Endocrine System

Dr. Aman Shakya

2080.11.08

Objectives

- To know about Endocrine System
- To describe structure of Pitutary Gland
- To describe structure of Hypothalamus
- To describe structure of Thyroid Gland
- To describe structure of Parathyroid Gland

Endocrine System

- Helps control the following:
  - ✓Growth and development
  - ✓Homeostasis
  - ✓Metabolism
  - ✓Reproduction
  - ✓Response to stimuli (stress and/or injury)
- Most hormones are synthesized from amino acids and proteins or from cholesterol (steroids)

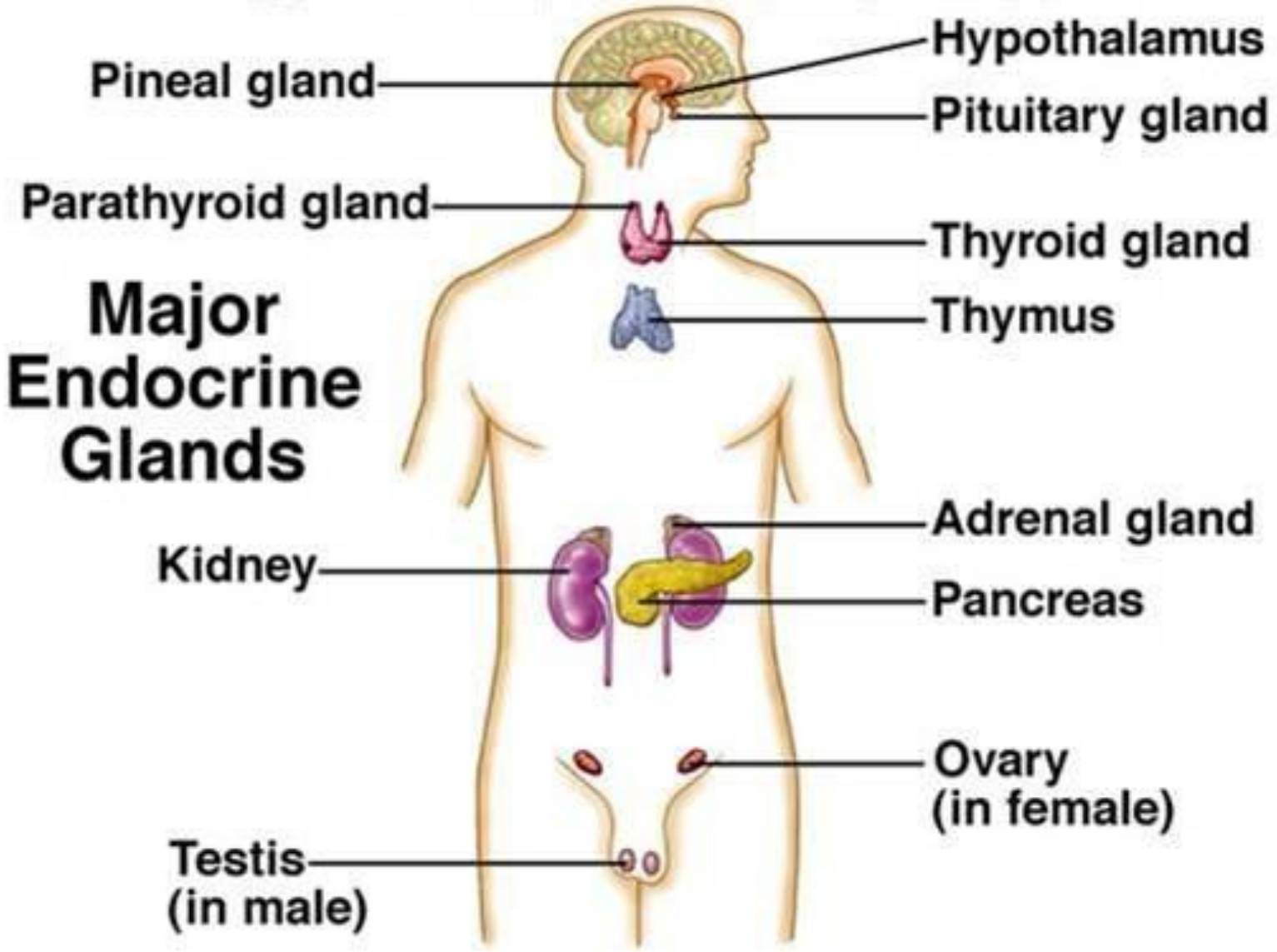
Endocrine System

- On reaching target cell hormone binds to *receptor* ⇨ chemical or metabolic reactions inside cell
- Water-soluble hormones (Noradrenaline, Insulin, Glucagon) - cell membrane
- Lipid-soluble hormones (Glucocorticoids, Mineralocorticoids, Thyroid hormones) - inside cell

Organs of Endocrine System

- Endocrine glands are:
  - ✓1 Pituitary gland (controlled by Hypothalamus)
  - ✓1 Pineal gland
  - ✓1 Thyroid gland
  - ✓4 Parathyroid glands
  - ✓1 Thymus gland
  - ✓2 Adrenal glands
  - ✓Pancreatic islets
  - ✓ 2 Ovaries (female)/ 2 Testes (male)
  - ✓Placenta

