Histology of the endocrine system

General functions of endocrine organs

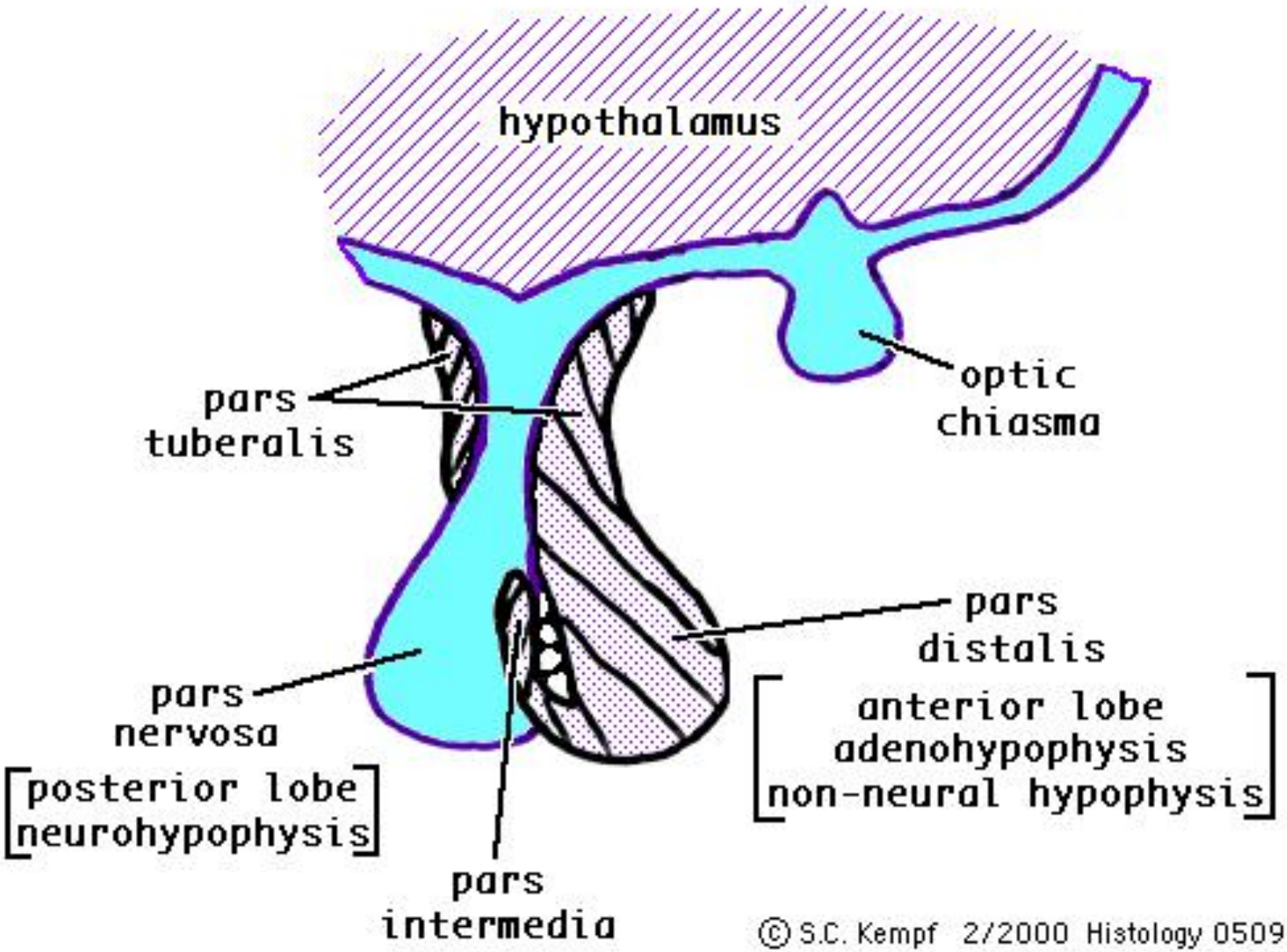
- Endocrine glands are a group of organs that synthesize and release hormones that affect the function of other target organs or tissues in the body.
- In some cases there are interactions between the hormone and the nervous system.
- So we can say that the nervous system and the endocrine system are each affected by and modulate the activities of the other.
- Thus, the nervous and endocrine elements of control are often lumped together under the heading neuroendocrine system.

