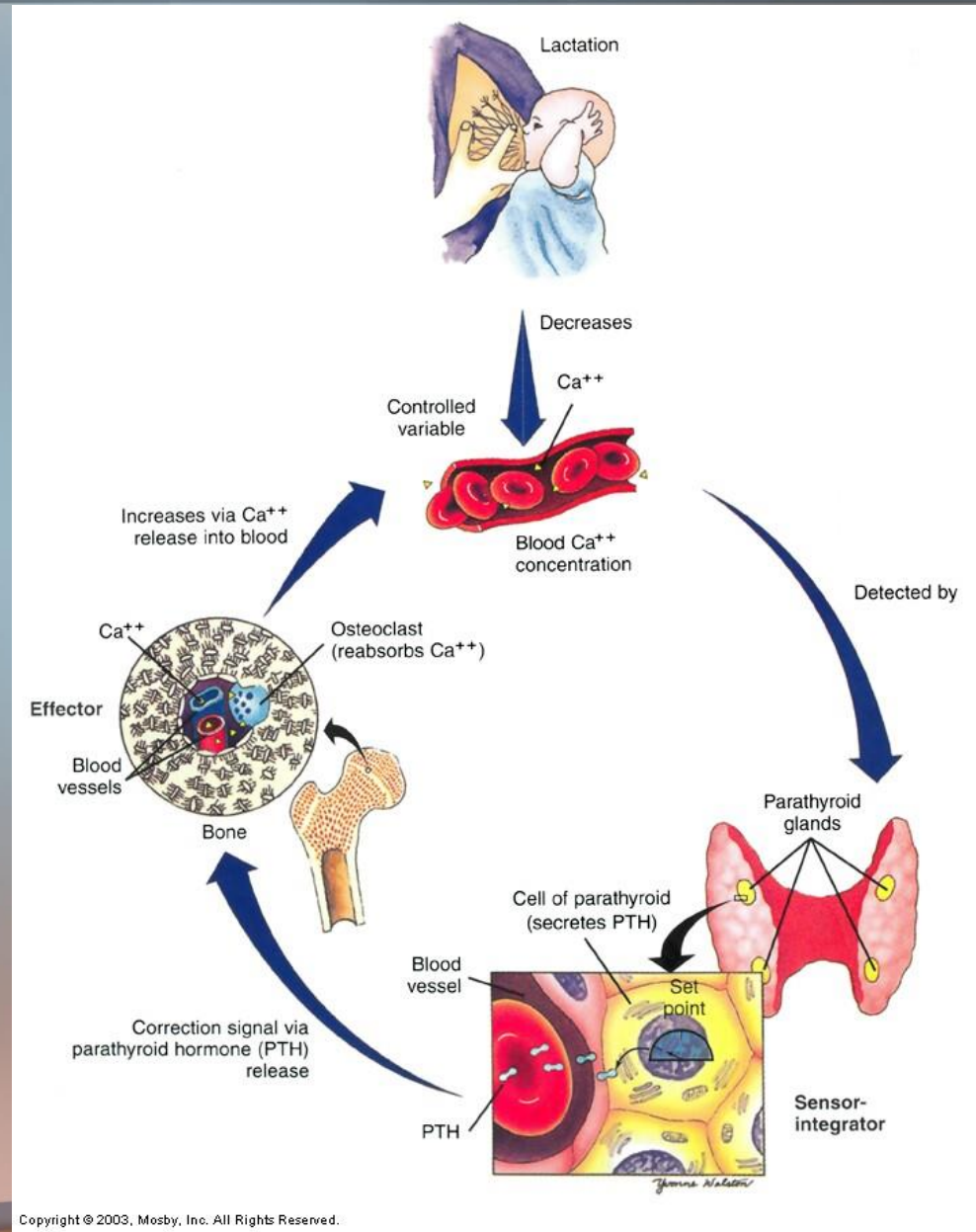
Non-steroid Hormone action

- Hormone binds to receptor protein on target cell membrane
- This “first-messenger” triggers the creation of a “second-messenger” inside the cell
- This second messenger then creates the target cell’s response
- This triggered reaction greatly amplifies the hormones effects on the cells
- Small amounts of hormones have immediate and large effects
- **Second messenger hypothesis**



Regulation of Hormone Release

- Endocrine reflexes control hormones with feedback loops
- Glands monitor blood for signals from target cells
- Nervous system can have direct effect on release of hormones
 - ex: epinephrine



Prostaglandins

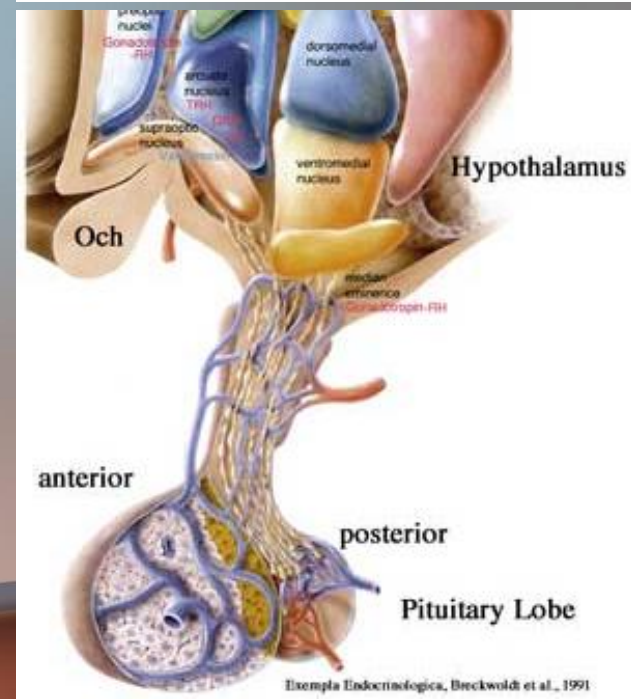
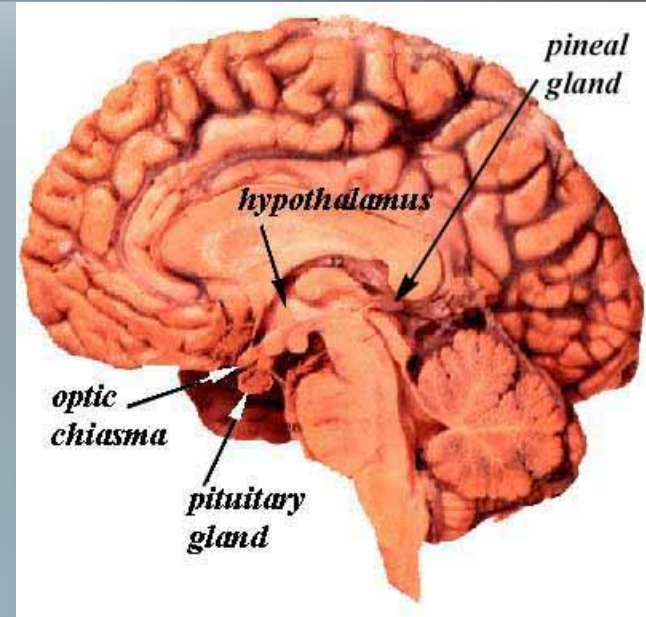
- Unique group of lipid compounds that rapidly metabolize in the blood stream
- Often referred to as tissue hormone
- Very diverse and powerful reaction
 - Cause relaxation of smooth blood vessels dropping blood pressure dramatically
 - Have role in systemic inflammation such as fever
 - Regulates secretion of HCL in stomach
 - Cause uterine contraction in delivery
- Are an area of great interest for medical applications