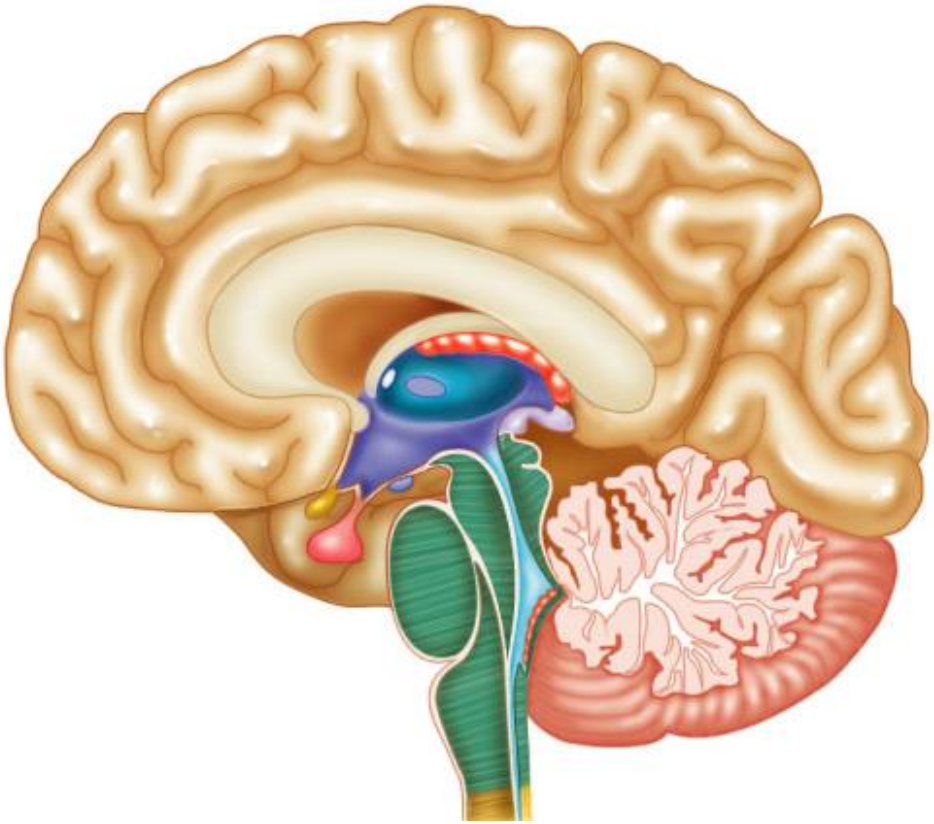
Organs of Endocrine System



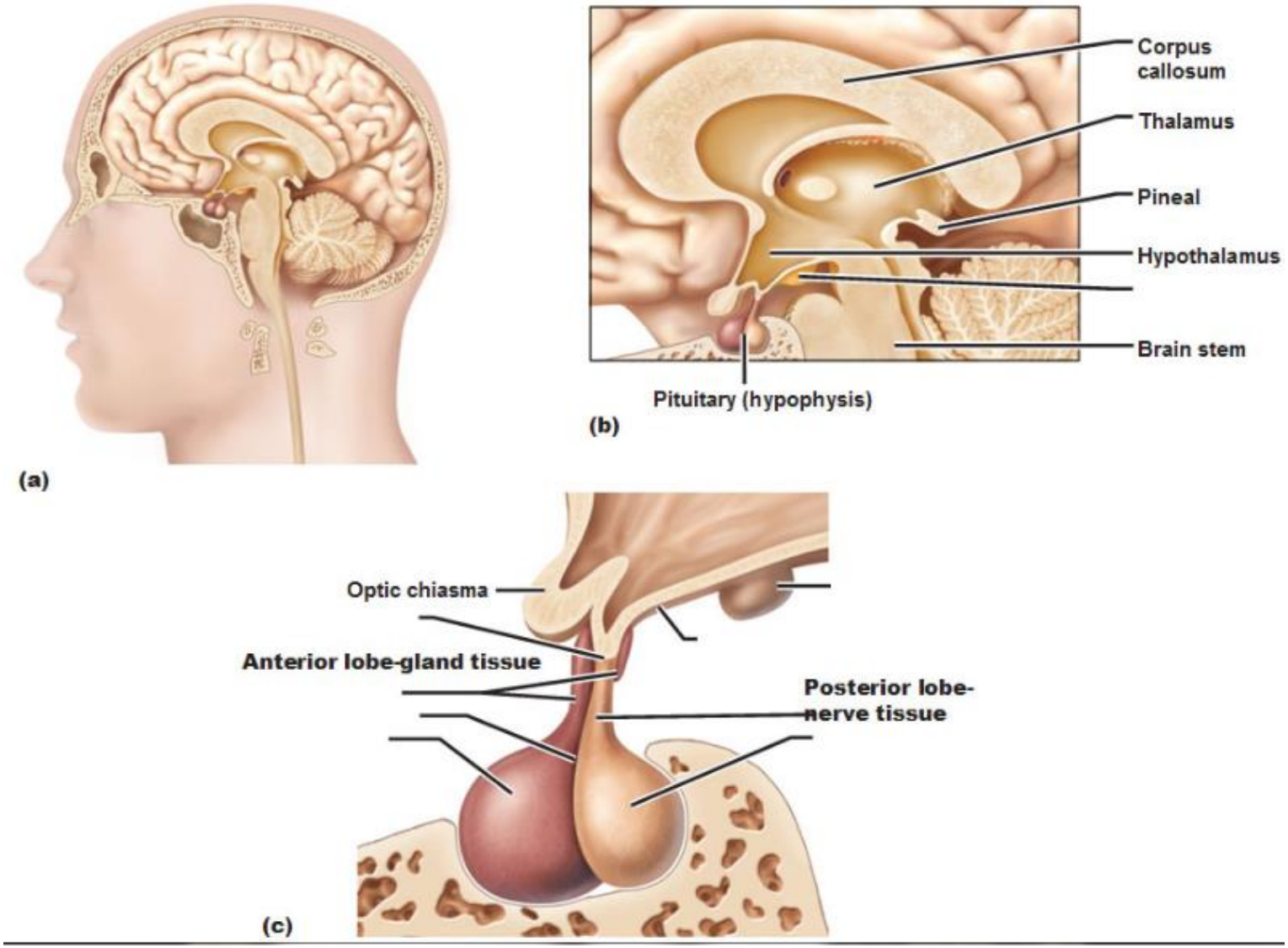
Hypothalamus and Pituitary Gland

- Act as a unit, regulating activity of other endocrine glands
- Hypothalamus lies just below and in front of thalamus, just above the brain stem and pituitary gland; size of an almond
- Hypophyseal fossa in sella tursica of sphenoid bone, immediately below the hypothalamus (attached by infundibulum); size of a pea; 4 g

Hypothalamus and Pituitary Gland



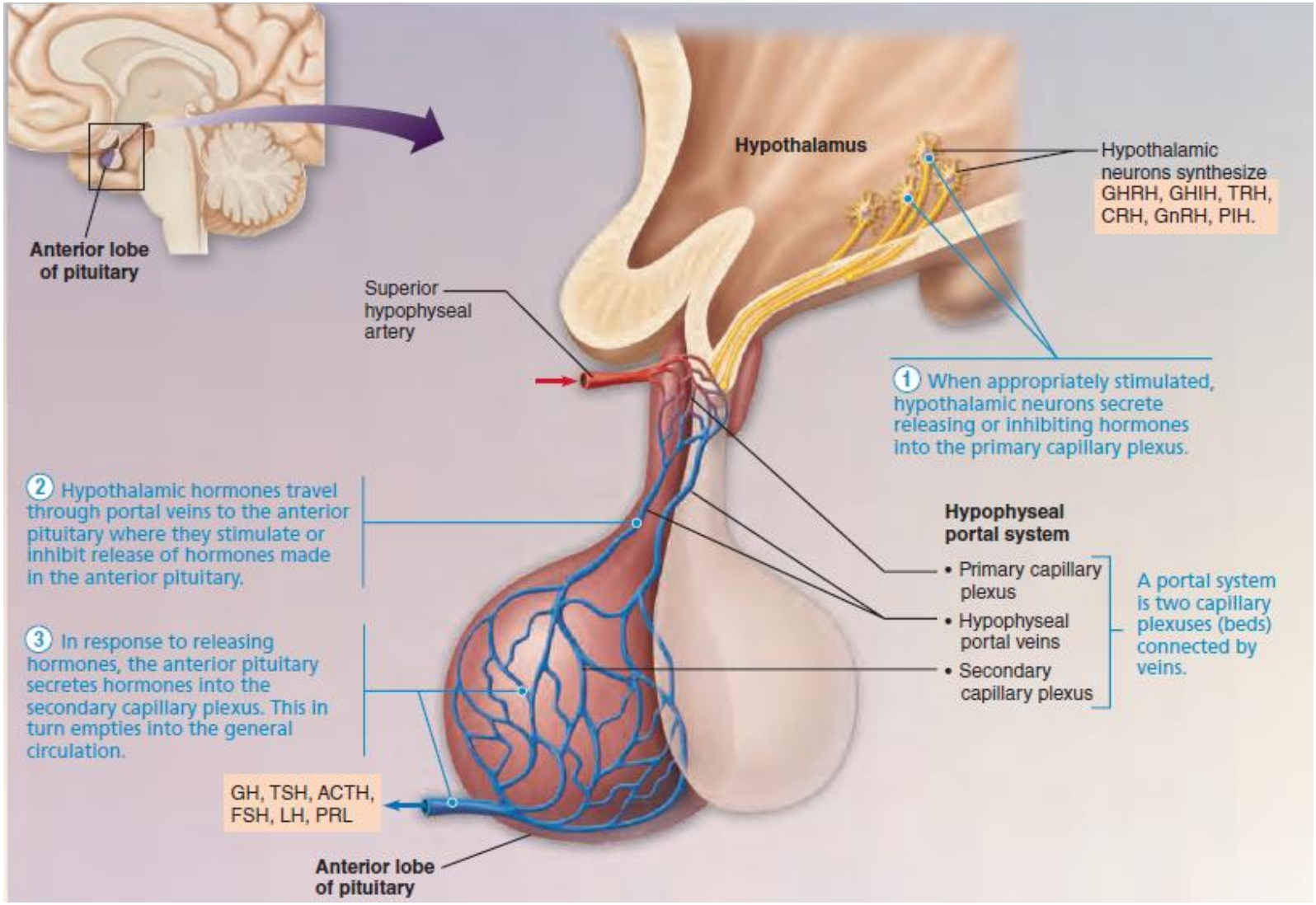
Hypothalamus and Pituitary Gland



Hypothalamus

- Part of the brain
- Controls output of hormones from anterior and posterior lobes of pituitary gland
- Maintains the body's homeostasis
- Hypothalamus –portal system of blood vessels- anterior lobe
- Hypothalamus –nerve fibers – posterior lobe

Hypothalamus and Anterior Pit



Hypothalamic Hormones

- Primary hormones are:
  - ✓**Thyrotropin releasing hormone (TRH)**
  - ✓**Corticotropin-releasing hormone (CRH)**
  - ✓**Gonadotropin-releasing hormone (GnRH)**
  - ✓**Growth hormone-releasing hormone (GHRH)** and **Growth hormone-inhibiting hormone (GHIH)** (also known as somatostain)
  - ✓**Prolactin-releasing hormone (PRH)** and **Prolactin-inhibiting hormone (PIH)**(also known as dopamine)

