

Biology 224

Human Anatomy and Physiology II

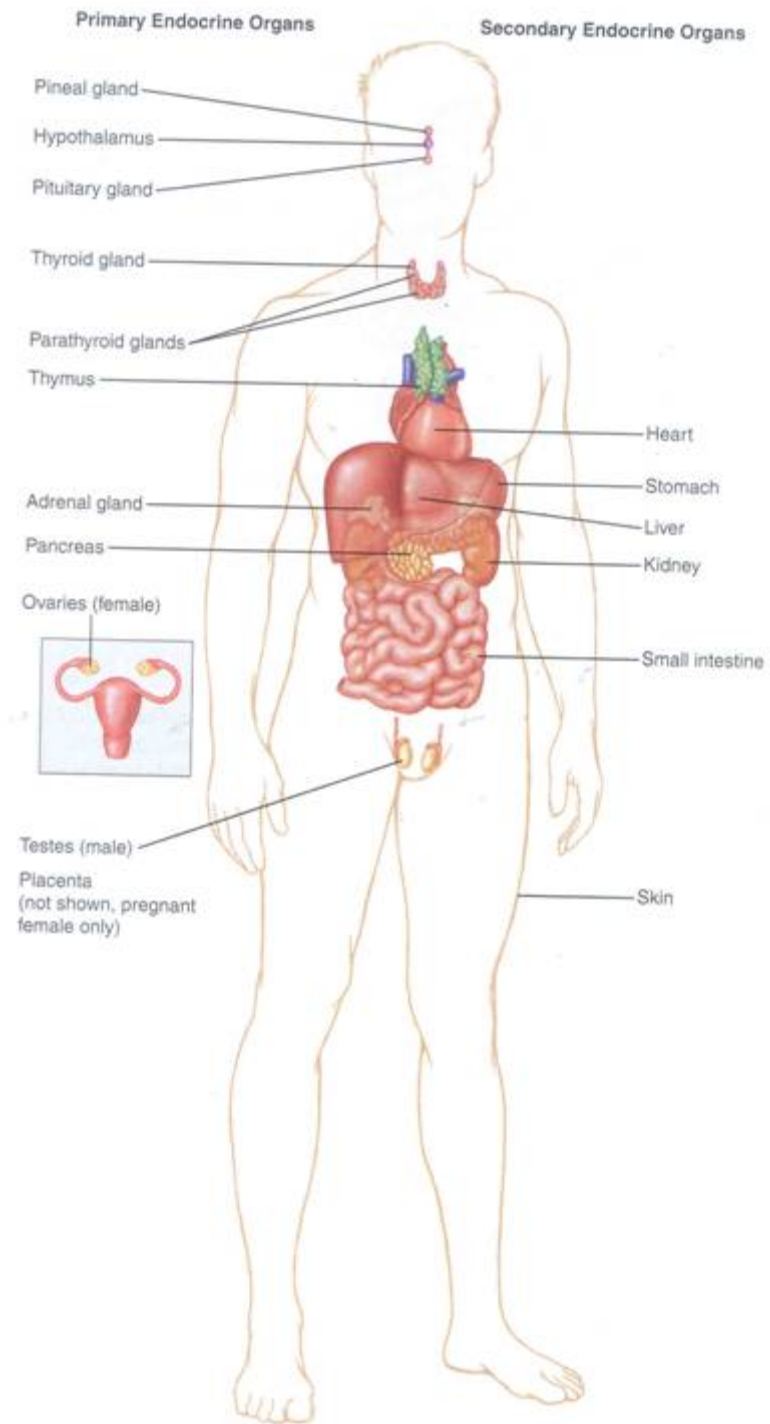
Week 8; Lecture 2; Wednesday

Stuart Sumida

Overview of the structures of the endocrine system

WHAT I EXPECT YOU TO KNOW ABOUT EVERY ENDOCRINE STRUCTURE

- What is it?
- What is its location (where is it)?
- What is its embryological derivation?
- What is its **innervation**?
- What is its **arterial supply**?
- What is its **venous drainage**? (This is particularly important, as hormones must be placed into the circulatory system.)
- What is its function? (In other words, what do its hormones do?)



NEUROENDOCRINE RELATIONS

We usually contrast nervous system structures with endocrine structures. But...

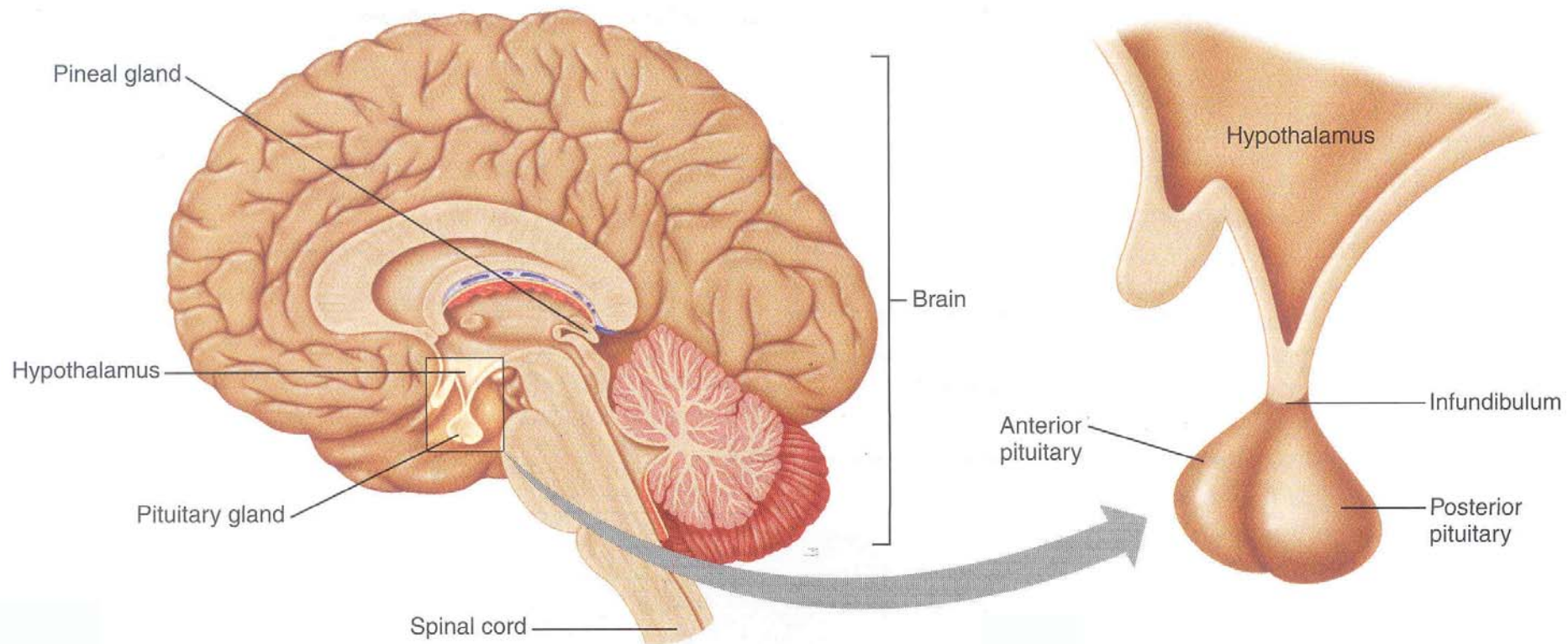
...certain nervous system cells act as endocrine cells and certain endocrine tissues are derived from neural ectoderm.

Nerve cells that produce hormones and secrete them into the bloodstream are called **NEUROSECRETORY CELLS**. In humans, neurosecretory cells are found in the **HYPOTHALAMUS**.

HYPOTHALAMUS & PITUITARY GLAND

Location: Small but complex appendage that sits at the base of the brain – in the sella turcica – most median depression in the medial cranial fossa of the sphenoid bone.

- Pituitary lies just inferior to hypothalamus.
- Hypothalamus an Pituitary connected by stalk containing nerve fibers and blood vessels.
- Pituitary composed of two lobes: ANTERIOR PITUITARY and POSTERIOR PITUITARY.



HYPOTHALAMUS & PITUITARY GLAND

Embryological Derivation:

- Hypothalamus is an outgrowth of brain, neural ectoderm.
- Posterior Pituitary is an outgrowth of hypothalamus, neural ectoderm.
- Anterior Pituitary develops as a superiorly directed outgrowth of roof of mouth, endoderm.

HYPOTHALAMUS & PITUITARY GLAND

Innervation: Part of brain or very close to it in case of pituitary. Some hypothalamic neurons secrete neurohormones – they pass down connecting stalk to terminate close to the capillaries serving posterior pituitary.

Arterial Supply: **circulosus artriosus cerebri**

Venous Drainage: **cavernous venous sinus**

HYPOTHALAMUS HORMONES (FUNCTION)

- Hypothalamic hormones enclosed in vesicles that move down axon and accumulate near terminal ends that are close to the posterior pituitary's capillaries.
- In response to an action potential– hormones are released from vesicles (much like a neurotransmitter), in this case into venous capillaries.

HYPOTHALAMUS HORMONES (FUNCTION)

Most hormonal interactions of the hypothalamus-pituitary complex follow a common pattern:

1. A hypothalamic hormone effects control over the secretion of an anterior pituitary hormone;
2. The corresponding anterior pituitary hormone controls secretion of the hormone of another endocrine gland; and
3. That secretion of that gland affects other target tissues/organs.

HYPOTHALAMUS HORMONES (FUNCTION)

So...

Hypothalamic hormones can have effect of stimulating or inhibiting the release of anterior pituitary hormones.

Called **RELEASING HORMONES** (“RH”) or **INHIBITING HORMONES** (“IH”) respectively.

HYPOTHALAMIC HORMONES (FUNCTIONS)

Includes two peptide hormones: **OXYTOCIN** and **VASOPRESSIN** (also called antidiuretic hormone, or **ADH**).