Pituitary gland

- **Pituitary gland = Hypophysis -** an endocrine organ with obvious neural and non-neural endocrine components
- **Non-neural hypophyseal tissue**.
  - In mammals and birds it's called Rathke's pocket/pouch.
  - Composed of non-neural ectoderm.
  - Cells either
    - separate from the ectodermal external surface and migrate through the head mesenchyme to the infundibulum of the diencephalon. These cells come to lie adjacent to floor of infundibulum, or
    - the cells of the external ectoderm invaginate to form a tube that extends back to the infundibulum (mammals, birds). The tube eventually separates from the external epithelium.
- **Neural hypophyseal tissue**
  - Infundibulum forms as outpocketing of floor of diencephalon that associates with Rathke's pocket.
- Together these tissues form the hypophysis.

- **Neurohypophysis:**
  - Composed of :
    - **pars nervosa** = posterior lobe of the pituitary**; stain lightly.**
    - Infundibulular stalk
    - Median eminence
  - Continuous with **hypothalamu**s of brain.
  - Neurosecretory cells in hypothalamus extend axons through the median eminence and infundibulular stalk, and into the pars nervosa where neurosecretory products are stored and released.
- **non-neural hypophyseal tissue** (lining of Rathke's pocket in mammals and birds) forms the **adenohypophysis**
  - This is composed of 3 major parts.
    - **pars distalis** (anterior lobe of the pituitary gland) - largest component of adenohypophysis; **stain darkly.**
    - **pars intermedia**
      - lies between pars nervosa and pars distalis. Separated from pars distalis by "primitive fissure"/intraglandular cleft which is the remainder of the cavity within the invagination that formed Rathke's pocket.
      - Remnants of Rathke's pouch lumen
      - Prominent in lower vertebrates (amphibians and fishes) but rudimentary in mammals
      - Cords of weakly staining basophils, few secertory granules, small barely visible
      - Rathke's cysts, (front of the pars intermedia), cuboidal epithelium, with colloid
      - Amphibians - MSH
      - Function not well understood
    - **pars tuberalis** - adenohypophyseal tissues that surround the stalk of the pars nervosa but mainly anterior to it.
      - Cells aranged in cords along blood vessels
      - Secrete mostly FSH & LH

