# The Intricate Web of Hormone Relationships

## Transcript

Hello and welcome to the Institute of Nutritional Endocrinology's presentation of the Intricate Web of Hormone Relationships. Hormones are complicated and their relationships are very intertwined. We are going to use this presentation to give you an overview of how all those relationships fit together. As we delve more deeply, later on, into the specific hormones and the specific families, you will have a much broader overview of what is going on.

Before we begin, let's just make sure you are aware that any of the information that I am presenting here is not intended to replace a one-on-one relationship with a qualified healthcare professional and it is also not medical advice. When you are presenting to your clients you need to be really careful and make sure that they are aware that what you are presenting, and what I am presenting here today, is intended as a sharing of my knowledge, information, clinical research, and clinical experience over many years. I encourage you, and you should encourage your clients, to make their own health care decisions based upon your research and in partnership with a qualified healthcare professional. This is especially true for people who are on any medications. I want to make sure that the things that we talk about in terms of nutrition are not going to interfere with the protocols.

Let's get started. I like to look at hormones in pairs. Not all of them have a paired counterpart, but when we look at pairs we often see is one of the pairs will increase the function of the gland, and the other one will decrease it. Let's take a look at some of the most common ones. *Insulin and Glucagon*: insulin and glucagon are the blood sugar handling hormones. Insulin is secreted when the blood sugar gets elevated after a meal or after stress or sometimes after exercise, and the blood sugar needs to be put back into the cells. So insulin gets secreted; its job is to get the blood sugar back into the normal range.

Glucagon is partner in crime with insulin. When the blood sugar starts to get too low, for any number of reasons, glucagon steps in and causes stored glucose, in the form of glycogen (usually stored in the liver or in the muscles) to be released so that the blood sugar goes up. When these guys are both functioning properly, the blood sugar stays in a very healthy, ideal range. Sometimes the blood sugar gets too low, and there is too much insulin secreted as a result of a very high carbohydrate load.

Sometimes glucagon can overshoot the mark and release too much sugar, so you end up with this yo-yoing back and forth. When we do our *Blood Sugar Balancing* module, you will get into all the little details behind the scenes of how insulin and glucagon work, in concert with many other hormones to keep the sugar balanced.

*Cortisol and DHEA* are also somewhat opposite, not in the same exact way as insulin and glucagon. Cortisol is released from the adrenal cortex when there's stress: whether it is a physiological stress or a psychological stress, whether it is it perceived stress or a real stress; cortisol gets involved and creates all the different chemistry that is required to get you running away from tigers and keep yourself safe. It is secreted in the times of stress. DHEA on the other hand is secreted when the cortisol levels go down. DHEA is responsible for growth and repair and all of the good maintenance functions that get shut off when cortisol is in the system.

DHEA also has the effect of inhibiting cortisol, which can be a good thing. So the cortisol goes down the DHEA goes up. DHEA inhibits cortisol until the next big stressor. It keeps everything in balance. The intricacies come when we start to supplement and try to support people in adrenal stress. If you overdo the DHEA, or you overdo some of the cortisol releasing factor herbs and nutrients, you can get into trouble. We will talk in more detail about that when we get into the *Adrenal* module.

*Leptin and Ghrelin* are in charge of appetite and fat burning. Leptin is actually a hormone that is secreted by the fat cells. Interestingly enough the fat cells are actually endocrine glands. When the fat cells get nice and plump and juicy, and they don't need any more nutrients or storage coming in, leptin gets released to say, 'hey, shut off the appetite, you don't need to eat anymore.' Ghrelin, on the other hand, is secreted by the lining of the stomach. It gets secreted during times of hunger. When the blood sugar starts to drop and the stomach is empty, ghrelin gets secreted. Ghrelin stimulates appetite. It says 'hey hello, eat, we are low.' The cool part about ghrelin is it also stimulates growth hormone, because growth hormone helps us to release that from stored tissue and it is also good for repair and muscle building. It's actually a good thing to be hungry for a little while before it becomes an emergency. Leptin and ghrelin work in concert with each other and we will go more into those when we do the *Blood Sugar* module.

*Estrogen and Progesterone* are female hormones. Estrogen is what is called the proliferative hormone. It causes the uterine or the breast tissue to enlarge and engorge. It causes extra fat to be stored around the middle, which is good during pregnancy but not so good at other times. Progesterone is an antiproliferative, more of a protective hormone.