OXYTOCIN –

initiates labor

stimulates mammary glands to release milk

Stimulates uterine contractions in activities other than labor

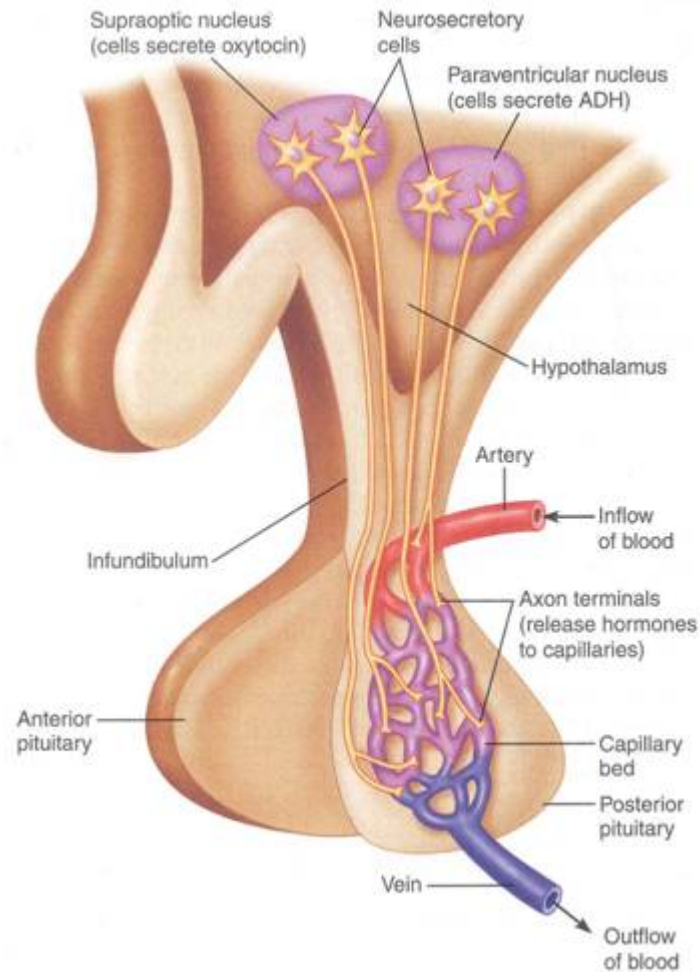
VASOPRESSIN (ADH) – decreases urine output.

RELEASING HORMONES – stimulate release of anterior pituitary hormones.

INHIBITING HORMONES – inhibit release of anterior pituitary hormones.

POSTERIOR PITUITARY GLAND HORMONES

Oxytocin and **Vasopressin** are manufactured in the hypothalamus, but released in the posterior pituitary.



ANTERIOR PITUITARY GLAND HORMONES

GROWTH HORMONE (GH) – regulates growth; affects protein, fat and carbohydrate metabolism.

THYROID STIMULATING HORMONE (TSH) – controls secretion of thyroxin.

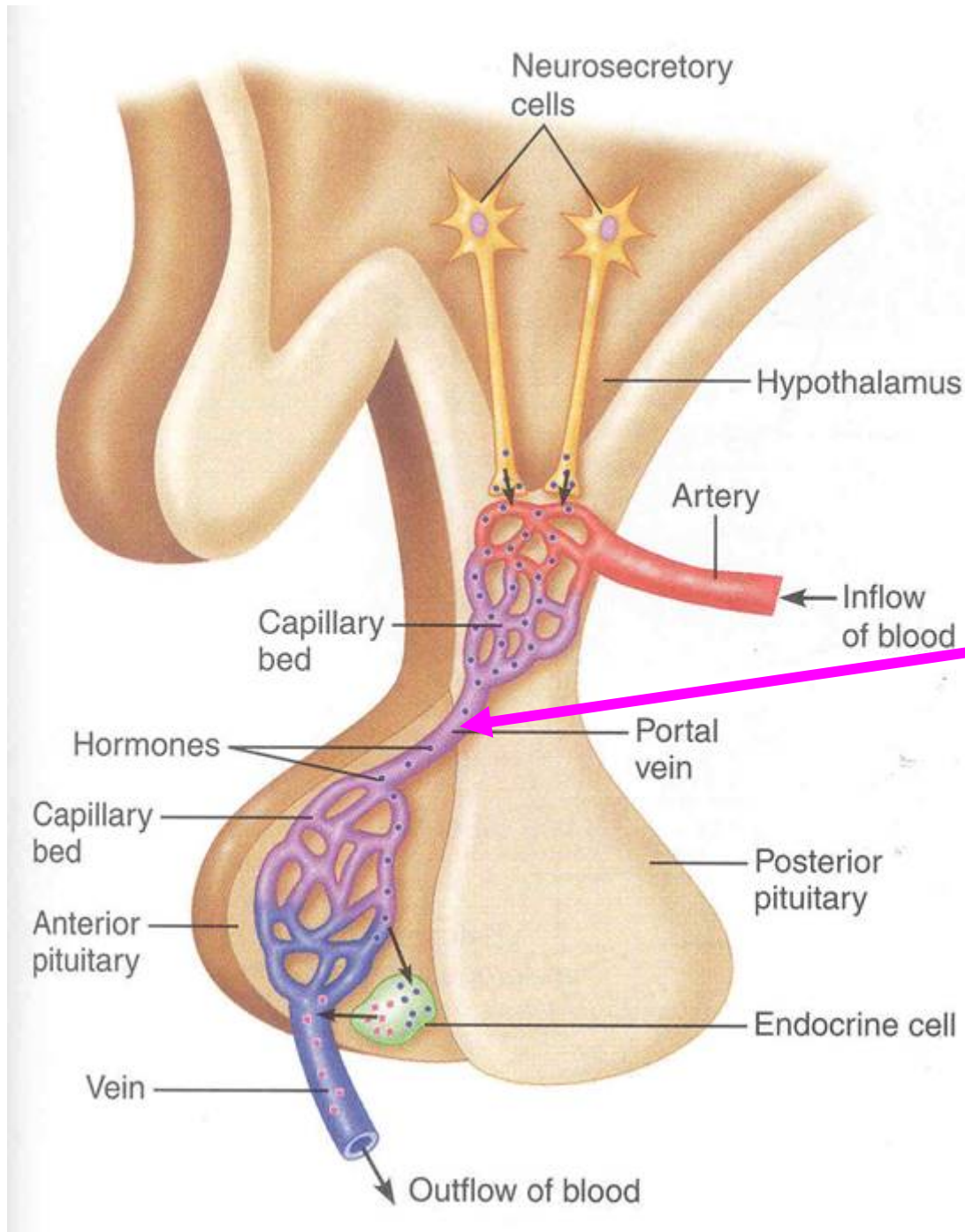
ADRENOCORTICOTROPIC HORMONE (ACTH) – controls secretion of hormones released by adrenal cortex.

FOLLICLE-STIMULATING HORMONE (FSH) – in females, stimulates maturation of egg cells and estrogen secretion by ovaries.

LUTENIZING HORMONE (LH) – in males, stimulates secretion of testosterone and sperm production by testes. In females, stimulates release of ovum by ovary.

MELANOCYTE-STIMULATING HORMONE (MSH) – along with ACTH, affects pigment release in skin.

PROLACTIN (PRL) – stimulates milk production.



Note Pituitary Portal System!!

PINEAL GLAND

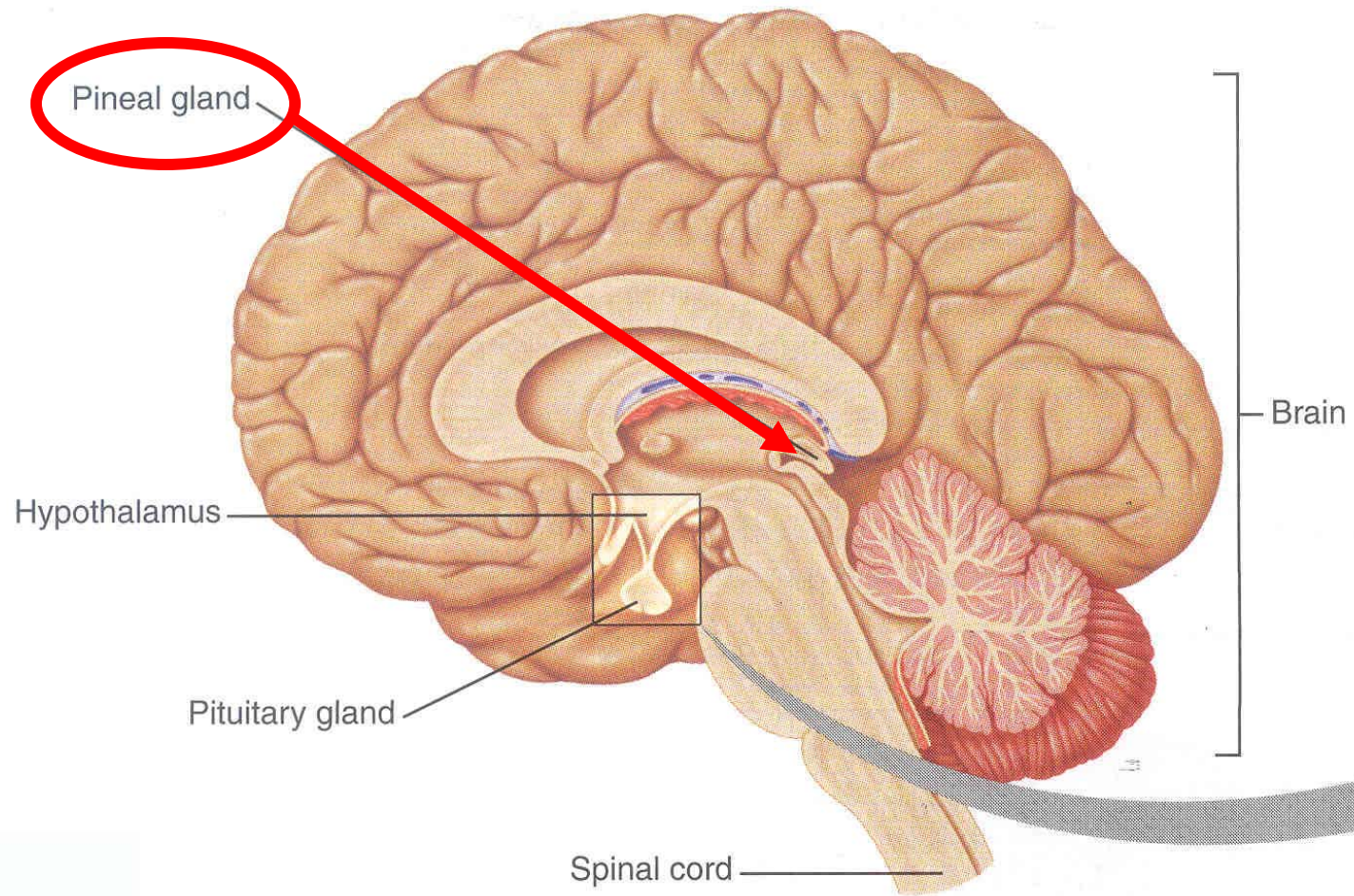
Location and Development: outgrowth of the roof of the diencephalon. Found near the posterior margin of the corpus callosum, slightly cranial and superior to cerebellum.

