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Endocrine System Lecture Objectives

- Describe the location, histologic components, and embryologic origin of the pituitary gland.
- List the hormones produced by the anterior and posterior pituitary and know their general function.
- Describe the location, histologic components, and embryologic origin of the thyroid gland.
- List the hormones made by the thyroid gland and know their general function.
- Describe the location, cell types and hormone of the parathyroid glands.

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Endocrine System Lecture Objectives

- Describe the location, cortical layers, and medulla of the adrenal glands.
- List the hormones made in the cortex and medulla, and know their general function.
- Describe the location of the pancreas, and the structure and cellular components of a typical pancreatic islet.
- List the hormones made by the islet cells and know their general function.
- Describe the location, cell types, and hormone produced by the pineal gland.

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Endocrine System Lecture Outline

- Introduction
- Pituitary
- Thyroid
- Parathyroid
- Adrenal
- Pancreas
- Pineal

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Endocrine System Lecture Outline

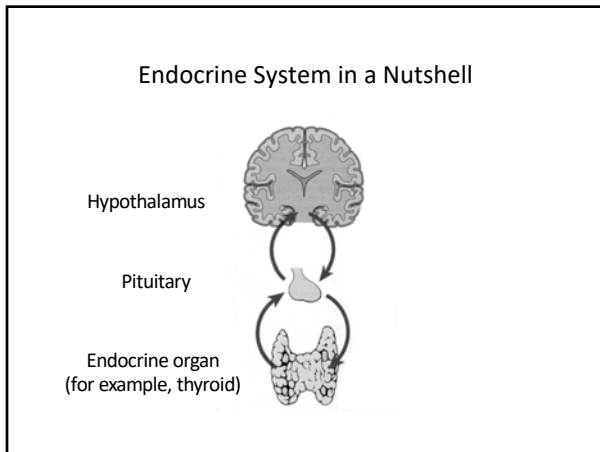
- Introduction

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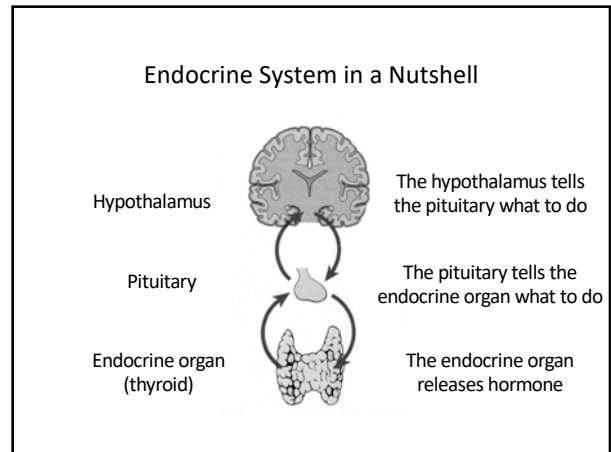
General Features of the Endocrine System

- Endocrine organs secrete hormones through the blood (no ducts!).
- Hormones travel elsewhere and have effects on different tissues.
- The classical endocrine system consists of all the organs we will discuss in this lecture.
- Male and female reproductive systems also have endocrine functions (we'll discuss these later).

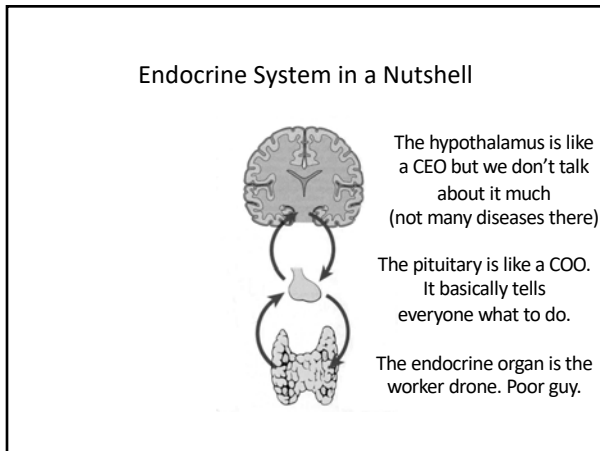
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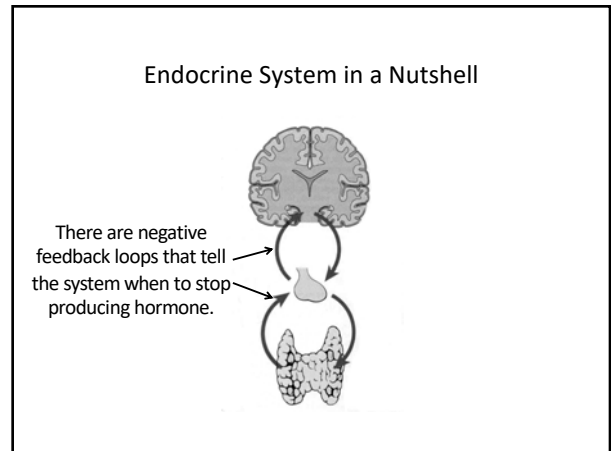
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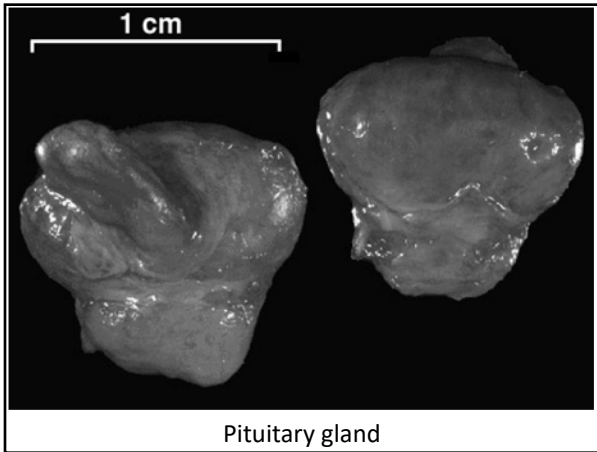
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- ### Endocrine System Lecture Outline
- Introduction
 - Pituitary