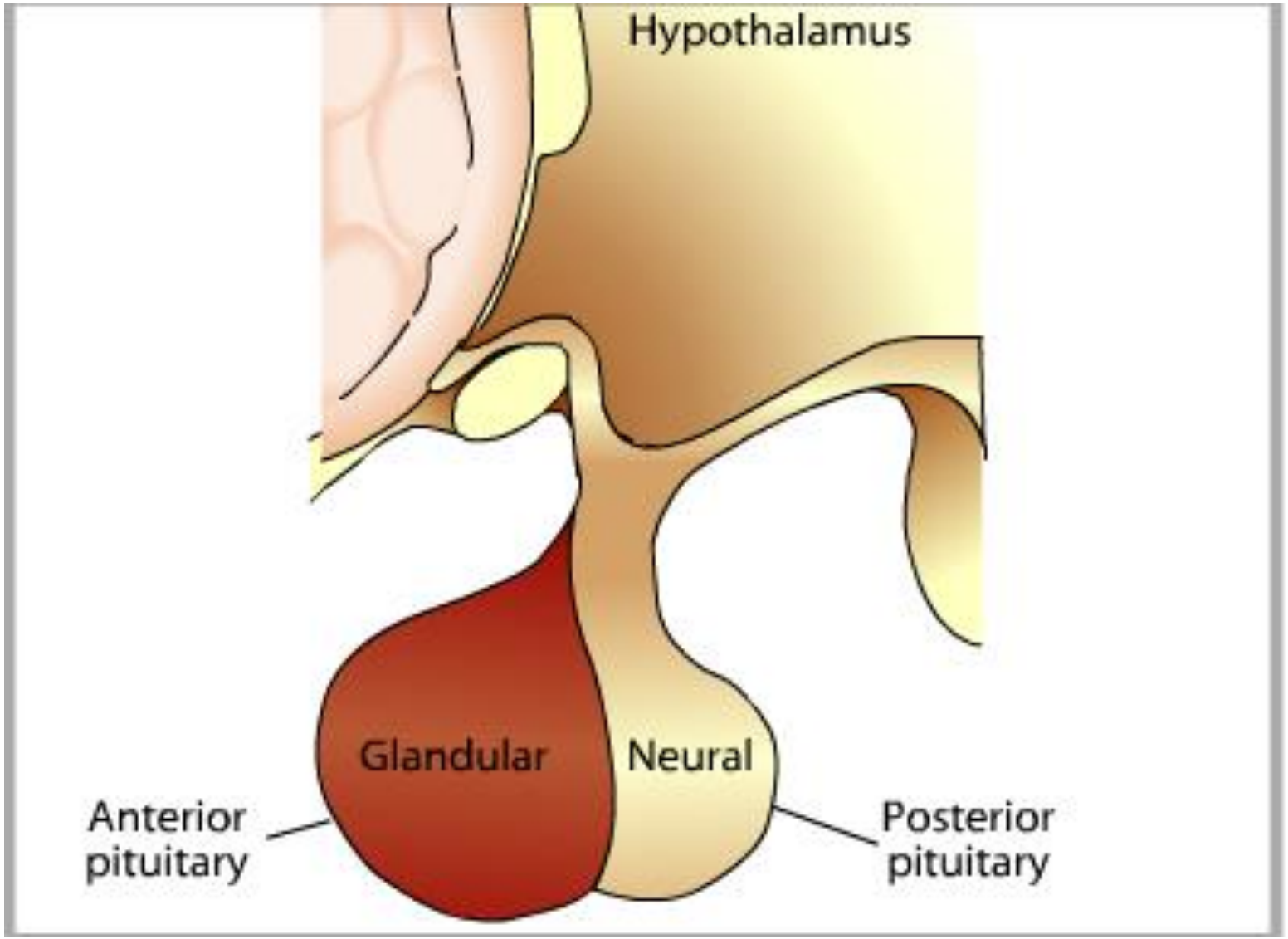
Releasing and Tropic hormones

Releasing Hormone	Tropic Hormone
Thyrotropin-releasing hormone (TRH)	Thyroid-stimulating hormone (TSH)
Gonadotropin-releasing hormone (GnRH)	Follicle-stimulating hormone (FSH) and Luteinizing hormone (LH)
Prolactin release-inhibiting hormone Prolactin-releasing hormone	Prolactin
Somatostatin (inhibits) Growth hormone-releasing hormone (stimulates)	Growth hormone (GH)
Adrenocorticotropin-releasing hormone	Adrenocorticotropic hormone (ACTH)
Melanocyte-stimulating hormone release-inhibiting hormone	Melanocyte-stimulating hormone (MSH)

Pituitary Gland

- Consists of three regions that originate from different types of cells:
  i. Anterior pituitary gland (adenohypophysis)
  ii. Posterior pituitary gland (neurohypophysis)
  iii. Intermediate lobe
- 'Master gland'

Pituitary Gland



Pituitary Gland-Blood supply

- Anterior lobe is by portal system of blood vessel
- Posterior lobe is by branch of internal carotid artery

Pituitary Gland Hormones

- Anterior lobe releases hormones after receiving releasing or inhibiting hormones from the hypothalamus
- **Anterior Lobe Hormones:**
  - ✓ **Adrenocorticotropic hormone (ACTH)**
  - ✓ **Follicle-stimulating hormone (FSH)**
  - ✓ **Luteinizing hormone (LH)**
  - ✓ **Growth hormone (GH)**
  - ✓ **Prolactin**
  - ✓ **Thyroid-stimulating hormone (TSH)**
  - ✓ **Melanocyte-stimulating hormone (MSH)**

Ant Pit Hormones-Functions

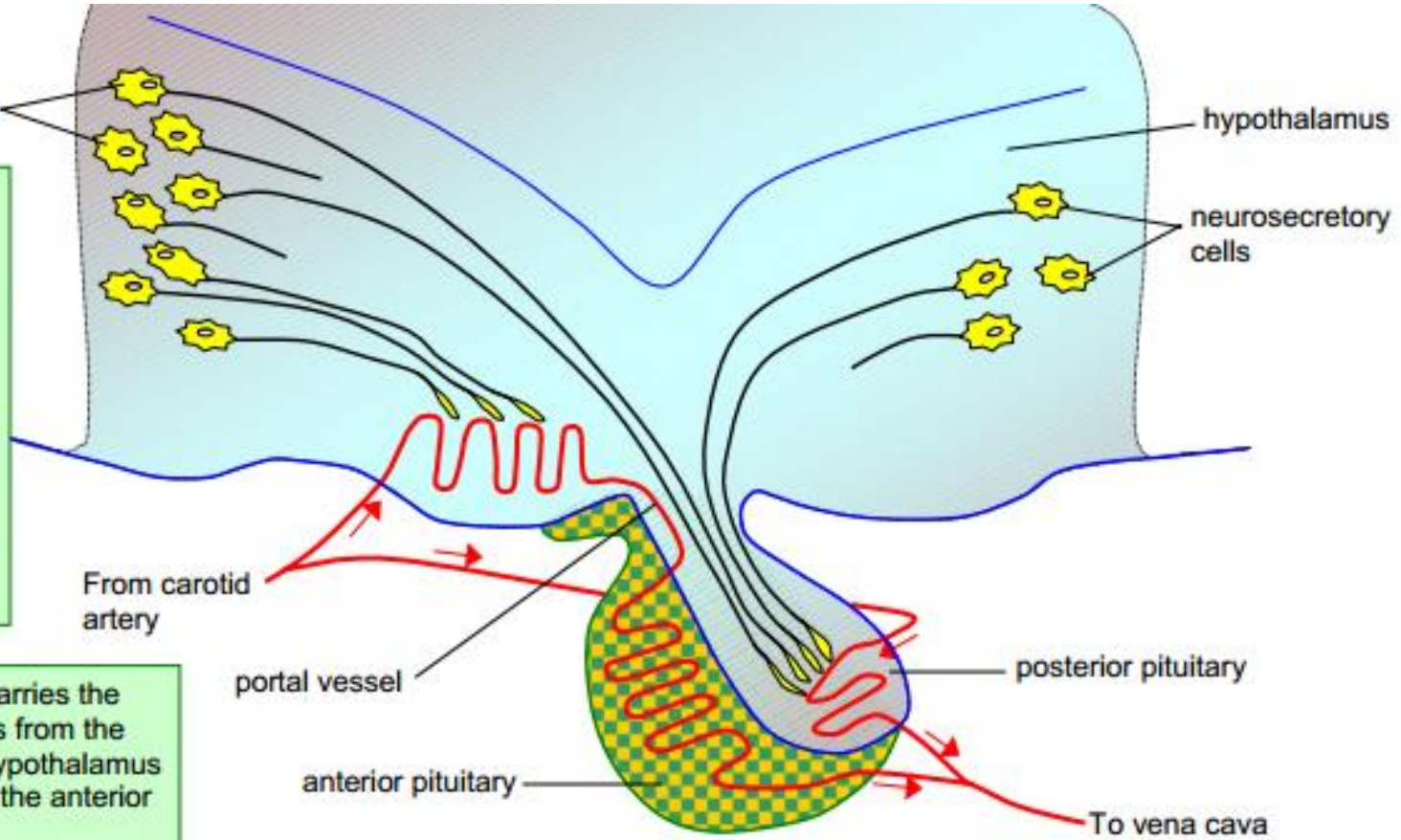
Table 9.2 Summary of the hormones secreted by the anterior pituitary gland and their functions

Hormone	Function
Growth hormone (GH)	Regulates metabolism, promotes tissue growth especially of bones and muscles
Thyroid stimulating hormone (TSH)	Stimulates growth and activity of thyroid gland and secretion of T_3 and T_4
Adrenocorticotrophic hormone (ACTH)	Stimulates the adrenal cortex to secrete glucocorticoids
Prolactin (PRL)	Stimulates milk production in the breasts
Follicle stimulating hormone (FSH)	Stimulates production of sperm in the testes, stimulates secretion of oestrogen by the ovaries, maturation of ovarian follicles, ovulation
Luteinising hormone (LH)	Stimulates secretion of testosterone by the testes, stimulates secretion of progesterone by the corpus luteum

Pituitary Gland Hormones

- Posterior lobe contains ends of nerve cells coming from hypothalamus
- **Posterior Lobe Hormones:**
  - ✓**Anti-diuretic hormone (ADH) or Vasopressin**
  - ✓**Oxytocin**

Pituitary Gland Hormones



Neurosecretory cells are modified nerve cells that secrete chemicals that act as hormones. They travel down the axon and are stored at the ends. Their release is controlled by nerve impulses.

The portal vessel carries the releasing hormones from the capillaries in the hypothalamus to the capillaries in the anterior pituitary.

Clinical Correlates

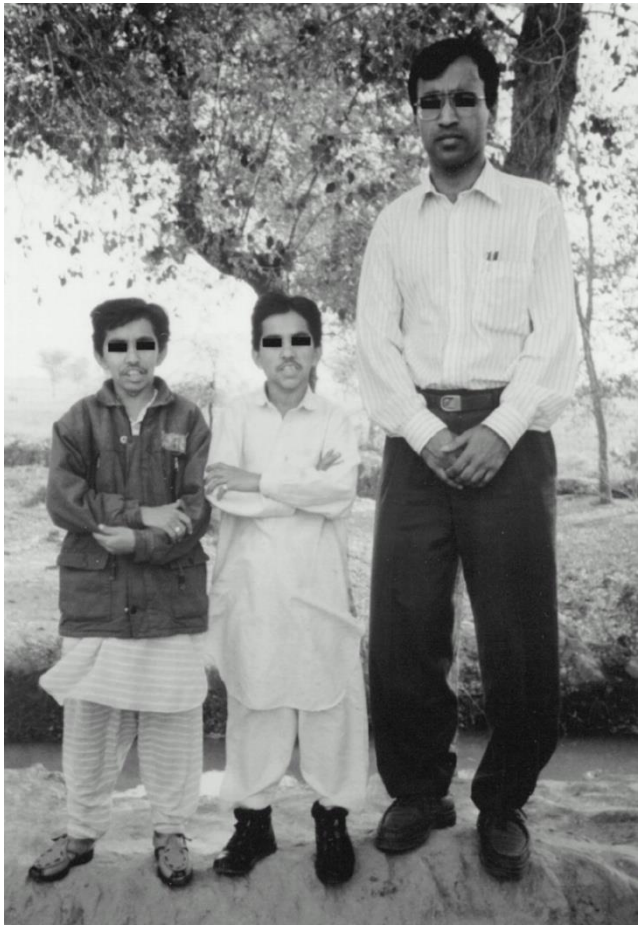
- Disorders of Anterior Pituitary lobe
  - ✓ Gigantism and Acromegaly
  - ✓ Pituitary dwarfism
  - ✓ Hyperprolactinemia (d/t Prolactinoma – most common pituitary tumour)
  - ✓ Ischemic necrosis (Sheehan's syndrome – hypotension following antepartum or postpartum hemorrhage)
- Disorders of Posterior Pituitary lobe
  - ✓ Diabetes insipidus (hyposecretion of ADH)

