



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



# Endocrine System

Anatomy/Embryology/Histology

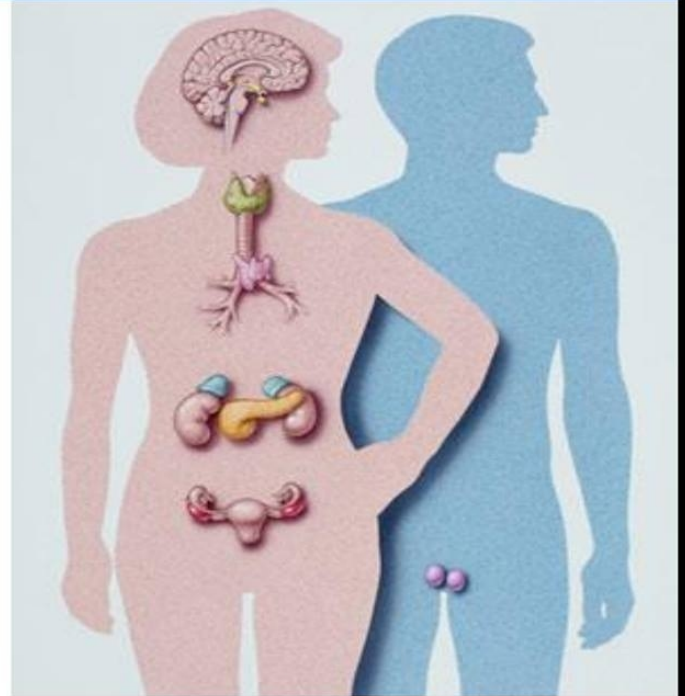
Biochemistry

Physiology

Pharmacology

Pathology

PBL



Slide

Sheet

Handout

Other

Lecture #: **4**

Date:

Dr's Name:

Price:

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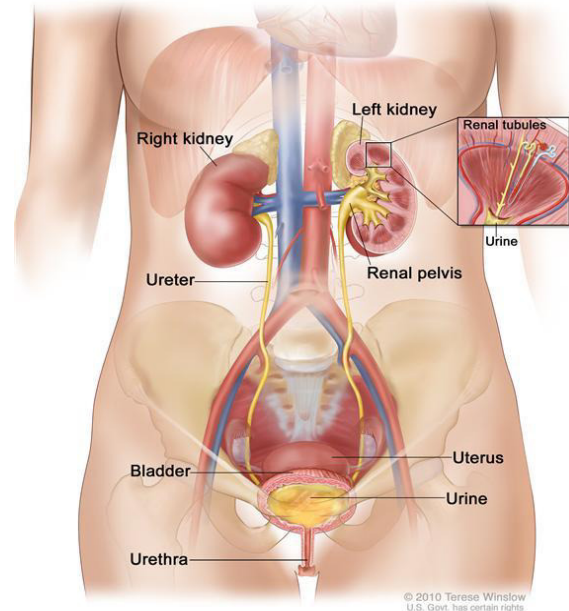
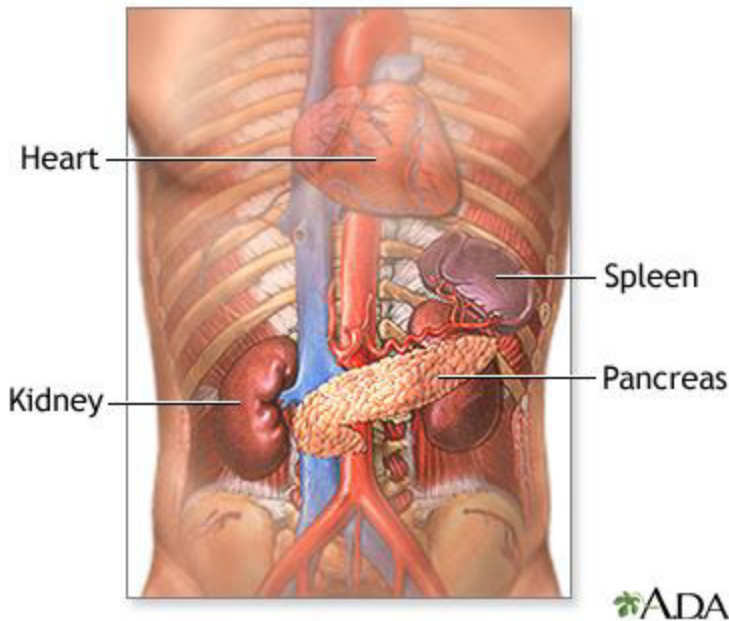
# ADRENAL GLAND & PANCREAS

The doctor spent the first 10:50 minutes of the lecture talking about researches if you want to get more information you can get back to record 4 section 2 , now let us start our lecture .