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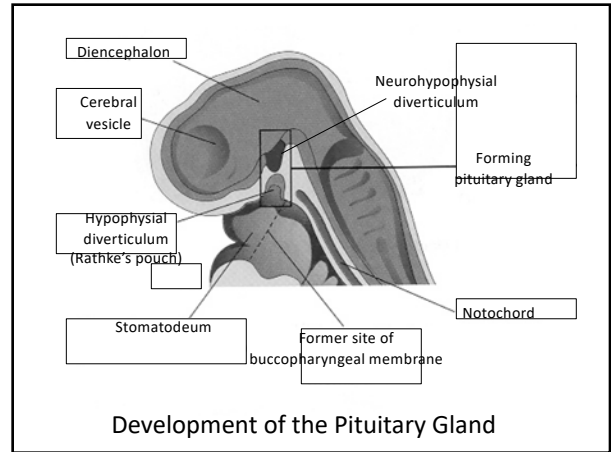
- ### Pituitary Gland
- Located in the sella turcica (Turkish saddle) in the sphenoid bone.
 - Connected to the hypothalamus
 - Two lobes:
 - Anterior (adenohypophysis)
 - Posterior (neurohypophysis)

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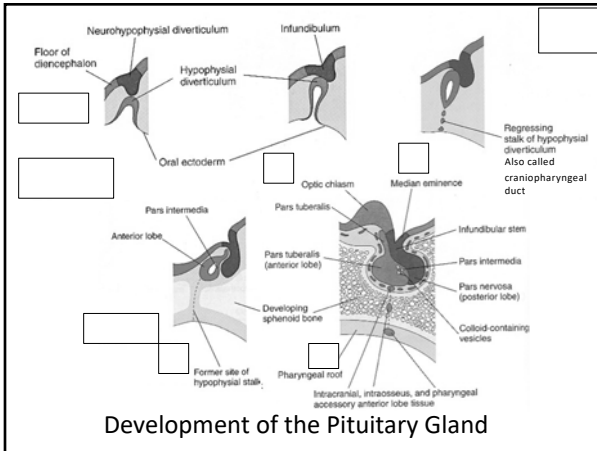
Pituitary gland

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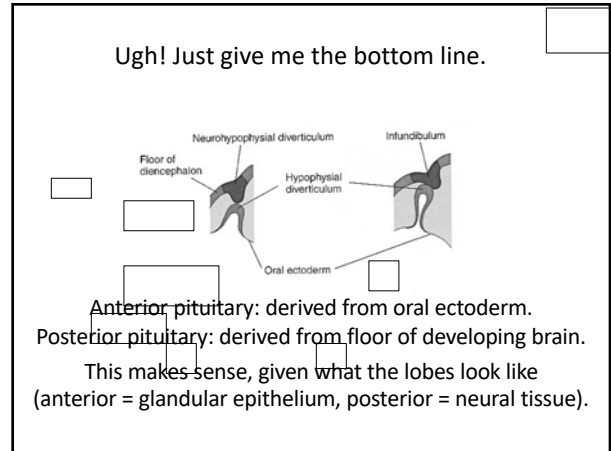
Development of the Pituitary Gland

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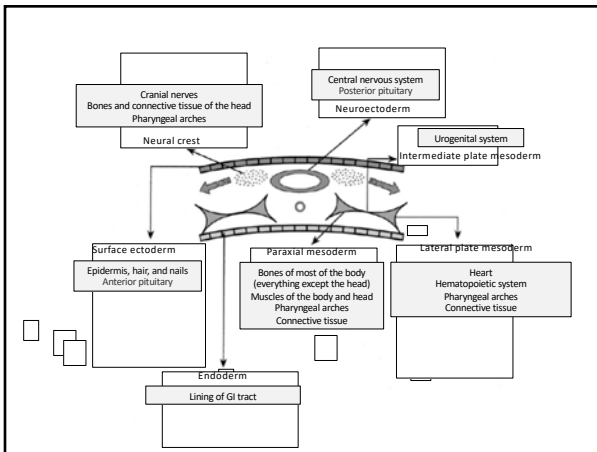


Development of the Pituitary Gland

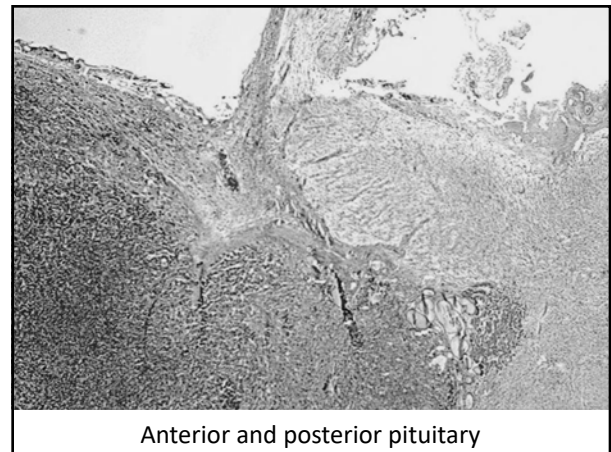
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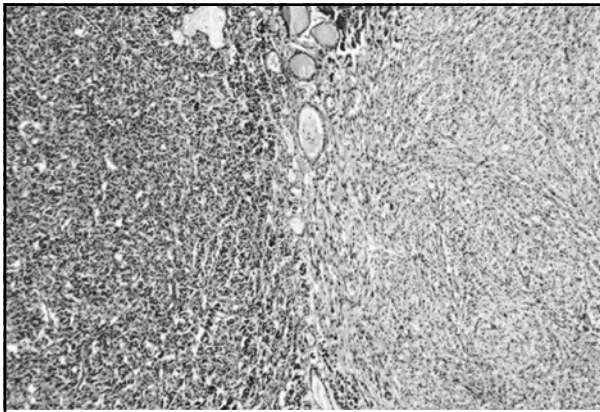


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Anterior and posterior pituitary

