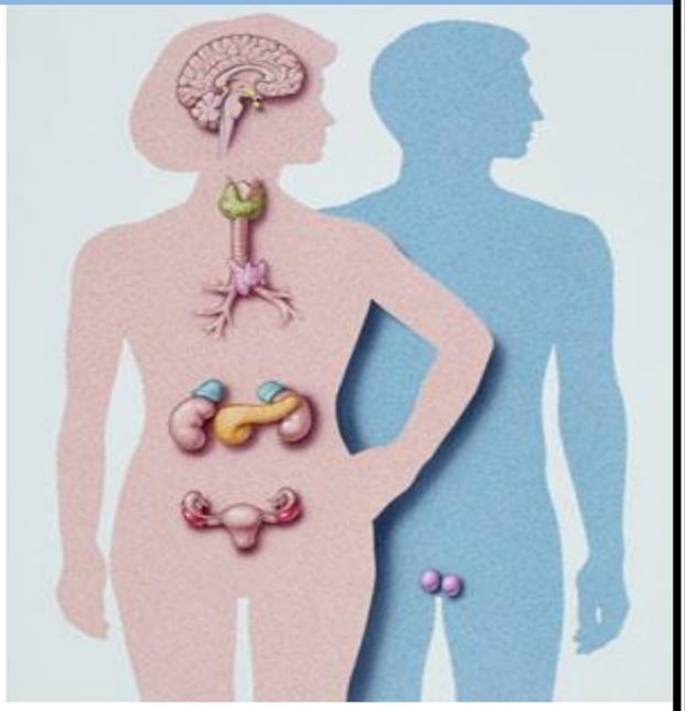
University of Jordan - Faculty of Medicine
(2013-19)

Medical Committee
The University of Jordan

Endocrine System



- [x] Anatomy/Embryology/Histology
- [ ] Biochemistry
- [ ] Physiology
- [ ] Pharmacology
- [ ] Pathology
- [ ] PBL

- [ ] Slide
- [x] Sheet
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- [ ] Other

Lecture #: 1

Date:

Dr's Name:

Price:

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Designed by: Zakaria W. Shkoukani

PITUITARY GLAND

Introduction:

How to study this course: for Histology the doctor says the histology general junqueira's book will be enough, specifically all the subjects are found in chapter 20; however the book contains an extra subject under the headline Pineal Gland which will not be included due to the fact that there is a big debate about this subject. For Anatomy either Gray's or Snell, however for the pituitary gland the subjects in Gray's are scattered all over the book, whereas in Snell it's more organized. In the practical, we will take endocrine pancreas, endocrine testes and endocrine ovary; however the exocrine parts of these organs must be covered by the systems which they are related to.

General principles:

1- endocrine and exocrine glands are made of epithelium (with a specific function), if attached to an organ it's then given a specific name, while if it's scattered all over the body it has a different name; DNES cells (**d**iffuse **n**euro**e**ndocrine **s**ystem cells), examples on this type are G-cells and S-cells in the stomach (if you're wondering G-cells are found in the pancreas and the duodenum in addition to the stomach), these cells are not connected to a specific organ in other words they are diffused all over the body hence the name. Another name, in pathology, for these cells is APUD cells which stands for **A**mine **P**eroxidase **U**ptake and **D**ecarboxylase cells.

2- All endocrine glands in the body have 2 different embryonic origins.

3- All the cells that produce steroids must have sER and a lot of mitochondria because this process is an active process.And as a result of the large number of sER and mitochondria they stain acidophilic, in other words, steroid synthesis cells → increase in sER and mitochondria → stain acidophilic. When preparing the specimen those steroids are lost and as a result when viewed under the microscope they appear as large vacuoles, so sometimes these vacuoles can indicate the activity of this cell (vacuoles appear whitish in color).

4- On the other hand amino acids are produced on the rER which stains basophilic (due to the large amount of ribosomes).

5- Endocrine glands, in general, receive enormous blood supply from more than one source (pituitary gland has 2 major sources, thyroid gland also has 2 major sources, adrenal gland has 3 major sources).