## ADRENAL GLAND

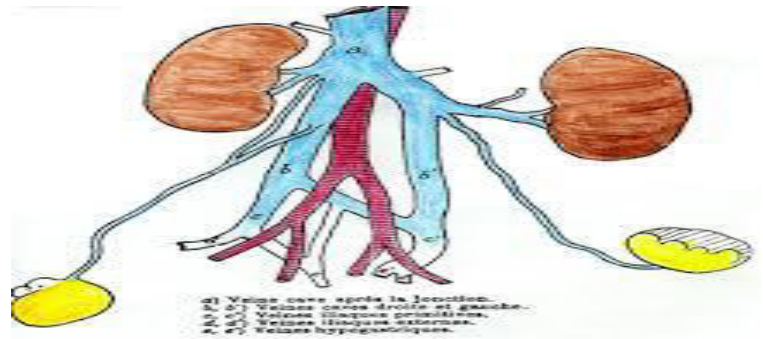
### - ( anatomy )

Anterior and posterior relations of adrenal glands : the posterior relations of both the right and left adrenals are the same which are the crus of diaphragm and superior pole of kidney . anterior relations are different , the doctor is showing 2 dissections trying to reach the adrenal glands , he is pointing some structure for orientation (refer to the slides to check these dissections )



The adrenal gland is retroperitoneal it's situated in the posterior abdominal wall So we have to go deep through the abdomen to reach them .

In the posterior abdominal wall the IVC is always to the right and the abdominal aorta is to the left. During embryonic life the embryo had two IVC one on the right and one on the left but later on the left IVC was replaced by the left renal vein and the structures that were supposed to drain in the left IVC now drain in the left renal vein so you can say that the venous drainage on the left side to the left renal vein is equivalent to the venous drainage on the right side to the IVC.



Anterior relations :

Right adrenal : right lobe of liver laterally and IVC medially. Left adrenal : we have to remove stomach, pancreas, lesser sac, splenic vein running behind the neck of pancreas which is closely associated to the tortuous splenic artery running in the superior border of the pancreas.

In the right side the liver is so large that it elevates the diaphragm upwards consequently the position of right kidney and suprarenal gland is lower than the left. It's showed up in the pictures.

The doctor said that he was observing a nephrectomy (kidney removal surgery) and the surgeon removed the kidney without the adrenal glands so the doctor asked the surgeon what about the adrenals? he answered that he didn't see them, the reason behind that is that there is a weak septum of connective tissue separating the kidney from the gland allowing kidney's surgical removal easily.

By taking a cross section you can notice that you can remove the kidney without seeing the adrenal gland because kidney is highly surrounded by adipose tissue, you can notice the gland by seeing the brownish tissue up there.

Relations \ adrenal gland	left	right
Anterior	Stomach Lesser sac of peritoneum The inferior area is in touch with the pancreas and splenic vein	Inferior vena cava (medially) Right hepatic lobe (laterally)

**- embryology**

We will be concerned with Two important embryonic structures which are the neural crest and the notochord .