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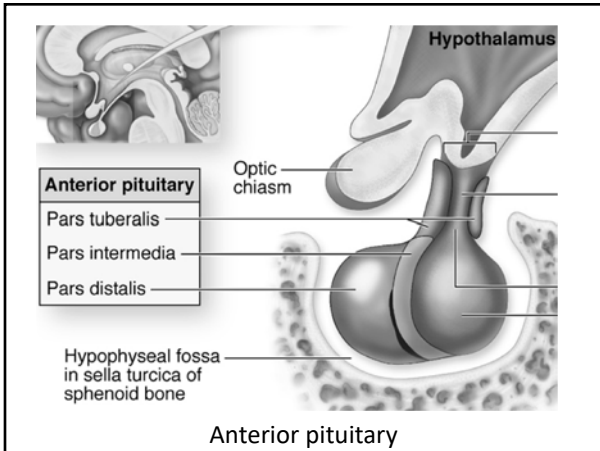
Anterior and posterior pituitary

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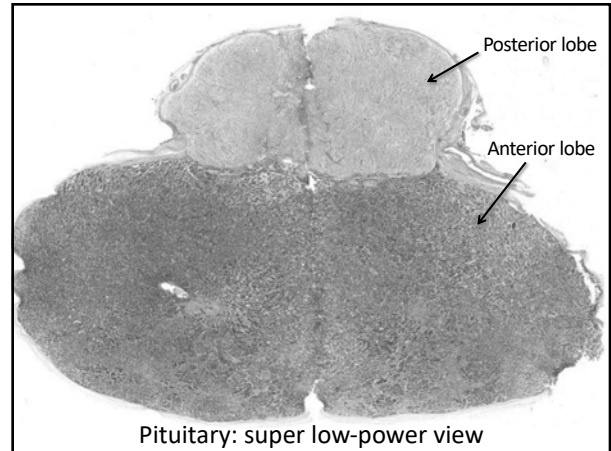
Anterior Pituitary (Adenohypophysis)

- Composed of cords of glandular epithelial cells separated by capillaries.
- Makes and secretes a bunch of hormones.
- Subdivisions
 - Pars distalis (biggest and most important part)
 - Pars tuberalis (superior extension of pars distalis)
 - Pars intermedia (separates pars distalis from pars nervosa)

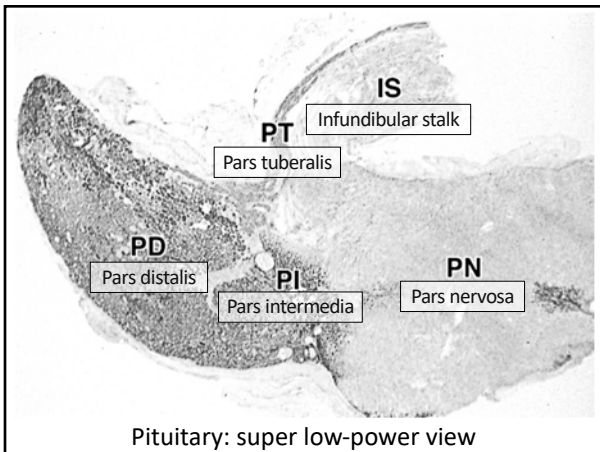
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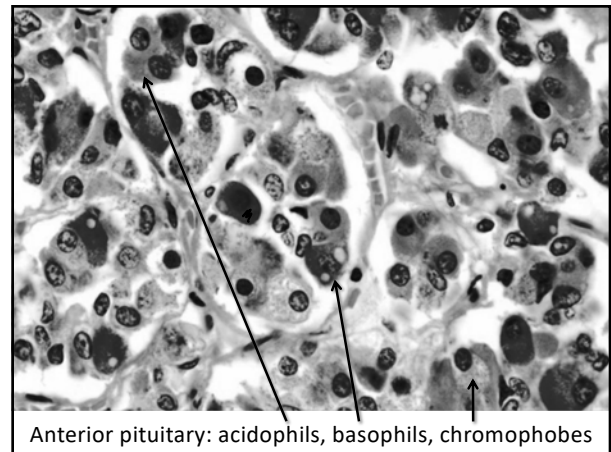
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Hormones of the Anterior Pituitary

Anterior pituitary makes and secretes:

- Growth hormone (GH)
- Prolactin (PL)
- Follicle-stimulating hormone (FSH)
- Luteinizing hormone (LH)
- Adrenocorticotropic hormone (ACTH)
- Thyroid stimulating hormone (TSH)

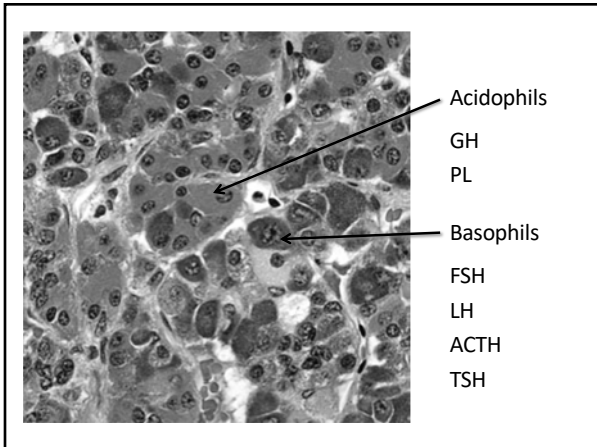
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ROS* of Anterior Pituitary Hormones

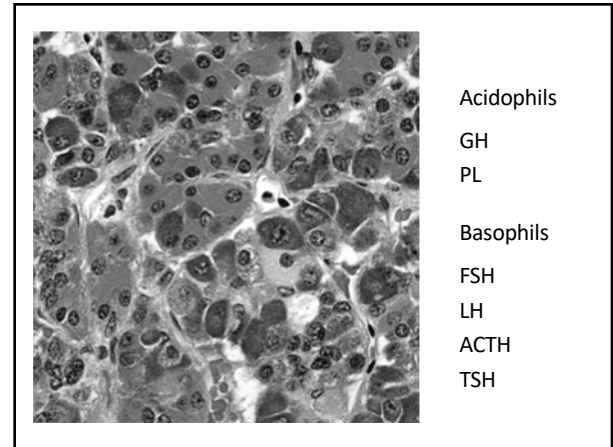
Hormone	Stimulates
GH	Growth of bones and many other functions
PL	Milk secretion
FSH	Females: ovarian follicle development Males: spermatogenesis
LH	Females: ovarian follicle development Males: testicular hormone secretion
ACTH	Secretion of hormones of the adrenal cortex
TSH	Secretion of thyroid hormone