Innervation: (Already) Part of brain.

Arterial Supply: **circulosus artriosus cerebri**

Venous Drainage: **cavernous venous sinus**

Function: **MELATONIN** – amino acid derivative thought to have connection with regulating sleep cycle.



THYMUS GLAND

Location: Located just deep to sternum and just ventral to great vessels of heart. Until puberty, a large structure, after which it begins to atrophy and gets replaced with adipose tissue.

Development: from epithelial cells derived from endoderm of third pair of visceral pouches (3rd gill slit pouch).

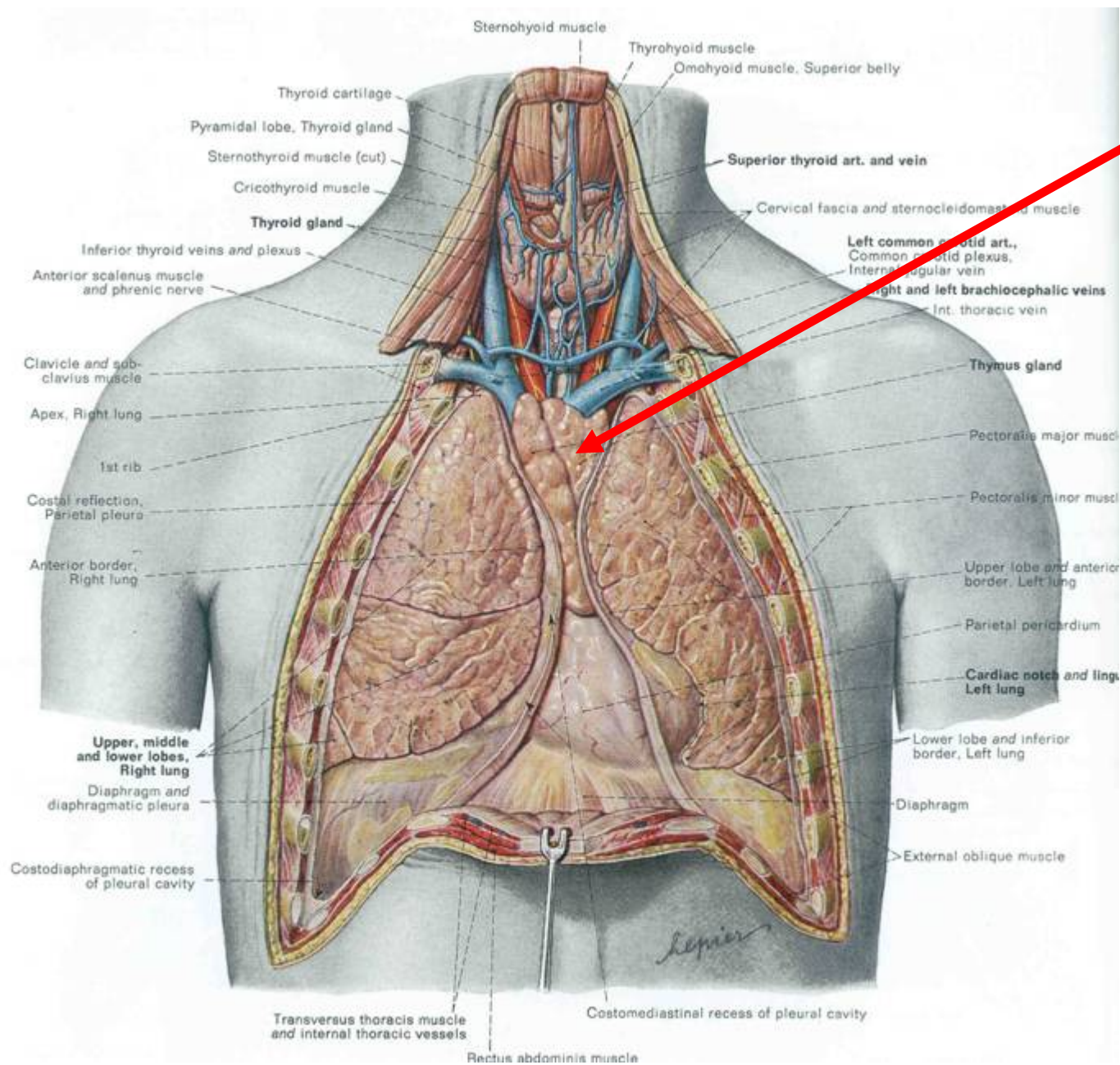
Innervation: **Vagus Nerve (X)**, like any posterior gill slit structure!

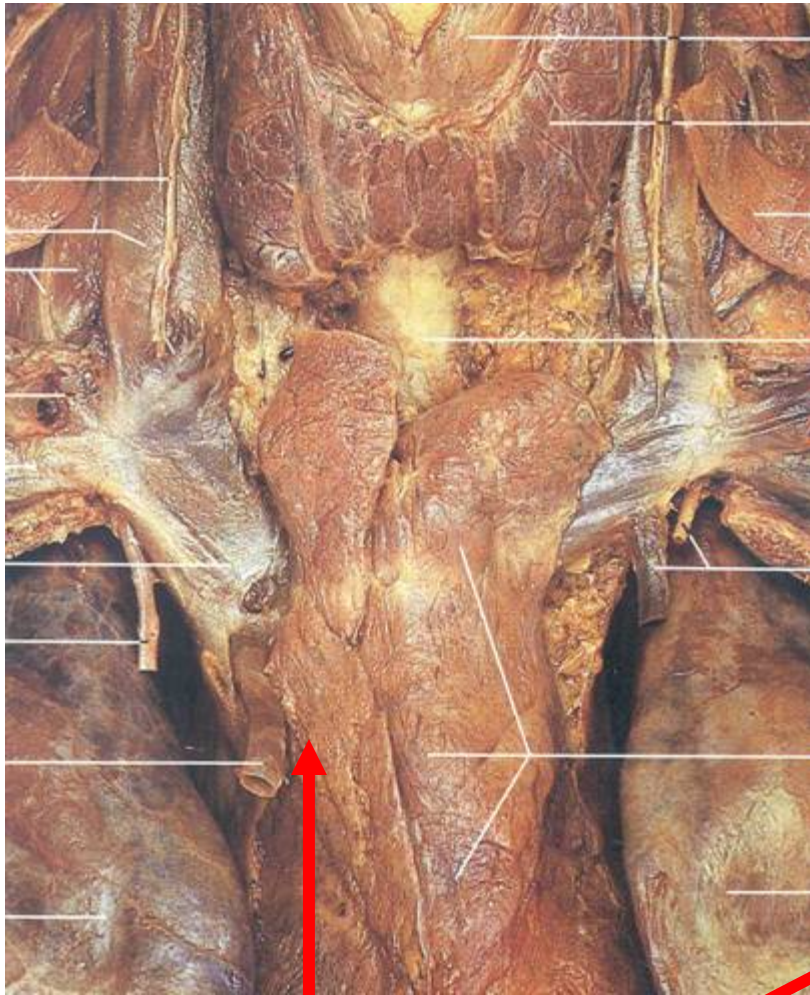
Arterial Supply: anastomosis from **internal thoracic artery** (branch of subclavian) and **superior and inferior thymic arteries**.

Venous Drainage: **thyroid veins** and left **brachiocephalic vein**.

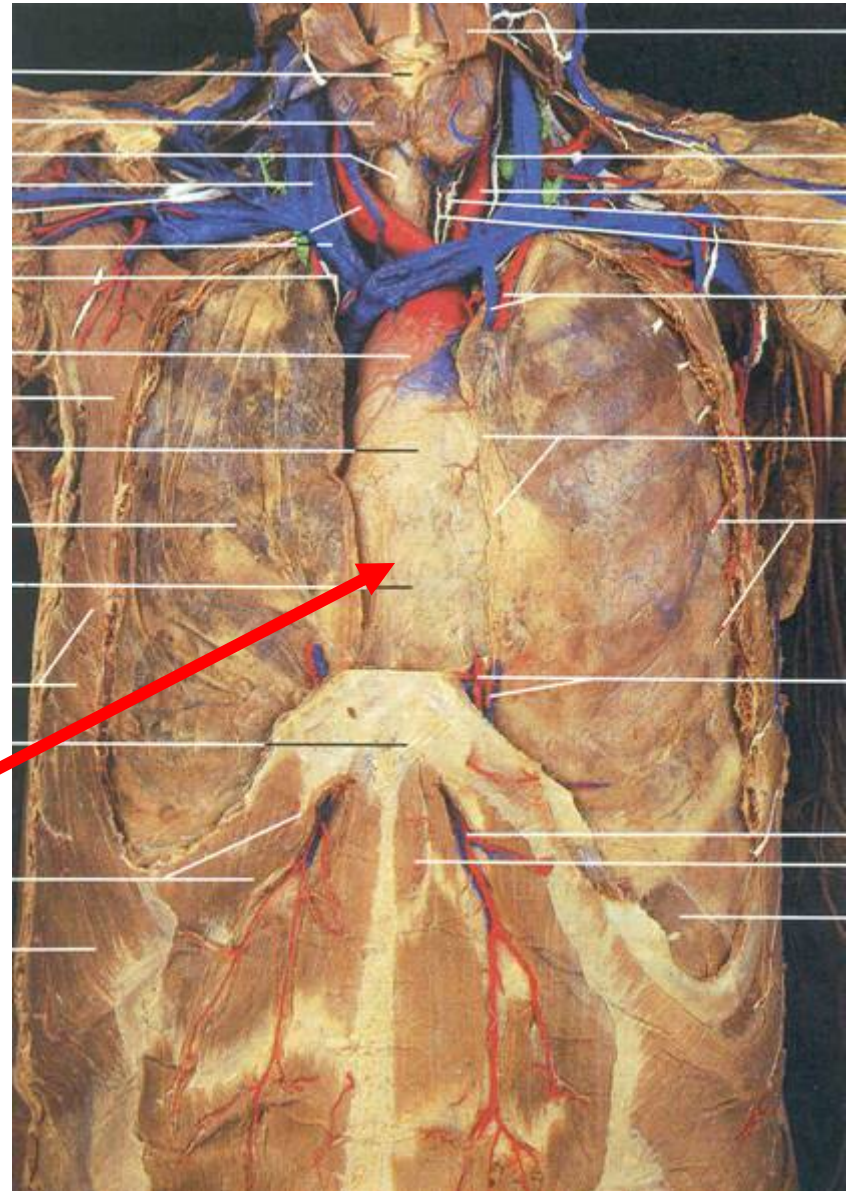
Function: **THYMOSIN**, **THYMUS HUMERAL FACTOR**, **THYMOPOIETIN** – convert embryonic lymphocytes into T-cells.