If progesterone levels get low, and estrogen levels get high, we end up with an imbalance that can predispose a person to proliferative cancers, meaning of the hormone-secreting areas like breast tissue and uterus. We will talk more about that when we get to the *Reproductive Hormone* module.

*Testosterone and DHEA* are actually androgens. So they are not opposite each other, they are actually intertwined by one being able to be converted into the other. They are both male hormones, but females need to have good amounts of these. Not the large amounts that males have, but decent amounts. DHEA can be converted into testosterone and then testosterone can actually be converted into estrogen. We will go into all the intricacies of those when we do our *Reproductive* module as well.

Finally on my list of important hormone pairs is *Growth Hormone and Somatostatin*. Growth hormone stimulates fat burning and lean muscle storage, so it is really important for athletes, or when you are exercising. It's also important that you do things to support growth hormone, which we will talk a lot about in our *Blood Sugar Managing* module. Somatostatin actually opposes growth hormone. It basically turns off growth hormone. So if the growth hormone gets too high, somatostatin says 'okay, stop.' We will go into all of these in much more detail as we progress through our course.

Let's take a look at hormone families. In looking at the way hormones are grouped together and their functions, I decided that they are really like families that need to work in concert with each other; that need to communicate well with each other, and to support each other. Let's look at some of those families. Then we will look in more detail at what hormones are in each.

*Metabolic Rate* hormones: these are the ones that support how fast your cells burn oxygen, and those are generally thyroid related hormones. *Blood Sugar Balancing*: keeps the blood sugar nice and steady, so all of the cells in the body have plenty of sugar to support themselves. Those are the ones we talked briefly about already. There are a lot that are involved in blood sugar balancing, including insulin and glucagon, but also including ghrelin and leptin, and cortisol and thyroid hormone. *Appetite and Digestion*: most people don't think about the digestive tract as an endocrine gland, but the digestive tract secretes lots of endocrine hormones, and we will go through what some of those are. Digestion is actually controlled by the endocrine system.

*Stress* hormones: these are the hormones secreted by the adrenal glands to protect you from threats, from threats to your life. They are: adrenaline, cortisol, and DHEA. *Sex and Reproduction*, we mentioned a few of these already: estrogen, progesterone, testosterone, and DHEA, but there are a lot more; oxytocin, prolactin, and other hormones.

*Sleep, Thoughts, and Emotions*: there are hormones that control how we think, and breathe, and how well we can sleep. Some of those would be melatonin, growth hormone, cortisol, and adrenaline; there are a lot of hormones that are involved in sleep. Some of these family members overlap from one family to the other. It is kind of like if you think about cousins. Whereas you might be in a family with one cousin you might be in another family with another cousin because they come from different lineages. *Organ Functions*: there is a family of hormones that control organ functions. There are hormones in the cardiovascular system. There are hormones that control the kidney. There are hormones that control the lungs. So general organ functions is where I leave it.

Let's look at how those hormone families interact with each other. This slide shows some of the interactions, but not all, because it would have been so crowded with arrows that it would become difficult to be understood. Stress affects sleep. If you are under stress and are secreting cortisol and adrenaline, you are not going to be able to fall asleep very well. Stress and appetite are interconnected. If you are under stress your digestive tract turns off and you don't digest your food very well. If you are eating foods and have leaky gut and have microbes in your gut, the digestive tract affects your stress response.

Appetite and digestion affect blood sugar. How much you are eating at any point in time? What are you eating? Are you eating high glycemic foods or foods that maintain study blood sugar? Sleep and organs: certain organs are going to affect how you sleep. If you've got problems with the cardiovascular or kidneys, that can interrupt your sleep. Metabolic rate organs and blood sugar are all connected; as are thyroid, adrenals and insulin. When those things are not working properly, then your metabolic rate is going to be disrupted. Your blood sugars are going to be disrupted. If your blood sugars are out of whack, your metabolic rate gets messed up and all of your organs are involved with that as well. Metabolic rate affects blood sugar, and blood sugar affects metabolic rate, thyroid, and insulin. We will go into more detail on these as we progress through the program. This is just to give you an overview.

Reproduction. Thyroid and estrogen are super connected. When you have problems with the thyroid, you can have problems with fertility. If the metabolic rate is low and the thyroid is low, you will not be able to produce and mature the eggs and sperm as well. Sleep and reproduction: progesterone actually helps to induce sleep. Shortages of progesterone will contribute to insomnia: it goes both ways.