* Ridiculously Oversimplified Summary

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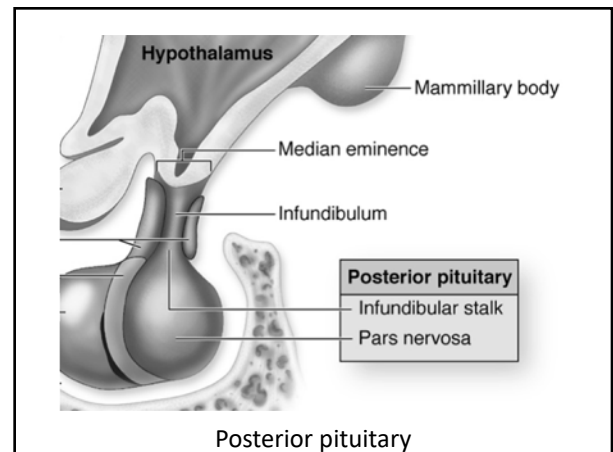


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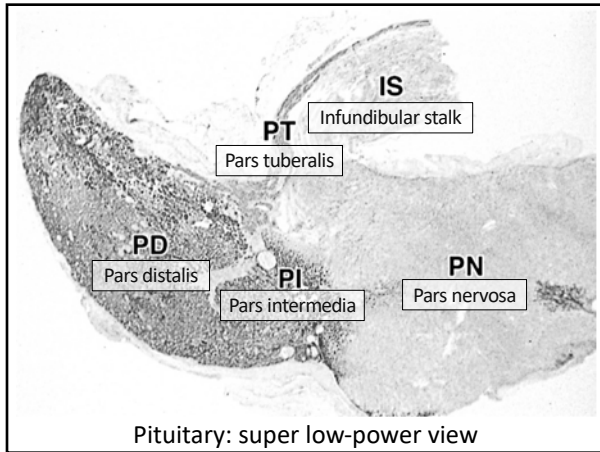
Posterior Pituitary (Neurohypophysis)

- Composed of neural tissue (mostly axons).
- Subdivisions
 - Pars nervosa (biggest and most important part)
 - Median eminence (floor of the hypothalamus)
 - Infundibulum and infundibular stalk (axons traveling from hypothalamus to pars nervosa)

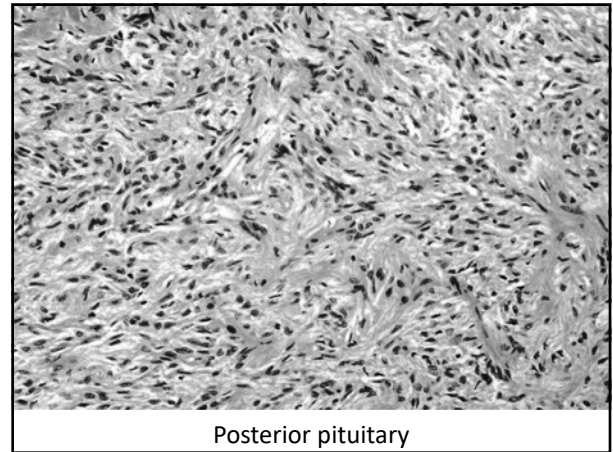
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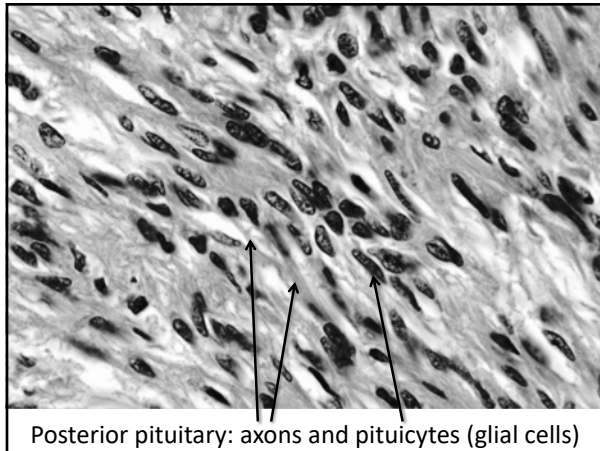
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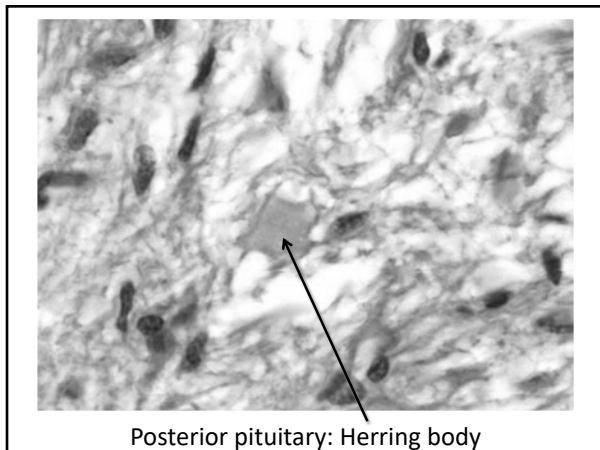


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Hormones of the Posterior Pituitary

- Posterior pituitary doesn't make hormones! It secretes hormones made by the hypothalamus.
- Herring bodies are dilated portions of axons containing with hormone-filled vesicles.
- Hormones:
 - Antidiuretic hormone (ADH) (also called vasopressin)
 - Oxytocin

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BAHS* of Posterior Pituitary Hormones

Hormone	Stimulates
Antidiuretic hormone	Water reabsorption in the kidney
Oxytocin	Contraction of uterine smooth muscle in labor. Contraction of breast cells to allow milk let down.