Many cells originate from neural crest for example the melanocytes in the skin which migrate from neural crest and can be arrested anywhere to form الشامات و (الوحمات)

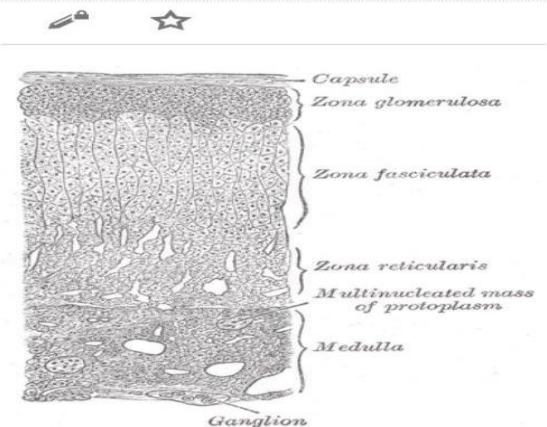
From neural crest cells start to differentiate and migrate anteriorly to form clusters of cells that will eventually make the adrenal medulla (from inside) , neural crest is responsible for formation of sympathetic ganglion as we were saying that adrenal medulla is a modified sympathetic ganglion that was arrested during migration .

Cells migrate from notochord (coelomic mesoderm) to form the cortex( from outside)

So for orientation cells migrate from both the neural crest and the notochord toward the dorsal aorta till they meet one another forming the adrenal medulla from the neural crest inside and the adrenal cortex from the notochord outside.

At the beginning the cortex is divided into two parts 1-definite cortex (thin) 2-fetal or infantile cortex (thick)

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Later on at puberty age the fetal cortex will disappear and the cortex will all be definite and will differentiate into zona glomerulosa ,zona reticularis ,zona fasciculata .

As Cells migrate from neural crest to adrenal medulla , it might be arrested anywhere through its pathway and because tissue of adrenal medulla is called **chromaffin tissue** any arrest in its migration will create extra adrenal chromaffin tissue and it will secret extra adrenalin and noradrenalin.

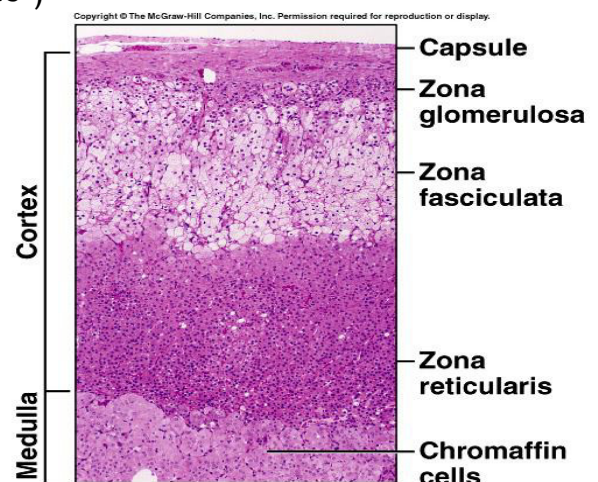
One of the most important causes of hypertension is adrenaline so sometime there will be hypertension and you examine the medulla, it will be normal but when you investigate the patient and make a urine collection for 24 hour you found VMA very high( vanillymandelic acid) the end product of adrenalin and noradrenalin metabolism ,so VMA is high and medulla is normal so the cause of hypertension is that there is extra chromaffin tissue arrested elsewhere and it responsible for the extra secretion of adrenalin and noradrenalin.

So that insure the rule of duality of origin of endocrine.

Adrenal gland → 1 - medulla → neural crest( inside )

2- cortex → mesoderm (outside )

The point that was left out from yesterday lecture is the histology of the adrenal cortex .the adrenal cortex is made of 3 layers : the outermost zona glomerulosa and inner most zona reticularis with zona fasciculata in between them , notice that the layers are overlapping each other and there are no straight lines between them .In the glomerulosa layer the cells are forming a circular pattern and they are surrounded by capillaries , on the other hand in the zona fasciculata the capillaries are found in a cytosol between cells .The zona reticularis is described as the darkest area .



## -clinical applications:

**Cushing syndrome** ..hyper secretion of cortisol ...

Clinical features:

1. you can see stretching marks on the skin (striae) . Some ladies during gestation can find marks on their abdomen because of abdomen enlargement.
2. First of all → cortisol cause personality change → it form psychological disorder in those patients
3. Moon face of the patient → skin is stretched → different touch → it can be distinguished easily .
4. Extremities are thin compared to their body
5. Breast enlargement in males → gynecomastia( female breast like )
6. Disturbances in gastrointestinal tract → patient will always suffer from hyperacidity ,because of continuous stimulation of the parietal cells of the stomach by cortisol
7. They might develop Osteoporosis consequently any minimal trauma which in normal condition won't affect normal people it will break a bone in that patient .
8. easily bruised by any minimal trauma
9. Female complain from amenorrhea ( انقطاع الدورة الشهرية ) and when they have their period it will be spotting bleed rather than normal .
10. Abnormal distribution of hair → hair grow in places not usual to grow in .
- 11- **hypernatremia** (increase in  $\text{Na}^+$  levels in the blood ) and wherever sodium goes water follows and this explains the edema in these patients