The Pituitary Gland “master gland”

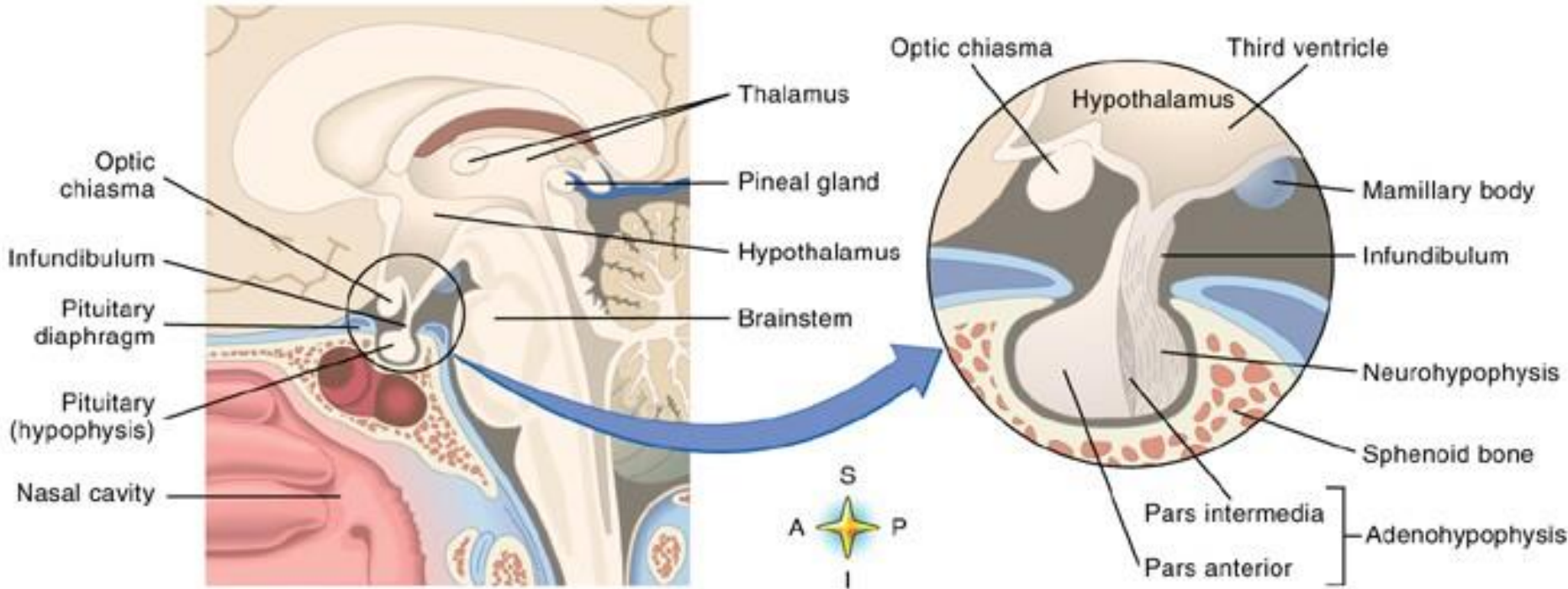
Also called the
hypophysis

Made up of two glands

- **Adenohypophysis**-
anterior pituitary
(glandular tissue)
 - pars anterior
 - pars intermedia
- **Neurohypophysis**-
posterior pituitary
(neurosecretory
tissue)