Clinical Correlates

- Gigantism

- Acromegaly

Clinical Correlates



Endocrine System II

Dr. Aman Shakya

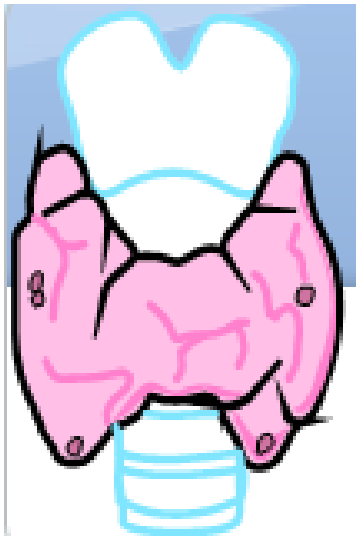
2080.11.10

Objectives

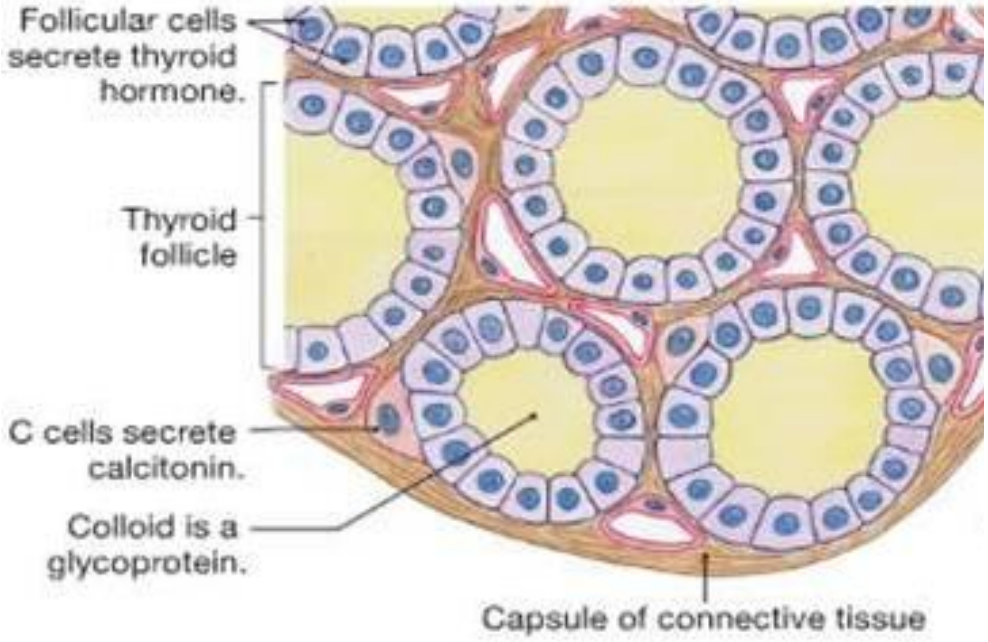
- To describe structure of Thyroid Gland
- To describe structure of Parathyroid Gland
- To describe structure of Pancreatic Islets of Langerhans
- To describe structure of Adrenal Glands
- To describe structure of Ovaries
- To describe structure of Testes

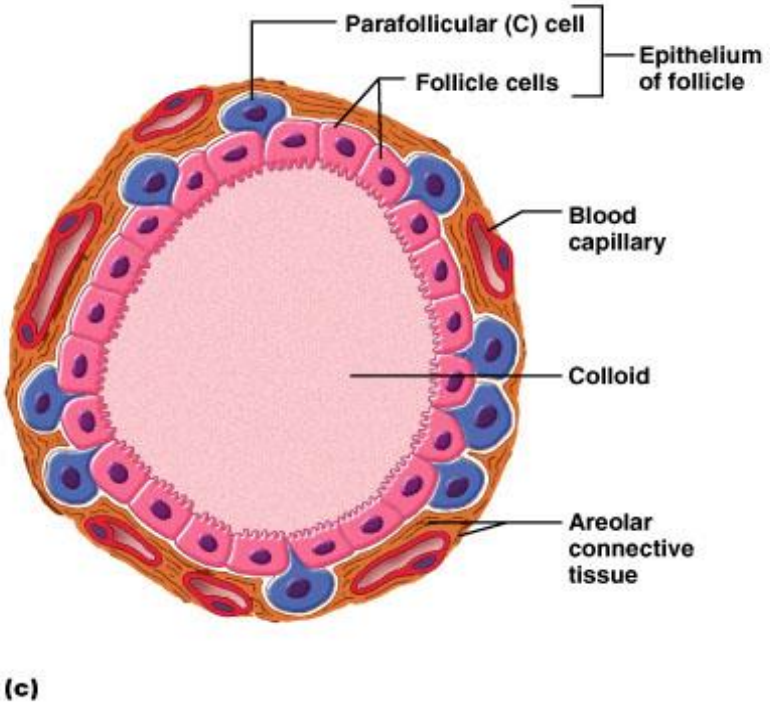
THYROID GLAND

- Anterior neck; Inferior to thyroid cartilage
- C5-T1
- Highly vascular gland
  surrounded by fibrous capsule
- 2 lobes joined by a narrow isthmus
- Composed of cuboidal epithelium
  which form follicles containing colloid



Thyroid Gland





Thyroid Gland-Hormones

- Hormones:
  - Thyroxine (T4) and Triiodothyronine (T3)
  - Calcitonin
- Follicular cells; T3 and T4 combine with colloid and are stored as thyroglobulin
- C-cells; Calcitonin has opposite action to PTH

Thyroid Gland-Hormones

- T3(active form; 4X) and T4 are essential for physical growth and mental development
- Also regulate :

  -BMR (basal metabolic rate)

  -Carbohydrate, protein and lipid metabolism

  -Normal functioning of CVS and CNS

  -Peristalsis

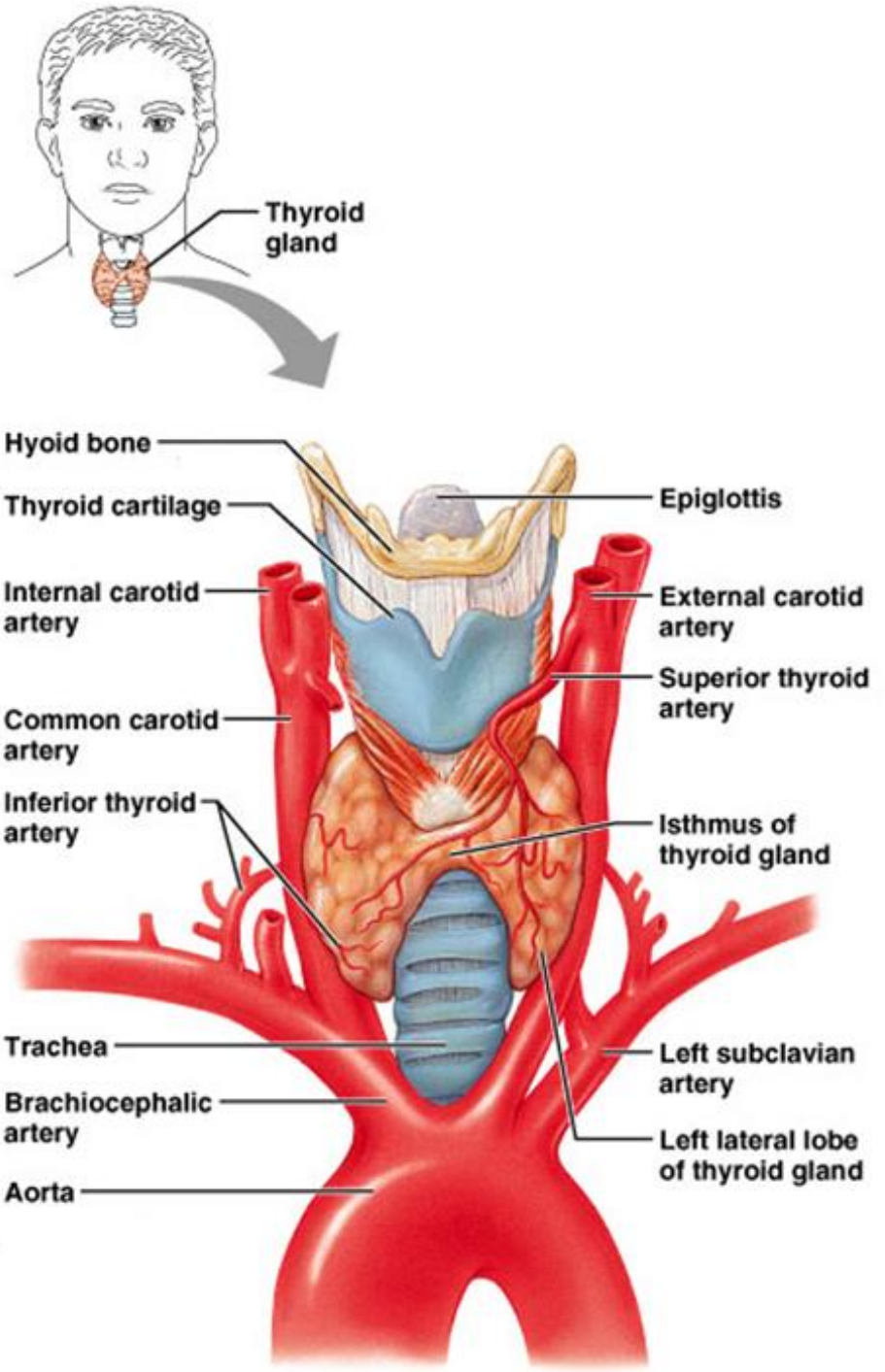
  -Female reproductive cycle and lactation