Pituitary Gland



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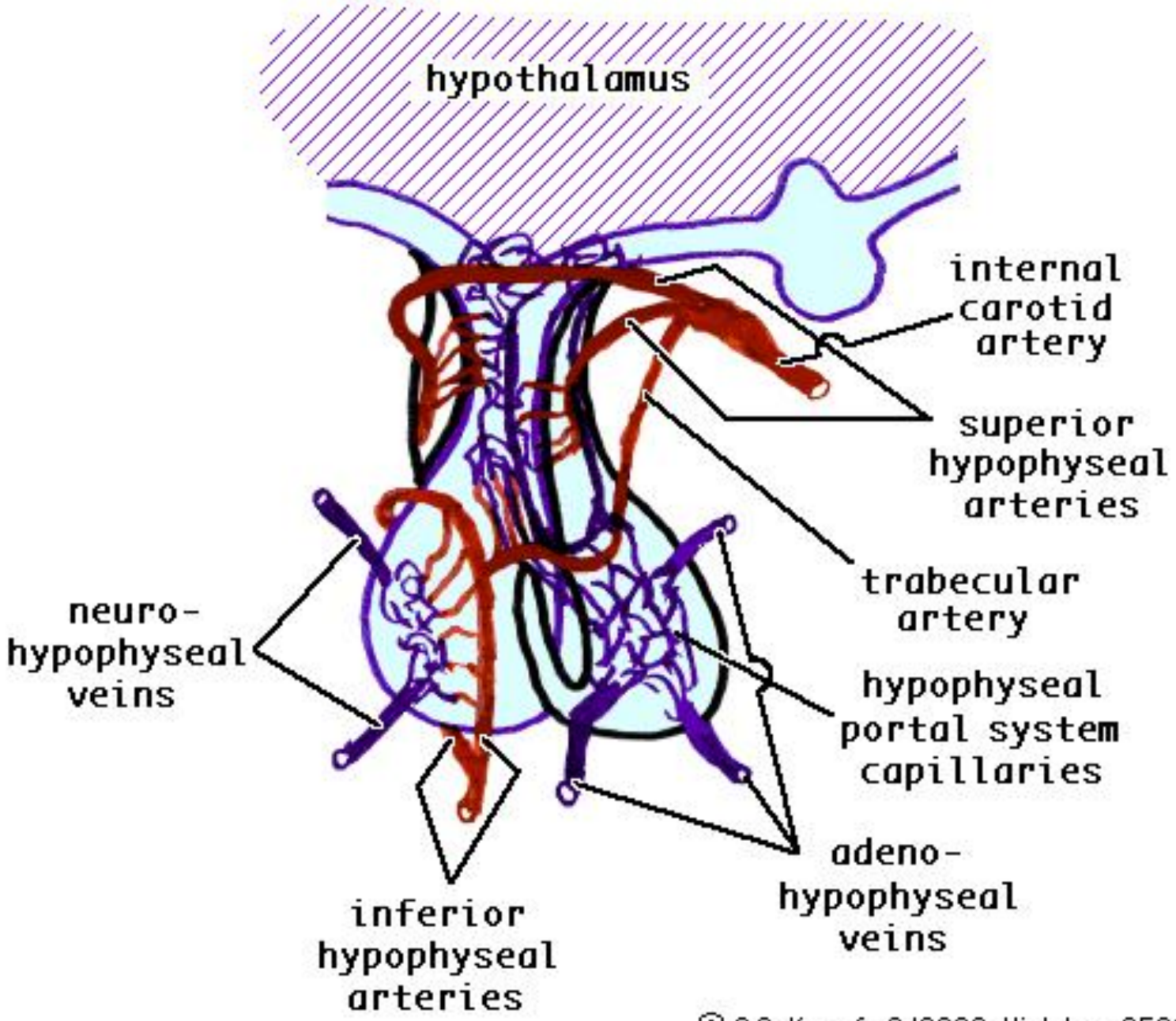
Caridovascular circulation to the pituitary gland

- Since these tissues secrete hormonal substances, we would expect a well developed vascular system that would provide a means of carrying these hormones to other parts of the body.
- Five arteries provide blood to the pituitary gland. these are,
  - 2 superior hypophyseal arteries
  - 2 inferior hypophyseal arteries.
  - the trabecular artery
- These arteries enter the pars nervosa where they form a capillary mesh in its tissues. Some of the arterial branches entering the pars nervosa form a capillary mesh in the median eminence region.
- The capillaries merge to form venules and veins
- In the median eminence region, the venules that are formed extend into the pars tuberalis and then the pars distalis. Venules and veins originating from other capillaries exit the pars nervosa.
- Those veins that enter the pars distalis form a second capillary mesh (a portal system) within its tissue = **hypophyseal portal system**
- These capillaries coalesces to form venules and veins that leave the pars distalis
- **Importance of this portal system:** The **hypophyseal portal system** carries hormones from the median eminence region to the pars distalis where they have an effect on the secretion of hormones by cells in that part of the pituitary gland.

