PROFESSOR: Okay. So we'll get started. We're doing Chapter 20, the Endocrine Glands.

So basically, we could spend a semester studying the endocrine system, the endocrine system and endocrine glands. This is obviously a very, very condensed lecture, but you'll have a general understanding of the endocrine glands and what they are and what they do. Basically an endocrine is a gland that produces a secretion of protein, and it is secreted into the bloodstream. It goes into the bloodstream, as opposed to secreting or producing a protein that goes into a duct or a tube. And then they influence reactions in the body. So major endocrine glands include the pituitary, the thyroid, parathyroid, adrenal cortex, medulla, pancreatic islets, ovaries and testes. So the pituitary gland is located in the head and there's a diagram a little bit further in the book on where it's located. It shows the anatomy. And it's right by the trans-sphenoid bone, and it receives input from the hypothalamus. The hypothalamus is basically the thermostat of the body. It regulates body functions. You know how a thermostat can regulate the heat or the cool hair in a room, the hypothalamus does the same thing. It does it and regulates the body's functions through -- a lot of the body's functions through influencing the pituitary gland, which then also releases hormones to go to the other organs, the other endocrine glands. So the pituitary gland is located in the head. The thyroid gland is located in the neck. It's got an isthmus, narrow portion, and a lobe on the right and left side. At the back of the thyroid gland, the back surface in the lobes of the parathyroid gland involved with calcium metabolism. The parathyroid glands typically -- classically, there's going to be two little nodules in the left lobe and two little nodules in the right lobe. Sometimes that's inconsistent; there can be three on one side and two on the other side. The adrenal cortex. The adrenal gland is located above the kidneys. It has an outer portion called the cortex and an inner portion called the medulla. Pancreatic islets are located within the pancreas. They are islands and they are called the islets of Langerhans. And then there's the ovaries and the testes.

Now, the level of hormone in circulation, basically controls the amount of hormone synthesized and released by the endocrine gland. So there a balance with feedback. You can disorders or hyper, or increased secretion, or hypo or under secretion. And it can have -- the hyper or hyposcretion secretion can clinical effects. It can affect the person. And there will be varying degrees of dysfunction. And very often
the determination of the clinical effects will also depend on the age of the person or the sex.

So the pituitary gland is suspended by a stalk from the hypothalamus at the base of the brain, and it's divided into two basic portions: the front lobe and the back lobe. Anterior means front, front lobe. And the posterior lobe, which is the back, okay. The intermediate lobe is very negligible. And the communication between the hypothalamus and the anterior lobe is through a network of capillaries. We call it the hypophyseal portal system. The communication between the hypothalamus and the posterior lobe is through neurosecretory type cells, basically neurons. So one is vascular and one neuronal. The posterior lobe is going to be neuronal. The anterior lobe is going to be vascular.

Now, tropic hormones are hormones that regulate other endocrine glands. The regulation is determined by the level of hormone produced by the target glands. I'll give you an example of this in a minute. Very often there is a self-regulating mechanism that maintains uniform hormone output. So the regulation is usually through stimulatory type hormones; however, prolactin is different. Prolactin, okay, is controlled by PIF, prolactin inhibitory factor. When people, women, get a microadenoma, a small tumor in the anterior pituitary, it can lower levels of PIF. If it lowers the levels of PIF, then they end up having elevated prolactin levels. When they have elevated prolactin levels, they are not pregnant but they have a milky discharge from the breasts and they become amenorrhea. In my practice in 20 years, I had several patients who had microadenomas of the anterior pituitary gland, and they had elevated prolactin levels. And the very first patient I had at the time, we didn't have medication to treat the elevated prolactin levels, and so she had a transsphenoidal resection. They actually went in through the nose, through the sphenoid bone and resected the microadenoma. But most, okay, of the hormones are controlled by a stimulatory. So the thyroid stimulating hormone TSH stimulates the release of thyroid hormones. People who have excess production of TSH and are hyperthyroid, sometimes they can also have elevated prolactin levels.