Thyroid Gland-Hormones

- Calcitonin acts on bone and kidneys to reduce blood calcium level
- Calcitonin release is stimulated by an increase in ionized calcium in blood

Thyroid Gland

- **Arterial supply:**
  - Superior thyroid artery (External carotid artery)
  - Inferior thyroid artery (Subclavian artery)
- **Venous drainage:**
  - Thyroid veins (Internal jugular vein)



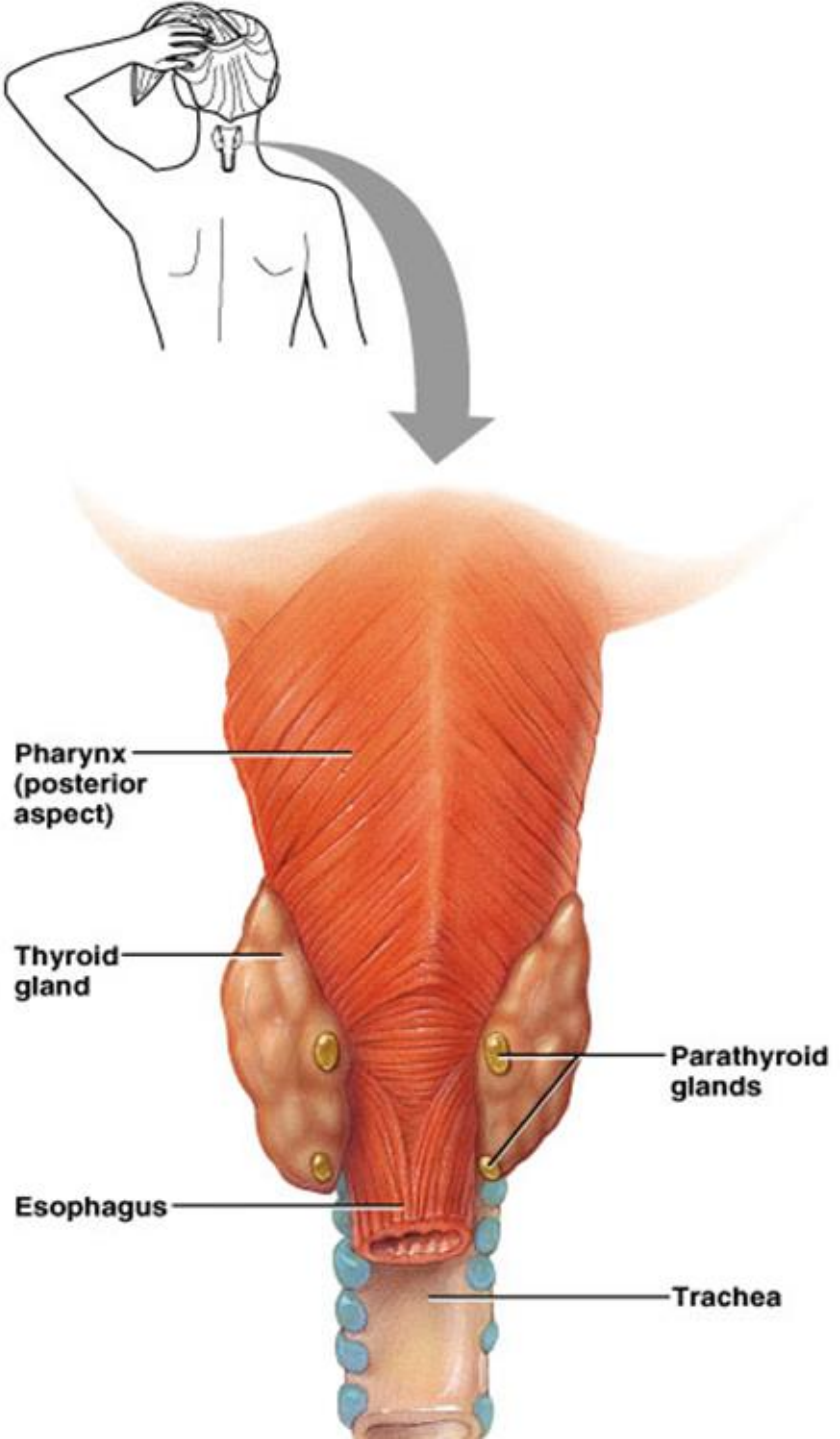
Clinical Correlates

- Increased levels of T3 and T4 decrease TSH secretion and vice versa
- When the supply of iodine is deficient, excess TSH is secreted and there is proliferation of thyroid gland cells and enlargement of the gland **(Goitre)**

Clinical Correlates

PARATHYROID GLANDS

- 4; Posterior surface of thyroid gland
- Surrounded by a fine connective tissue capsule
- Parathormone (PTH) maintains homeostasis of ionized calcium level in the blood
- When blood level of ionized calcium falls, secretion of PTH increases



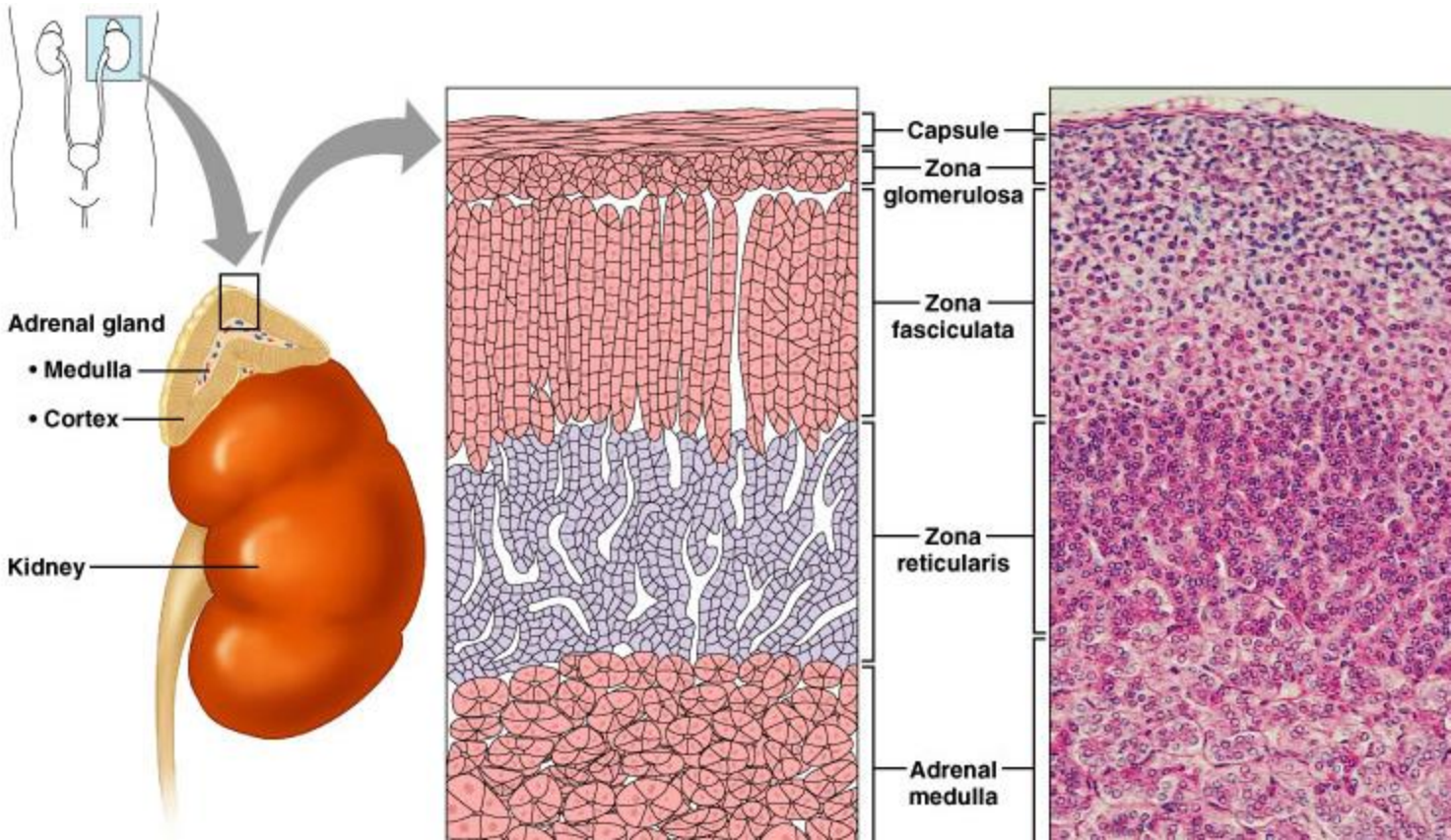
ADRENAL GLANDS

- 2; Upper pole of each kidney
- Within the renal fascia
- 4cm

  X 3cm

X 1cm

- 5gm



Adrenal Gland

- Two endocrine glands in one
  - **Adrenal cortex** – outer; bulk of the adrenal gland; most of the steroid hormones
  - **Adrenal medulla** – inner; a knot of nervous tissue within the gland; catecholamines (epinephrine, NE)