Pituitary Gland - Circulation



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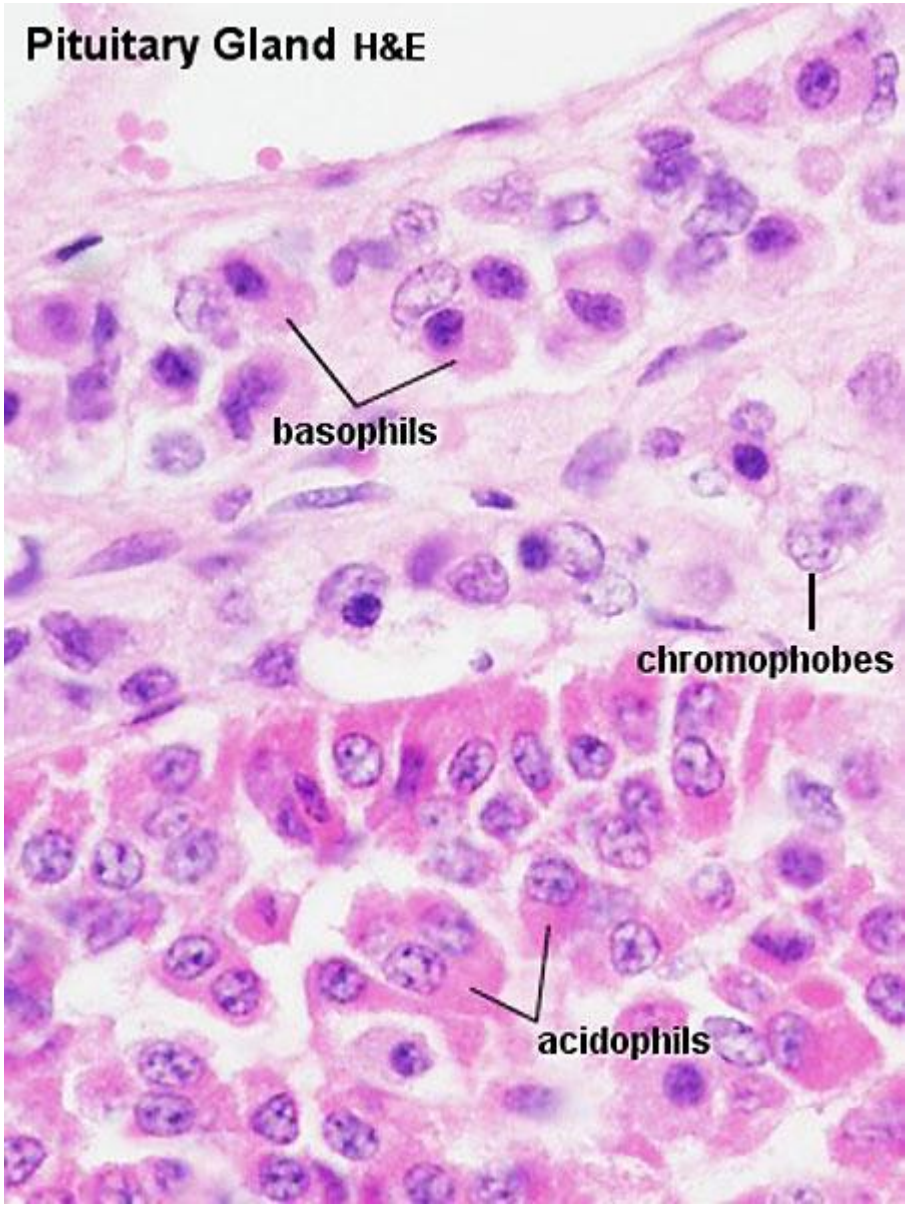
Tissue structure and cell types of the **pars distalis**