Adult THYMUS

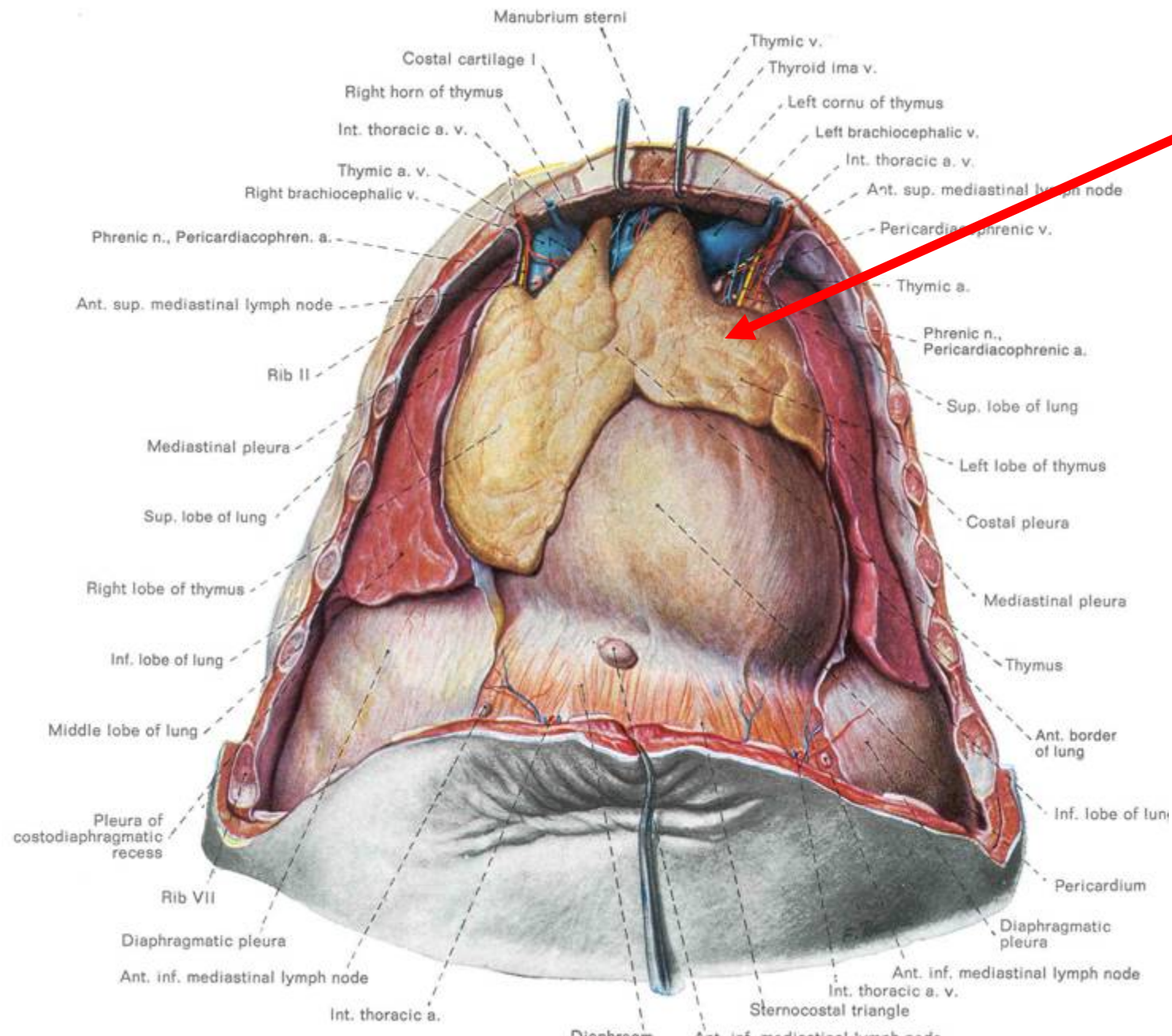




**Adult
THYMUS**



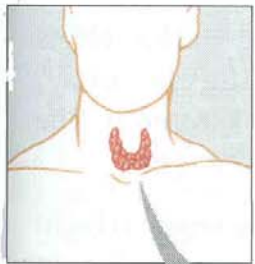
One-year old THYMUS



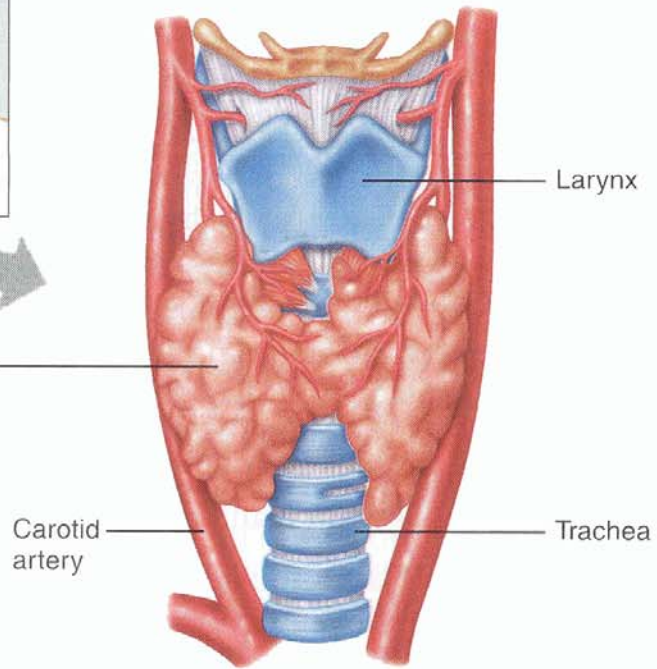
THYROID GLAND

Location: Located close to thyroid cartilage. Has two **lateral lobes** connected by **thyroid isthmus** medially. Isthmus covers cricoid cartilage in ventral view.

Development: first endocrine gland to appear during development. Develops from endodermal thickening in floor of early pharynx and epithelium of 3rd and 4th gill slit pouches as early as 24 days after fertilization. Starts out caudal to tongue, but ultimately comes to be wrapped around laryngeal cartilages.



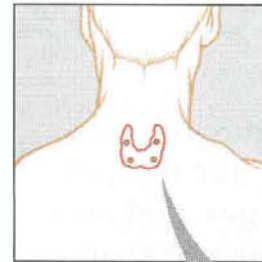
Thyroid gland



Larynx

Carotid artery

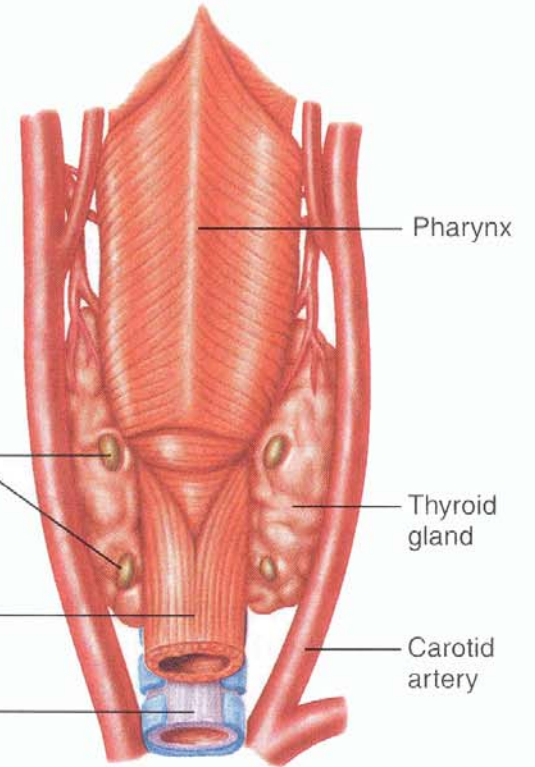
Trachea



Parathyroid glands

Esophagus

Trachea



Pharynx

Thyroid gland

Carotid artery

THYROID GLAND

Innervation: **Vagus Nerve (X)**

Arterial Supply: **superior thyroid artery** (branch of external carotid artery).

Venous Drainage: drained by dense interconnected network of **pharyngeal veins** that eventually dump into **superior thyroid vein** and **inferior thyroid vein**. These are tributaries of internal jugular veins and left brachiocephalic vein respectively.

Functions:

THYROXIN – regulate rate of metabolism

CALCITONIN – decreases levels of calcium and phosphate in the blood (partially antagonistic to parathyroid hormone).

PARATHYROID GLAND

Location:

- Usually paired.
- Very small (less than 5 mm).
- Called *parathyroid* glands because of their position on posterior margins outer surface of thyroid gland.
- More superior of each pair usually near middle of margin of lobe.
- More inferior of each pair usually at inferior apex of lobe.