* Boring as heck summary

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VIS* of Oxytocin

Situation	Stimulates
Interpersonal connection	Trust
Orgasm	Pleasure AND connection with that particular person
Intimate relationship	Monogamy
Sports teams	Better performance

* Very interesting summary

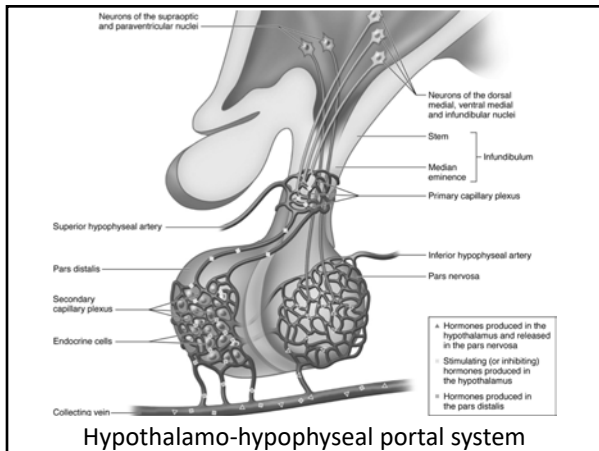
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Control of the Anterior Pituitary

Hypothalamus
 The hypothalamus produces and releases hormones that stimulate or (less commonly) inhibit hormone secretion from the anterior pituitary.

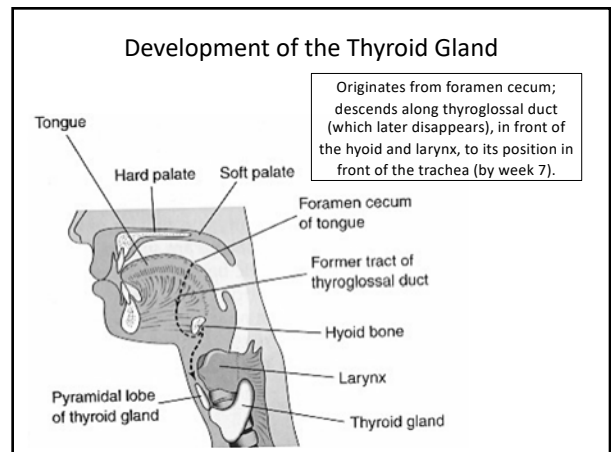
Target organs
 Hormones produced by target organs exert negative feedback on both the hypothalamus and the anterior pituitary. Too much hormone turns off production/secretion for a while. Nice!

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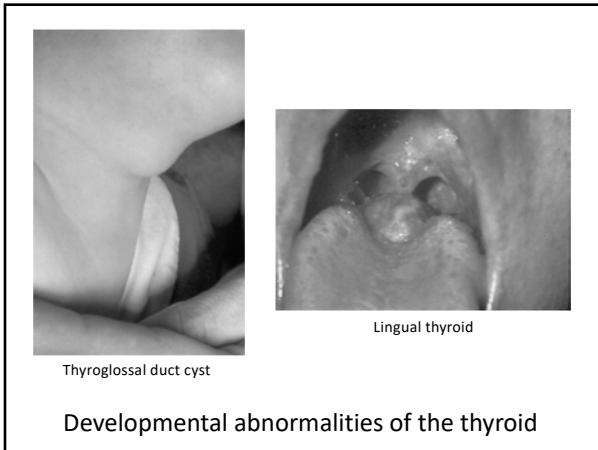
Endocrine System Lecture Outline

- Introduction
- Pituitary
- Thyroid

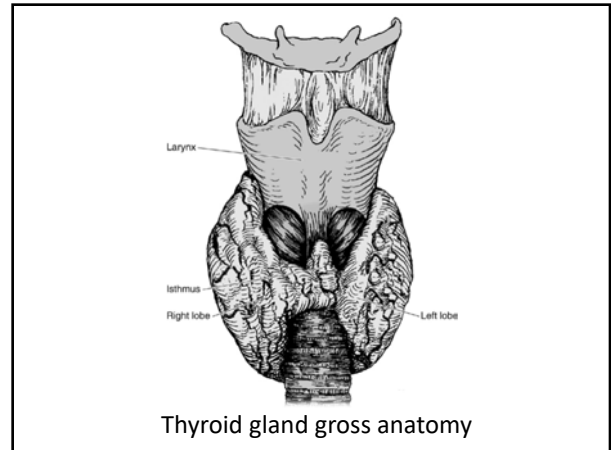
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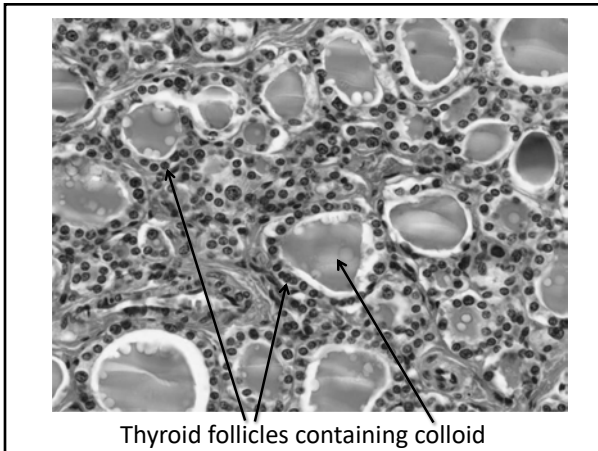
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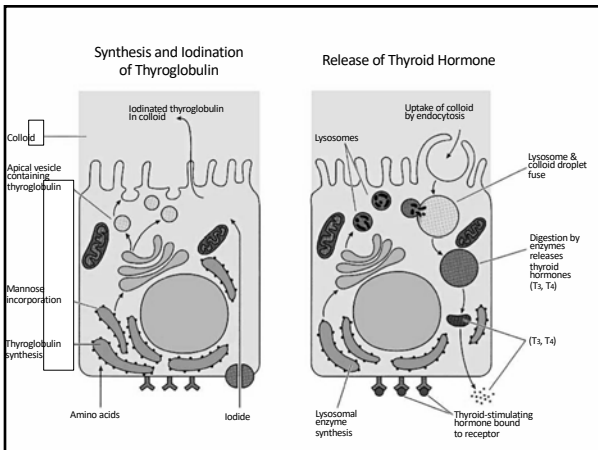


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Thyroid Gland

- Composed of round follicles lined by simple squamous to cuboidal epithelium and filled with colloid.
- Follicular cells synthesize thyroid hormones (T3 and T4) and secrete them into the blood.
- Hypothalamus releases TRH (thyrotropin releasing hormone), which makes pituitary release TSH (thyroid stimulating hormone), which makes thyroid release thyroid hormone.

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What Does Thyroid Hormone Do?