Now, so the anterior lobe produces a growth hormone. The growth hormone stimulates growth of tissues and the effect of the growth hormone is going to depend on the age of the person, their stage of development. In adults, once the epiphyseal disks close, if they have excess growth hormone being produced, they are not going to grow tall in stature. But what happens is they have an increase in width of the flat bones, the small bones, and they develop a condition called acromegaly. There is a picture in the book later on of a person with acromegaly. And they have very broad, gnarled type of hands. They have a very broad nose, and that is due to excess growth hormone. Excess
growth hormone in the pediatric age group will increase stature and increase the size of the child. Prolactin is used to stimulate milk production. All right, let's see. TSH stimulates the thyroid gland. ACTH, adrenocorticotropic hormone, ACTH stimulates the adrenal glands basically to produce corticosteroids. FSH stimulates the follicles to produce estrogen, estrogen levels rise, and then LH is released. LH triggers ovulation. The posterior lobe only produces two hormones, ADH and oxytocin. ADH stands for antidiuretic hormone. So that tends to make urine more concentrated. It's antidiuretic. It counteracts diuresis. The oxytocin, what that does is it causes the myoepithelial fibers in the breast that are around the glands producing milk, it causes them to contract so that when the infant nurses, as it suckles on the nipple there is increased released of oxytocin. It causes the muscle fibers to contract and squeezes the milk out of the glands into the ducts so it's available for the infant, the nursing infant. Also, in labor causes the uterine muscle fibers to contract.

So here is the an example of how hormones work. You have the hypothalamus that causes releasing hormones. They either go through the hypophyseal portal system in the anterior lobe or through to the posterior lobe. Here they have the anterior pituitary, and that then releases the tropic hormones, goes to the endocrine gland. The endocrine gland then produces or releases circulating hormones which then has their target effect. Also, there is the feedback inhibition, which goes back to the hypothalamus. Now, the term panhypopituitarism refers to where the anterior lobe fails to secrete all the hormone in adequate levels. Dwarfism can result from a deficiency of growth hormone at the pediatric age of development. Diabetes insipidus is a term that we use for lack of production of ADH, which is from the posterior pituitary lobe, or the inability of the kidney to respond to ADH. And so what happens then they are unable to absorb H2O, water, and they produce large amounts of dilute urine.

Growth hormone overproduction very often caused by an adenoma, pituitary adenoma, causes gigantism in children. If it occurs in adults, it's acromegaly. The pituitary gland is right next to an area of the brain we call the optic chiasm. It's where the ophthalmic nerve comes in from the eyes and 50 percent of the fibers cross and they go to opposite sides of the brain. So that chiasm is right where the anterior pituitary gland is. If there a tumor of the anterior pituitary gland, it can put pressure on the optic chiasm and in effect cause visual disturbances. Typically it's going to be visual disturbances of the peripheral fields. If you look straight ahead, you lose your side or peripheral field vision. You can't really see the fingers moving. Prolactin overproduction can also be from another small pituitary adenoma, and it causes amenorrhea, lack of a period, and galactorrhea, which is secretion of milk from
nonpregnant breasts.

Pituitary tumors. Many of the pituitary tumors, the endocrine disturbances can be caused by the tumors. And the manifestation will depend on the size of the tumor and the hormone produced. You can have functional tumors that produce hormones or you can have nonfunctional tumors that don't produce hormones. They can encroach on other important areas in the brain that can disturb hormone-producing functions.

So treatment is going to be determined by the type, the size, and the hormone produced by the tumor. Sometimes you can give them drugs to suppress tumor growth. With microadenomas that affect secretion of prolactin inhibitory factor, PIF, you can treat it with medication. Sometimes they need to have a transsphenoidal resection. I mentioned about that patient of mine earlier.