## Adison disease...hyposecretion of cortisol

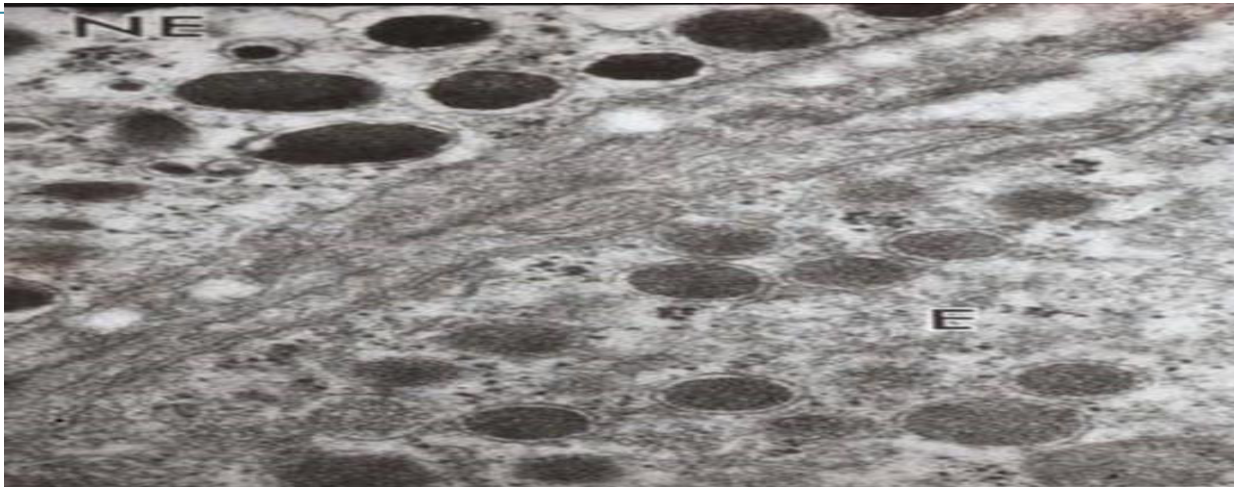
Adison is the scientist that first described the disease )  
John Kennedy served as the 35<sup>th</sup> president of the United States had that disease which means that it doesn't affect mental ability .

Clinical feature:

1. Bronze pigmentation in his skin
2. Change in the Distribution of hair
3. Postural hypotension : Once he stand up after resting , if you measure the blood pressure before and after they got postural hypotension , when you are sleeping and get up suddenly you will feel drowsy so it's better to set down for a while then stand up , so the patient can't get up immediately because blood pressure will fall suddenly he is going to fall down .
4. GI disturbance
5. Weight loss because of low levels of cortisol since hypersecretion of cortisol cause weight gain then hyposecretion will cause the opposite.
6. They have weak musculature , they can't do an effort which other people find very easy → patient can get fatigue easily .
- 7. Hyponatremia and hyperkalemia** : because the physiological function of cortisol is to preserve sodium in the blood , when cortisol go down ->sodium will go down (hyponatremia ) -> Potassium will go up to compensate for sodium loss (hyperkalemia )

\*\* about adrenal medulla the doctor wants to emphasize about 3 to 4 points

\*in H&E stain it is very difficult to differentiate between cells that secrete epinephrine and cell that secrete norepinephrine , but it is very easy to distinguish them by electron microscope , we use special stain to differentiate between 2 types of cells that secrete epinephrine and norepinephrine



adjacent cells of adrenal medulla some secrete norepinephrine or noradrenalin the other secrete adrenalin or epinephrine in electron microscope some permit electrons to pass through and appear light (electron lucent), other don't (appear dark they reflect electrons back) .....electron dense

noradrenalin secreting cells have electron dense granules while adrenalin secreting cells are light in color (electron lucent). that's the best way to differentiate cells of adrenal medulla

### **pheochromocytoma PCC (clinical application)**

it is a neuroendocrine tumor of the adrenal medulla that secretes enormous amounts of epinephrine.