Adrenal Cortex

- 3 groups of hormones from cholesterol; collectively k/a adrenocorticoids (corticosteroids, corticoids):
  - Mineralocorticoids (Aldosterone)
  - Glucocorticoids (Cortisol/Hydrocortisone and corticosterone)
  - Androgens (Sex hormones)

- ***Aldosterone*** is the main mineralocorticoid
- increases reabsorption of Na and water and excretion of (K^+) by kidney.
- Its functions are associated with the maintenance of water and electrolyte balance in the body. It stimulates the reabsorption of sodium (Na+) by the renal tubules and excretion of potassium (K+) in the urine.
- Sodium reabsorption is also accompanied by retention of water and therefore aldosterone is involved in the regulation of blood volume and blood pressure Renin-Angiotensin-Aldosterone System (RAAS)

- **Sex hormones**
- Sex hormones secreted by the adrenal cortex are mainly *androgens* (male sex hormones) and the amounts produced are insignificant compared with those secreted by the testes and ovaries in late puberty and adulthood. (Important in post menopause)
- It is thought that they contribute to the onset of puberty. An elevated level in female causes masculinisation

Glucocorticoids

- *Cortisol* (hydrocortisone), *corticosterone* and *cortisone* are the main glucocorticoids. They are essential for life, regulating metabolism and responses to stress
- Secretion is stimulated by ACTH from the anterior pituitary and by
- stress

<u>Role of glucocorticoids</u>

- *gluconeogenesis*
- *lipolysis* (breakdown of triglycerides into fatty acids and glycerol for energy production)
- breakdown of protein, releasing amino acids,
- promoting absorption of sodium and water from renal tubules (a weak mineralocorticoid effect).

Glucocorticoids also:

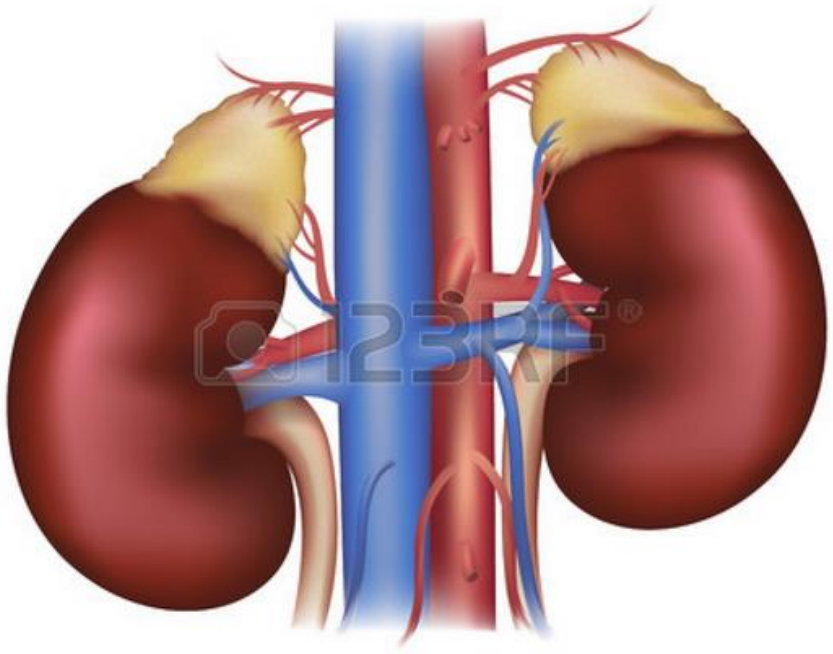
- have an anti-inflammatory action
- suppress the immune response
- suppress the response of tissues to injury
- delay wound healing

Adrenal Medulla

- Closely allied to sympathetic nervous system
- Adrenaline and Noradrenaline (1:4)
- In response to sympathetic nervous system and stress
- NA maintain BP by general vasoconstriction **except** coronary arteries
- A: 'fight, flight, or fright'
- Together these hormones potentiate the fight or flight response after initial sympathetic stimulation by:
  - increasing heart rate
  - increasing blood pressure
  - diverting blood to essential organs including the heart, brain and skeletal muscles by dilating their blood vessels and constricting those of less essential organs, such as the skin
  - increasing metabolic rate
  - dilating the pupils.

Adrenal Gland

- **Arterial supply**:
  - Branches from abdominal aorta and renal arteries
- **Venous drainage**:
  - Suprarenal veins