6- Normally the heart pumps blood through arteries which ends as capillaries which collect as veins and return to the heart, that's called systemic circulation. However, in the portal circulation the heart pumps blood through arteries which end in capillaries which form veins as normal, however, these veins break into capillaries again which form veins again and return the blood to the heart; this happens to increase the length of circulation. (Remember this point we'll come back to it later in the lecture).

Generally, these glands are located in certain places where they are well protected; pituitary gland exists inside a bone, thyroid gland is surrounded by the infrahyoid muscles and adrenal gland has a huge amount of adipose tissue surrounding and protecting it.

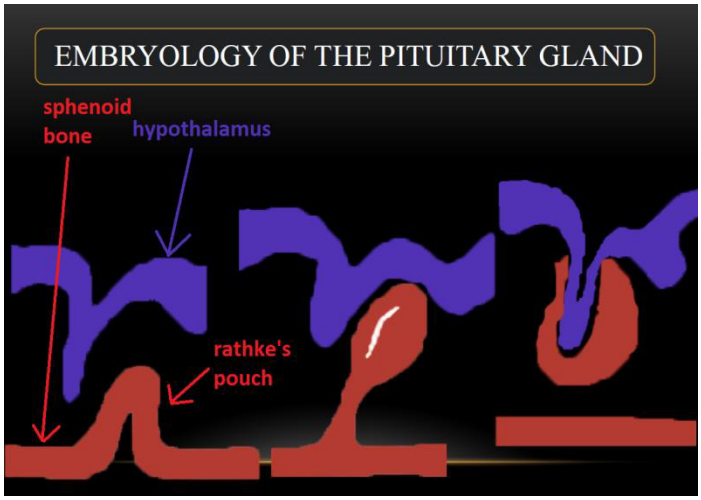
Pituitary Gland:

Today we'll be talking about the pituitary gland, which is also called hypophysis cerebra (Gr. *Hypo,* under, + *physis*, growth)

Generally speaking the pituitary gland is 2 glands; the anterior is a true gland (adenohypophysis) while the posterior part isn't a true gland it's just a site of storage of substances (hormones). Actually the hormones which exist inside the posterior pituitary belong to the hypothalamus; they are synthesized in and released from the hypothalamus, and therefore the posterior part is considered neurohypophysis. (Adeno- means gland, neuro- related to the neural system).

Embryology

(Check the picture to understand the following)



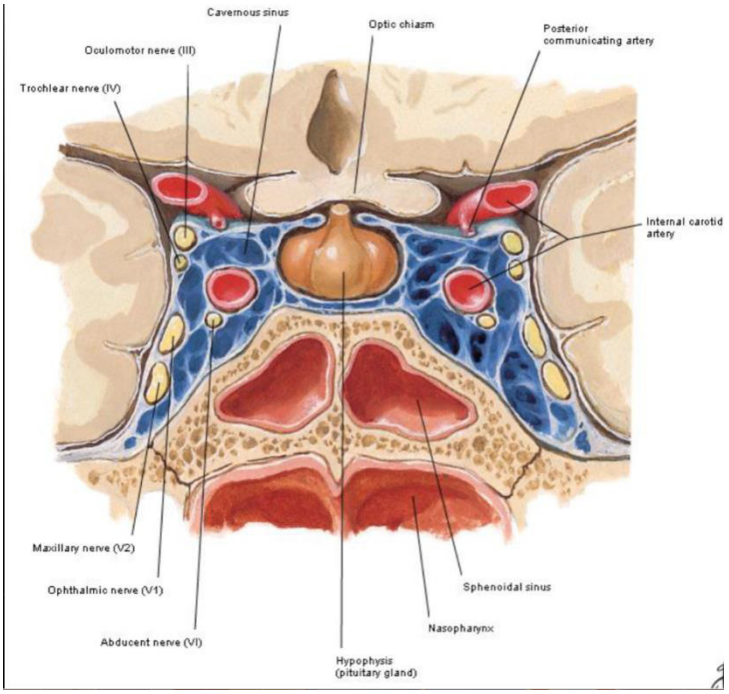
During development there is a bone called the sphenoid bone, which has two parts, these 2 parts surround a membranous structure (Rathke's pouch) that evaginates outwards in between the two parts of the sphenoid bone and arises from the stomodeum (primitive oral cavity). As time goes on the two parts of the sphenoid get closer together. Eventually the bones will come in contact with one another and the pouch loses contact with the sphenoid bone. On the other hand, there will be a pouch descending from the hypothalamus, this pouch and Rathke's pouch approach each other, gradually they become very close to each other and in a way they wrap around one another, therefore as we mentioned before the pituitary gland obeys the law of 2 different embryonic origins (duality of origin) for each gland in the endocrine system. One of them is from the oral ectoderm (stomodeum) and the other one is from the hypothalamus (neural ectoderm) and they enclose each other.***so the pituitary gland origin is purely ectodermal*.**