Sleep affects your stress response. I am just going to add all of these in: stress and the organs; sleep and the organs affect growth and repair of the organs, and they are not going to function as well. Those are the families and now we are going to go into a little bit about each of the families. Know that when we get to the particular topics, the particular modules, we will have an entire module devoted to each of the hormone families.

What are the hormones in charge of metabolic rate? The main ones are the thyroid hormones. If you see over on the left-hand side here, we've got the thyroid and it produces called hormones T3 and T4 that directly attach to the metabolic receptors (or the thyroid receptors) on each of your cells and each of your client cells, and it affects the oxygen uptake, the rate of metabolism of those cells. The thyroid is stimulated by the pituitary gland, the interior part of the pituitary. The interior part of the pituitary also stimulates the adrenals and the gonads. When you have impaired functioning of the pituitary level, sometimes as a result of overstimulation under stress, you can impact the adrenals and the gonads. Metabolic rate is also affected by the small intestine, and by glucagon and insulin. If you can't get the blood sugar managed (if the blood sugar is up and down and all over the place) the thyroid suffers. We will go into more detail about this later.

Let's look a little more closely; this is just a reference chart. Note that we will go into all of these, in more detail, in the *Thyroid* module. We've got thyroxine and free T4 (which is basically T4 either in the free or protein-bound state) and we will learn more about what that means later on. They convert into the active form, which is T3. That is what stimulates your cells. So T3 (triiodothyronine) and free T3 are what you would measure on a blood test. They have the most profound effect on increasing metabolic rate. Thyroid stimulating hormone (TSH) comes from the anterior pituitary and stimulates the release of T4; mostly T4 (a little bit of T3 is produced by the thyroid but it's mostly T4). TRH (thyrotropin releasing factor) is produced by the hypothalamus and that stimulates the release of TSH.

We've got reverse T3, which is produced from T4. T4 is either converted to T3 or reverse T3. It is converted to reverse T3 when you are over stimulated and when there is a shortage of nutrients like iodine and selenium that support the conversion from T4 to T3.

Insulin is secreted by the pancreas in the Islet cells, and enhances the uptake of glucose into the cells and subsequent ATP production. Next we have epinephrine, which is secreted by the adrenal gland and enhances metabolic rate, and also insulin. Cortisol, which is secreted by the adrenal cortex, enhances the release of stored sugar and supplies additional fuel to cells. So you can see while the thyroid is the primary player in the metabolic rate hormone family, there are other hormones and interactions that are very important for controlling metabolic rate.

There is a thyroid, your thyroid has an effect on everything: the G.I. tract, the gallbladder, liver, lipids (that is blood fats), protein, glucose, red blood cells, hormones, other hormones, bone, cardiovascular system, and brain. When the thyroid is not working properly everything suffers. Everything slows down and that is why there are such a wide variety of symptoms that you see in someone with a problematic thyroid.

It can mimic, it can be confusing because someone is presenting with end organ or other gland dysfunction. Sometimes it can be confusing to track it down to the thyroid. Typically we are going to learn about some blood tests that you can do but also some functional tests that a person can do at home to isolate whether the thyroid is at the seat of their problems.

The thyroid has an effect on the citric acid cycle and we are going to learn more about the Citric Acid Cycle in our *Cellular Metabolism* module. There are a lot of nutrients that are important for producing energy. It is thyroid function, and then the actual mitochondrial function, that are important for metabolic rate; so I could not help but put this in there. We will go into more detail on that in the *Cell Metabolism and Energy Production* module.

Thyroid control: how does it get controlled? Your hypothalamus secretes a releasing factor, thyrotropin releasing factor (TRH), and it stimulates the anterior pituitary. The pituitary then stimulates the thyroid by producing TSH (thyroid-stimulating hormone) that circulates in the blood stream. It makes its way into the thyroid and the thyroid says, ‘oh, I am getting a kick in the pants. I need to speed up. I need to make more T4’ (generally), sometimes a little more T3, but mostly T4. It produces that. Then there is a negative feedback loop, which is very common in endocrinology, very common in hormone control. There is a stimulating hormone, and it stimulates the gland (the gland that makes more of that hormone), and the extra level of that hormone in the blood causes that stimulating hormone level to go down.