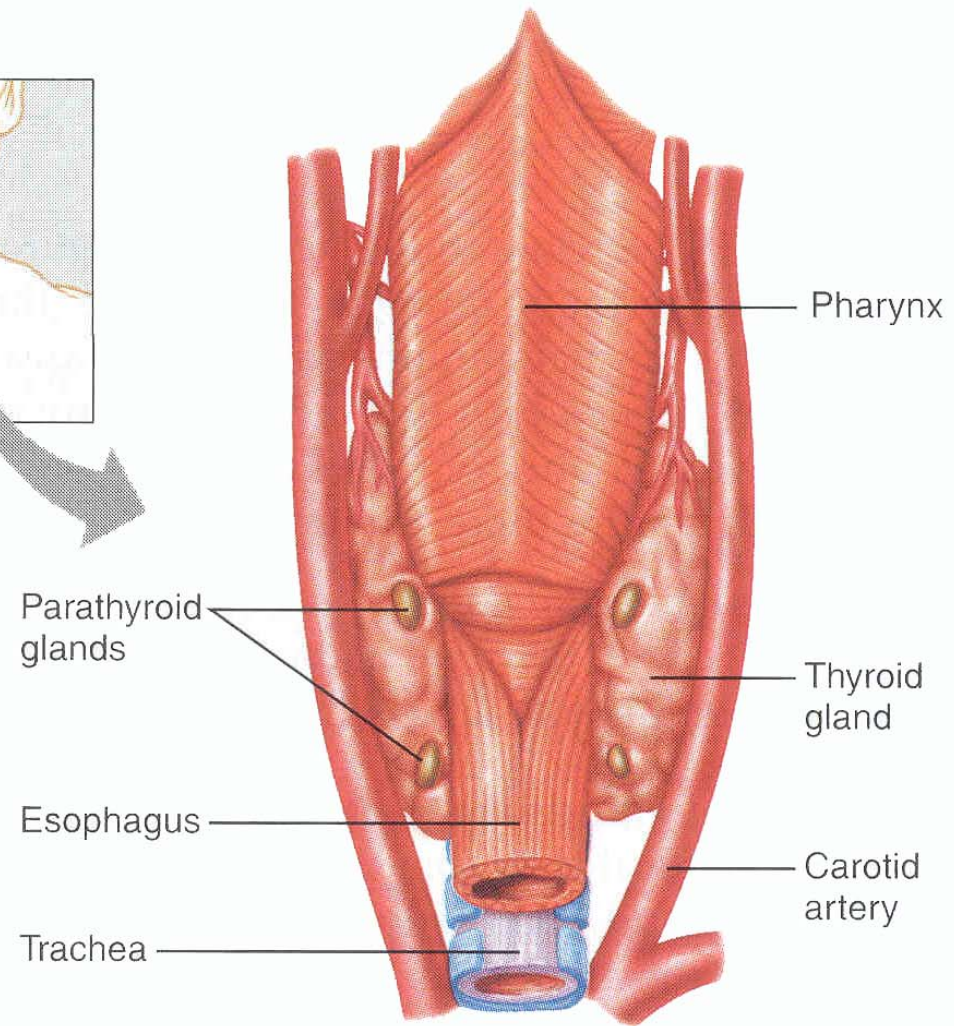
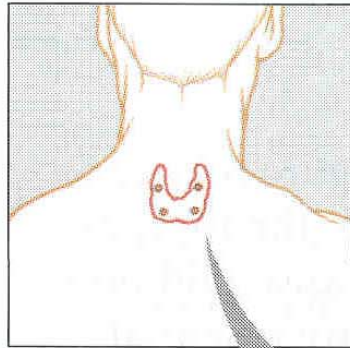
Development: Like thyroid gland, develop from endodermal thickening in floor of early pharynx and epithelium of 3rd and 4th gill slit pouches.

PARATHYROID GLAND

Innervation, Vascularization: same as thyroid gland.

Function:

PARATHYROID HORMONE (PTH) – raises the level of calcium in the blood, decreases levels of blood phosphate. Partially antagonistic to calcitonin of thyroid gland.



ADRENAL GLAND

Location : on cranial (superior) surface) of kidney (“suprarenal” gland). Have inner medulla and outer cortex.

Development:

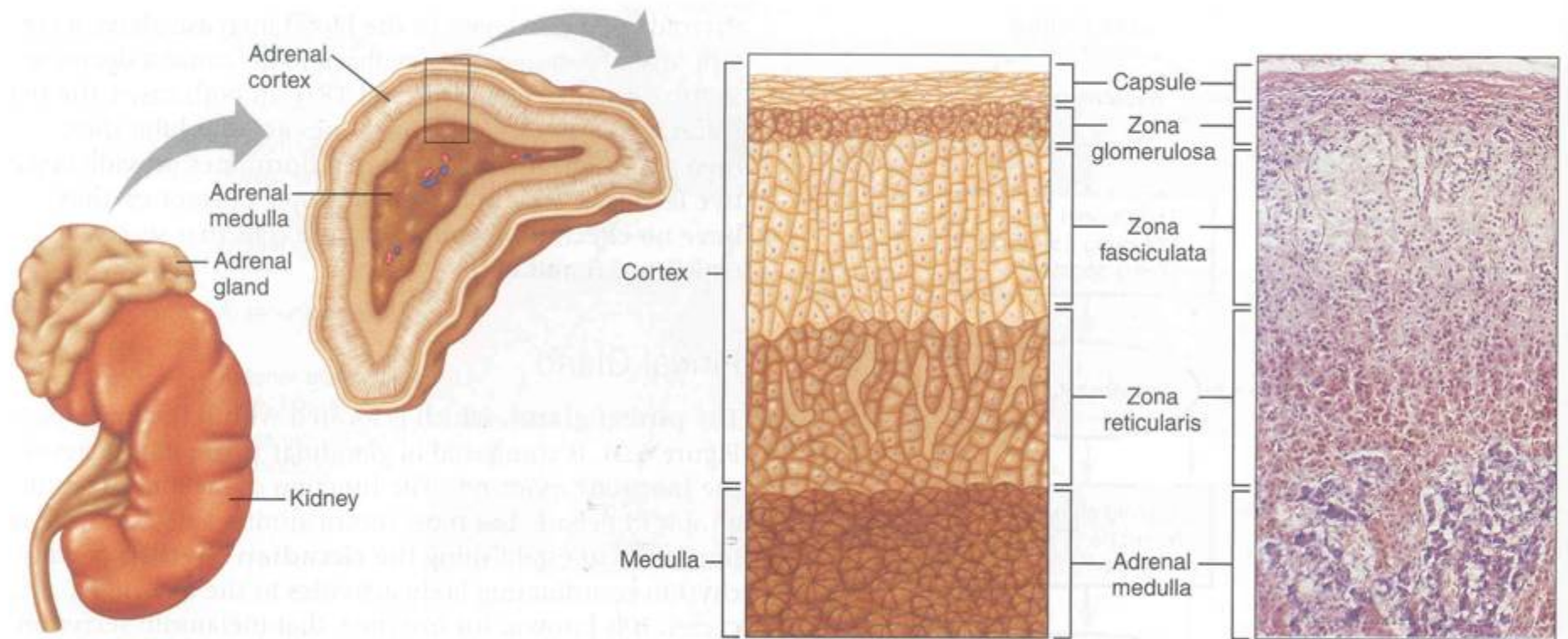
Adrenal cortex – mesoderm of posterior abdominal wall.

Adrenal medulla – neural crest cells that are derived from adjacent sympathetic ganglion.

Innervation: adjacent sympathetic fibers. No parasympathetic innervation.

Arterial Supply: adrenal arteries

Venous Drainage: adrenal veins



ADRENAL GLAND

Adrenal Cortex, Function :

MINERALOCORTICIDS – regulate sodium retention and potassium loss.

GLUCOCORTICIDS – act as anti-inflammatory agents; affect metabolism of food.

ANDROGENS – regulates control over rapid growth spurts in preadolescents.

Adrenal Medulla, Function :

ADRENALINE (EPINEPHRINE) – increases heart rate and blood pressure.

NORADRENALINE (NOREPINEPHRINE) – constricts arterioles.

PANCREAS

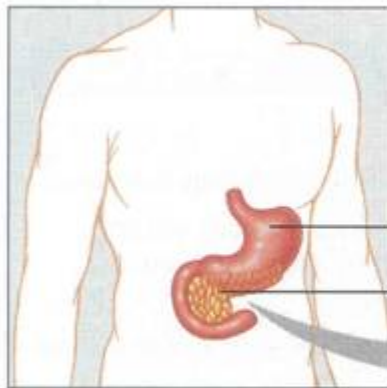
Location : inside notch of duodenum; retroperitoneal. Has body, and tail. Tail crosses midline and comes in contact with middle third of left kidney.

Development: outgrowth of embryonic foregut. Dorsal and ventral embryonic buds eventually fuse.

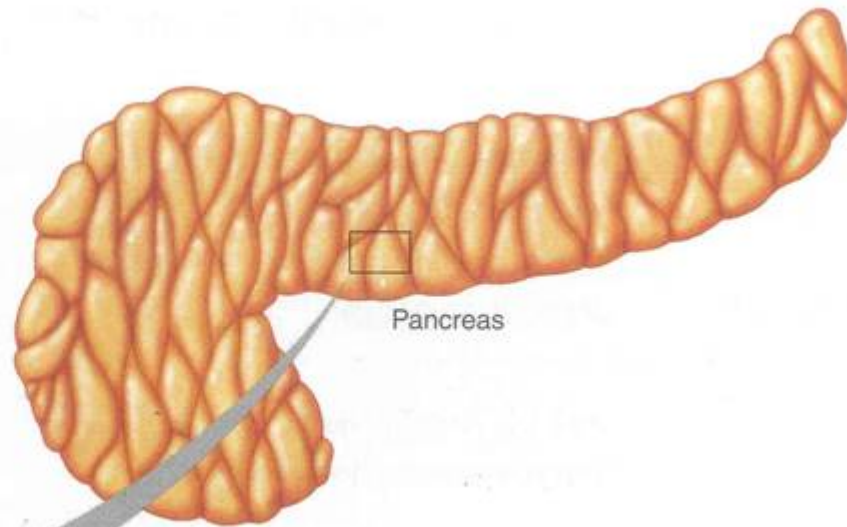
Innervation: foregut: sympathetic – greater splanchnic nerve; parasympathetic – Vagus nerve (X).