Anatomy:

The pituitary gland lies below the brain (it's suspended from the brain) in the Sella turcica which is a part of the sphenoid bone, as we know there is a meninx (plural: meninges) called the dura mater, this dura matter attaches to 2 parts of the sphenoid bone called the anterior and posterior clinoid processes, leaving a space between them which allows the pituitary gland to descend in it, the part of the dura mater that covers it superiorly is called the diaphragma sellae.

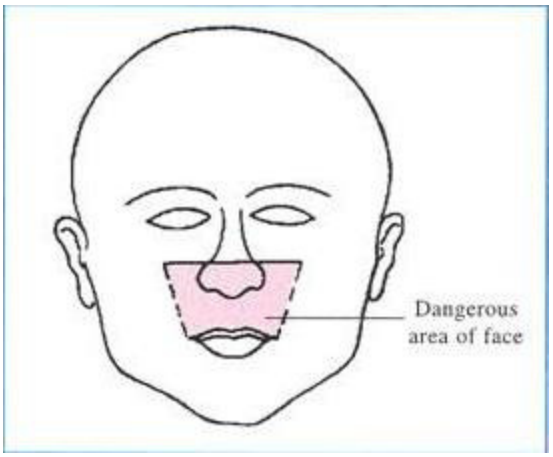
The mass of the pituitary gland is 0.5 g; the anterior part is 3 times as large as the posterior part.

If we look at the following picture, we can notice that the pituitary gland lies in the Sella turcica. Anteriorly we can see the **optic chiasm** which is the part of the brain where the optic nerves (CN II) partially cross. On the lateral sides of the pituitary gland are the cavernous sinuses which are important structures. Inside the cavernous sinus lie the internal carotid artery and the abducent nerve (CN VI) on each side. Both (right and left) sinuses are connected together anterior and posterior to the pituitary gland.