Here is a person with acromegaly. Notice the course features of the hands and the face. That's due to hypersecretion of growth hormone.

Here they are just demonstrating to you the transsphenoidal resection of the microadenoma. You see the tumor in the brighter orange. The peach is the pituitary gland. It sets in what we call the pituitary fossa, and the approach is through the nose. So you can see that's really difficult surgery.

STUDENT: (Inaudible)

PROFESSOR: Yeah. And so the thyroid gland. As I mentioned, it's got two lobes connected by an isthmus. It contains follicles that produce and store thyroid hormone. The typical thyroid hormone is going to be what we call T3, T4. And T4 is thyroxine. T3 is triiodothyronine. And it's called tri because it has three atoms of iodine for every molecule, okay. The thyroxine has four atoms of iodine per molecule. And also around the follicles are the parafollicular cells that are involved in the production of calcitonin, which is involved in calcium regulation. Also, let's see. So basically, it controls the rate of metabolic processes and it's required for normal growth and development. Becomes very active once puberty starts.

Here is an example of the thyroid gland. You see the isthmus, the narrow connection between the two lobes.

Here is a demonstration of thyroid tissue. This is classic. You see this at really -- you can't confuse it with anything else. The large round pink areas are the stored thyroid hormone, and it's bordered by the -- probably those are what we'd cuboidal cells, a ring of cuboidal cells, and they border the follicle.

So with the thyroid glands, you can have either hyperthyroidism or hypo. Here is how the gland influences the body. If it's hyper, you are going to have rapid pulse, increased metabolic rate, hyperactive reflexes, increased
emotional lability, meaning emotions can go up and down. It's going to stimulate the GI tract so there is diarrhea. And there's going to be warm, moist skin. Hypothyroid is the exact opposite. Instead of a rapid pulse, you have slow pulse. All right. You have a decreased metabolism. These people because of decreased metabolism, sluggish reflexes, they tend to be cold. They feel cold. They have dry skin. They don't have diarrhea. They have constipation. And they tend to have a very flat type of affect.

Now, goiter refers to an enlarged thyroid gland. The gland enlarges, okay, to produce hormone secretion. So what causes it to enlarge? Maybe it doesn't produce adequate hormone so it's stimulated to produce more. It may enlarge due to an iodine deficiency or an enzyme deficiency, inadequate enzyme function. And the treatment basically then for a nontoxic goiter is to give them thyroid hormone. By giving them thyroid hormone -- and thyroid hormone is very easy to give and control. It's tolerated great. No one gets side effects. By giving them thyroid hormone, it allows the thyroid gland to rest. Give enough thyroid hormone that they take by mouth then the thyroid gland doesn't have to produce hormone. As a result it may shrink and resolve in size. Sometimes it doesn't, and you need surgical removal. Sometimes the thyroid gland can get so enlarged it puts pressure on the trachea and interferes with breathing and respiration.

Let's see. The pathogenesis of a nontoxic goiter. What it shows basically is the causes, and as a result -- because there's inefficient output thyroid hormone, you have increased pituitary release of TSH, which then causes an enlargement of thyroid gland and hopefully increases the output in the thyroid hormone so they have normal thyroid function.

Hyperthyroidism, all right. So that's hyperfunction of the thyroid gland. We call it toxic goiter or Graves disease. It can be caused an antithyroid antibody, so that's an autoimmune disease where there is production of antibodies that act against thyroid antigen. And this serves to stimulate the thyroid glands. Mimics the effects of TSH, thyroid stimulating hormone, but you can't control it. It's not able to be regulated. So treatment can be antithyroid drugs, drugs that may destroy some of the thyroid, such as radioactive iodine or they remove part of the thyroid, thyroidectomy.

Here is someone with a toxic goiter. If you notice -- it's not a great picture. It shows that the lower part of the neck right above the clavicle is a little bit swollen, little bit full, which represents the enlarged thyroid gland, the goiter.

