16
ENDOCRINE

The Endocrine system spans many of the other systems that have been covered already. The main purpose of the endocrine system is to send messages from one gland to various parts of the body for mass effects. The messages sent are called hormones, so a hormone is a chemical messenger released into the blood for mass effect. It is wise to remember the cell when starting this as well as the two solubilities of different molecules and what can pass where. Some hormones are made from amino acids which can be linked or modified. These are usually water soluble (though there are some exceptions) Then there are some hormones which are cholesterol or fat based which will usually be hydrophobic. It is not just the hormone that is important, but the receptors as well. In some places a hormone might activate a cell while in another it can deactivate it. To understand the endocrine system, it is important to return to how the basic cell functions.

If a protein is being made as a cell surface receptor it must go through the basic process of the Central Dogma of molecular biology. The DNA must be copied to mRNA which will leave the nucleus and find a ribosome. The ribosome will bind to the Endoplasmic Reticulum so that the protein will be made embedded within a phospholipid bilayer. The new protein in a membrane will be part of a vacuole which will be sent to the golgi and further processed before becoming a finished vacuole which will bind to the cell membrane and remain as a hormone receptor for water soluble hormones. If the receptor is for hydrophobic hormones, many times it is made and sent to any place in the cell including the nucleus so that the hormone will have immediate function when it reaches the cell.

Just like the receptors, water-soluble hormones which are protein based will have to go through the steps of the central dogma. In the case of mono-amine hormones, the amino acid will be enzymatically modified then released as needed if a water-soluble hormone. If the hormone is a fat-soluble hormone, it will likely be made in the Smooth Endoplasmic Reticulum and secreted as made. There are exceptions to this.

1. Draw a cell labeling the phospholipid bilayer with the transmembrane and peripheral proteins, the nucleus, the rER and sER, the Golgi complex, and secretary vesicles.

2. What is the solubility of the middle of the cell membrane?

The endocrine system works with feedback loops with the organ affected by a hormone usually sending some message to the gland that affected it to stop the hormone secretions, there are some glands that seem to have more mass effects. For simplicity, it is best to start with the Hypothalamus as it tends to effect glands below it. It is part of the brain located between the midbrain and cerebral cortex of the brain and is involved in both neural and endocrine functions.

The borders of the hypothalamus are the thalamus on top, and the pituitary below. The hypothalamus makes many hormones, most of which have names that include "releasing hormones" within them which tells you what they do. It also makes two hormones which are taken to the to the pituitary for storage. These are Antidiuretic hormone, and oxytocin.

Below the hypothalamus hangs the pituitary which sits inside the Sella Turcica of the Sphenoid bone. This gland is divided into three functional and histological parts. The posterior pituitary takes Oxytocin and Antidiuretic hormone from the hypothalamus and stores it to be released when needed.

Just anterior to the Posterior pituitary is the pars intermedia which makes and releases Melanocyte stimulating hormone. This is followed by the Anterior pituitary which makes most of the hormones of the pituitary. Most of the hormones of the pituitary will act on various places to stimulate an action within the body.

Behind the thalamus one can find the Penial gland which is responsible for melatonin which many have linked to sleep wake cycles.

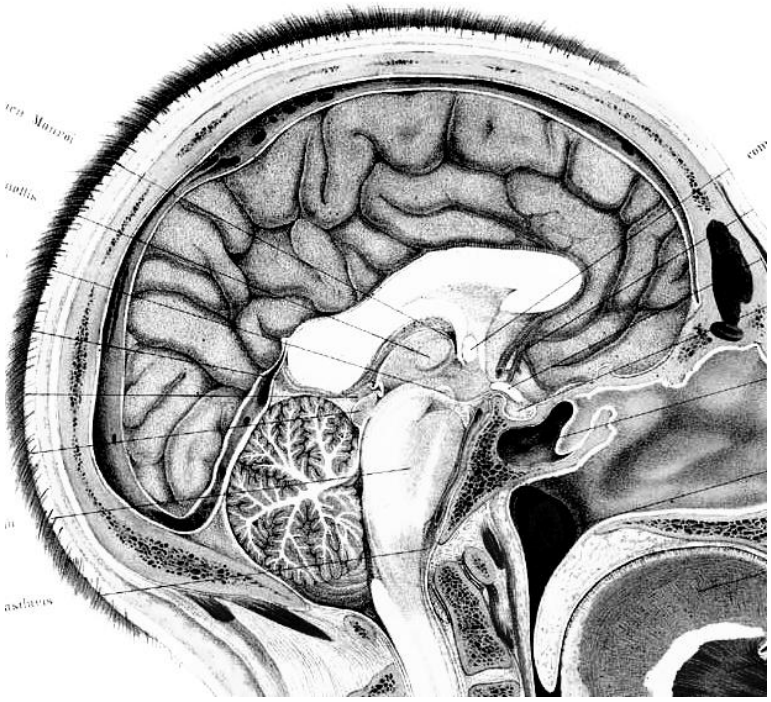
3. What is a chemical molecule that is secreted into the blood for mass effect?