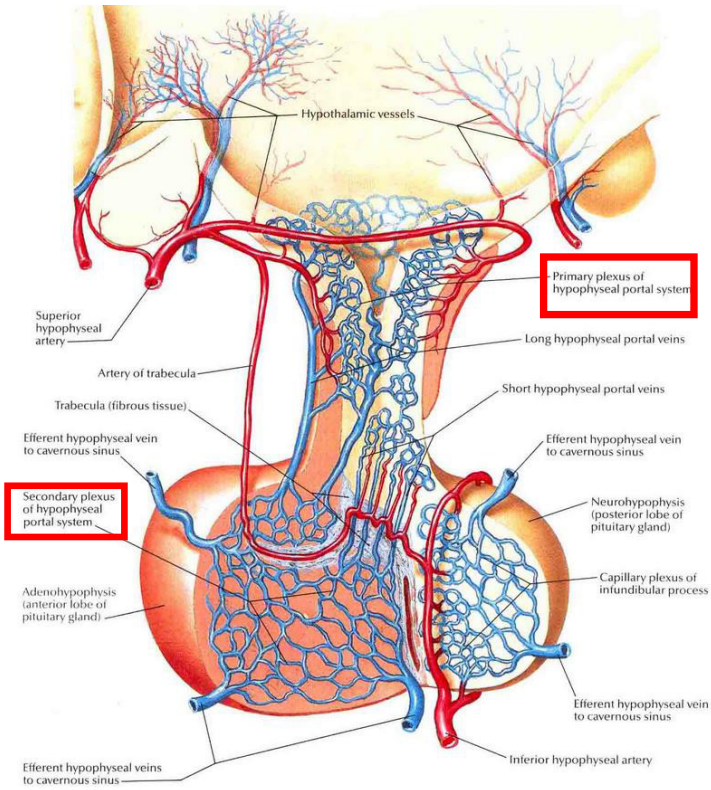
Cavernous sinus is a very important structure, simply because anything that happens in the cavernous sinus will be reflected on the blood supply of the pituitary gland and the nerves located within the cavernous sinus itself (e.g.: oculomotor, trochlear, abducent, ophthalmic, maxillary). Another thing about the cavernous sinus is that a part of the face (picture where skin overlies cavernous sinus) is vulnerable to acne and sometimes people will pop the pimples in this area which is dangerous. There is a

vein called the ophthalmic which communicates with the cavernous sinus, so when a boy or girl squeezes the pimple, they are introducing infection to the ophthalmic vein which communicates with the cavernous sinus.



This could lead to a stroke or it could affect a nerve or multiple nerves or the internal carotid artery. Therefore this area should be respected and not played around with. If something happened with the internal carotid artery the pituitary gland will be affected because its blood supply is coming from the internal carotid artery.

Blood supply: the pituitary gland is supplied by the internal carotid artery, which gives off two branches the *superior and inferior hypophyseal arteries*; superior hypophyseal supplies the anterior part of the pituitary gland while the inferior hypophyseal supplies the posterior part of the pituitary gland.



The superior hypophyseal artery firstly supplies the hypothalamus by some branches, and then it gives off a branch which anastomoses with the inferior hypophyseal artery.
And finally before reaching the pituitary gland, it divides into 2 branches which encircle the stalk or infundibulum (however, the inferior hypophyseal artery divides into 2 branches which encircle the posterior pituitary), now go back to the 2 branches of the superior hypophyseal

artery that encircle the stalk; these branches end up as capillaries which we call fenestrated capillaries because they have pores in their endothelium. Now these capillaries form veins, which form capillaries once again, leading to the portal circulation we mentioned before, here its name is *hypophyseal portal circulation*.The capillaries in the upper part in the stalk are called the PRIMARY hypophyseal plexus, while those in the lower part in the anterior part of pituitary gland are called the SECONDARY hypophyseal plexus.

Note: portal circulation doesn't necessarily mean the portal circulation in the liver, when talking about that circulation we have to mention that it's specific to the liver that's why it's called HEPATIC portal circulation; it's only an example of portal circulation.

The reason behind forming the hypophyseal portal circulation in the pituitary gland is to slow down the blood in order to give the cells of the pituitary gland more time to analyze and respond to the hormonal blood levels. The terminal veins which leave the pituitary gland shown in the picture, end up in the corresponding cavernous sinus. And for that reason if there was a problem in the cavernous sinus there will be a block in the venous drainage of the pituitary gland which consequently affects the gland. Since the cavernous sinuses are interconnected, any problem in one side would affect both sides.

On a side note, an abscess in the pituitary gland was very hard to deal with prior to the use of endoscopic surgery, due to the fact that the pituitary gland lies in the base of the brain, so it's extremely difficult to operate on it. Also it has a noticeable degenerative ability, for example if we take a sample and send it to the lab, before applying formalin we'll notice that degeneration has took place already.

In animals, they used to say that the pituitary gland has 3 parts: anterior, middle and posterior; however, in human there are only 2 parts anterior and posterior, the middle is part of the anterior.

Once again, histology is a two dimensional study of a three dimensional reality.