In this case when the thyroid says hey, ‘okay, I will make some more T4.’ If it does that the pituitary says ‘oh great’ and then it slows down. When the thyroid is sluggish or it’s missing some nutrients and it can't do that, what happens is it does not produce any more; so the anterior pituitary produces even more TSH, and the thyroid is not producing much more; then the anterior keeps producing, until the TSH levels go very high. The thyroid levels make it into the normal range, but when you see the TSH very high and the thyroid hormone normal, that means the pituitary has to kick the thyroid really hard, and it means that there is something wrong. You do not want to wait until the T3 and T4 are out of balance before you take action to help your client restore function.

Let's now look at blood sugar balancing hormone family. There is a bunch in here as well. Again there are some that are secreted by the pancreas, the main seat of blood sugar balancing, but there is a lot of interaction with the other parts. Insulin is the main blood sugar balancing hormone that we know about. It is secreted by the pancreas, the beta cells in the pancreas. It stimulates uptake of glucose into the cells. It basically stimulates the receptors on these cells and says ‘hey, I've got some sugar, let me go in.’ As a result of proper insulin production and proper cell receptors, what will happen is blood glucose will reduce, which is going to decrease the stimulation to the pancreas, so it doesn’t produce more insulin until the blood sugar levels get high again.

Glucagon is also secreted by the pancreas, in the alpha cells. It stimulates glucose release from glycogen, and synthesis from amino acids and fats. Your body can create energy; create glucose from some of the amino acids and fats. Glucagon's job is to find storage. If it can't find storage than it finds it from amino acids and fat. It is stimulated when the blood sugar gets too low. It is suppressed when the blood sugar goes back up to a normal level.

Somatostatin is a hormone that's secreted in the stomach, intestines, and the pancreas. It suppresses the release of glucagon and insulin, gastric hormones, growth hormone, TSH and prolactin. We will go into a lot more detail about somatostatin when we look at the digestive tract.

Growth hormone is secreted by the anterior pituitary. It can antagonize insulin. Growth hormone and insulin do not like to play together and vice versa; insulin antagonizes growth hormone. A surge of growth hormone (when people take shots of growth hormone and it is excessively large) can antagonize insulin. What usually happens is the levels of insulin are powerful enough that they suppress growth hormone.

Epinephrine (adrenaline), produced by the adrenal medulla, enhances the release of glucose from glycogen and fat. Adrenaline gets in there when there is an emergency. It's a quick need for extra glucose like when there is a tiger chasing you. It's not sufficient to ask the glucagon to go in and get rid of the stored starches as glycogen; that comes in when there's more of an emergency need for extra blood glucose and it is not necessarily when the blood glucose is low. Whereas glucagon just comes in when the blood glucose goes too low. Adrenaline will step in when there is an emergency even if the blood glucose is normal; it wants to help get the blood glucose much higher.

Cortisol is produced from the adrenal cortex. In an emergency situation, the cortisol is going around finding storage, and it likes to find storage in the muscle. Cortisol is best at breaking down muscle in a process called gluconeogenesis, to help increase the glucose. Glucagon usually goes to the stored glycogen. Adrenaline usually goes towards the fat storage. There is overlap between these functions. Cortisol, adrenaline, and glucagon all help to bring the blood sugar up, usually in different ways, but sometimes there is some overlap.

Thyroxine (T4) is important in blood sugar managing because it enhances the release of glucose from glycogen, and absorption of sugar from the intestine. It helps to increase the metabolic rate and is looking for places where it can increase the energy to the cells, so they can use oxygen better and create more energy. ACTH (adrenocorticotropic hormone) is produced by the anterior pituitary; it is the adrenal stimulating hormone that enhances the release of cortisol and fatty acids from adipose tissue.

Incretin (which is one that most people never heard of) is secreted by the small intestine and it increases the insulin even before glucose enters the blood stream. Incretin's job is to forewarn the pancreas that there is about to be a surge of glucose into the bloodstream because there is food in the small intestine. That increases the level of insulin; it's almost like giving it a head start.

Again, this is everything involved in blood sugar balancing. I am giving you all of this and we will go into more detail when we get to the *Blood Sugar Balancing* part of the program. This is to give you an understanding that it is not a simple process (for some people it is), but it is giving you the background so when things are not going the way they should in terms of balancing the blood sugar, you know there are other places to look.