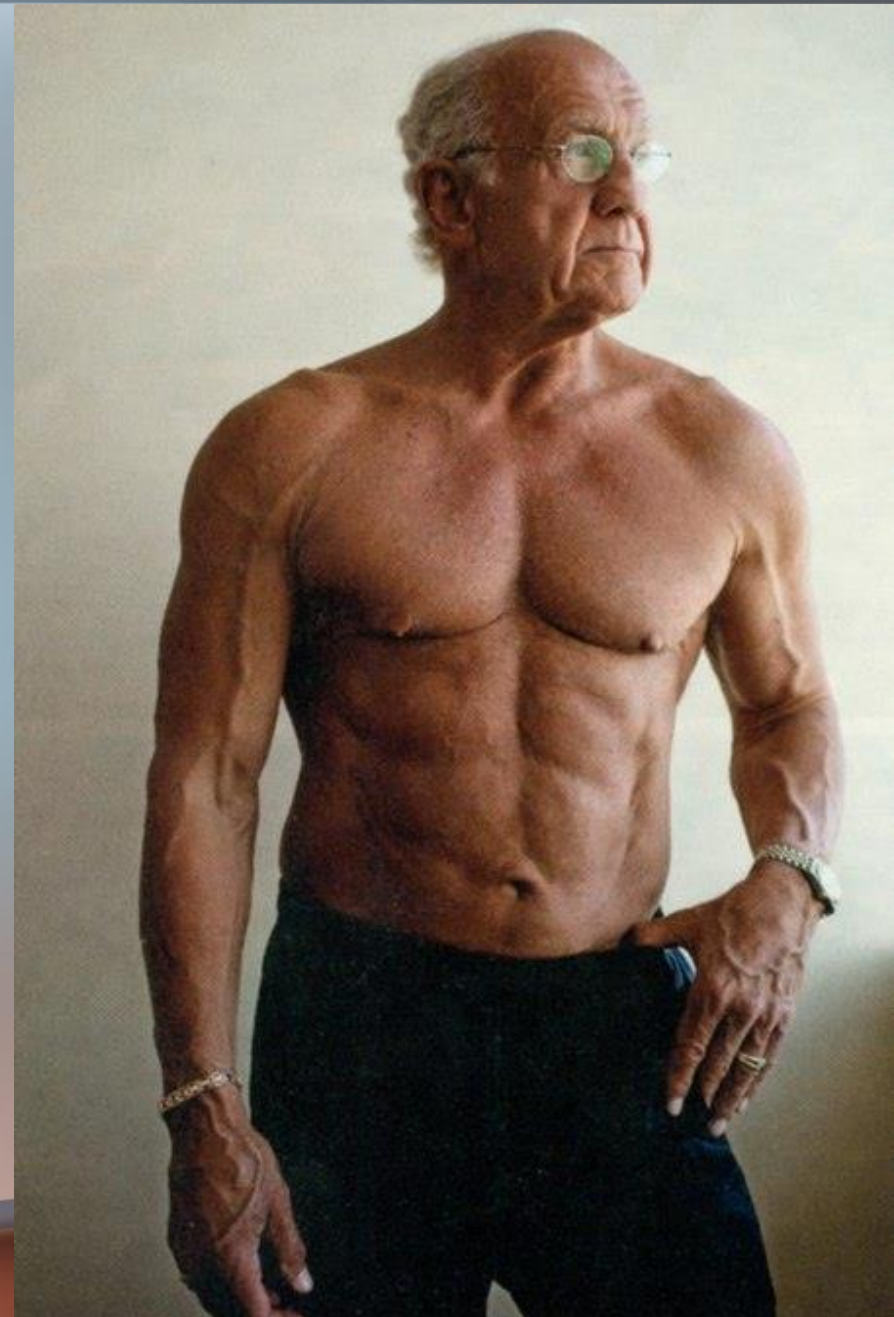


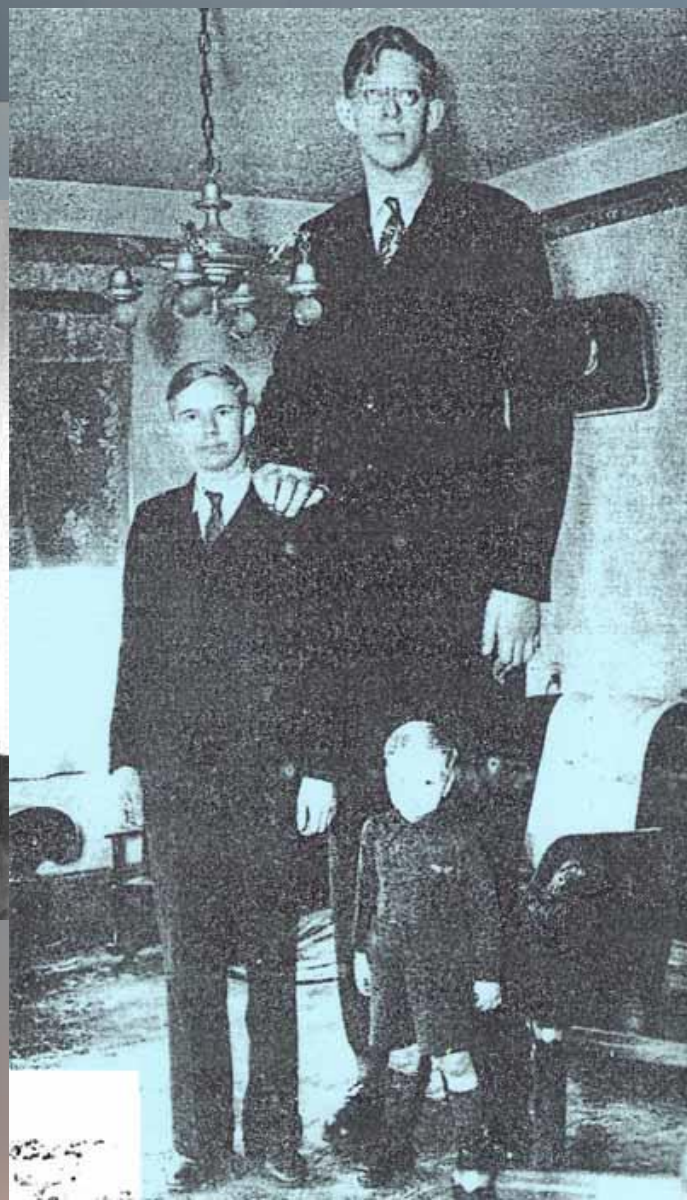
Hypophysis and surrounding structures



Hormones of the Adenohypophysis

- **Growth Hormone(GH)**
or **Somatotropin(STH)**
 - increases protein anabolism by increasing cellular uptake of amino acids
 - Stimulates lipid catabolism
 - Indirectly increases blood glucose levels (hyperglycemic affect)
- *Hypersecretion of GH causes gigantism*
- *Hyposecretion of GH causes pituitary dwarfism*





Pituitary dwarfism

Robert Wadlow was 8'11" the tallest man ever to live

Hormones of the Adenohypophysis

Prolactin(PRL)

– Causes lactation in breast feeding women

- *Hypersecretion in non-lactating women causes lactation, interrupted menstrual cycle and impotence in men.*
- *Hyposecretion can prevent a woman from breast feeding*



Hormones of the Adenohypophysis

Trophic hormones- have stimulating effect on other endocrine glands

- **Thyroid-stimulating hormone(TSH)**- causes it to secrete thyroid hormones
- **Adrenocorticotrophic hormone(ACTH)**-stimulates hormone release from adrenal cortex
- **Follicle-stimulating hormone(FSH)**- causes ovulation and aids in spermatogenesis
- **Luteinizing hormone(LH)**- promotes secretion of estrogen and progesterone in females and testosterone in males

Hormones of the Neurohypophysis

- **Antidiuretic hormone(ADH)**
 - Decreases urine production
 - Osmoreceptors in the hypothalamus trigger release of ADH
 - Causes reabsorption of water in tubules of kidney

**Hyposecretion of ADH can result in diabetes insipidus, patients produces extremely large amounts of water.*
- **Oxytocin**
 - Causes uterine contractions during labor
 - Begins process of breastfeeding
 - Both controlled by positive feedback loops