Histology:

Remember: in the immunohistochemistry we give antibodies against structure and it's the most specific histological diagnosis. If we give an antibody against a cell that secretes substance X, this antibody is called antibody against X and it's labeled. Diagnosis depends on knowing what is the antibody that's given against this structure.

The anterior pituitary contains 3 parts:

1- Pars Distalis: This is the largest part of the anterior pituitary.
2- Pars Tuberalis: This part forms the sheath that connects the Pars Distalis with the pituitary stalk.
3- Pars Intermedia: This part resembles the middle pituitary in animals and it connects the anterior pituitary with the posterior pituitary.

The posterior pituitary contains 3 parts:

1- Pars Nervosa: this is the largest part of the posterior pituitary.
2- Median Eminence: This is sometimes considered part of the brain.
3- Infundibulum or pituitary stalk: this part contains hypothalamo-hypophyseal tract which connects the hypothalamus with the posterior pituitary.

Now we added H&E stain (hematoxylin and eosin), some cells didn't stain well, so we called them chromophobes, while those which stained either hematoxylin or eosin we called them chromophils which were sub-divided again into acidophils and basophils.

Chromophobes are identified as small weakly stained acidophilic or basophilic cells, some people say that these cells are stem cells which means that they can differentiate to other type of cells that can be acidophils or basophils if they are needed; however other people believe that these cells are retired cells that have finished their job, due to staining either weakly basophilic or weakly acidophilic.
Regardless of their job, they are significant in number and sometimes they have granules inside them.

*** Folliculostellate cells**: large chromophobic cells with many processes that form clusters, these cells are of unknown function and they surround other cells. People have believed that these cells form barrier.

Chromophils:

These cells secrete hormones that affect other cells. Some of them have releasing hormones; which means that the hormones won't be released from the pituitary unless stimulated by the hypothalamus. Others have inhibiting hormones.

1. Acidophils: compose 70% of chromophils and contain:
    A. Somatotrops: They are the most abundant cells in the anterior lobe making nearly 50% of total number of chromophils; their main function is to secrete growth hormone (GH). Histologically speaking, they form clumps and clusters; they have a central nucleus, large number of rod shaped mitochondria which accounts for the acidophilic appearance, many rER, and small to moderate Golgi apparatus. (Action of GH: Acts on growth of long bones).

    B. Mammotrops: they make up nearly 20% of total number of chromophils; their main function is the secretion of prolactin. Histologically speaking, they occur singly unlike Somatotrops which form clumps and clusters. Their organelles are ill-defined. However, the number and size of these organelles increase during lactation and at the end of pregnancy. Moreover, sometimes the number of these cells increase; as a result many pregnant women at the end of pregnancy they experience headaches because of the increase of the number of the cells in a confined space which increases the intracranial pressure that leads to headache. Colostrum which is the first milk of the mother contains no proteins, it contains only carbohydrates and antibodies, this happens because for the babies to digest proteins there should be renin enzyme in their stomachs, and renin only develops 48 hours after birth. Also another importance of the colostrum is that it helps the meconium (earliest green stool of an infant) to reach the caudal end.

2. Basophils:
   A. Gonadotrops: constitutes 10% of all chromophils, they are rounded cells with a nucleus that contain prominent nucleolus. Their main function is the secretion of FSH (follicle stimulating hormone) and LH (luteinizing hormone). In the start, the female embryo has 2,000,000 ova, while at birth this number decreases to 400,000 ova, of which only around 400 reach maturity at puberty and can be fertilized. Action of FSH: promotes ovarian follicle development and estrogen secretion in women, and spermatogenesis in men. Action of LH: promotes follicular maturation and progesterone secretion in women and Leydig secretion in men.