Here this profile is little bit more dramatic. Here is a large nodule goiter.

So hypothyroidism, underfunctioning of the thyroid gland. And in the adults another term for it is myxedema. They have metabolic slowing. And the treatment is going administration of
thyroid hormone. Now, if hypothyroidism is not picked up in the child, if they have it then they develop cretinism. And they have impaired growth, impaired CNS development. It causes hypometabolism. So prevent cretinism in the child, you need to have an early detection of the lack of thyroid hormone. Chronic thyroiditis or Hashimoto's thyroiditis, that's when autoantibody destroys the thyroid tissue. Now, if the thyroid tissue gets destroyed, then what it does it results in underfunctioning. It's an immunologic reaction not from an infection. Very often you diagnose it by a biopsy, and the biopsy will show characteristics of a Hashimoto's thyroiditis, which is destruction of follicles.

Here you can see -- oops. Here you can see the -- this is Hashimoto's and the follicles are very small. You can see a little bit of the secretions from the follicle, but what you do see is a lot of dark cells, and these are the () lymphocytes. So it's an autoimmune disease, very active B and T lymphocytes. We call that basically lymphocytic infiltration of the thyroid gland and the normal thyroid architecture is destroyed.

So thyroid tumors can be benign or they can become cancerous. Usually they are well differentiated. The cure rate for thyroid cancer is probably the highest cure rate of all the cancers. They can be well differentiated follicle and papillary carcinoma. They treat it with a surgical resection. Occasionally, you get a poorly differentiated carcinoma with a poor prognosis, and it can grow rapidly.

Here is an adenoma benign, well defined adenoma of the thyroid glands. The arrows point to the adenoma. Notice how you can see the borders of this adenoma. The adenoma doesn't infiltrate the thyroid grand. What it does is it grows and it compresses the margin and extends, but it doesn't infiltrate. So we know it's benign.

This is an example of a papillary carcinoma of the thyroid. You don't really see the follicles that we saw in the beginning pictures.

Parathyroid glands, they -- parathyroid glands are responsible for producing parathormone. And basically they maintain the blood calcium level. Of course, the biggest source of blood calcium level is going to be the bone. So the parathyroid glands produce parathormone. And what parathormone does is it acts on the cells, the osteoclasts, which are in the bone. Osteoclasts will break down bone. So by breaking down bone, it raises calcium level. So low calcium level will cause tetany. Calcium is very important for function of the neuromuscular system. And then high calcium levels will lower neuromuscular excitability. Hyperparathyroidism, very often it comes from an adenoma. They have high blood calcium. And the concern is that when you have something like a parathyroid adenoma and high calcium levels, you run the risk of getting renal stones. They precipitate in the urine and in extreme
cases you get calcium deposition in tissues. Treatment has got to be removal of the tumor.

Hypoparathyroidism usually occurs from the accidental removal of the parathyroid glands during thyroid surgery. Remember I told you the parathyroid glands are located in the back of the lobes of the thyroid gland. And so as a result, they get hypocalcemia and they can get neuromuscular excitability and tetany. So the treatment is you have to raise calcium levels.

Adrenal cortex, very interesting. Adrenal cortex is -- the adrenal gland has two portions. The cortex, the outer portion, and the inner portion is the medulla. So the adrenal glands are paired. They're above the kidney. And they produce glucocorticoids which is involved in inflammation and healing. The mineralocorticoids -- the most common mineralocorticoid is aldosterone. Control and release of aldosterone is pretty much through the renin-angiotensin system. The adrenal cortex also produces some of the weaker sex hormones, sex hormones that are not as potent. Now, the concern is the overproduction of aldosterone. It can occur from aldosterone-producing tumors. If so, remember what aldosterone does is increases the absorption of sodium from the kidney. As a result aldosterone tumors, they have high sodium levels. And remember that sodium holds on to water. So as a result they have high sodium levels and holds on to water, so they have increased blood volume and then they have -- because of the increased blood volume they have increased blood pressure. And they will tend to have low potassium levels which the can neuromuscular manifestations.