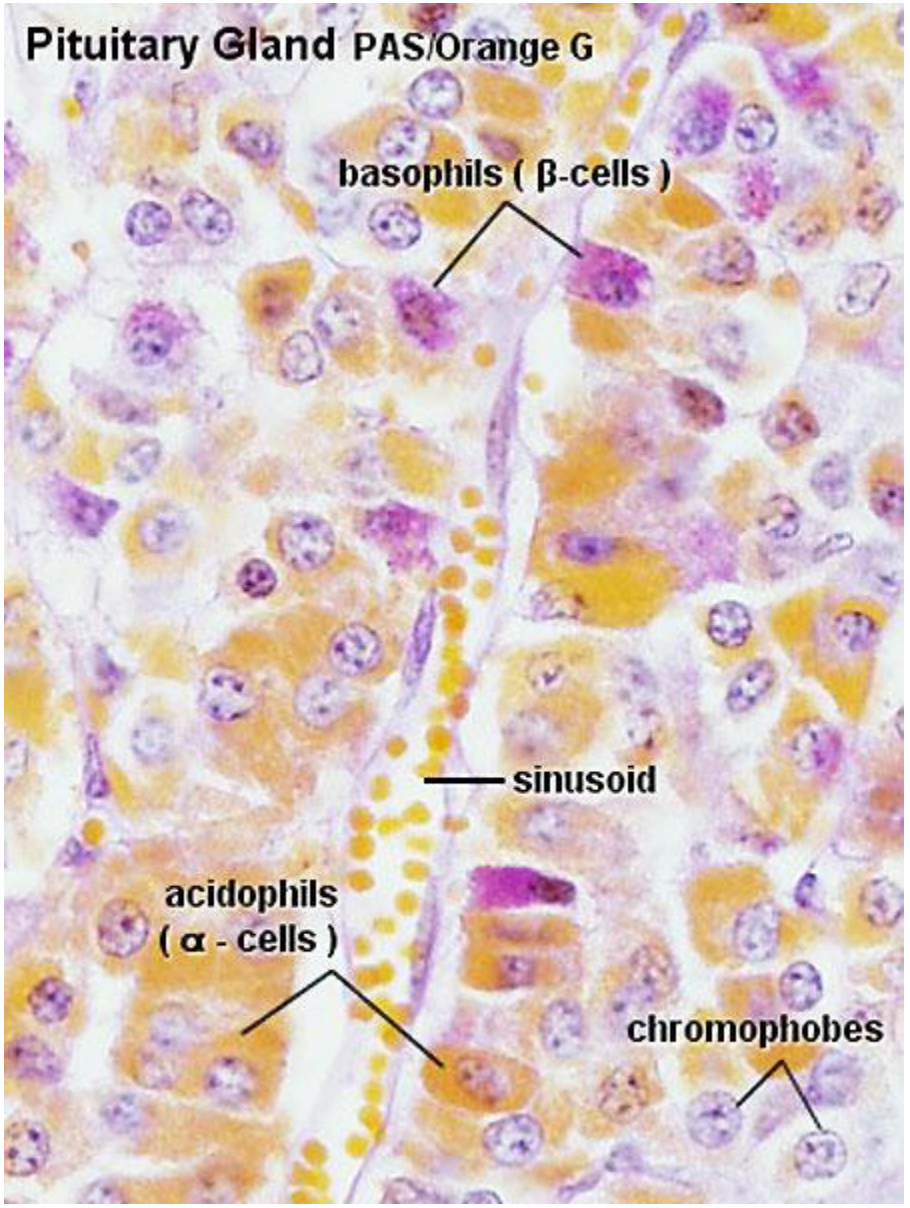
- Has typical appearance of endocrine tissue, that is groups of cells organized into cords or follicles
- Through this tissue run **fenestrated capillaries** that are part of **hypophyseal portal system**.
- Two major classes of cells are present in the pars distalis. Classification is based on staining characteristics.
  - **Chromophobes or chief cells**
    - don't pick up stain
    - cytoplasm appears white or clear in stained sectioned material
    - Smaller than chromophils
    - EM=some with few very small granules, others, none
    - Star shaped, between capillaries
    - Center of the gland.
    - This group of cells includes the
      - **Follicular cells** that form a supporting meshwork for the tissues of the adenohypophysis.
      - **Secretory cells** that are thought to secrete hormones, but that are not well understood at present.
    - One type of chromophobe in rats secretes adrenocorticotropic hormone that stimulates the adrenal gland. (However, in humans this hormone is produced by a basophilic chromophil)

- **Chromophils** - these cells pick up acidic or basic stains
  - **Basophils (Beta cells)**
    - Distributed throughout pars distalis but more toward the center
    - Cytoplasmic granules stain blue with hematoxylin

    - **Gonadotropic cells**
      - Secrete hormones that affect reproductive organs (follicle stimulating hormone, FSH. leuteinizing hormone, LH. interstitial cell stimulating hormone, ICSH).
        - » **FSH** - glycoprotein that stimulates and supports early growth of follicles in ovary and gametogenesis in testis.
        - » **LH** - Stimulates Corpus luteum in Ovary. glycoprotein that reaches peak during menstrual cycle. 24 hr after peak, ovulation occurs. In males leuteinizing hormone is called interstitial cell stimulating hormone (**ICSH**) - stimulates interstitial cells of Leydig in testes to secrete testosterone
      - Small round cells with dense, basophilic, secretory granules
      - Distributed throughout pars distalis.
      - FSH and LH secreting cells test positive with the periodic acid schiff (**PAS**) stain because the hormones are glycoproteins.
    - **Thyrotropic cells**
      - Secrete thyroid stimulating hormone =thyrotropin (**TSH**)- stimulates synthesis of thyroid hormones.
      - Positive **PAS** because hormone is a glycoprotein.
    - **Adrenocorticotropic cells**
      - **Secrete ACTH and lipotropin (LPH)**