Arterial Supply: pancreaticoduodenal (branch of celiac artery)

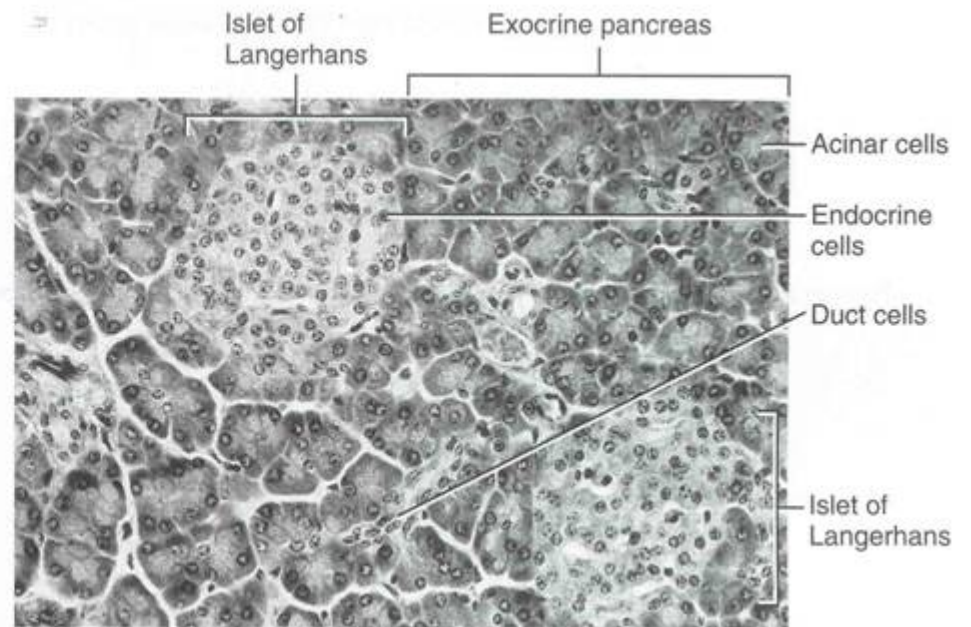
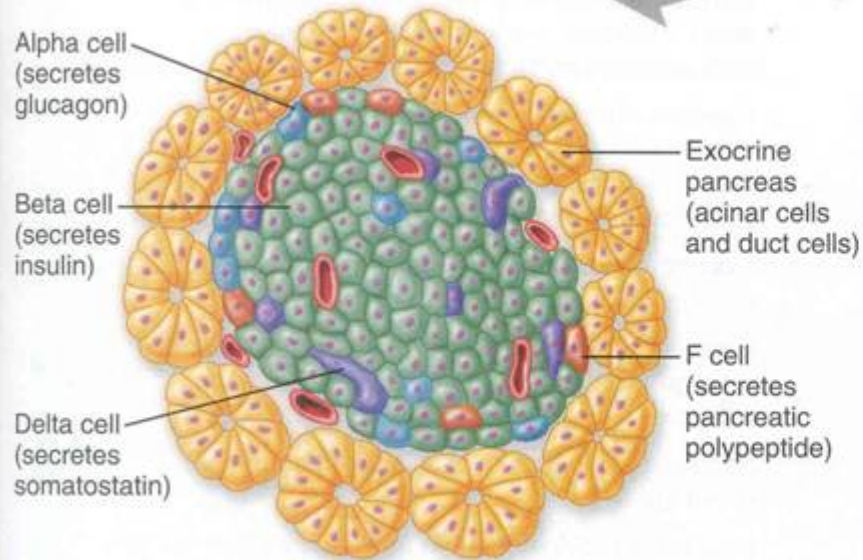
Venous Drainage: pancreaticoduodenal vein is tributary of splenic vein



Stomach
Pancreas



Pancreas



PANCREAS

Function: pancreas is not only an exocrine gland for digestion.

GLUCAGON – from alpha cells of pancreatic islets, raises blood glucose level.

INSULIN – from beta cells of pancreatic islets, lowers blood glucose level.

OVARY

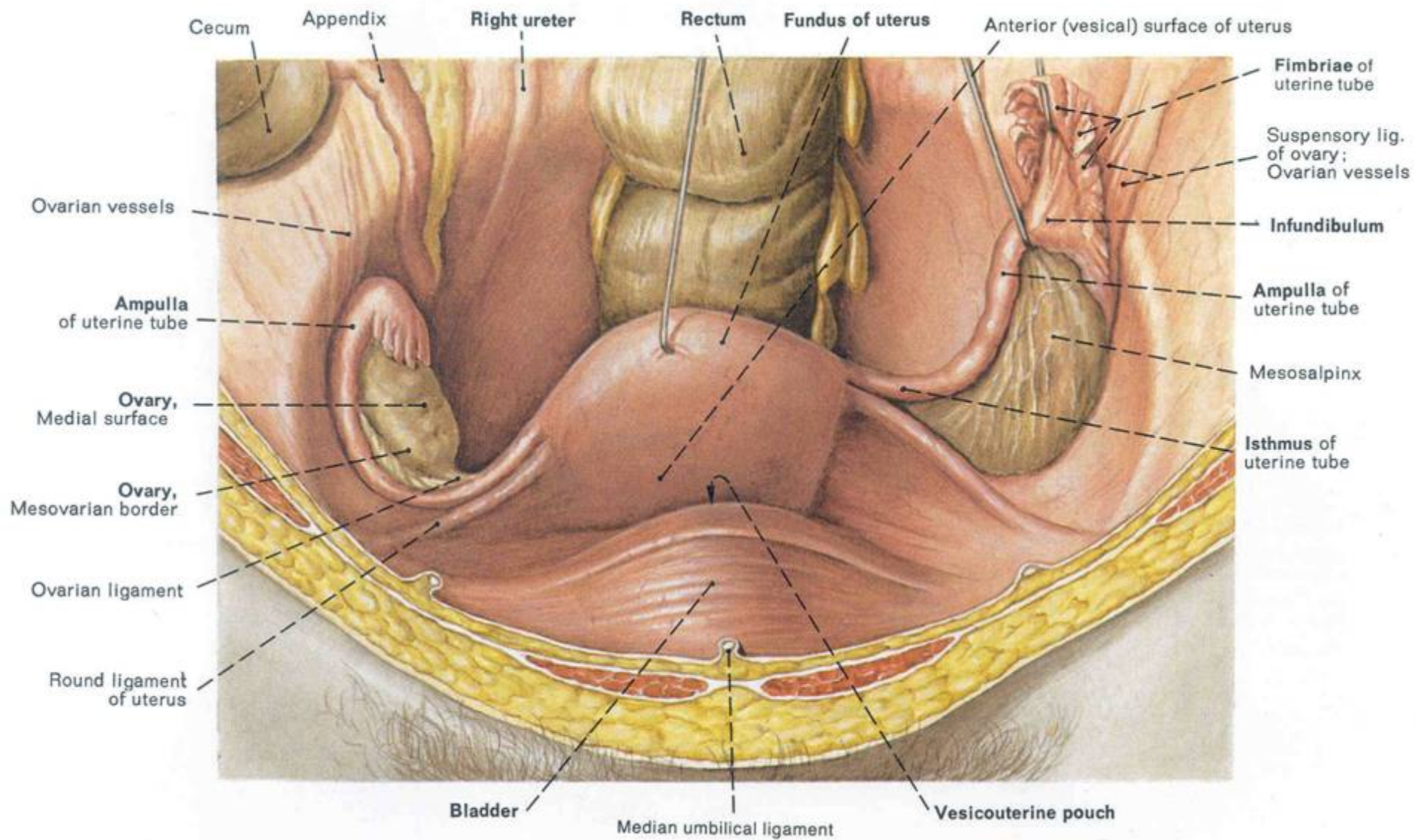
Location : near kidneys, anchored by fallopian tubes to uterus.

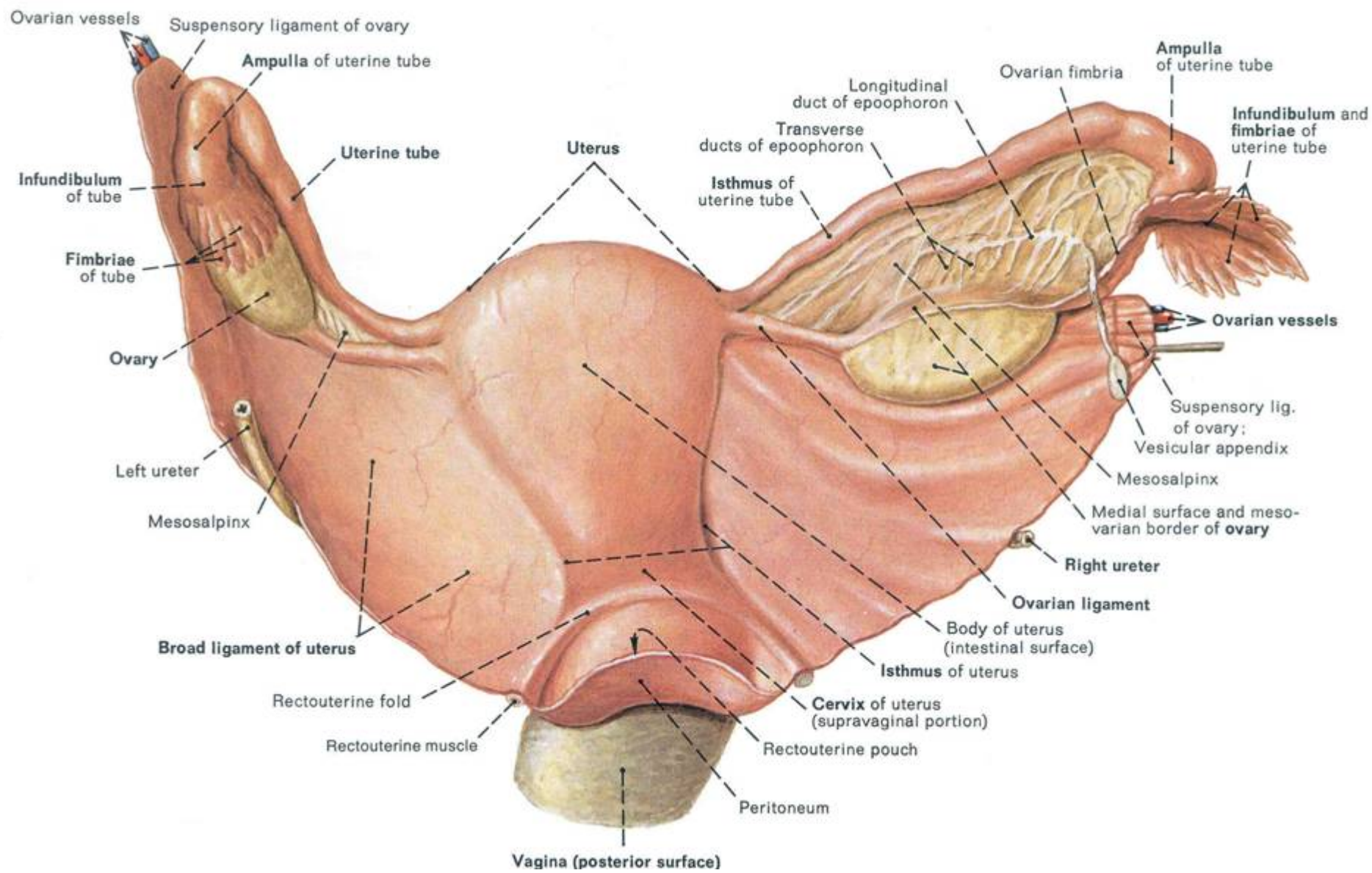
Development: intermediate mesoderm. Ovaries migrate somewhat caudally, retain position near kidneys.