Pituitary Hormones

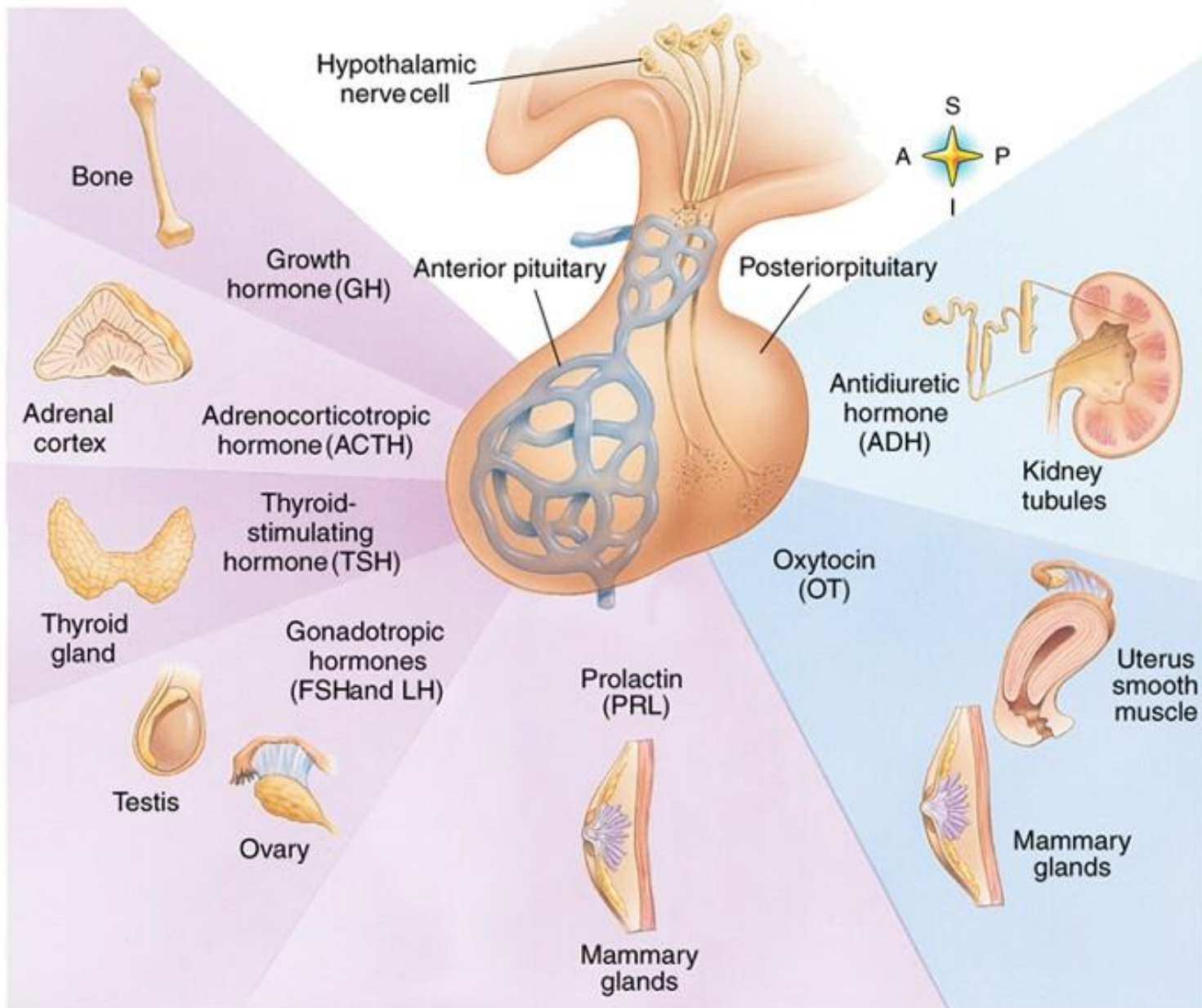
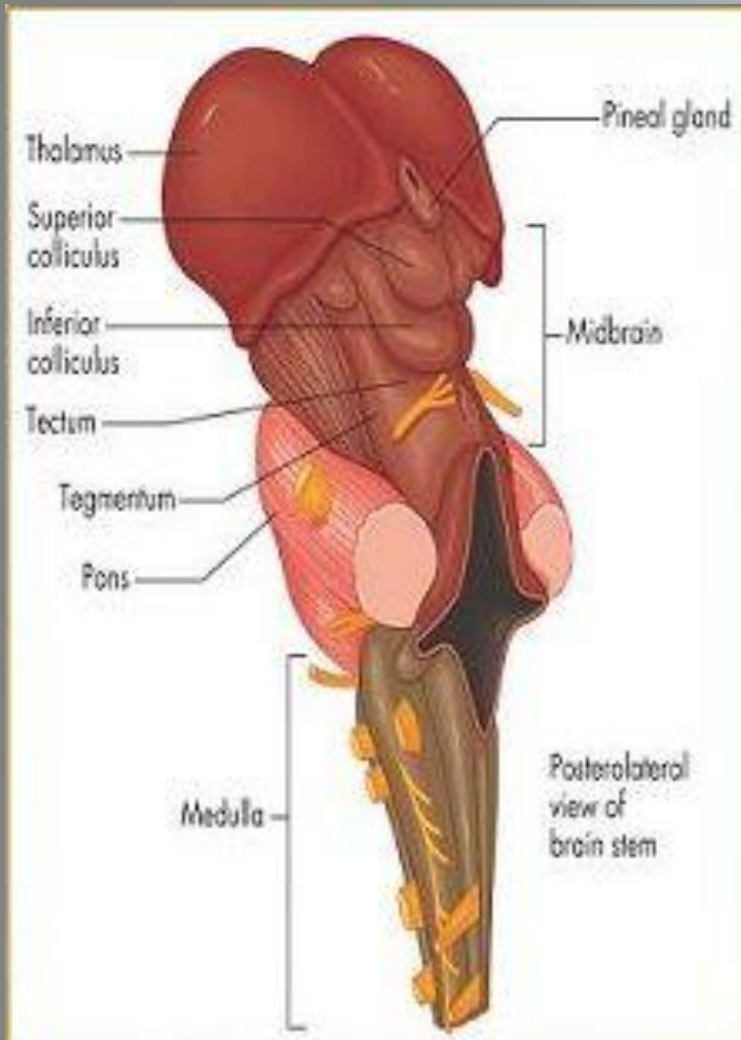


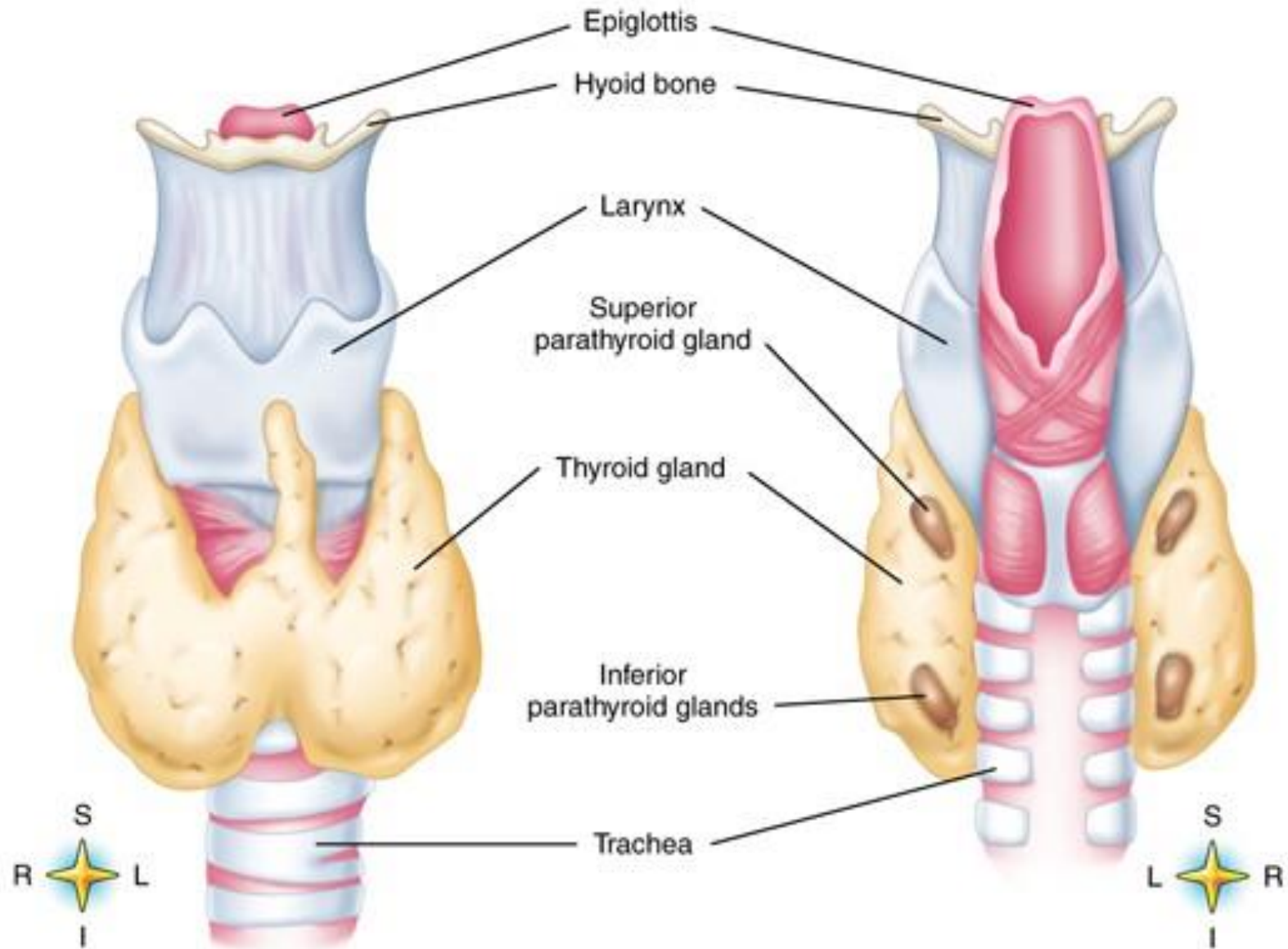
Table 16-4 page 501, summary of pituitary hormones