- **Acidophils (Alpha cells)**
  - Distributed throughout pars distalis but more toward the periphery
  - Cytoplasmic granules stain pink with eosin
- **Somatotropic cells** - secrete **growth hormone**
  - Growth hormone = **somatotropin** (**STH**)- protein.
    - Most marked effect is on epiphyseal cartilage of bone, hormone acts on liver to cause production of a peptide called somatomedin. This peptide stimulates growth of epiphyseal plate. Lack of this hormone results in hypopituitary dwarfism which can now be treated in some cases with hormone injections. Overproduction of STH can cause gigantism and may eventually result in acromegaly which is expressed as extra growth of bones and extremities (nose, fingers, jaw, etc.) causing deformity and disability.
- **mammotropic cells** - secrete **prolactin**
  - Protein hormone that triggers development of mammary glands during pregnancy and secretion of milk by mammary glands during lactation.


Pituitary Gland H&E
basophils
chromophobes
acidophils


Pituitary Gland PAS/Orange G
basophils (β-cells)
sinusoid
acidophils
(α - cells)
chromophobes

- The cells of the pars distalis are caused to secrete various hormones by the action of hormonal factors synthesized in the hypothalamus and secreted in the median eminence. These are called **releasing factors**, e.g. growth hormone releasing factor (GHRF), gonadotrophic releasing hormone (GnRH).
- In many cases the hypothalamus, hypophysis, and affected organ work in concert with positive or negative feedback occurring between them.

Hypothalamus Releasing Hormones (Control Anterior Pituitary Function)

- GBH- Gonadotropin Releasing Hormone
- LRH- Luteinizing Releasing Hormone-Both for FSH and LH
- PIH- Prolactin Inhibitory Hormone, Suppresses Prolactin in non Pregnant
- CRH, Corticotrophin Releasing Hormone, stimulates release of ACTH
- SRH(GRH) -Somatotrophin (Growth Hormone) Releasing Hormone
- Somatostatin, Somatotrophin and TSH Inhibitory Hormone