The interaction between thyroid and glucose: we go into more detail about this in our *Thyroid* and *Blood Sugar* modules. Basically, in a nutshell, thyroid dysfunction causes a decreased rate of glucose uptake by the cells, a decreased rate of glucose absorption in the gut, a slower response of insulin to elevated blood sugar (that means it takes longer to get the blood sugar into the cells), and a slower clearance of insulin from the blood: meaning the person is subject to the negative side effects of insulin, which we will go through into more detail later.

Let's now look at insulin and glucagon imbalance. When you have fluctuating blood sugar it can weaken and imbalance many different parts of the body including gut, lungs, brain, hormone levels, adrenal glands, detoxification pathways, and did I say blood vessels as well? We talked about that before. We go into more detail in the *Blood Sugar Balancing* program. But what this leads to is impairment of metabolism, weakened thyroid function, and as long as the blood sugar is dysregulating, whatever you do to fix the thyroid is not going to work.

That is why when we look at the hierarchy we look at blood sugar problems before we look at thyroid. We look at digestion before we look at blood sugar balance, because we want to make sure that the foundations are working. What should happen is you eat food, you make insulin, the cells resist insulin if there is too much. When we have an excess of sugar and carbohydrates in the diet, it causes the sugar to get stored as fat, the person gets tired and hungry shortly after eating, and then they eat again. The vicious cycle continues. When we do our *Blood Sugar Balancing* module you will learn how to step in and intervene here.

Let’s take a quick look at the appetite and digestion hormone family. When we do the *Digestion* module we will go into more detail. Leptin is produced by the fat cells and stimulates satiety. Ghrelin is secreted by the stomach lining, and signals hunger. Gastrin is secreted by the stomach itself as soon as food hits it, to increase the production of stomach acid.

Cholecystokinin (CCK), which is secreted by the small intestine, stimulates the production of pancreatic juices so that it helps digest the food that is about to go in there. As soon as the food hits the small intestine, cholecystokinin gets secreted and says, ‘hey, pancreas we need some enzymes.’ ‘Hey, gallbladder, give us some bile.’

Secretin is secreted by the duodenum (the upper part of the small intestine) and it stimulates bicarbonate production by the pancreas, bile production by the liver, and pepsin by the stomach. So it has a very wide range of functions. It is also secreted by the stomach, I believe. It stimulates bicarbonate because the food that is in the stomach, which is no longer food and is called chyme  (it’s like a smoothie consistency), is very acidic in the stomach so that protein digestion can begin. When it goes into the small intestine it needs to be more alkaline so the digestive enzymes can work on it. So the job of the pancreas and the gallbladder is to start to produce the bicarbonate.

Then we have peptide YY mainly secreted by the ileum and colon, but a little bit in the other parts of the G.I. tract. It basically inhibits gastric (stomach) motility, as it’s no longer needed anymore, because food is already down in the small intestine. It increases water and electrolyte absorption in the colon to keep the feces in the right consistency; it can suppress the pancreatic secretions, as we don't need to secrete pancreatic enzymes once the food has been digested. It increases the efficiency of digestion. Again, we will go into these in more detail later.

Incretins include two categories of hormones: gastric inhibitory peptides (GIP) and glucagon-like peptides (GLP). They are secreted in the small intestine. The role is to increase the insulin, inhibit glucagon, slow the rate of absorption and nutrients by reducing gastric emptying. So we have a nice, steady influx instead of a rapid influx.

Somatostatin is secreted by the stomach, the intestine, and the pancreas. It inhibits gastrin, CCK, secretin, GIP and growth hormone, TSH, glucagon, and insulin. It is basically an inhibitory hormone that turns everything down when it is no longer needed. Dopamine is secreted by the brain and the G.I. mucosa. Most people don't realize that dopamine, in addition to being a neurotransmitter in the brain affecting mood, also affects gut motility and it protects the mucosa. The same thing with serotonin, which is a very important brain neurotransmitter.

Here is a picture of an overview of the endocrinology of digestion. It is just a preview of what you have to come. We will go into more detail about how this works when we do our *Digestion* module. So let's take a look at the stress hormone family.