The Pineal Gland



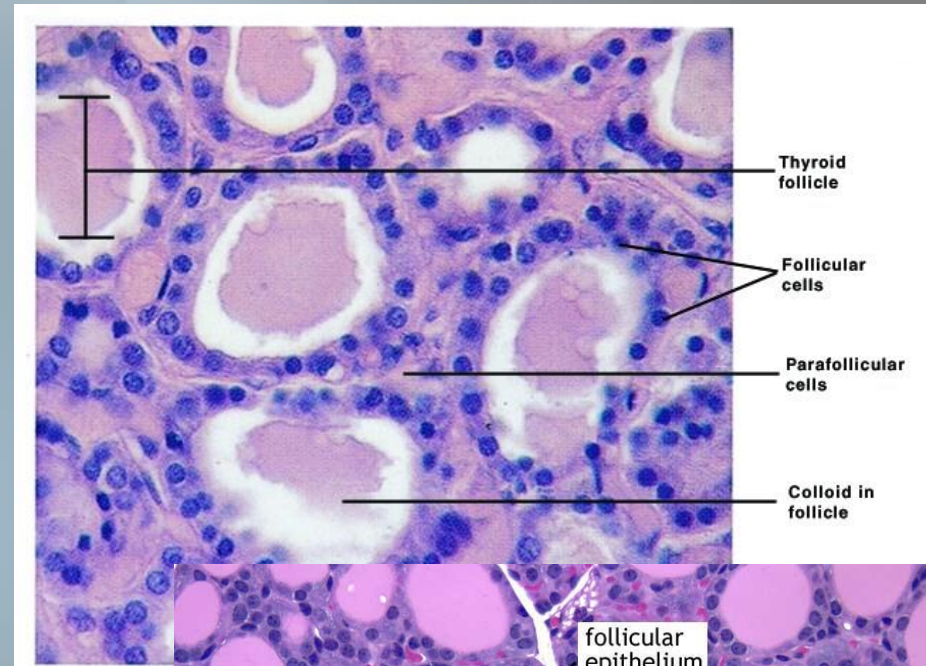
- Biological clock
- Controls hunger, sleeping, reproductions and behavior
- Part of the nervous system because light seems to inhibit production of melatonin.
- Melatonin is primary hormone released thought to induce sleep
- Winter depression or SAD is thought to be brought on by too much mood altering melatonin

Thyroid and Parathyroid

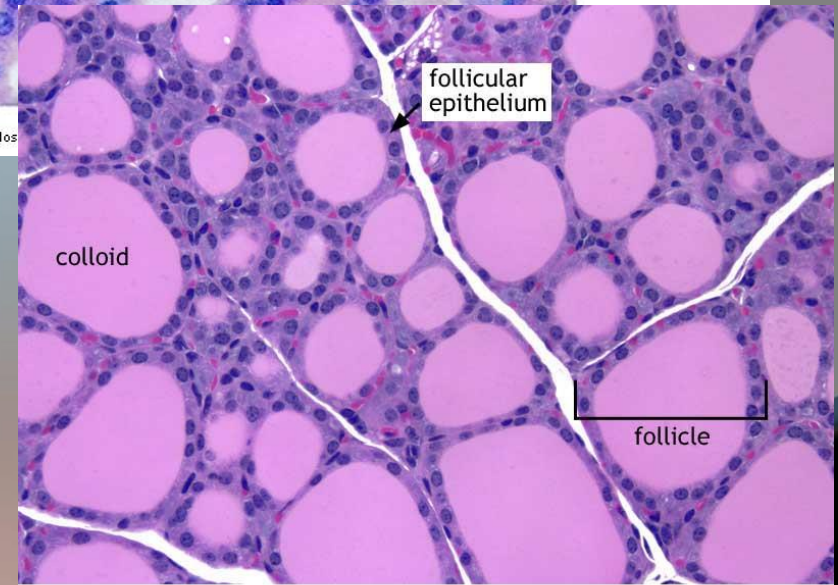


Thyroid

- Composed of follicles filled with thyroid colloid
- Releases T_4 and T_3 which are bound to Iodine
- T_4 and T_3 are collectively referred to as TH(thyroid hormone) or Thyroxine
- TH regulates cell metabolism, growth and differentiation
- Calcitonin is produced by thyroid and decreases blood Ca^{++} levels, thus increasing hard bone matrix.



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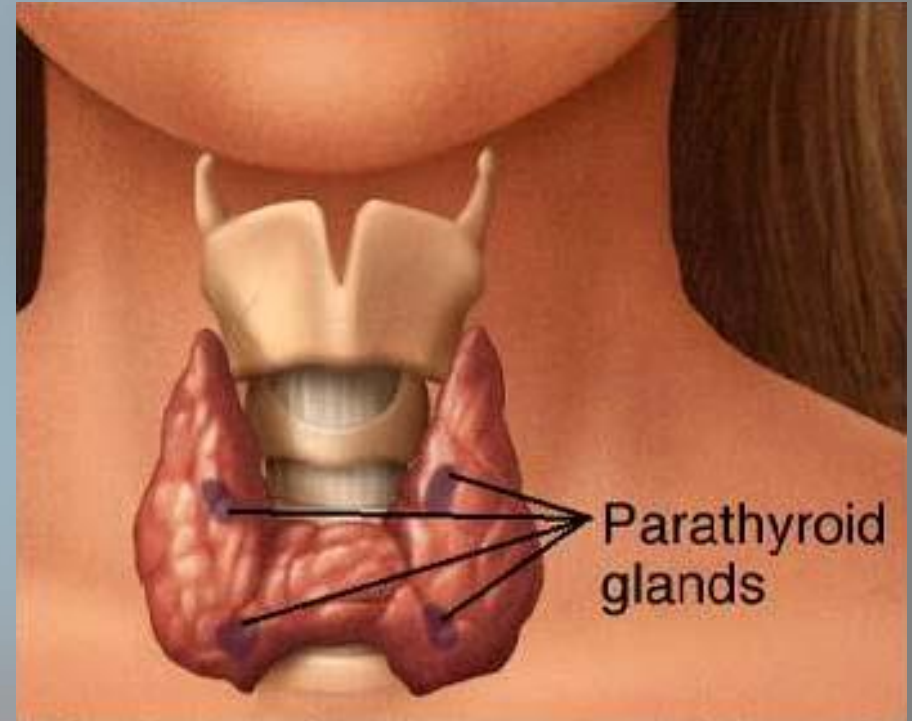
Thyroid disorders