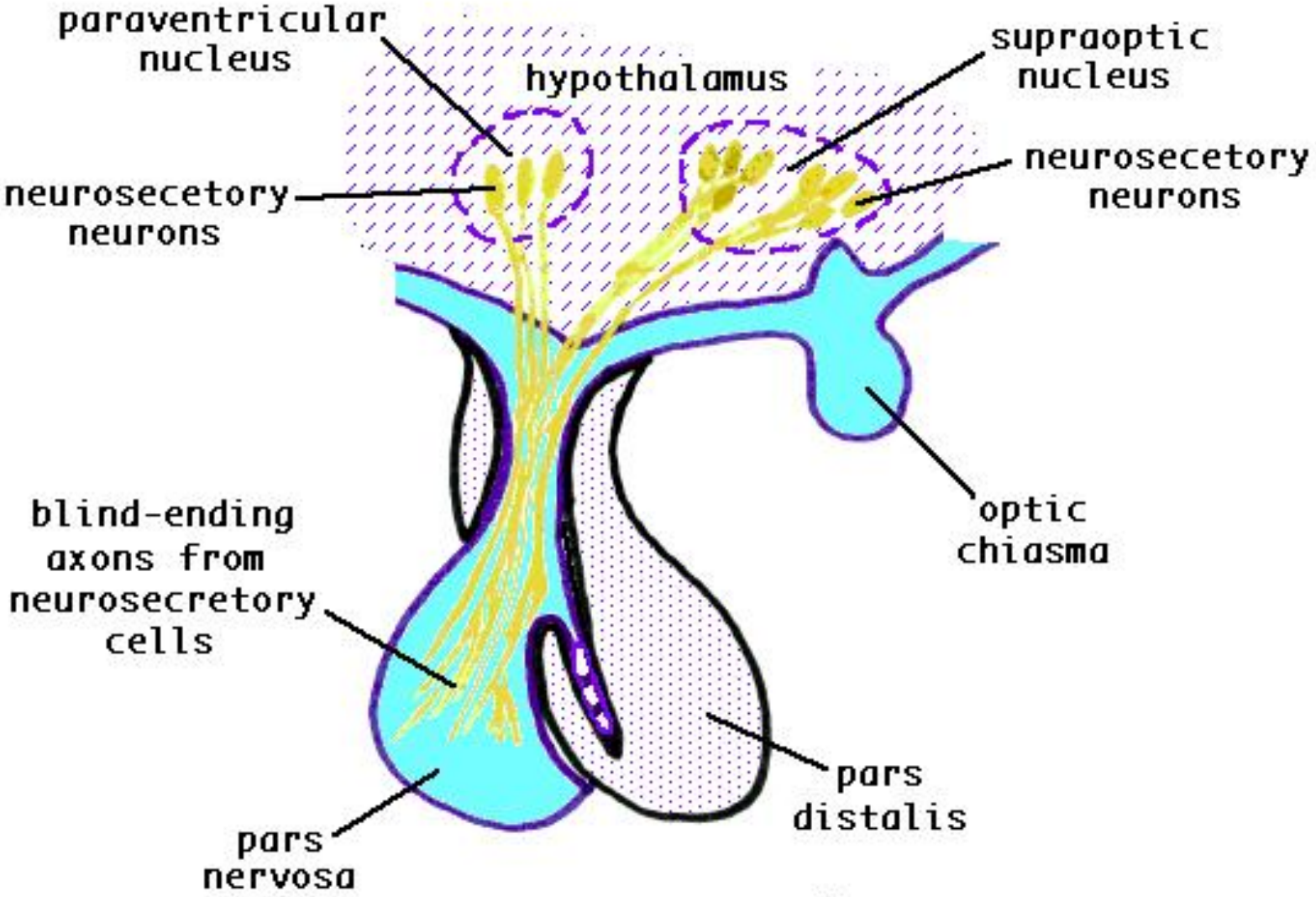
Tissue structure and cell types of the **pars nervosa**

- This is the posterior lobe of the hypophysis that is formed from the tissues of the diencephalic infundibulum. These tissues remain attached to the part of the brain that becomes the hypothalamus.
- The pars nervosa and the stem of the posterior lobe are mainly composed of unmyelinated axonal processes.
- These axons arise from neuron perikarya that are located in the supraoptic and paraventricular nuclei of the hypothalamus.

- These hypothalamic cells are neurosecretory neurons that synthesize neurosecretory products such as **oxytocin** and **vasopressin (anti-diuretic hormone, ADH)**, and the various releasing factors mentioned above. The oxytocin and vasopressin accumulate in the dilated blind endings of these axons that are located in the pars nervosa **(Herring bodies).**
  - Major effect of vasopressin is to increase permeability to water of the tubules of the kidney. This causes a higher rate of re-absorption of water by these tubules and thus concentrates the urine.
  - Oxytocin promotes contraction of the smooth muscle of the uterine wall during parturition (birth/labour). Also, causes contraction of myoepithelial cells that surround ducts of the mammary glands helping to express the milk as a baby feeds.
    - * In the case of child birth distension of the vagina excites stretch receptors in the vaginal wall. These cause action potentials to be sent to the CNS where the appropriate neurosecretory cells of the hypothalamus receive nervous stimulation and release oxytocin in the pars nervosa. This hormone enters the circulatory system and is carried to the muscles of the uterine wall where it causes these muscles to contract.
- So the hypothalamus is actually a component of the posterior pituitary's endocrine function since the actual hormones are synthesized there and then stored in the blind endings of axons in the pars nervosa.