Also, there can be overproduction of the adrenal sex hormones, and that's associated with congenital adrenal hyperplasia. Hyperplasia refers to increase in activity, increase in number.

Now, the medulla, all right, is more neurologically related in that it produce catecholamines. And catecholamines are involved in the sympathetic nervous system, norepinephrine and epinephrine. You can get a tumor of the adrenal medulla called a pheochromocytoma. It's a very interesting tumor. It's a dangerous tumor. It's a tumor that produces catecholamine. So once again, catecholamines are norepinephrine, epinephrine. So what happens is this pheochromocytoma, it's independent. It's not regulated by ACTH. It produces catecholamines, and then periodically it dumps the catecholamines into the circulatory system. When it dumps the catecholamines into the circulatory system, it's like the person has almost a hypertensive crisis. Their blood pressure goes up. They have this sudden feeling of anxiety and panic. They get a facial flush. And it's all due to the increase presence of epinephrine in the bloodstream. Remember epinephrine and the sympathetic nervous system is responsible for the fight or flight response. So when a pheochromocytoma dumps all the catecholamines in the
bloodstream, it's like all of a sudden, boom, they are ready for flight or flight. They don't know what's happened, but they have this overwhelming sensation coming on. Of course, because of the severity, they can get a hemorrhage or stroke. And as a result it becomes a very emotional issue. And it's difficult to diagnose because most of the time they have normal levels of epinephrine. So what you have to do is if you suspect a pheochromocytoma, what you do is you have -- you collect a 24-hour urine specimen. In the urine specimen, it goes to the lab, and they look for metabolites of epinephrine and norepinephrine in the urine.

Addison's disease, what that basically is hypofunction of the adrenocortical gland, the adrenal cortex. As a result, it's a deficiency of all the steroid hormones. Deficiency of the glucocorticoids, mineralocorticoids. So because there is deficiency in mineralocorticoids, they have low blood volume. They have low blood pressure. Also, because of the hypofunctioning of the adrenal gland, what is the whip that drivers the adrenal glad? That's ACTH. So there is increased amounts of ACTH that's released. And as there's increased amounts of ACTH released, there's also increase in release of MSH, melanocyte stimulating hormone. So as a result people with Addison's disease have a darker skin complexion. They describe it as a coppery type color. Addison's disease is probably on the basis of an autoimmune disorder, development of antibodies against the tissue antigens in the adrenal cortex. One of the treatments can be administering corticosteroids. Cushing's disease is the exact opposite. Cushing's disease is excessive production of the adrenal corticosteroid, the glucocorticoids. So as a result you have excess glucocorticoids. You're going to have disturbed carbohydrate metabolism, disturbed fat and protein metabolism. You also have high mineralocorticoid excess, as a result high blood pressure and high sodium level, high blood volume. Treatment is going to be tumor removal. In the book they have a picture of a woman with Cushing's syndrome and she has a typical body habitus of Cushing's. They tend to have extremities that are fairly thin, a lot of central weight. Sometimes also they can have a moon face. It's very round. They get like a collection of fat over the cervical spine area. So for Cushing's disease, you can have a hormone-producing pituitary microadenoma that can be an adenoma of the adrenal cortex. You can have hyperplasia of the adrenal glands or sometimes with Cushing's, it results from administration of large amounts of corticosteroids. Someone who has an autoimmune disease like lupus, if it's a severe lupus episode then they may have to go to on high doses of corticosteroids. As a result they may get that round face, that moon face that we associate with Cushing's. It's a temporary thing and it usually resolves as they go down on their glucocorticoid level or their Prednisone level.
Here is someone with the typical body habitus of Cushing's. The only thing is notice on the frontal picture on her left side that stria, that red streak that happens with the increase levels of glucocorticoids, the production of stria.