- Hypersecretion- Graves disease, thought to be autoimmune in origin. Symptoms are nervousness, arrhythmias, increases heart rate, weight loss and eye protrusion.
- Hyposecretion- decreased metabolic rate, mental and physical lethargy, weight gain
- Goiters- unavailability of iodine in the diet causes the adenohypophysis to release TSH causing and increase thyroid size.

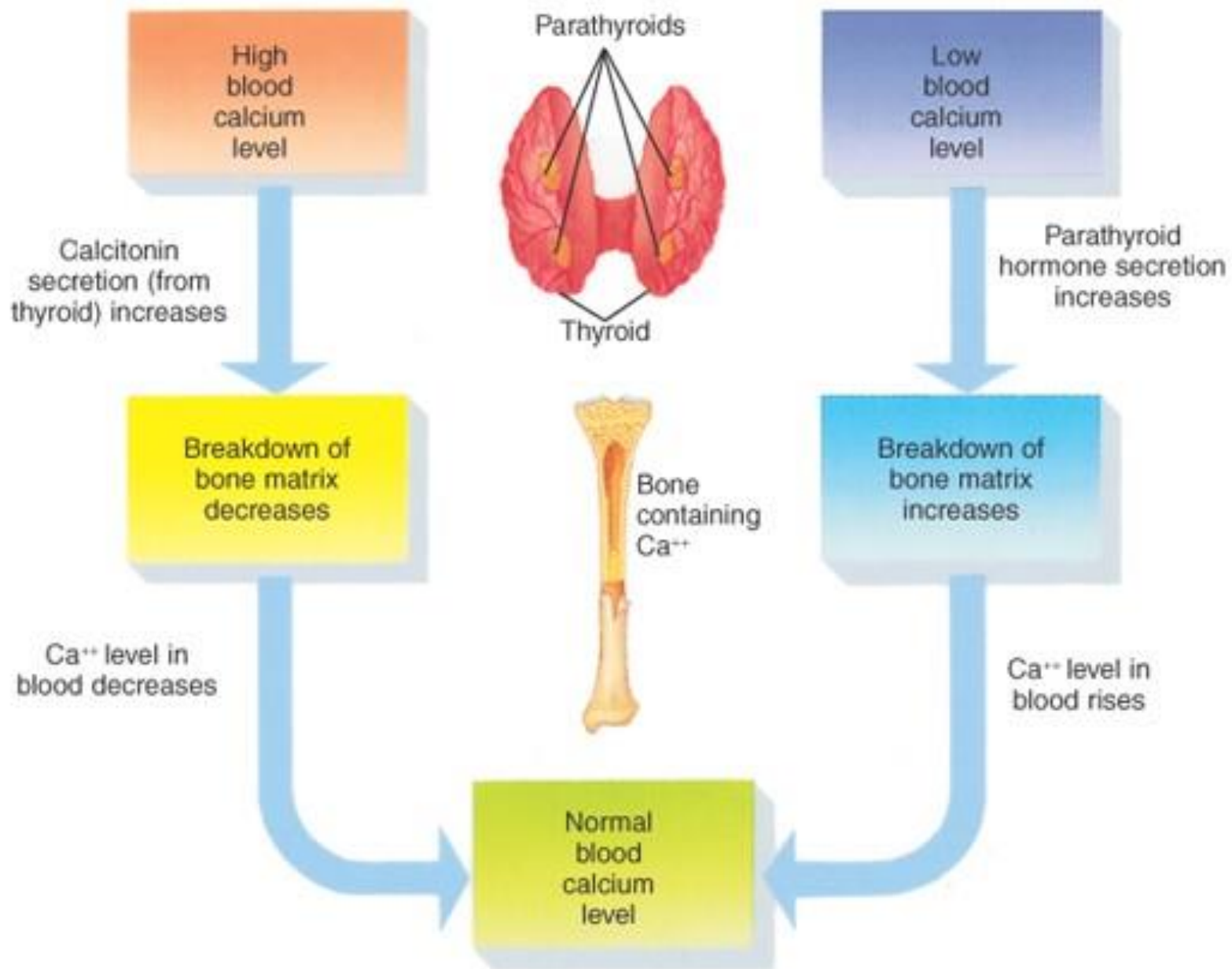


Parathyroid

- Embedded in posterior portion of thyroid
- Releases Parathyroid hormone (PTH), antagonist to calcitonin
- PTH causes osteoclast activity and the release of Ca^{++} from bone.
- PTH also activates vitamin D which aids in Ca^{++} reabsorption in the kidneys.
- PTH and calcitonin activity is crucial in maintaining blood Ca^{++} levels.