- You will also find the cells called **pituicytes** in the tissues of the pars nervosa. Generally, only the stained nuclei (oval nuclei)of these cells can be seen in histological sections.
  - These cells are of irregular shape and often have numerous cytoplasmic processes.
  - They are considered to be a type of glial cell, but their function is not well understood.
- Accumulations of oxytocin or vasopressin in the blind endings of axons in the pars nervosa form the **Herring bodies (corpuscles)** seen in this tissue with the light microscope.
- When appropriate neural stimulation of the neurosecretory cells occurs, the blind endings of the axons release their secretory products into capillaries in the pars nervosa. The hormones are then carried to their point of action in other parts of the body (e.g. oxytocin).

Pituitary gland - pars nervosa



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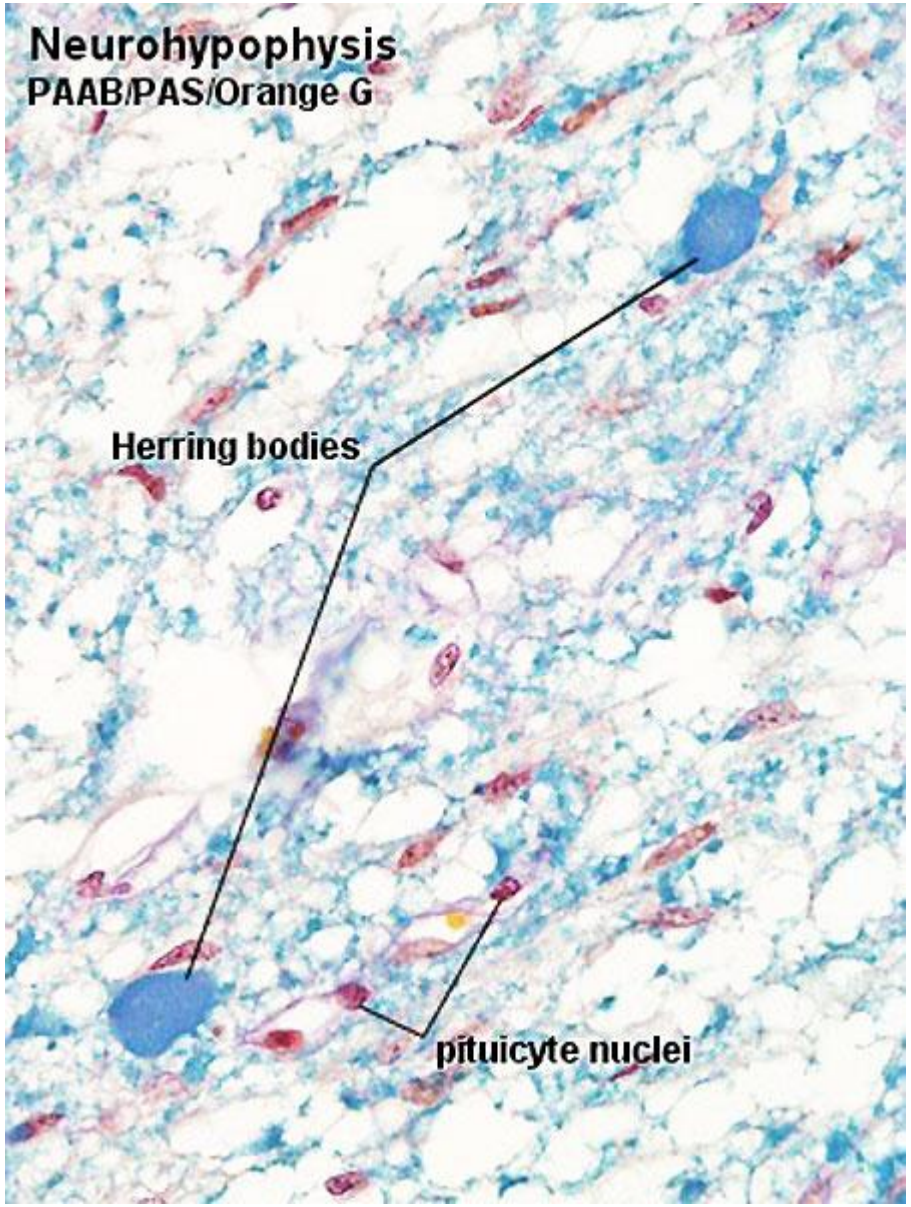
Neurohypophysis
PAAB/PAS/Orange G
Herring bodies
pituicyte nuclei