   B. Thyrotrops: constitutes 5% of all chromophils, they are usually located away from sinusoids but again we have the 2-D to 3-D reality issue, Secretes TSH (thyroid-stimulating hormone) which helps the thyroid gland in its synthesis and secretion of thyroxine. TSH blood level test is usually indicated alongside T3 and T4 blood levels for patients who sleep a lot, if the level of TSH is high this indicates that the thyroid gland isn't responding well to the TSH (hypothyroidism) so large amounts should be produced for the thyroid gland to function, or a pituitary gland tumor that is making too much TSH, This is uncommon. while if the level of TSH is low then the pituitary gland isn't working (note: after searching I found that it's a result of an overactive thyroid (hyperthyroidism), or damage to the pituitary gland that prevents it from making TSH), so the TSH level is a good indicator of the function of the thyroid gland.

   C. Corticotrops: constitutes 10-20% of all chromophils, they are difficult to be localized inside the pituitary gland because their shape is not different from other cells. They secrete ACTH (Adrenocorticotropic hormone) which functions on the adrenal cortex, specifically on the zona fasciculata of the adrenal gland.

Now the doctor talks about the abnormalities in the slides:

1- Slide 40/57 **Hypogonadism**: the breast in the female is not well developed. Both males and females suffer from infertility, they look pale (pallor), they have low body metabolic rate and finally they are intolerant to stress in terms of exposure to extremes of temperatures (high or low) or different types of stress.

2- 41/57 **Dwarfism**: notice the proportions of his body parts.

3- 42/57 **Acromegaly**: again notice the proportions of his body parts; here in such patient the proportions are distorted. Usually we use the rule of thumb, that is the length of the nose should be equal to the length of the thumb, the distance between the margins of the eyes and the ears should be equal to the length of the thumb etc. Also he has a hump in his back. For the teeth the lower jaw will show spacing between the teeth (they're widely separated) and malocclusion can be noticed (A malocclusion is a misalignment or incorrect relation between the teeth of the two dental arches when they approach each other as the jaws close).

The record from 54:00 and there after is a mess, and in section 2 recording the doctor didn't mention anything from it. So the following was written based on notes, memory and google.

(Notes from the record that can be heard):
* Posterior pituitary is more acidophilic than the anterior pituitary.
* Anterior pituitary gland contains acidophils and basophils but posterior pituitary doesn't.

Posterior pituitary:

Does not contain secretory cells. But instead contains secretory neurons which secrete the hormones to the arteries.

It secrets 2 main hormones: (Most Oxytocin is released from paraventricular nuclei while most ADH is released from supraoptic nuclei).

1- Oxytocin: this hormone is produced as a result of stimulation by either uterus contraction or nipples sucking. This hormone functions by increasing milk production by increasing myoepithelial cells contraction and increasing uterine contractions, thus creating a positive feedback loop, in which uterus contraction increases oxytocin, that causes further uterus contractions, this happens

during labor. Also uterine contraction after birth helps replace uterus to its normal position.
During breastfeeding, there's a positive feedback loop thus increased level of oxytocin so mothers who breastfeed their babies usually have a better mode than those who don't.
* People who have depression usually have low oxytocin, also those who have bad social behavior also have low oxytocin.

2- ADH (vasopressin): This acts as an antidiuretic hormone, which helps in water absorption from renal tubules which leads to an increase in blood pressure by contracting arterioles.
* Low levels of ADH lead to a disease called diabetes insipidus which causes polyuria (frequent urination may be up to 70-120 times per 24 hours). The maximum normal bladder capacity equals 330 cc, so if the bladder contains 330 that's urgent. So one liter causes the bladder to be emptied 3 times.

The following are some past papers shared by our colleague Rashid Dahabreh.

1) Wrong about Pituitary gland?
Secretory cells are present near the capillaries in the pars nervosa.

2) Which of the following in incorrect about the pituitary gland?
a-primary capillary plexus surrounds median eminence
b- Secondary capillary plexus on pars distalis
c- Pituitary mothers cells located in Neurohypophysis
d- Most of pars distalis are acidophilic

3) Wrong about Pituitary gland?
Has endoderm and ectoderm origin.

This sheet is dedicated to: شعتل, I miss ___ & TP
"Ramadan Kareem" Omar David Arman
LEL