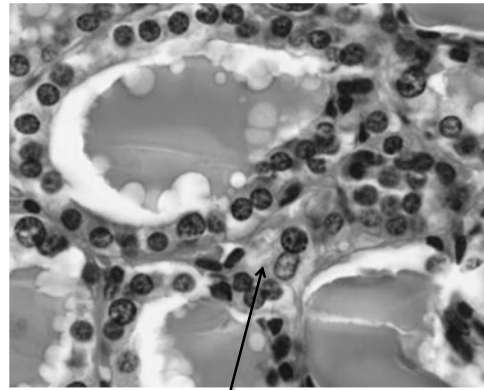
- Quick answer: increase growth and metabolism.
- More detailed answer: stimulate mitochondrial protein synthesis, increase absorption of carbohydrates, regulate fat metabolism, promote cell growth.
- Bottom line: it increases basal metabolic rate and revs up most bodily functions (increases heart rate, raises body temperature, increases nervous reactivity, increases GI motility...the list goes on).

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Parafollicular Cells (C Cells)

- Derived from neural crest ectoderm.
- Located between follicular cells and between follicles.
- Parafollicular cells are larger cells with clear cytoplasm and small secretory granules containing calcitonin.
- Calcitonin is made in response to high blood calcium (it's not regulated by the pituitary!).
- Calcitonin lowers blood calcium levels by inhibiting osteoclastic resorption.

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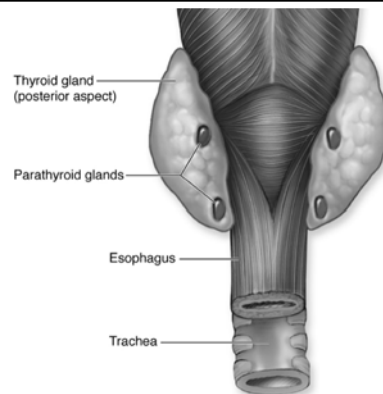
Parafollicular (C) cell

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Endocrine System Lecture Outline

- Introduction
- Pituitary
- Thyroid
- Parathyroid

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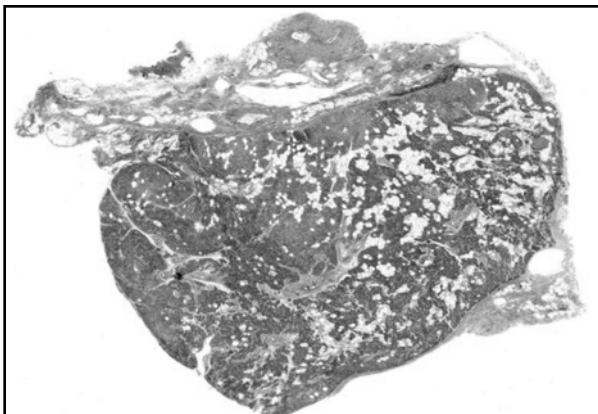
Parathyroid glands gross anatomy

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Parathyroid Glands

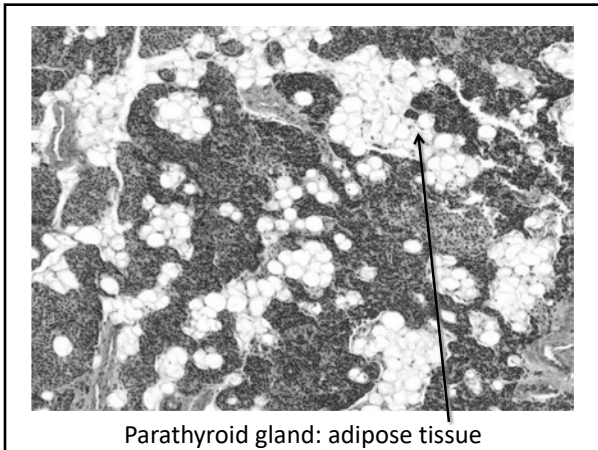
- Four glands on posterior surface of thyroid.
- Main function: secrete parathyroid hormone (PTH) to regulate calcium levels.
- PTH raises calcium levels in response to low serum calcium (it's not regulated by the pituitary!).
- Two main cell types: chief cells (secrete PTH) and oxyphils (function unknown).

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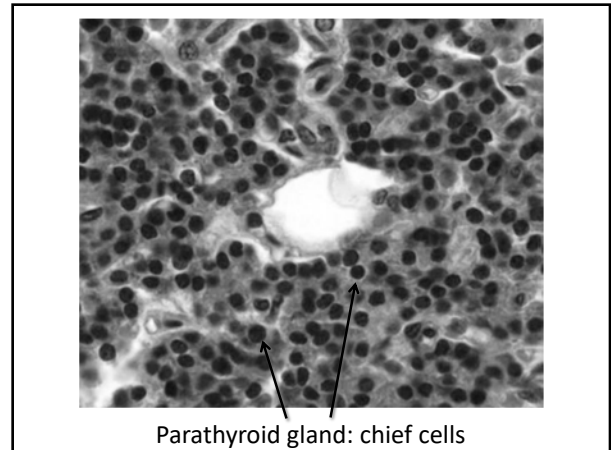


Parathyroid gland: super low-power view

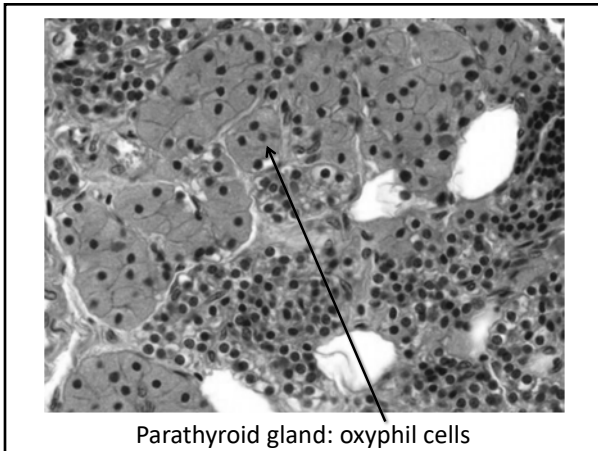
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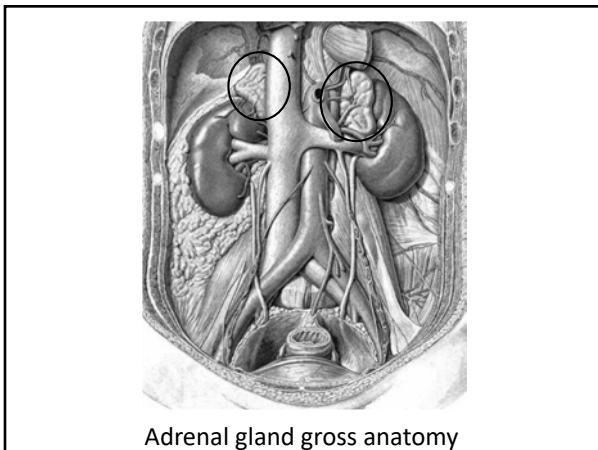