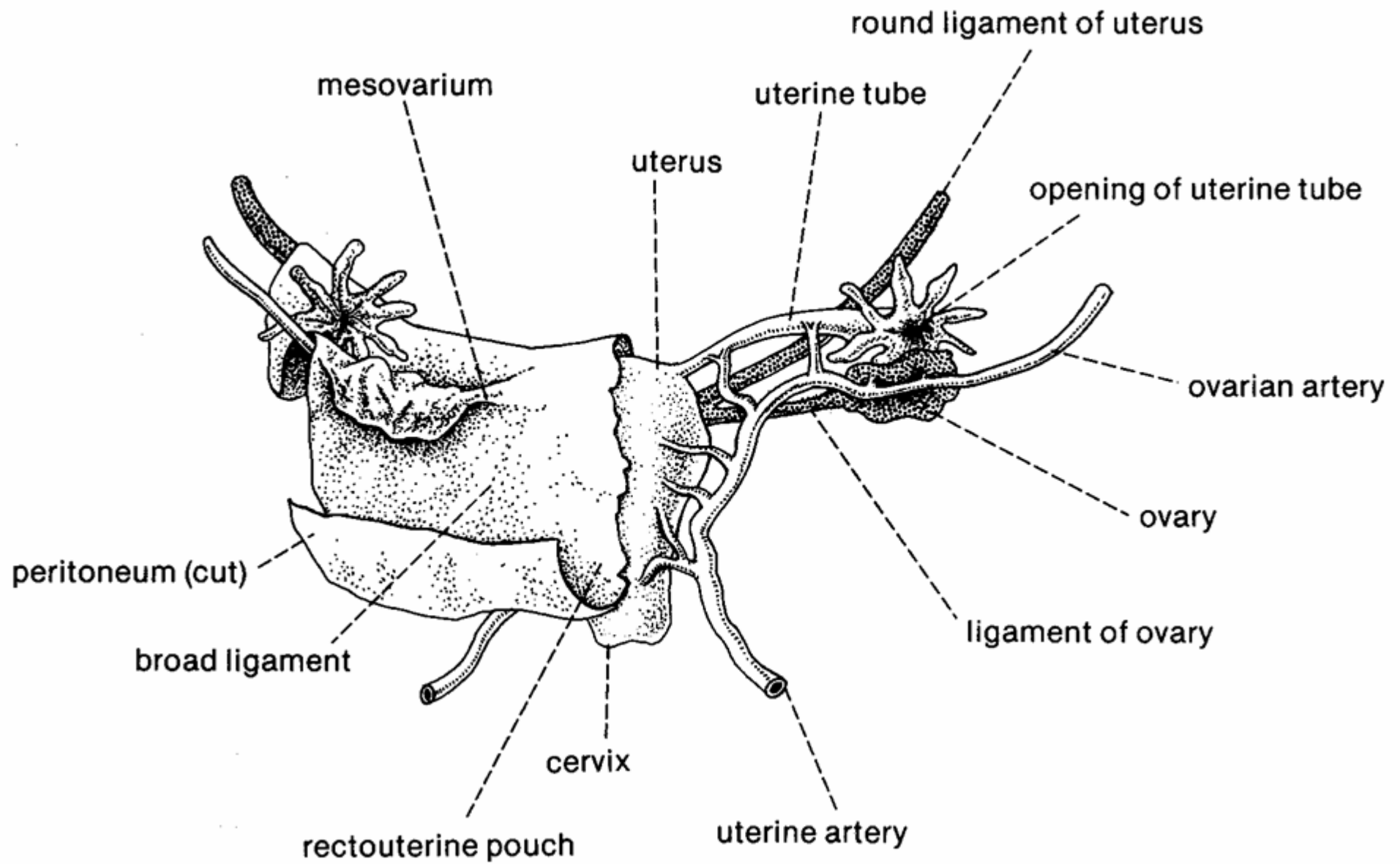
Innervation: sympathetic – similar to hindgut, level T12, follows least splanchnic nerve; parasympathetic – sacral outflow

Arterial Supply: ovarian artery, branch of abdominal aorta.

Venous Drainage: ovarian vein, dump into inferior vena cava.







OVARY

Function: ovaries produce ova (eggs; singular ovum) in regular cycle determined by hormonal secretions (covered in later lectures). Functions of ovarian hormones and their secretions are tied to secretion of FSH and LH from anterior pituitary gland.

ESTROGENS – stimulate development of female sex organs and sexual characteristics.

PROGESTERONE + ESTROGENS – regulate menstrual cycle; maintain pregnancy in presence of developing embryo or fetus.

TESTES

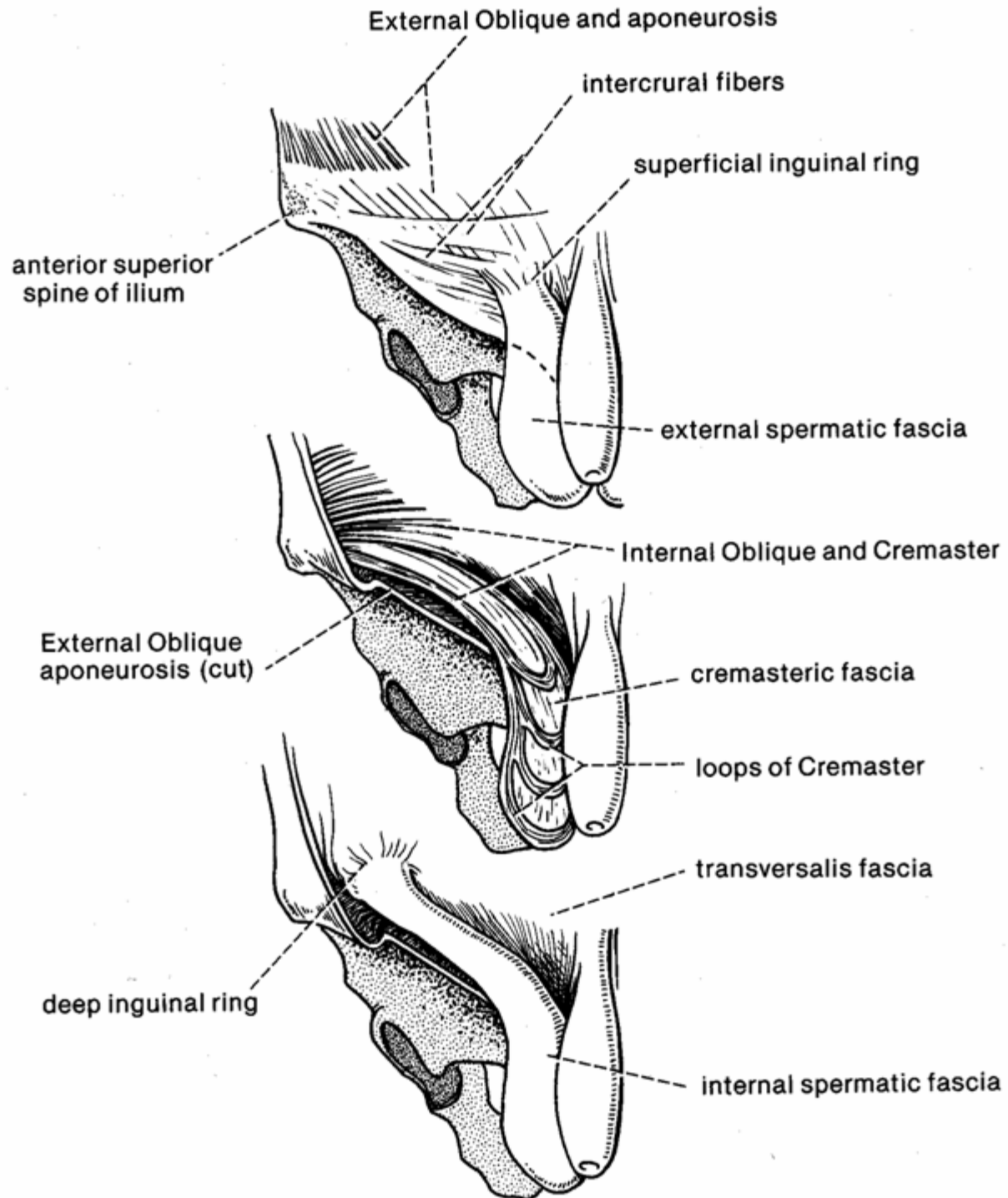
Responsible for sperm production and synthesis of male sex hormones.

Location : in postnatal males, in scrotal sac, connected to inner workings of body by spermatic cord.

Development: from intermediate mesoderm.

- As a transitory stage of kidney degenerates, a ligament called the **GUBERNACULUM** descends on each side of abdomen from inferior pole of gonad.
- Gubernaculum passes obliquely through developing anterior abdominal wall at site of future inguinal canal and attaches at internal surface of labioscrotal swelling (future position of scrotum in males or labium majorum in females).
- Gubernaculum is thought to guide descent of testes into scrotum, and ultimately anchors testis to scrotal wall.