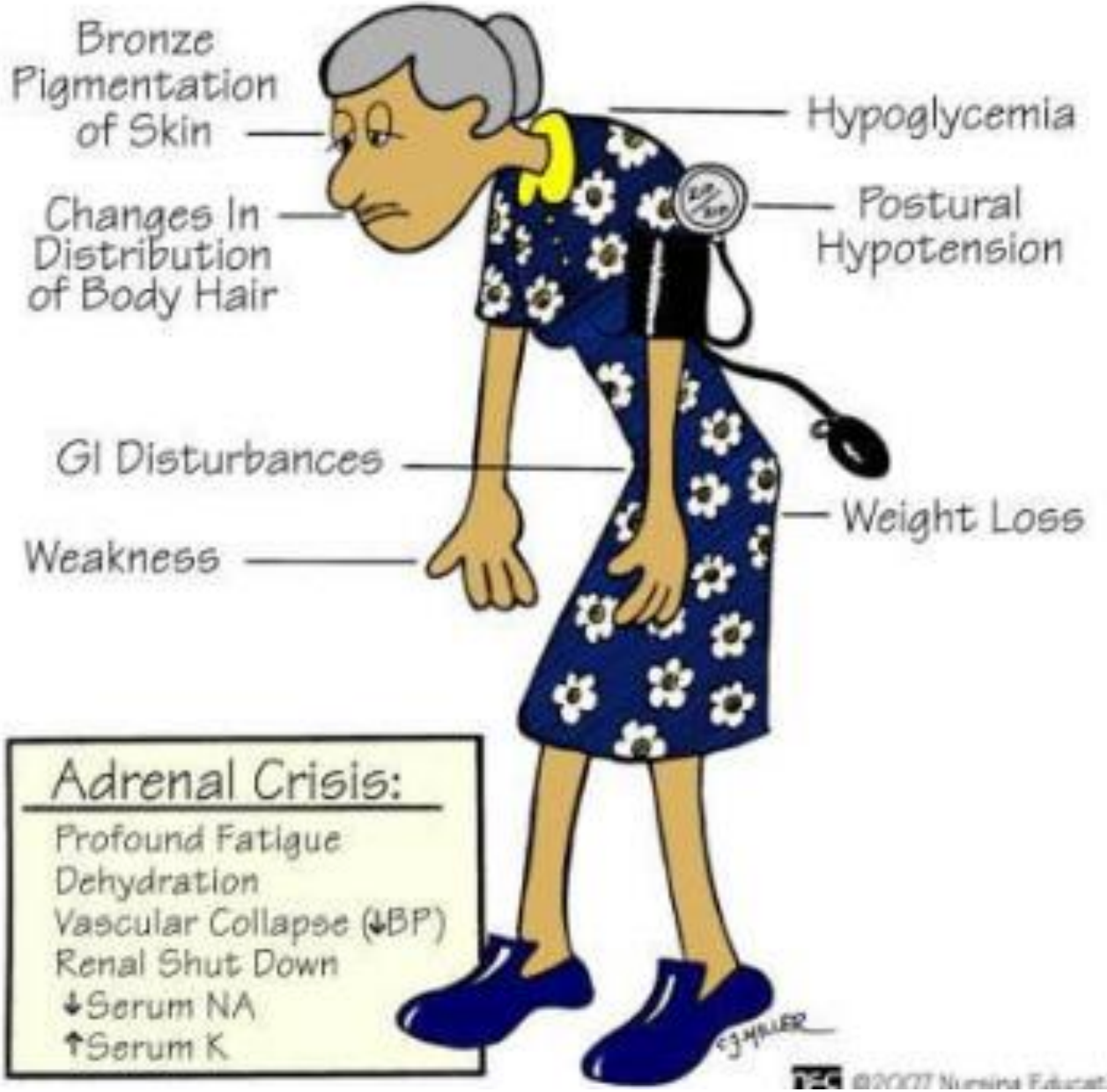


Adrenal Gland-Disorders

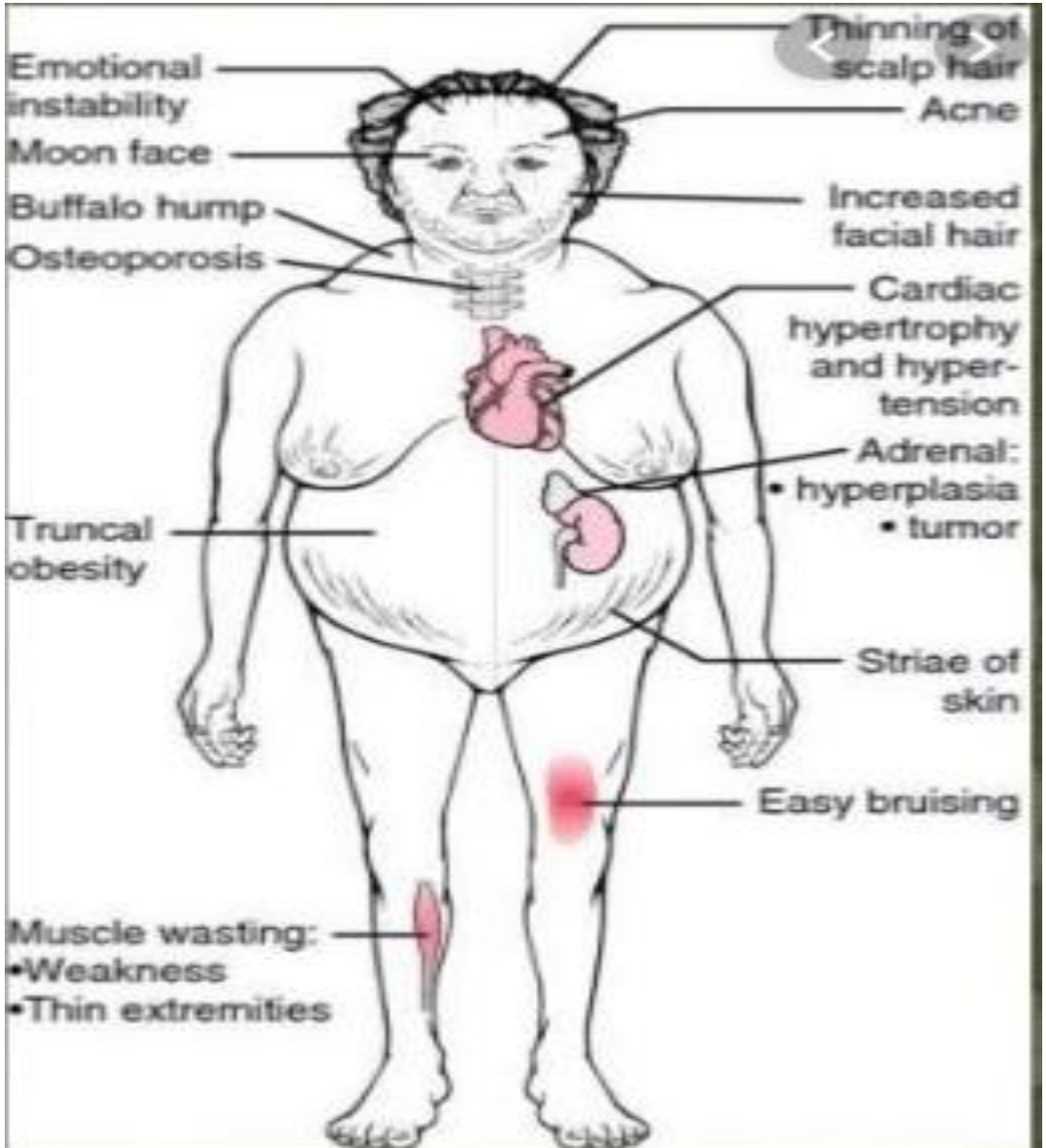
- Cushing's syndrome (Glucocorticoid excess)
- Addison's disease (Glucocorticoid deficiency)
- Conn's syndrome (Mineralocorticoid excess)
- Pheochromocytoma (Tumor of adrenal medulla)

Cushing syndrome

ADDISON'S DISEASE



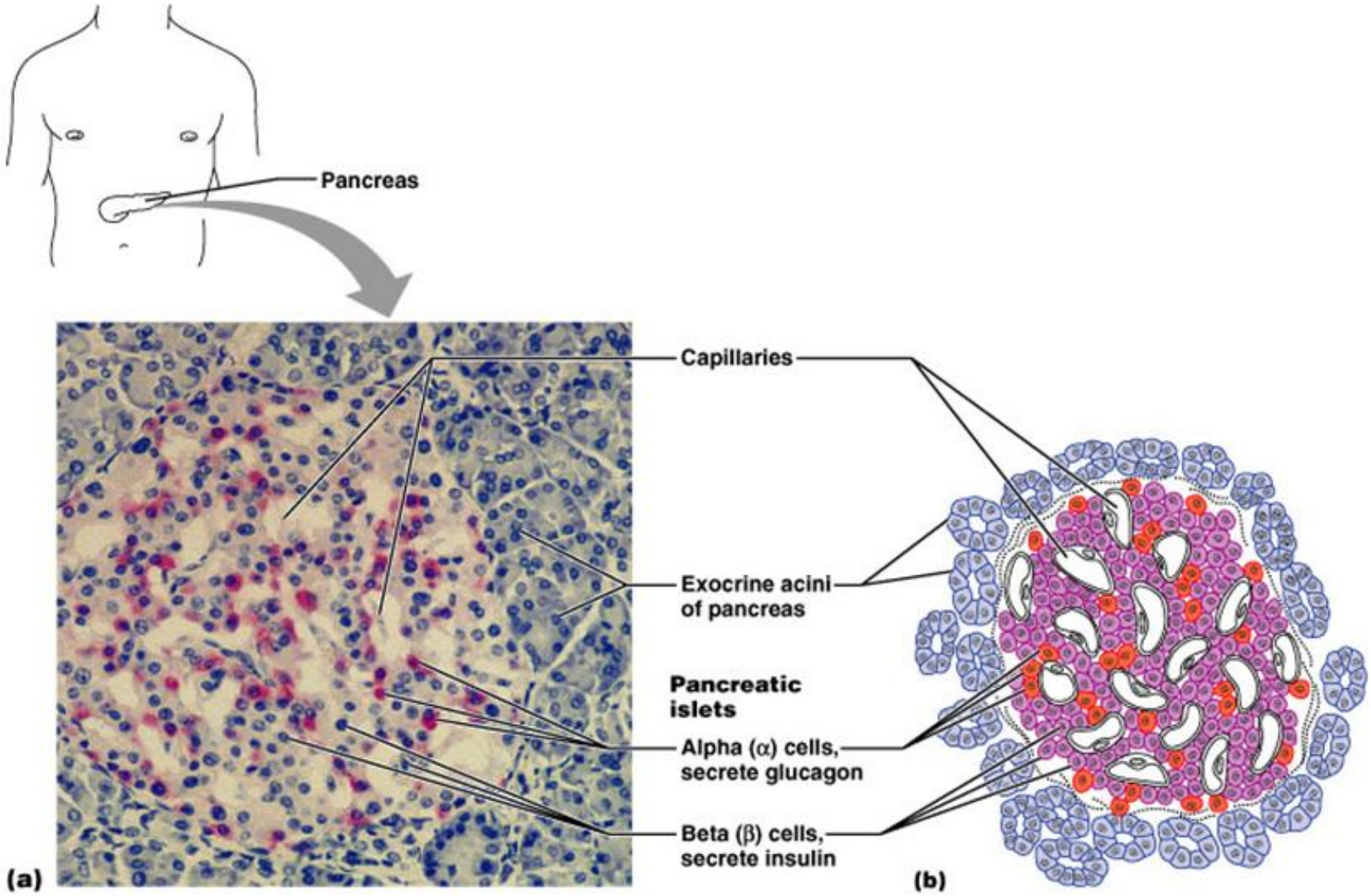
Conn's syndrome



PANCREAS

- Irregularly distributed pancreatic islets of Langerhans
- 3 main types of cells:
  - Alpha cells (Glucagon)
  - Beta cells (Insulin)
  - Delta cells (Somatostatin)

Pancreas


Pancreas
Capillaries
Exocrine acini of pancreas
Pancreatic islets
Alpha (α) cells, secrete glucagon
Beta (β) cells, secrete insulin
(a)
(b)

Pancreas

Insulin

- Lower blood levels of absorbed nutrients when they rise above normal

Pancreas

Glucagon

- Increase blood glucose levels by:
  - Conversion of glycogen to glucose in liver and skeletal muscles (glycogenolysis)
  - Gluconeogenesis

Somatostatin (GHIH)

- Inhibit the secretion of both insulin and glucagon

Applied aspect

- Diabetes mellitus
- Head of pancreas common site for carcinoma
- cyst

PINEAL GLAND

- Small body attached to roof of 3rd ventricle
- 10 mm long
- Capsulated
- Secretes melatonin
- Atrophy after puberty

Pineal gland

Melatonin

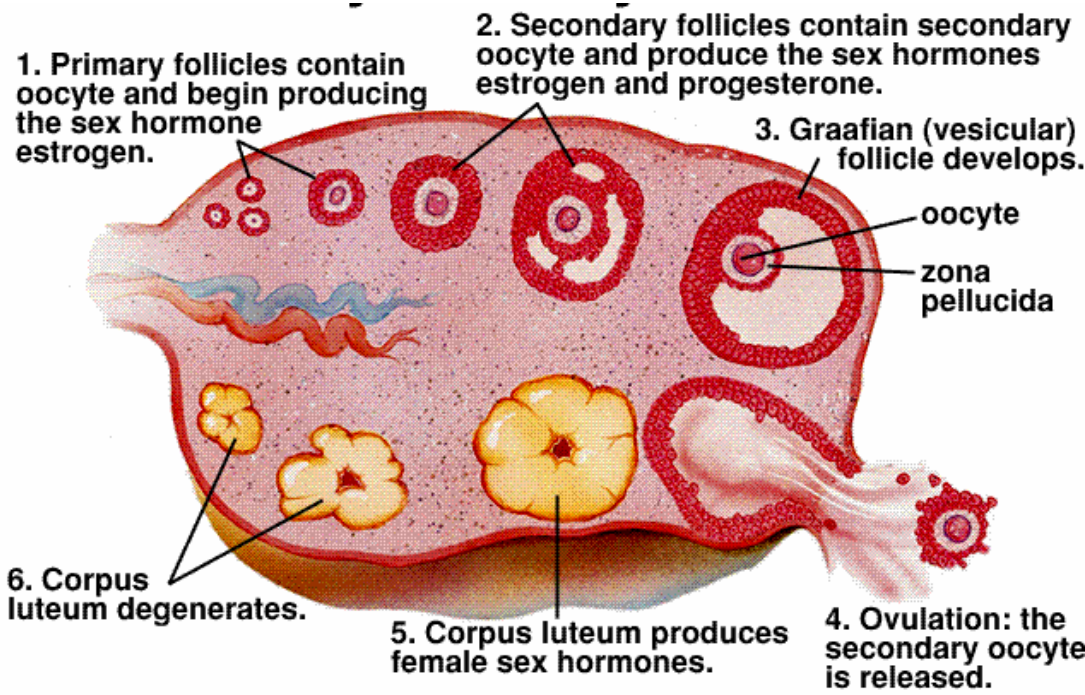
- Secretion is influenced by amount of light entering the eye
- Levels fluctuate during each 24-hour period
- **Functions:**
  - coordination of the circadian and diurnal rhythms of many tissues, possibly by influencing the hypothalamus
  - inhibition of growth and development of the sex organs before puberty, possibly by preventing synthesis or release of gonadotrophins