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Endocrine System Lecture Outline

- Introduction
- Pituitary
- Thyroid
- Parathyroid
- Adrenal

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The Adrenal Cortex and Medulla

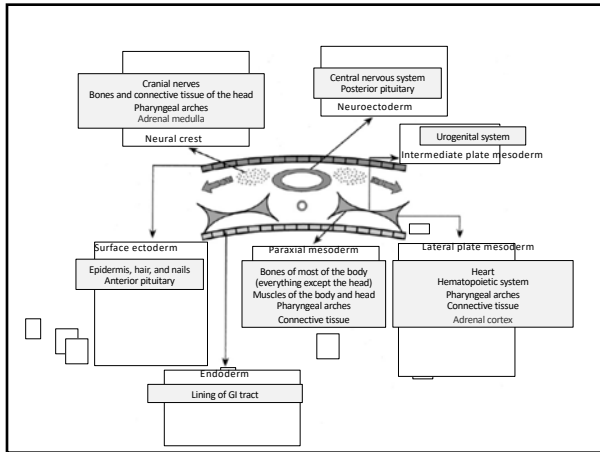
Adrenal cortex is on the outside

- Originates from mesoderm
- Produces steroids (mineralocorticoids, glucocorticoids, and sex steroids)

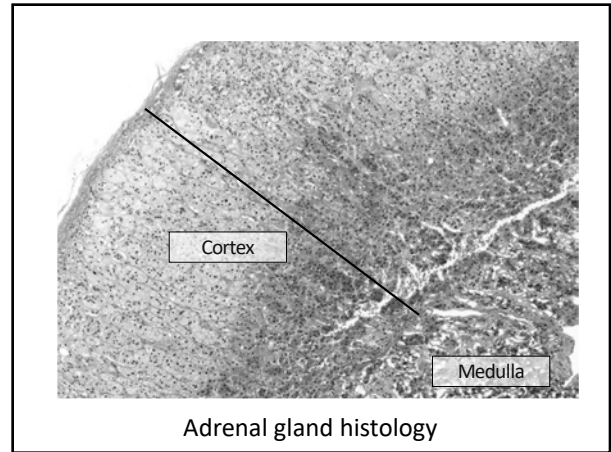
Adrenal medulla is on inside

- Originates from neural crest
- Produces epinephrine and norepinephrine

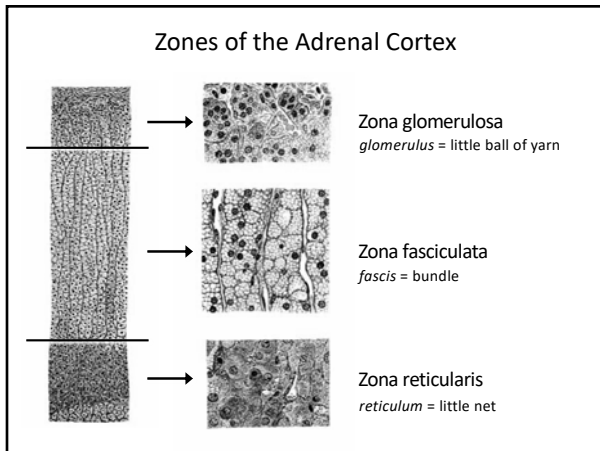
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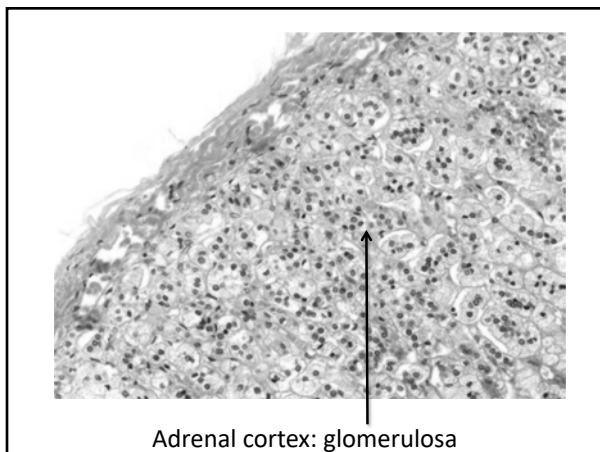


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Zona Glomerulosa

- Outermost zone. Cells arranged in little clusters.
- Cells produce mineralocorticoids (mostly aldosterone).
- Aldosterone stimulates sodium reabsorption by the kidney (leading to an increase in blood pressure).
- Aldosterone release is stimulated *mostly* by angiotensin II (only *slightly* by ACTH).

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Zona Fasciculata

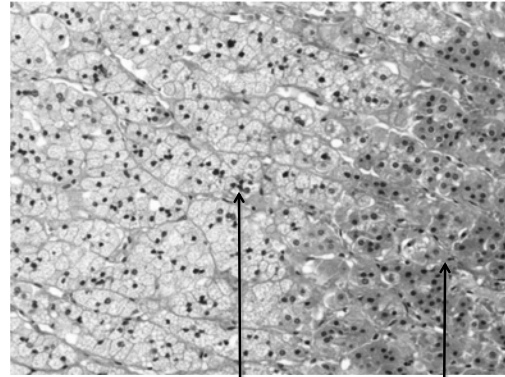
- Middle zone. Cells arranged in straight bundles.
- Cells make glucocorticoids (mostly cortisol), and a small amount of androgens.
- Cortisol is a long-term “stress” hormone
 - Mobilizes resources (increases blood glucose)
 - Shuts down stuff you don’t need (digestion, growth, immune response, reproduction)
- Cortisol release is stimulated by ACTH.