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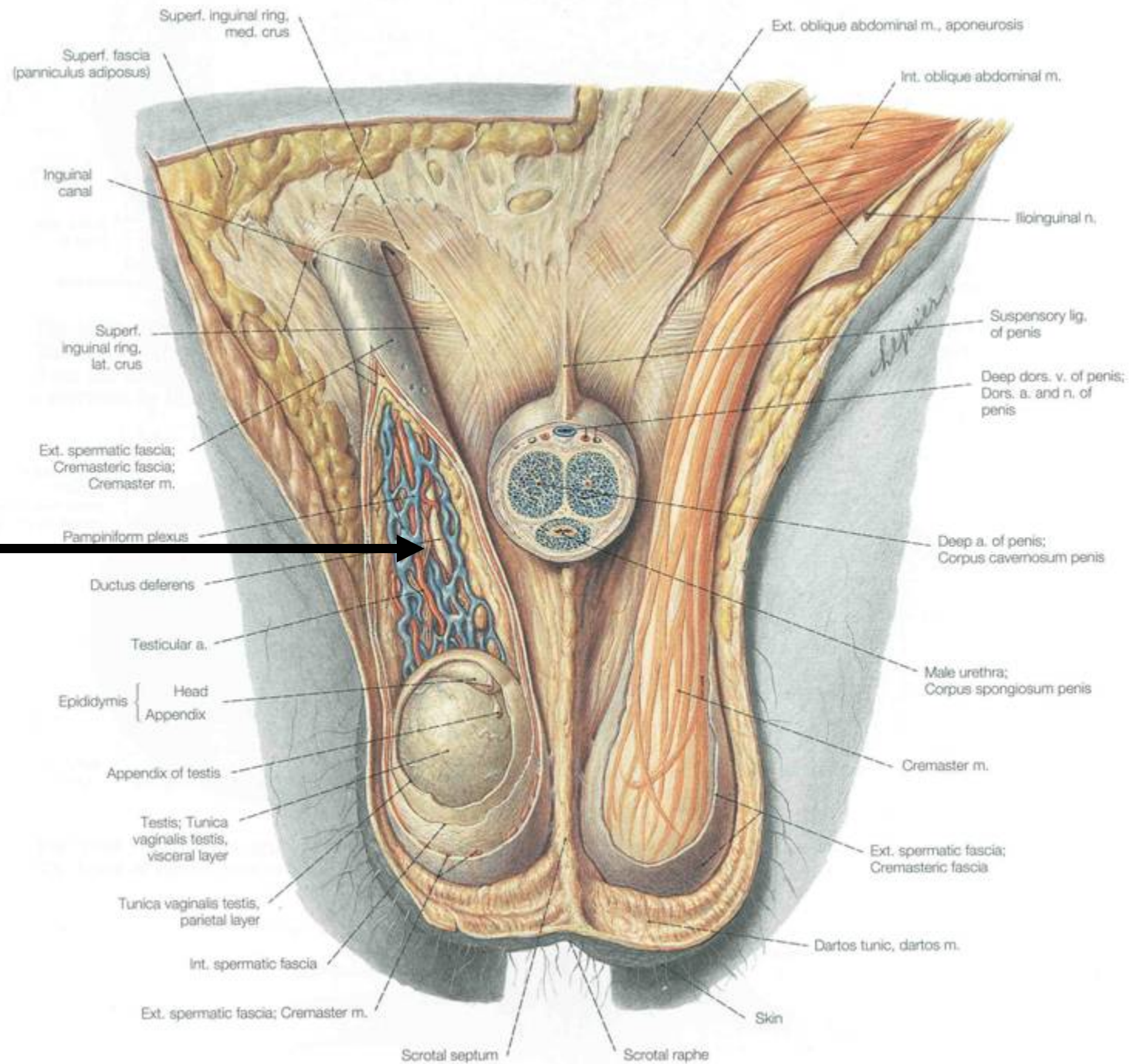
TESTES

Innervation: **sympathetic** – similar to hindgut, level T12, follows least splanchnic nerve, hook a ride down spermatic cord via testicular blood vessels; **parasympathetic** – sacral outflow.

Arterial Supply: **testicular artery**. Branches off of abdominal aorta, however developmental proximity of kidney means they sometimes branch off of renal artery. Arteries follow the developmental track of testes, and can thus be very long.

Venous Drainage: **testicular vein**, dump into inferior vena cava.

Pampiniform plexus



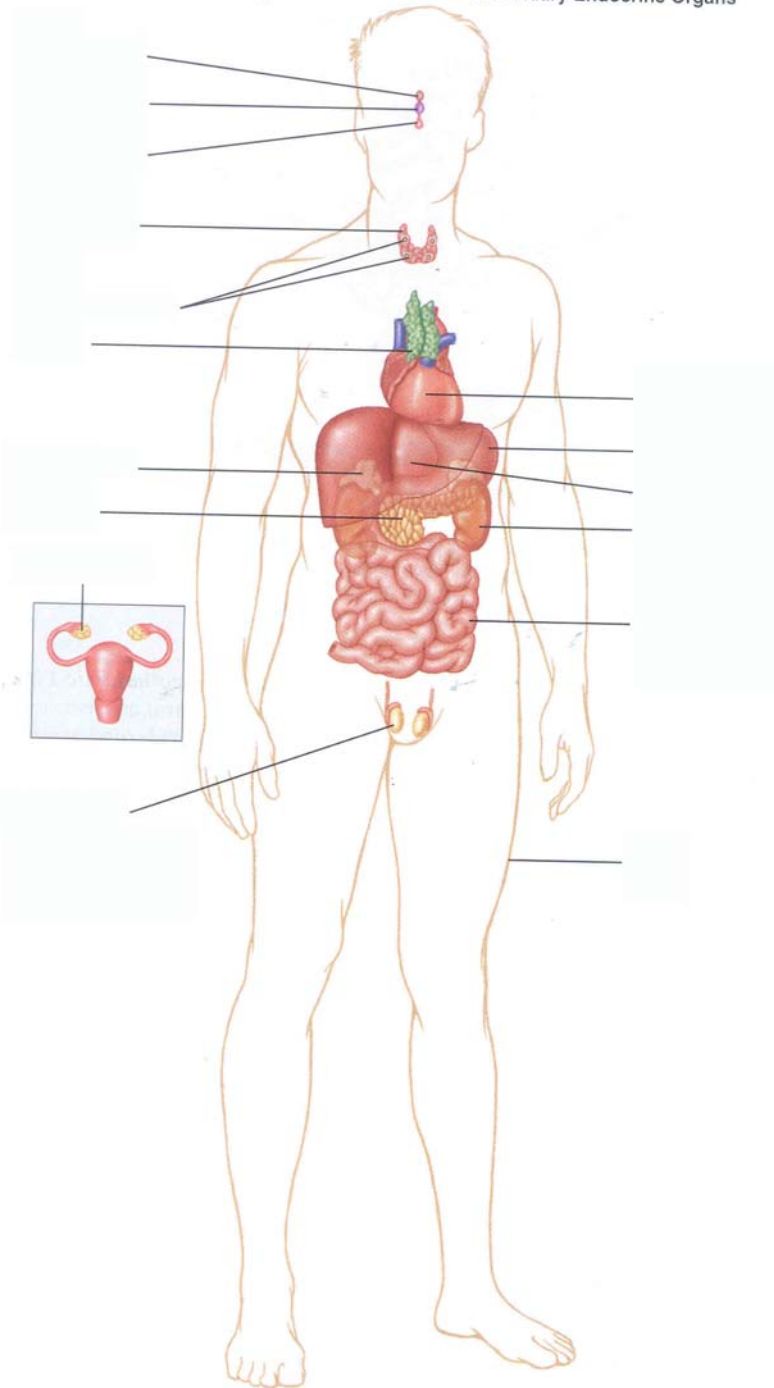
TESTES

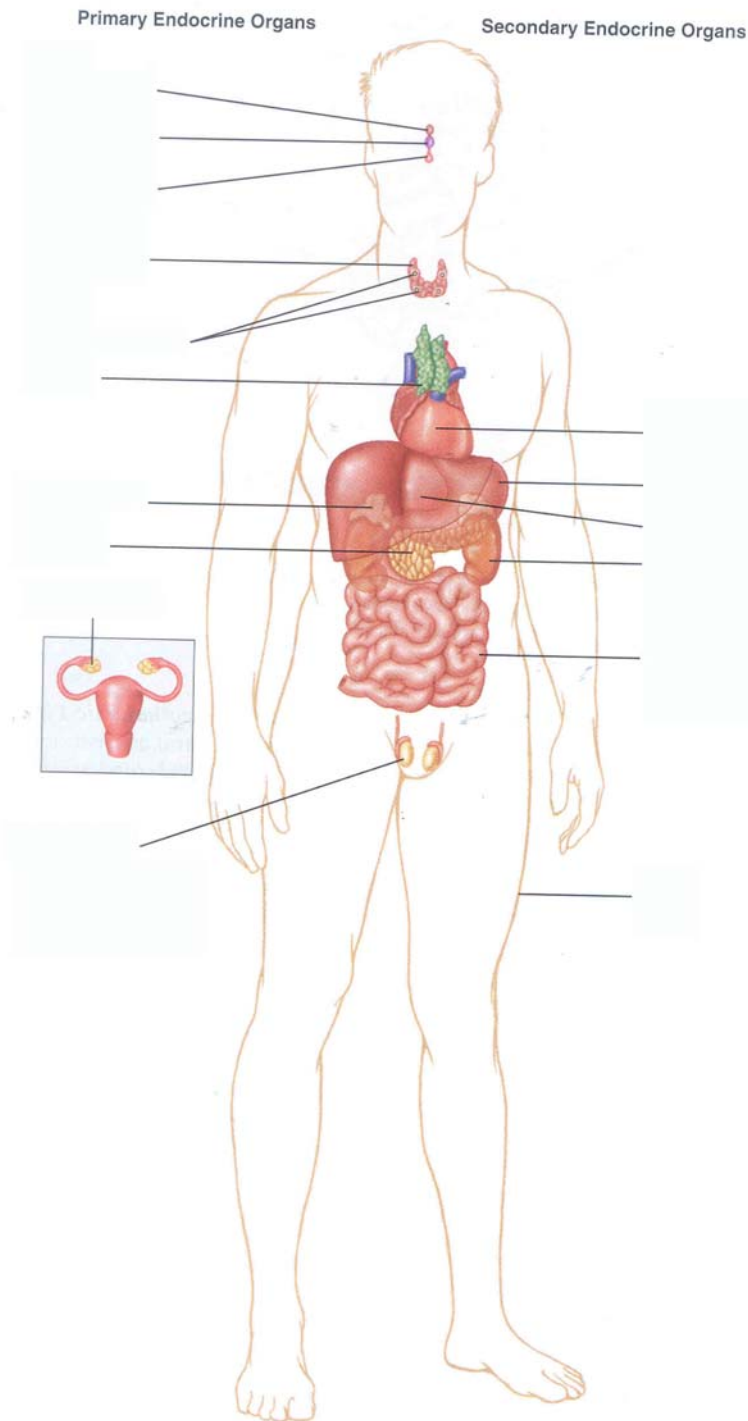
Function: Responsible for sperm production and synthesis of male sex hormones.

TESTOSTERONE – stimulate development of male sex organs, secondary sexual characteristics, and behavioral features. Functions of testosterone and its secretion is tied to secretion of LH from anterior pituitary gland.

Primary Endocrine Organs

Secondary Endocrine Organs





I should be able to point of any of these and ask:

1. Identify
2. Location
3. Function(s)
4. Sympathetic Innervation
5. Parasympathetic Innervation
6. Arterial supply
7. Venous drainage