OVARY

- Female gonad
- Fossa on lateral walls of the pelvis
- 3cm X 2cm X 1cm
- Attached to uterus by ovarian ligament; to back of the broad ligament by mesovarium (blood vessels and nerves)

Ovary

- Two layers of tissue:
  - Central fibrous medulla
  - Outer cortex (Ovarian follicles)

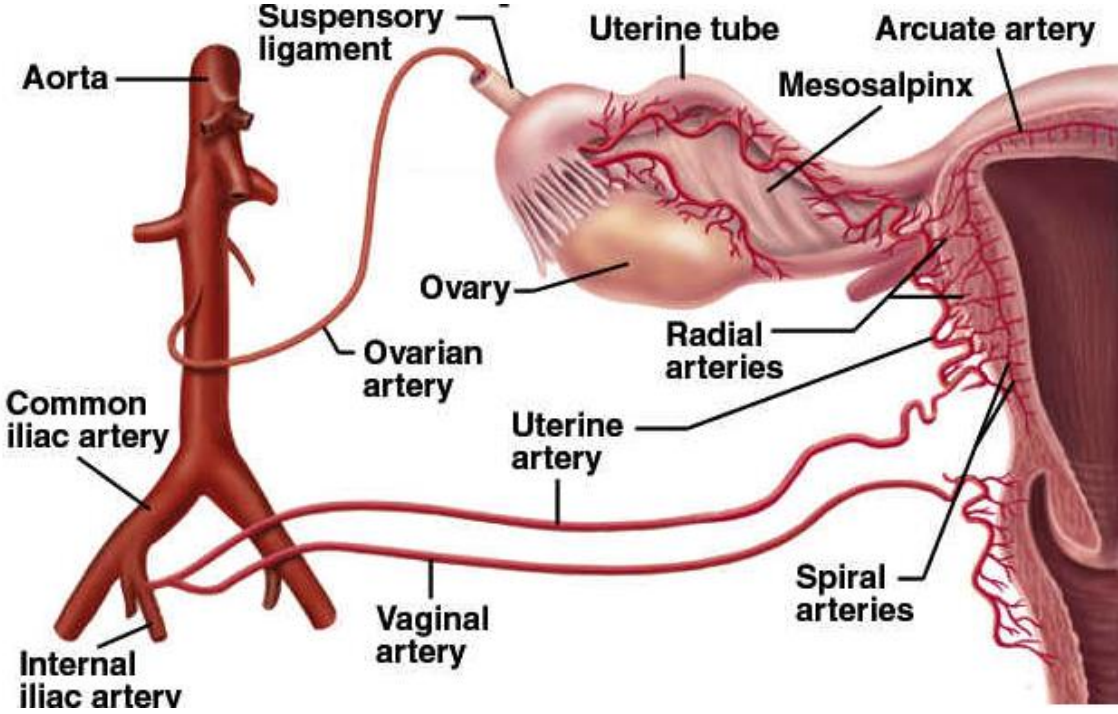


Ovary

- FSH - Maturation of follicle
- Follicle lining cells(granulosa cell): Estrogen
- LH - Corpus luteum
- Corpus luteum: Progesterone

Ovary

- Arterial supply:
  - ➢Ovarian arteries (Abdominal aorta)
- Venous drainage:
  - ➢Ovarian veins



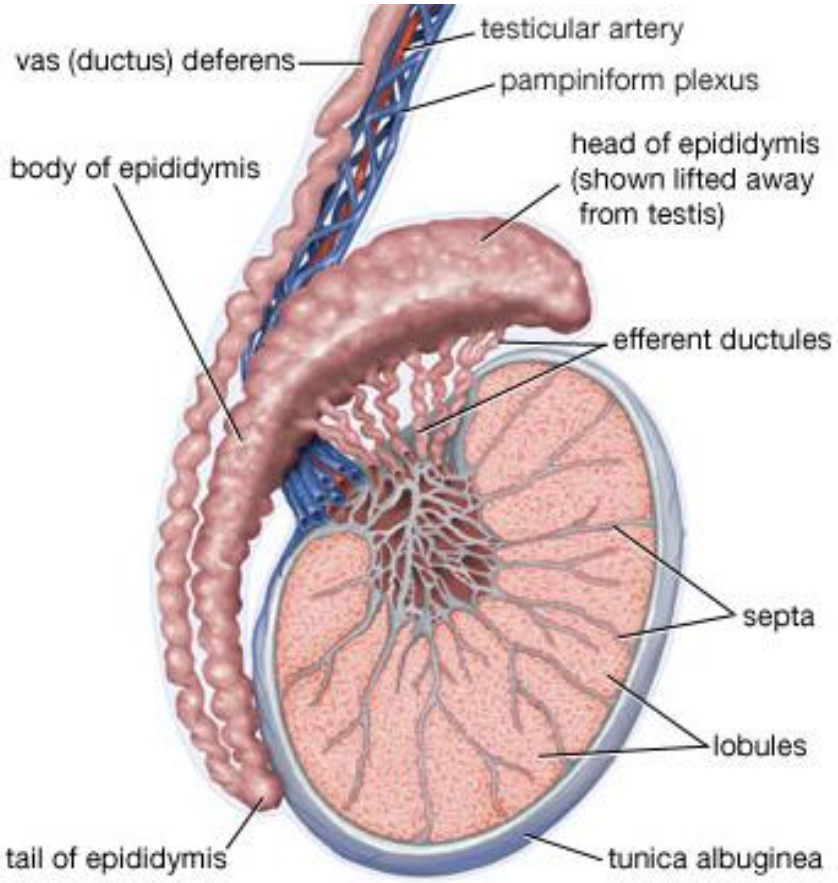
Ovary

- Lymph drainage:
  - Lateral aortic and pre-aortic
- Nerve supply:
  - Parasympathetic (sacral) and sympathetic (lumbar)

TESTES

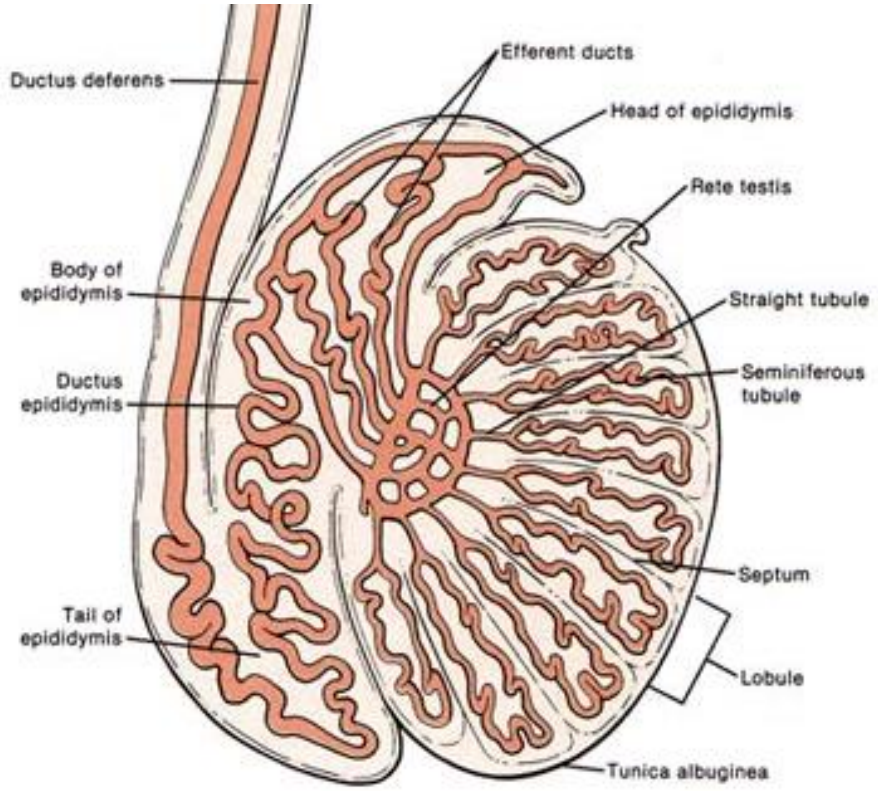
- Male gonads
- 4.5cm X 2.5cm X 3cm
- Suspended by spermatic cord
- 3 layers:
  - Tunica vaginalis
  - Tunica albuginea (Ingrowths-septa divide testes into lobules)
  - Tunica vasculosa

Testes


testicular artery
vas (ductus) deferens
pampiniform plexus
head of epididymis
(shown lifted away
from testis)
body of epididymis
efferent ductules
septa
lobules
tail of epididymis
tunica albuginea

Testes

- 200-300 lobules in each testis
- Each lobule 1-4 seminiferous tubules
- Between these are groups of Interstitial cells of Leydig



Testes

- FSH – Seminiferous tubules (Spermatozoa)
- LH – Interstitial cells (Testosterone)
- Testicular Artery
- Testicular Vein

Thank You