- patients look thin you can never ever find an obese patient
- they suffer from hypertension ..hypersecretion of adrenalin and noradrenalin

remember

You can remove the adrenal medulla but you can't remove the adrenal cortex because it is essential for life



# PANCREAS

## -history

Pancreas : it's a glandular organ in the digestive system and endocrine system. It's both an endocrine and exocrine organ .The endocrine part of pancreas is in away overlooked , actually it's a good example for researches for people who wants to think in a logical way . the endocrine part of pancreas was discovered first by **Paul Langerhans** when he was a 2<sup>nd</sup> year medical student , he discovered langerhans cell in the epidermis which are actually part of the immune system .

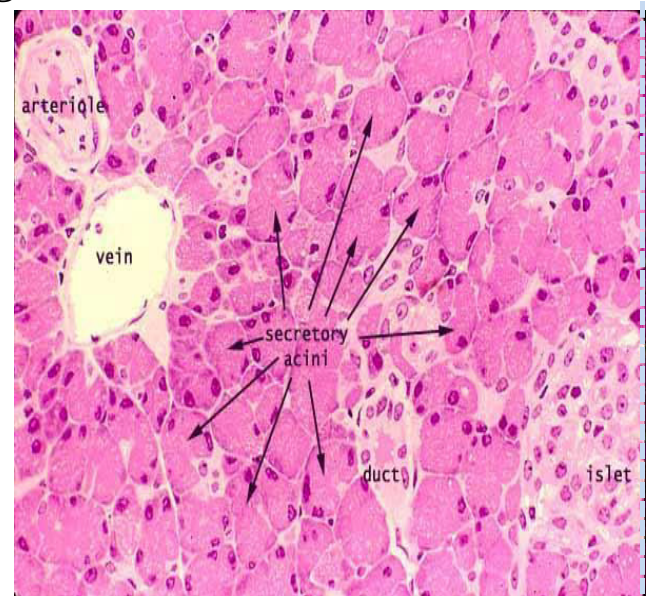
After graduation he was working with a pathologist called Pershaw ( one of the most famous names in pathology ) he had an idea that the pancreas which was with unknown function at that time has something to do with healing of incisions so he brought two groups of dogs , then did a pancreatectomy ( removed the pancreas from their bodies) to one group of these dogs and left the pancreas in the other group to see the effect of pancreas on the healing of incision , then he noticed that the group that don't have pancreas have more flies on their urine which means is has more sugar , when he tested that it was true so he conclude that the pancreas has something to do with sugar metabolism.

So he hypothized that pancreas prevent sugar lose in urine which has some sense.

## -histology

Langerhans took the pancreas to make sections in it then he examined by the light microscope , he found some cells are connected to a duct ( exocrine part ) and other one not connected to duct but surrounded by thin capsule of connective tissue invaded by blood vessels .

No duct ..good blood supply ...he said it might have an endocrine function



He couldn't reach to a conclusion until one person came after 10-15 years and he said that :

-these structure are insulans scattered here and there (insula means island )

-The number of these insulans per gram of tissue increase as we are moving from the head to the tail of the pancreas ,the tail which comes in contact with hilum of spleen has 1-1.5 million islets of langerhans .

These cells probably secret hormone , someone called it insulin because they named them insulans

### **The endocrine part of pancreas is called islet of langerhans.**

When he looked at island of langerhans he noticed that there are cells that secret other substances inside the pancreas , these cell are 1-not homogenously distributed. 2-they have different shapes 3- there's a probability that they have different function .

-the cells at the periphery are called alpha cells , it secrets glucagon which has an opposite effect of insulin .

- most of the cells of langerhans (about 70%) are beta cells ( cells which fill the islands) and they secret insulin .