4. What hormones does the hypothalamus make and secrete, what hormones are made there but stored in the pituitary?

5. Which gland makes Releasing hormones?

6. Which gland makes Stimulating hormones

7. On the image of the cut through the brain and label the following:
   A. Hypothalamus
   B. Pituitary
   C. Pineal gland.



8. What bony structure does the pituitary sit in?

9. Look at a slide of the pituitary and draw it. Label the posterior pituitary, pars intermedia, and anterior pituitary.

In the area of the neck, just anterior to the thyroid cartilage is the Thyroid gland. Histologically, it is divided into Follicular and parafollicular cells. The follicular cells make the two Thyroid hormones thyroxine (T4) and Triiodothyronine (T3) which are needed to regulate normal metabolism. The parafollicular cells produce the hormone Calcitonin which is needed to add calcium to bones. Within the thyroid gland is the parathyroid gland which produces Parathyroid hormone. Which causes calcium levels in the blood to rise at the expense of calcium from the bones.

10. Look at a slide of the thyroid gland, and find the two glands, the Thyroid and Parathyroid gland. Draw what is seen in this slide labeling the Follicular and parafollicular cells of the thyroid as well as the parathyroid gland.

11. What type of tissue you find in the thyroid gland and what makes it so different from the others?

12. Fill out the graph with the hormones of each gland or cell type:

Gland and cell	**Hormone**
Thyroid follicular cell	
Thyroid Parafollicular cell	
Parathyroid gland	

Inferior to the thyroid we can find the heart which can be considered an endocrine organ as it produces Atrial Natriuretic Peptide. Natri is Latin for sodium and Uretic means urine so Natriuretic means to put sodium into urine. This causes water to follow the sodium and causes a decrease in blood pressure by increasing urine output. There is a second hormone produced by the heart when it is failing which is B-type Natriuretic Peptide which is produced by the ventricles. This BNP is used to determine if the heart is reaching failure due to hypertension.

13. What are the hormones are produced by the heart and what do they do?

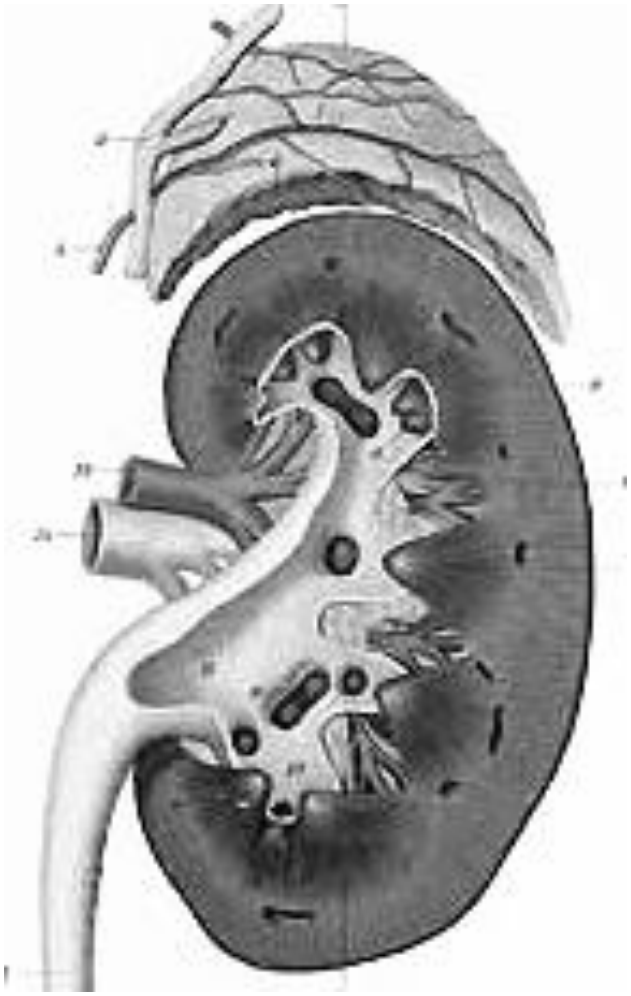
Once we go into the abdominal cavity, we can find the next endocrine glands. The Adrenal gland which sits just superior to the renal gland. These two glands are retroperitoneal meaning that they are located behind the peritoneal membrane. The Adrenal gland can be divided into two histological sections. These are the Adrenal Medulla and the Adrenal Cortex. The Adrenal Medulla makes Epinephrine and Norepinephrine which are involved in the Sympathetic Autonomic response, known as the "Fight, fright, or flight response." It is controlled directly by the nervous systems.