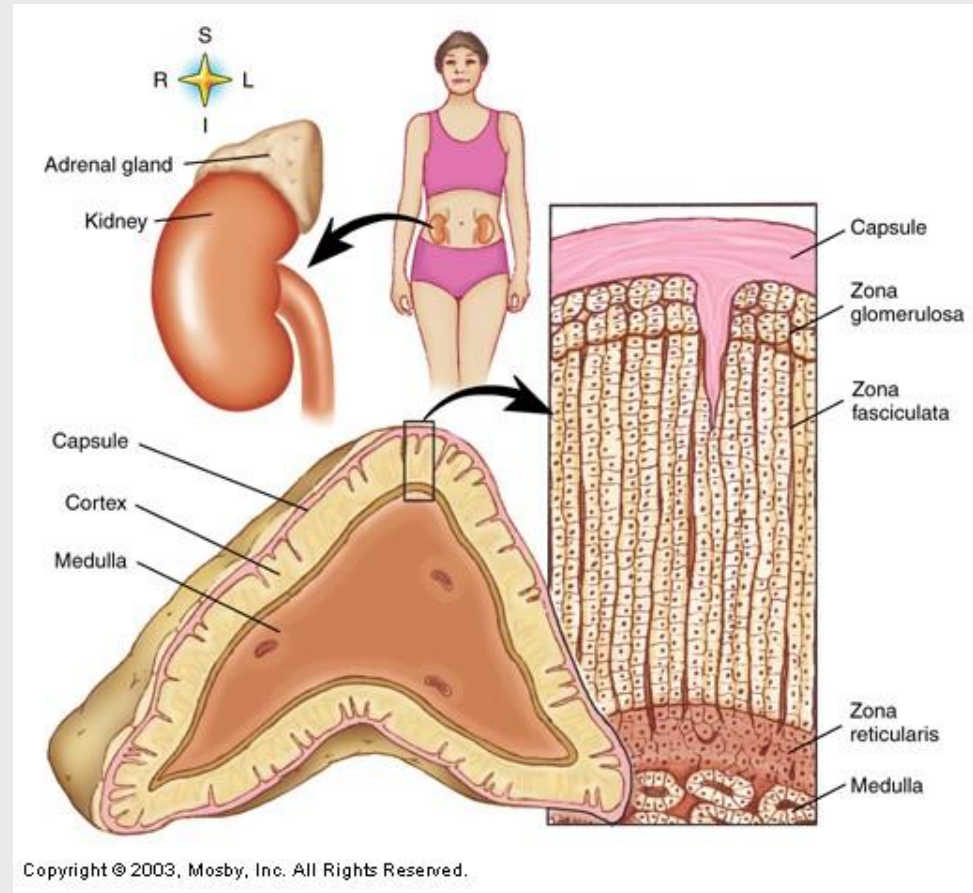


Thyroid and Parathyroid antagonistic functions



The Adrenals

- Fit over the kidneys like caps
- Also called suprarenal glands
- Adrenal cortex makes up outer portions and is made of endocrine tissue
- Adrenal medulla makes up inner portion and is made of neurosecretory tissue.



Adrenal Cortex Hormones

- **Aldosterone**- is a mineralcorticoid(controls) mineral balance of sodium thus controlling blood volume.
- **Cortisol**- is a glucorticoid that breaks down protein to form glucose(gluconeogenesis)
 - It acts permissively to allow epinepherine and norepinepherine to control blood pressure.
 - High levels can cause immune system to be compromised.
 - Acts as anti-inflammatory agent for injury recovery

**Hypersecretion results in Cushing syndrome*

- **Androgens** are male gonadocorticoids that produce male characteristics

Adrenal Medulla Hormones

- Norepinephrine & epinephrine-
- non-steroid hormones
- act to prolong the same effect they have in the nervous system.
- This a stimulating effect

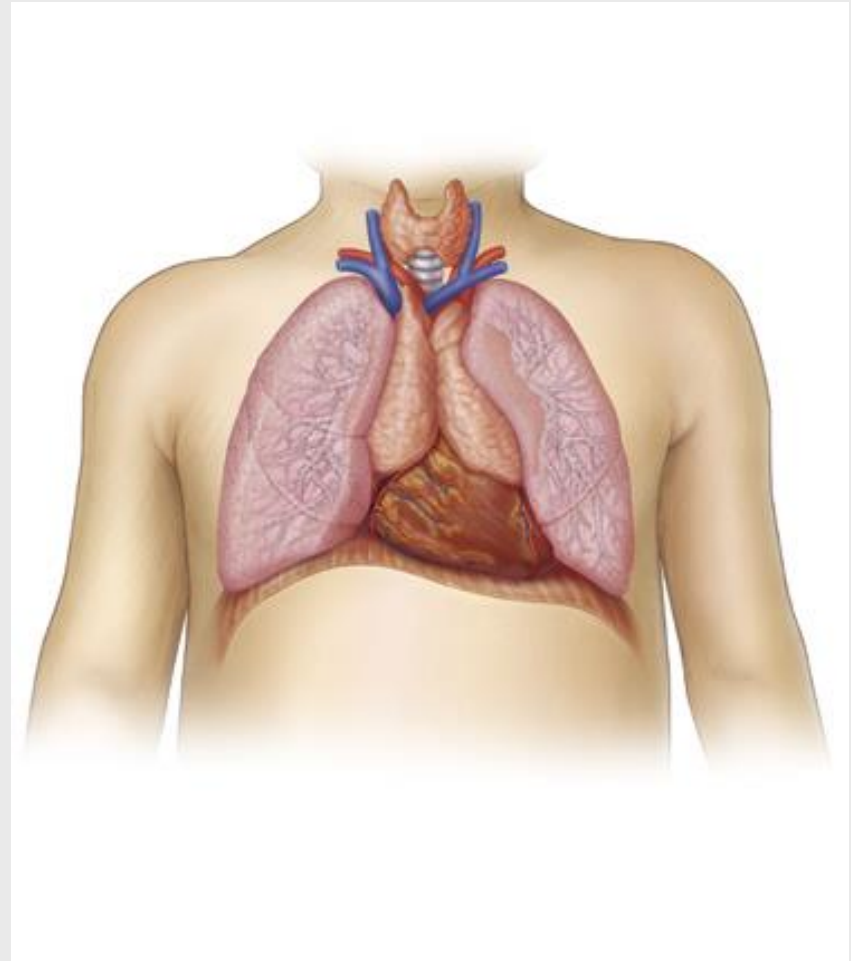


Adrenal cortex

Adrenal medulla

The Thymus

- Large in children until puberty then it atrophies
- In old age it is fat and fibrous tissue
- Secretes Thymosin which plays a role in the development of the immune system

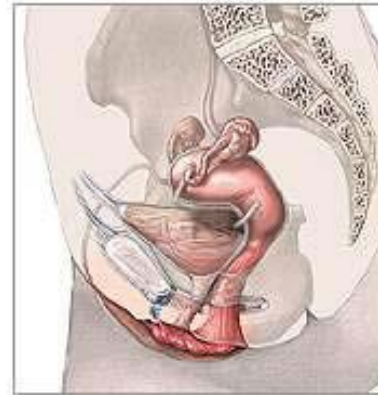


Gonads

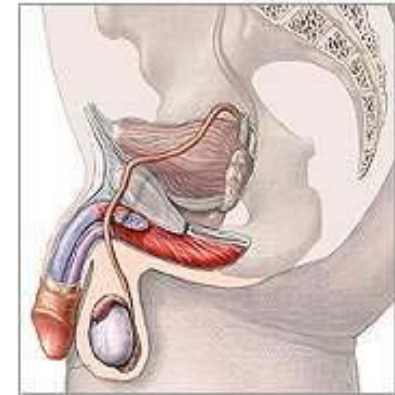
Testes(testis)- produce testosterone(androgen) which controls male characteristics and sperm production.

Ovaries-hormones are regulated by LH and FSH

- Estrogen controls female characteristics and menstrual cycle
- Progesterone is “pregnancy-promoting” hormone that maintains lining of uterus.



