**“Endocrine System”

{slide no.2}**

*\*\*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. It means that there’s interaction between the endocrine and neural system.

**{slide no.3}**
**\*\*Pituitary Gland**

**\*\* Pituitary gland (Hypophysis):** an endocrine organ with obvious neural and non-neural endocrine components/parts:
 **# Non-neural hypophyseal tissue**.

–In mammals and birds it's called Rathke's pocket/pouch because it’s derived from Rathke’s pocket/pouch.

–Composed of non-neural ectoderm (oral 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.

 These have something to do with embryology of the cells. In both cases the cells are derived from ectoderm, that goes deep inside through the head of the mesenchyme and come in close proximity to what’s called the infundibulum of the diencephalon, which is part of the brain, after that they become the hypothalamus.

 **# Neural hypophyseal tissue**

 Infundibulum forms as out pocketing of floor of diencephalon that associates with Rathke's pocket.

Together these tissues form the hypophysis.
The neural part is from the infundibulum of diencephalon, and the non-neural part (the ectodermic part) is from Rathke’s pocket.

**{slide no.4}**

\*\* ***Neurohypophysis:***–The neural part of Pituitary gland

–Divided into three parts:

**1.pars nervosa:** posterior lobe of the pituitary gland**; stain lightly.** It’s the largest part.
**2.Infundibulular stalk**

**3.Median eminence**.

–Continuous with **hypothalamus** of brain (coming down from the brain).

–Neurosecretory cells in hypothalamus extend axons through the median eminence and infundibular stalk, and into the pars nervosa where neurosecretory products are stored and released.
**Secretions of the posterior lobe** (pars nervosa) are produced from supra optic and para ventricular nuclei of the hypothalamus then they move along with axons of neurons, after that they’re stored in the neurons’ terminal parts then released.

**{slide no.5}**
At the lower end of infundibular stalk we find pars nervosa. Pars nervosa is the posterior lobe but when we say neurohypothalamus we mean the three parts.

**{slide no.4}**

 ***Non-neural hypophyseal tissue (adenohypophysis):***

–lining of Rathke's pocket in mammals and birds

–This is composed of three major parts:

**1.pars distalis** (anterior lobe of the pituitary gland), largest component of adenohypophysis; **stain darkly.**Even in sections with low magnification we can distinguish between pars nervosa and pars distalis by the dark or light stain

**2.pars intermedia**

– lies between pars nervosa and pars distalis (between the posterior and anterior lobe). Separated from pars distalis by "primitive fissure” or what’s called intraglandular cleft, which is the remainder of the cavity within the invagination that formed Rathke’s pocket.
–Remnants of Rathke’s pouch lumen

**{slide no.5}**In front of pars intermedia we find something like cleft or groove which is “primitive fissure” or intraglandular cleft.

**{slide no.4}**

 -**Pars intermedia** in general is prominent in lower vertebrates (amphibians(frogs) and fishes) but rudimentary and in small amounts in mammals

–Sometimes we find cords of weakly staining basophils, with few secertory granules that are small and barely visible

–And sometimes we find Rathke's cysts, (front of the pars intermedia), lined with cuboidal epithelium, and contain colloid in lower vertebrates more than the higher vertebrates by the fact that lower vertebrates are more developed

–It has been found that in Amphibians/frogs pars intermedia secretes Melanin-Stimulating Hormone (MSH)

–The function of this part is not well understood in higher vertebrates in mammals and humans.

**3.pars tuberalis:** adenohypophyseal tissues that surround the stalk of the pars nervosa (infundibular stalk) but mainly anterior to it.

–Cells arranged in cords along blood vessels.

–Secrete mostly FSH (Follicular Stimulating Hormone) & LH (Luteinizing Hormone), but it’s not the main source of them, instead it’s cells in the anterior lobe.

**{slide no.6}**

***\*\*Cardiovascular circulation to the pituitary gland***
\*We **only** need to know the hypophyseal portal system.

 The capillaries merge to form venules and veins, then those veins and venules form a second capillary mesh (a portal system) within its tissue = **hypophyseal portal system.**

 **Portal means** that capillaries merge to form veins then those veins distribute into capillaries and this is abnormal.
 In normal cases artery distributes into capillaries then those capillaries merge to form veins, and veins don’t go back to form capillaries.

 Capillaries are present in median eminence, where secretion of “control hormones” of hypothalamus takes place, they control the functions of the anterior pituitary gland (anterior lobe); because the posterior lobe is responsible for storage and release of hormones meanwhile the anterior lobe is responsible for production and release of hormones so it has to be under the control of hypothalamus.
 The control hormones will be secreted in median eminence (part of the hypothalamus) then enter the capillaries and coalesce in venules, after that they move to anterior lobe of pituitary gland (pars distalis) where they redistribute into capillaries to reach the target cells present in the anterior lobe; to manipulate the function either by increasing or decreasing the secretion.