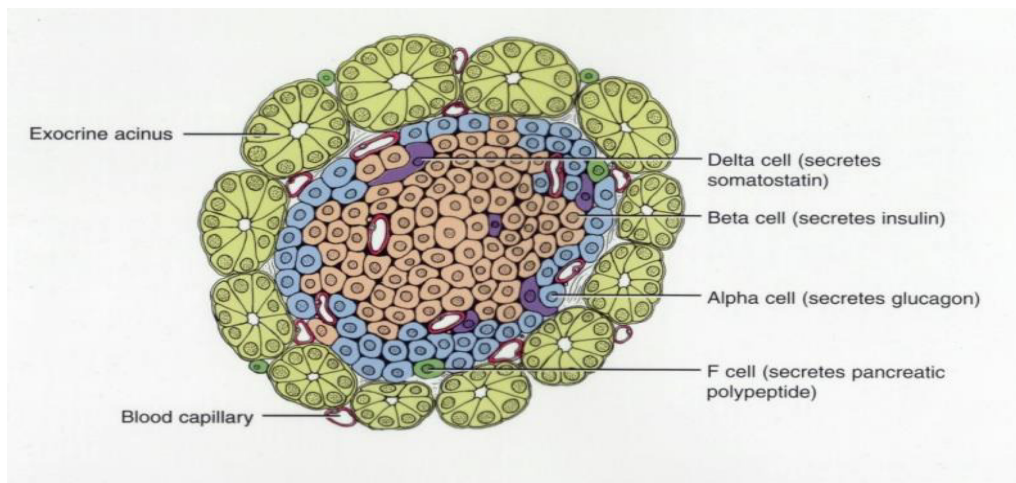
- there are other scattered cells which secret somatostatin and they are called delta cells) .

Wherever you find somatostatin its function is to inhibit the function of other nearby cells ( paracrine function ).. it inhibit beta and alpha cells secretions .

-a fourth minor type of cells are called **PP cells "(or F cells ")** and they secret pancreatic polypeptide which 1- increase the activity of chief cells ( chief cells secret pepsinogen ) 2- decrease bile secretion from the liver to the gallbladder

3- decrease pancreatic enzyme secretion which contain bicarbonate so it's important in the process of digestion 4- together with all of that it decrease the motility of GI tract because it is secreted in the 2<sup>nd</sup> part of the duodenum .

So there are four types of cells in islet of pancreas : **alpha cells** which secret glucagon , **beta cells** secret insulin , **delta cells** secret somatostatin , **PP cells** secret pancreatic polypeptide.



It's difficult to differentiate between these cells in light microscope , the best way is by immunohistochemistry , for example we use antibodies against insulin to see if any cell react with these antibodies it would be insulin secreting cells ( beta cells ) and so on..

Sometimes we resort to fluorescent microscopy in practical to see how the cell appears with antibodies .

Islets of langerhans don't necessarily have the same number of cells you can find an islet with four or three cells and others with million cells. So their size , shape , distribution is variable ,Generally speaking their number increase as we are moving from head to tail .

Langerhans visited Egypt , Palestine where he worked as a machinery and Syria , he came back with tuberculosis , he dead in early age .

## Past papers

- 1- Wrong about the adrenal gland : **medullary arterioles supply the zona fasciculata**
  
  - 2- Which of the following is incorrect about the adrenal gland
    - A- All capillaries are fenestrated
    - B- Medulla has dual arterial supply
    - C- Cortical arteries are formed at the corticomedullary junction \* ( people who collected this question are not sure )
  
  - 3- Which of the following is incorrect about the endocrine pancreas :
    - A- B cells are the most numerous in the islets of langerhans
    - B- F cells increase intestinal motility \*
  
  - 4- Androgens are secreted by : **Zona reticularis**
- 

قال الله تعالى: (وَمَنْ يَتَّقِ اللَّهَ يَجْعَلْ لَهُ مَخْرَجًا وَيَرْزُقْهُ مِنْ حَيْثُ لَا يَحْتَسِبُ وَمَنْ يَتَوَكَّلْ عَلَى اللَّهِ فَهُوَ حَسْبُهُ إِنَّ اللَّهَ بَالِغُ أَمْرِهِ قَدْ جَعَلَ اللَّهُ لِكُلِّ شَيْءٍ قَدْرًا)

صدق الله العظيم