Over the Adrenal Medulla is the Adrenal Cortex. This area has three regions called Zonas. The outer most area of the Adrenal Cortex is the Zona Glomerulosa which makes Aldosterone when stimulated by the Angiotensin hormone from the Renin-Angiotensin Cascade. Aldosterone causes the kidney to increase sodium reabsorption. Just deep to the Zona Gomerulosa is the Zona Fasciculata which make and secretes cortisol. Cortisol is a stress hormone that raises blood sugar levels and is released when stimulated by Adrenocorticotropin hormone (ACTH) from the pituitary gland. The deepest layer of the Adrenal Cortex is the Zona Reticularis which makes are releases precursors to androgens when triggered by ACTH.

14. Look at the adrenal gland, what organ does it sit on?

15. Label the picture to the side:
    A. Adrenal gland
    B. Renal gland

16. Draw a cross section of the adrenal gland and show the medulla and the cortex, what hormones does each produce?



17. Draw what you see in a slide of the adrenal cortex label the zona glomerulosa, zona fasciculate, and zona reticularis, what hormones does each produce?

There are many endocrine glands that have been covered in other places such as the pancreas, liver, and more, it would help all to review the functions of each in a chart. Besides those and the ones involved in

reproduction (given special consideration later), those endocrine producing or targets include the skin and adipose tissue. The melanocytes of skin are targets for MSH so that the skin will darken, the skin is also needed to make vitamin D which can act as a hormone when it is made by the body. Once Vitamin D is made, it will cause increased osteoblast activity.

Adipose tissue is another important hormone producer as it can make form leptin, a hormone needed so that the body feels satiety when energy stores are at ideal. This seems more important in females as leptin tends to affect menses. While discussed previously, the kidneys have major effects in endocrine both as the start of the renin-angiotensin system but also in activating vitamin D and the formation of and secretion of erythropoietin (90% with the last 10% coming from the liver) which stimulates the bone marrow to make red blood cells when oxygen levels in blood drop.

18. Fill out the remaining parts of the table

Hormone	**Function**	**Target**	
Hypothalamus			
Antidiuretic hormone	Reabsorption of water	Kidney	Stored in the posterior pituitary
Oxytocin	Smooth muscle contraction	Smooth muscle	Stored in pituitary
Somatostatin	Stops release of most other hormones		
Corticotropin releasing hormone (RH)		Pituitary	
Gonadotropin RH		Pituitary	
Growth hormone RH		Pituitary	
Thyrotropin RH		Pituitary	
Pituitary pars intermedia Melanocyte Stimulating hormone (SH)		Melanocytes in skin	
Pituitary, Anterior Prolactin		Breast	
Adrenocorticotropin		Adrenal cortex	
Growth hormone			
Luteinizing hormone			
Follicle SH			
Thyroid SH			
Heart: ANP/BNP			
Adrenal Cortex (**ZG**)Aldosterone			
(ZF) Cortisol			
(ZR) Androgens			
Adrenal medulla Epinephrine/norepi			
Kidney: Renin			
Erythropoietin			
Pancreas (Beta) Insulin			
(alpha) Glucagon			
(Delta) Somatostatin			
Adipose Leptin			
Skin Vitamin D			