**{slide no.8}**
*\*\*Tissue structure and cell types of the* ***pars distalis*** *(anterior lobe)*

•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** (at the end of it).

•Two major classes of cells are present in the pars distalis. Classification is based on staining characteristics:

1. **Chromophobes or chief cells**

•Don't pick up stain or possibly stain lightly.

•Cytoplasm appears white or clear in stained sectioned material (in hematoxylin and eosin stain).

•Smaller than chromophils in general

•In Electron Microscopy some of them contain few very small granules, others don’t contain any granules.

•Star shaped, and arranged between capillaries

•They are mainly present in the center of the gland (pars distalis).

•This group of cells includes the following:

–**Follicular cells** that form a supporting meshwork for the tissues of the adenohypophysis. They do not contain small granules.

–**Secretory cells** that are thought to secrete hormones, but that are not well understood at present. They contain small granules.

•One type of chromophobe in rats secretes adrenocorticotropic hormone (ACTH) that stimulates the adrenal gland. (However, in humans this hormone is produced by a type of basophilic chromophil responsible for producing this hormone.

**{Slide no.9}**2.**Chromophils** These cells pick up acidic or basic stains. They’re divided into two types; Basophils (β cells, stain blue) and Acidophils (α cells, stain pink or red)

 –**Basophils (Beta cells)**

–Distributed throughout pars distalis but mainly more toward the center (we might find them not in the center).

–Cytoplasmic granules stain blue with hematoxylin; that’s why we call them basophils.
–They are further subdivided into three types depending on their secretion:

a.**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 luteinizing 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 mainly in the center.

–FSH and LH secreting cells test positive with the periodic acid schiff (**PAS**) stain because the hormones are glycoproteins. When the secretion is glycoprotein, the cells will stain positively with PAS like gonadotropic and thyrotropic cells

b.**Thyrotropic cells**

–Secrete thyroid stimulating hormone =thyrotropin (**TSH**)- stimulates synthesis of thyroid hormones.

–Positive **PAS** because hormone is a glycoprotein.

c.**Adrenocorticotropic cells**

–**Secrete ACTH and lipotropin (LPH)** , it has something to do with mobilization of fat.

\*We can’t recognize each type of the three in EM, but we can only know that they are basophils.

**{slide no.10}**

 **–Acidophils (Alpha cells)**

–Distributed throughout pars distalis but mainly more toward the periphery.
–Cytoplasmic granules stain pink with eosin.
–Subdivided into two types:

a.**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.

b.**mammotropic cells** - secrete **prolactin**

•Protein hormone that triggers development of mammary glands during pregnancy and induce secretion of milk by mammary glands during lactation.

**{slide no.11}** The left figure represents a H&E stained section in pars distalis in which we expect to find chromophobes (their nuclei seem larger than chromophils’ ones but they’re smaller as cells due to the small amount of faintly stained cytoplasm inside it) and chromophils (acidophils and basophils).
 It’s better to look for chromophils before chromophobes.

 The figure on the right side represents a section stained with PAS/Orange G which stains acidophils.

**{slide no.12}**

•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.

**{slide no.13}**

***Hypothalamus Releasing (Controlling) Hormones (Control Anterior Pituitary Function)***•GBH- Gonadotropin Releasing Hormone
•LRH- Luteinizing Releasing Hormone-affects both for FSH and LH
•PIH- Prolactin Inhibitory Hormone, Suppresses Prolactin in non Pregnant

•CRH, Corticotrophin Releasing Hormone, which stimulates release of ACTH

•SRH (GRH) –Somatotrophin which affects (Growth Hormone) Releasing Hormone

•Somatostatin, Inhibit these Hormone Somatotrophin and TSH (Thyroid Stimulating Hormone)
Some of above hormones promote the release and others inhibit it depending on the feedback

**{slides no.14-16}**

*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 the cell body of 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 in median eminence. 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 :-
1.promotes contraction of the smooth muscle of the uterine wall during parturition (birth/labour).
2.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 nuclei of cells called **pituicytes** in the tissues of the pars nervosa(Their nurons’ nuclei are located in supra optic and para ventricular nuclei of the hypothalamus) . Generally, only the stained nuclei (oval nuclei) of these cells can be seen in histological sections; because they don’t take up the stain

–These cells are of irregular shape and often have numerous cytoplasmic processes.

–They are considered to be a type of modified glial cells (a type of Schwann cells which give support to neurons), 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).

**{slide no.17**}
The figure shows nuclei of neurons present in hypothalamus.
At the end of the axon there’s a dilation for storage of Oxytocin and ADH as well, by a proper signal they get released to the capillaries present in pars nervosa to the remainder of the body.

**{slide no.18}**The figure represents a section in pars nervosa special-stained to highlight Herring bodies.
There are no nuclei in pars nervosa but Pituicyte nuclei.



**Mayazeen Al-awamleh**