Pancreatic islets. Pancreatic islets, those are islets of langerhans. They are within the pancreas gland. Remember the pancreas has dual functions. Exocrine gland, produces digestive enzymes that go into the duodenum, it's an endocrine gland, also. The islets of langerhans produce insulin, glucagon, somatostatin. The hormones, as I mentioned, the beta cells produce insulin. Alpha cells produce glucagon. Glucagon serves to raise blood glucose levels. Insulin will lower blood glucose levels. And somatostatin will inhibit the action of both.

Of course, the gonads. The function of the gonads, the testes, and the ovaries are production of germ cells and also production of the sex hormones. The production of sex hormones are controlled FSH and LH even in the male. You have follicle-stimulating hormone. You have luteinizing hormone. And we talk about these a lot in relationship to the female menstrual cycle, the female hormonal cycle, but they also are present in the male and are involved in the development and maintenance of the endocrine portion for the gonads. So tumors can secrete some of these hormones. If so, they need surgical excision. They need to be removed. I did mention to you, I think, that occasionally -- very rarely, but sometimes we would have -- I did have one patient who presented with hypothyroidism, and it turned out she had a tumor in the ovary. It was what we call teratoma, and she had thyroid tissue, ectopic thyroid tissue, in the tumor. It was not under control of the pituitary gland, and as a result she was hyperthyroid because the ectopic thyroid tissue in the tumor was producing too much thyroid hormone.

Nonendocrine tumors. Here is what we were talking about. Ectopic hormones. Occasionally you can have tissue outside the endocrine system that produces a hormone. One of these is a special tumor in the lung of -- a special type of lung tumor. It's called an oat cell tumor and it can produce hormones. Not a variety of hormones, usually just one type of hormone. Also they can originate in the kidneys or connective tissue.

So stress and the endocrine system. Stress is any event that disturbs homeostasis or the balance. Here's all the causes, as you would know, injury, surgery, prolonged exposure to cold, exercise, pain. And the acute response to stress is the fight or flight, which I mentioned before. It increased release of epinephrine mediated by the sympathetic nervous system. Chronic response to stress, long-term stress alters metabolism, affects the cardiovascular system. It also can impair inflammatory immune responses.

Obesity. Obesity occurs when the caloric intake exceeds the requirements. Requirements can be altered by exercise and
physical activity. Usually it's not the result of an endocrine or metabolic disturbance. Health consequences of obesity. You know these things by now. It affects the cardiovascular system, diabetes, cancer, the musculoskeletal problems, osteoarthritis of the hips can be from obesity. Also, it affects the pulmonary function, taking deep breaths, respiratory excursion. People sometimes who are obese have difficult taking deep breaths. Treatment is going to be medical and diet. There's drugs on the market now to suppress the appetite. They mention fen-phen. That was a long time ago. That was a diet regimen. Very good success rate for weight loss; however, more than 50 percent of the people who were on the fen-phen diet had heart valve damage and needed cardiac surgery replacement of the valve. So you cannot take it together. Phentermine, I think, is still on the market. It's not associated with cardiac defects if you take it independently. Also, now there is surgery. Different ways to treat obesity. There is the gastric bypass. There's stapling of the stomach. There's the lap band, gastroplasty. All these procedures are basically designed to reduce food intake and decrease absorption.

STUDENT: No exercise?

PROFESSOR: Exercise is the first thing I said.

STUDENT: Oh, okay.

PROFESSOR: That's how you reduce your -- what did I say? Right there. When it says occurs when caloric intake exceeds requirements, I said you can increase your requirements by exercise.

Okay. Here is a diagram showing you some of the surgeries.

(End of class.)

CERTIFICATE OF TRANSCRIPTION

I hereby certify that the foregoing transcription is a true and accurate verbatim record of the recorded proceedings.

Kerry Mercade, CSR
813.404.2488, www.HRICART.com