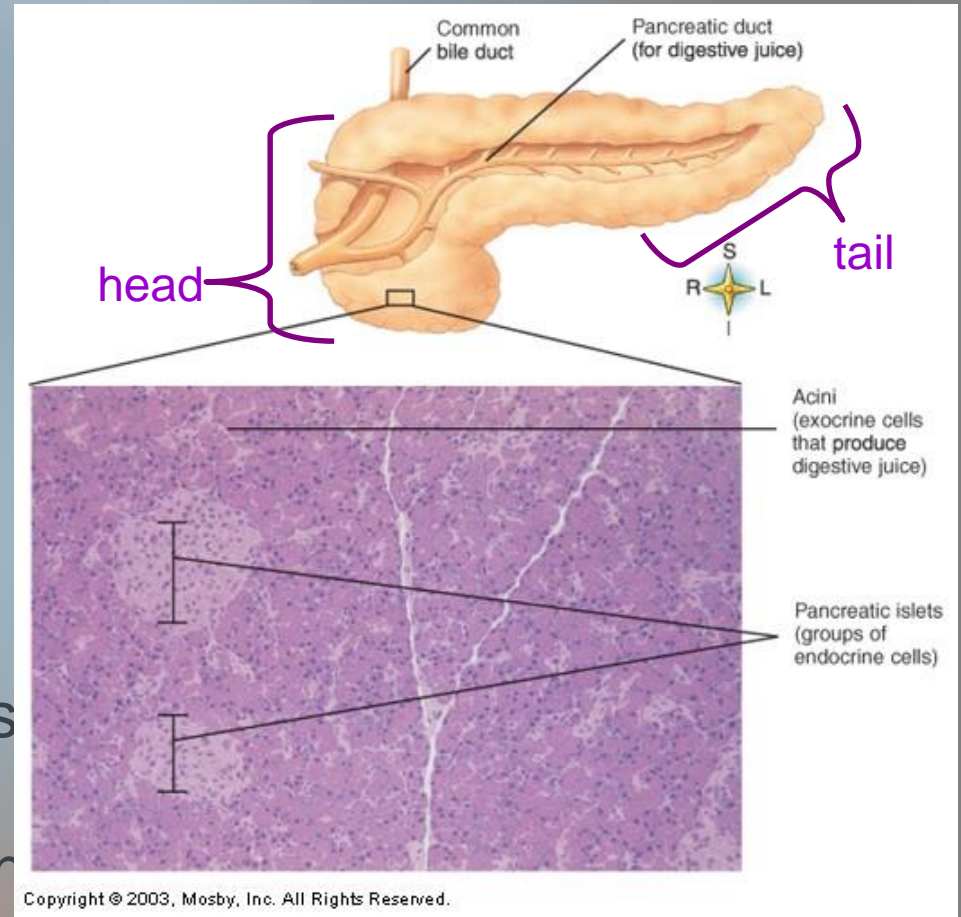
Female reproductive system



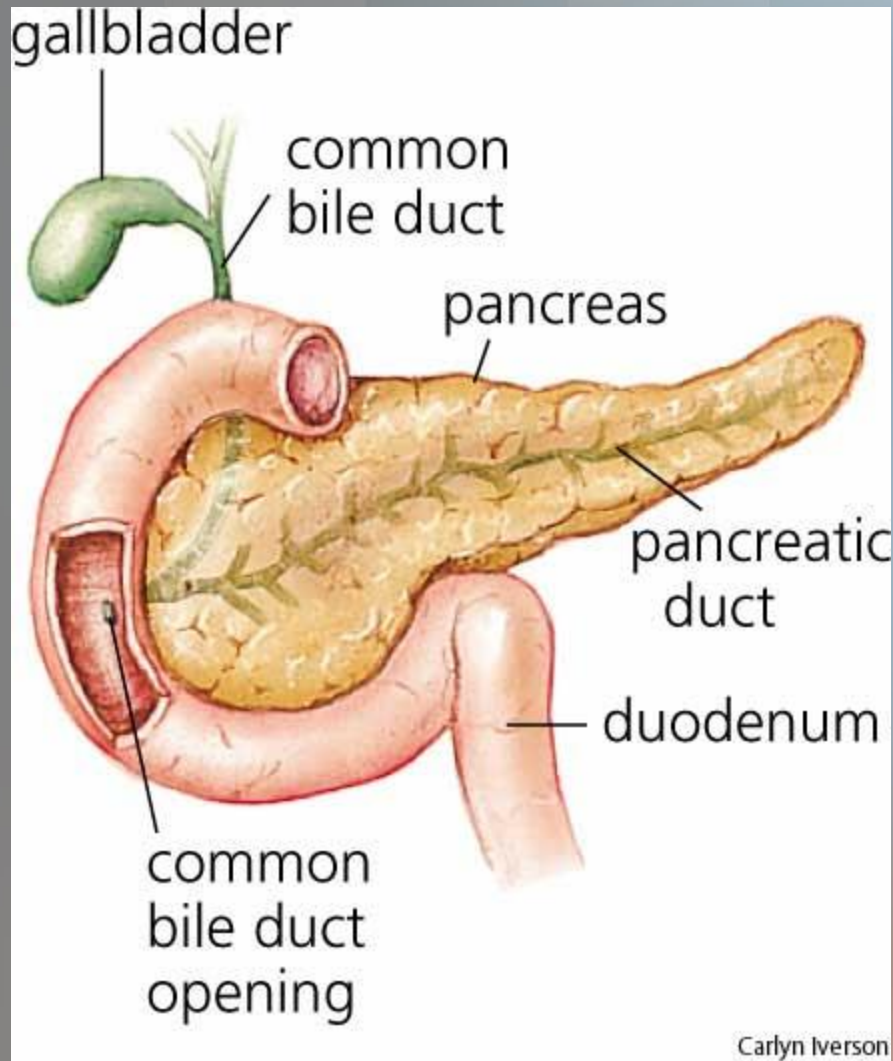
Male reproductive system

The Pancreas

- Is composed of both endocrine and exocrine tissue
- Pancreatic islets make up the endocrine portions that release hormones.
- Acini cells surround the islets cells, release digestive enzymes into ducts that drain in small intestines.



Pancreatic Hormones



- **Glucagon**(secreted by **alpha cells**)- stimulates breakdown of glycogen into glucose and gluconeogenesis
- **Insulin**(secreted by **beta cells**)- moves glucose into tissues and promotes glucose metabolism.
- **Somatostatin**(secreted by **delta cells**)- regulates secretion of other pancreatic hormones

Diabetes mellitus

Hyperglycemia is elevated levels of glucose in the blood.

Hypoglycemia is low levels of glucose in the blood.

Type 1 (juvenile diabetes)

- The body is unable to make insulin.
- Beta cells in pancreas are destroyed.
- Thought to be autoimmune and genetically linked.
- Persons with Type 1 diabetes must receive insulin injections.

Type 2

- Insulin is produced in greatly reduced amounts
- Symptoms-black line on back of neck, extreme thirst
- Receptors on target cells are reduced preventing adequate uptake of insulin
- Kidneys cannot reabsorb all the glucose and glycosuria (glucose in urine) results.
- Exercise and diet can often reverse Type 2 diabetes.

Gestational Diabetes

- Temporary diabetes during pregnancy
- Greatly increases risk of developing diabetes later in life

The Placenta

- Acts as a temporary endocrine gland during pregnancy
- Secretes human chorionic gonadotropin (hCG)
- Pregnancy tests detect the presence of hCG in urine