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Zona Reticularis

- Innermost zone. Cells form an irregular network.
- Cells make sex steroids (androgens).
- Androgens have weak masculinizing characteristics.
- Androgen release is stimulated by ACTH.

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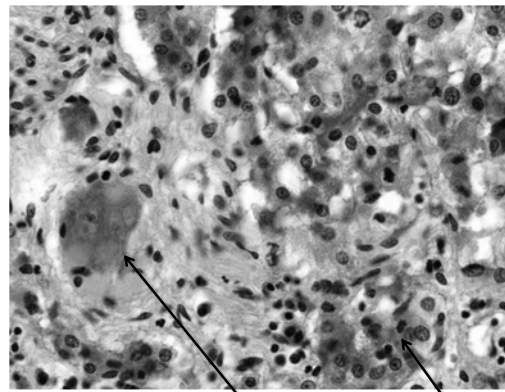
Adrenal cortex: fasciculata and reticularis

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Adrenal medulla

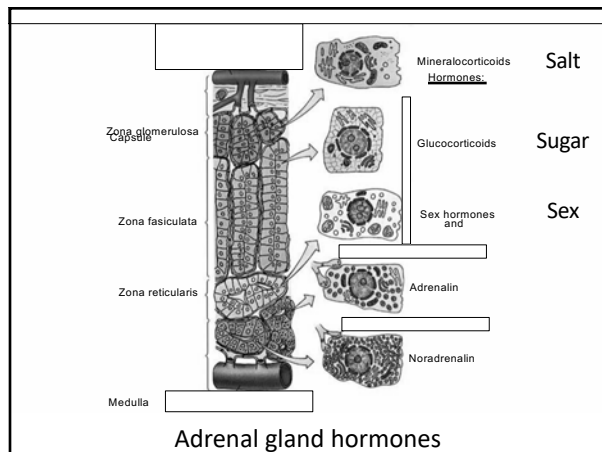
- Contains chromaffin cells (modified sympathetic neurons lacking axons and dendrites) and a few sympathetic ganglion cells.
- Chromaffin cells produce catecholamines (mostly epinephrine and a little norepinephrine) when stimulated by preganglionic sympathetic neurons.
- Catecholamines are the “fight or flight” hormones. They increase blood glucose, increase heart rate, increase blood flow to heart and skeletal muscle, and decrease blood to non-essential organs.

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Adrenal medulla: ganglion cell and chromaffin cells

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Endocrine System Lecture Outline

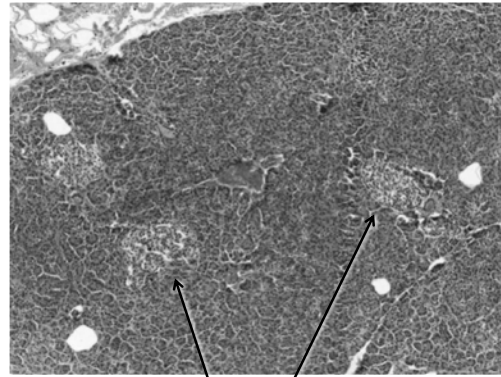
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- Pancreas

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Pancreas

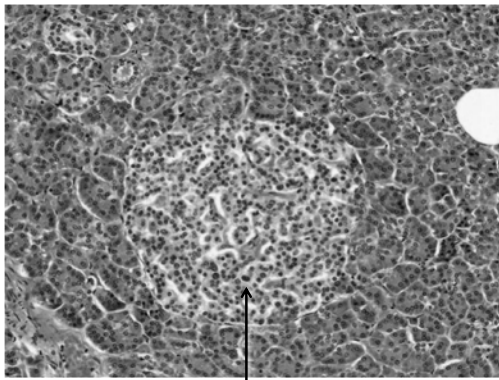
- The pancreas has both exocrine (ducts) glands and endocrine (ductless) glands.
- The exocrine glands produce digestive enzymes; we'll discuss these in the Pancreas, Liver and Gallbladder lecture.
- The endocrine glands produce hormones that regulate blood glucose: glucagon, insulin, and somatostatin. They also produce pancreatic polypeptide, which helps regulate the digestive system.

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Pancreatic islets (of Langerhans)

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Pancreatic islet (of Langerhans)

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Main Islet Cells and Hormones

A (alpha) cells

- Secrete glucagon when blood glucose is low
- Glucagon raises blood glucose

B (beta) cells

- Secrete insulin when blood glucose is high
- Insulin decreases blood glucose by making cells take up glucose and making the liver synthesize glycogen

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Other Islet Cells and Hormones

D (delta) cells

- Secrete somatostatin
- Somatostatin inhibits release of insulin and glucagon

F cells

- Secrete pancreatic polypeptide
- Pancreatic polypeptide inhibits release of digestive enzymes
- Also causes relaxation of gallbladder and decreases secretion of bile

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Endocrine System Lecture Outline

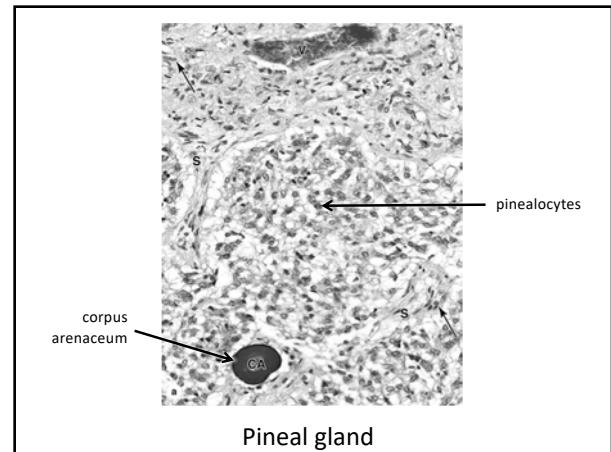
- Introduction
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- Pineal

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Pineal Gland

- Located in brain near posterior third ventricle
- Two main cell types: pinealocytes and glial cells
- Pinealocytes occur in clusters and produce melatonin (which helps induce sleep) in response to light.
- “Brain sand” (corpora arenacea) are globules of basophilic calcified material that can be seen radiologically.

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