We generally think of this as the adrenals. Yes the adrenals are the start of the show when it comes to stress, no doubt about it. Adrenaline is secreted by the adrenal medulla. We will go into more detail about the anatomy, and where things are secreted, when we get to the *Stress Adrenal* module. It allows fight flight. It increases heart rate, pulse, pressure, it is that feeling you get when you feel stress like suddenly palms that are sweaty, the heart rate increases, the blood pressure increases, and you might feel pressure in your head. Cortisol is from the adrenal cortex and is longer acting, slower to get into the picture hormone, in the picture of stress.

Adrenaline is very quickly in and out. The cortisol comes in and picks up the slack. It stimulates glucose release from glycogen, amino acids, and fats; so you can increase the blood sugar and shunt energy to the extremities, and you can run and fight. That's why one of the things that I recommend to people, when they get into a stressful situation and they are sitting at their desk, is to get up and move, and get rid of all that extra glucose in the blood. Go for a walk around the block, do some squats, do some jogging in place, whatever it takes.

Aldosterone is secreted by the adrenal cortex and it aids in the retention of fluid and electrolytes, conserves sodium, and secretes potassium. That gets increased when you are under stress, so you have more fluids and electrolytes; and when the adrenals are burnt out the aldosterone levels go low, and people tend to urinate out their electrolytes.

DHEA, secreted by the adrenal cortex, is a precursor to both male and female hormones, and is important for muscle growth and repair. The importance of it in stress (it's not really a player in protecting you from stress) is it gets disrupted by stress because the excess cortisol causes an inhibition of DHEA. Norepinephrine is similar to epinephrine (adrenaline), is also secreted by the adrenal medulla. It causes the sympathetic response, sharpens focus, antagonizes insulin, and stimulates gluconeogenesis. So the adrenaline and norepinephrine work together.

Thyroxine is very important for stress because it increases the metabolic rate. You have a decreased function of T4 with high amounts of stress, because it is inhibitory.

Finally, ACTH, which we mentioned before, produced by the anterior pituitary and increases the release of cortisol and fatty acids from the adipose tissue.

So here is a look at the adrenals. Again, we will go into more detail about these when we do our *Adrenal* module. You've got the outer zone (the cortex), which produces cortisol, DHEA, and aldosterone; and then you have the inner zone (the medulla), which produces adrenaline (epinephrine), noradrenaline (norepinephrine), and some of the androgens (testosterone, sex hormones, and other androgen precursors and intermediates).

This is a key chart. We will go into way more detail about it in both of our *Adrenal* and our *Sex Hormone* modules. There is this interaction between the stress hormones and the sex hormones. This chart basically explains why people lose their sex drive when they're under a lot of stress. If you look up at the top, the surprising grandma of it all is cholesterol. Cholesterol is actually the precursor molecule that gets turned into pregnenolone, and needs adequate B5. When we learn more in our *Adrenal* protocols, you will see that vitamin B5 (pantothenic acid), in amounts as large as 500 mg three times a day, is super important for restoring adrenal function, because it helps with that conversion.

Pregnenolone, the grandma, or mom (or whatever you want call her), gets converted into progesterone, and progesterone gets converted downstream to aldosterone. Pregnenolone also gets converted down to cortisol. If you are under a lot of stress, the body will prefer to keep you alive rather than to help you reproduce, or give you sex hormones, or help you have good periods. Most of this is called the pregnenolone steal, where a lot of the cortisol gets sucked down from pregnenolone, and then pregnenolone cannot be converted into progesterone, and then down into DHEA, the estrogens, or the testosterones. We will go into more detail about these later on.

Know when you are working with people, even now, that stress affects everything. People who have high blood pressure, frequently people who have been under a lot of stress, they may be in adrenal burnout by the time you see them. But the effects of the adrenal excess are hurting them: high blood pressure, increased heart rate, increased blood sugar leading to insulin resistance and diabetes, increased respiratory rate and shallow breathing rather than big full belly breathing, digestion impairment, slow down of enzymes, slowdown of stomach acid, immune system issues, slowdown of the immune system; or inflammation which then leads to autoimmune problems which then affects the thyroid receptors by decreasing their effectiveness.

Cortisol damages and inhibits the receptors on thyroid cells. A lot of people that you see will present with thyroid symptoms, but really at the heart of it is stress and adrenal dysfunction and high levels of cortisol for a long time. These are the people that come in to see you and they say “I think I have thyroid problems, my doctor says I don't because all of my tests came out normal.” These are the people who most likely have thyroid receptor burnout as a result of stress. When we go through our *Thyroid* module we will go through in detail all of the different nutrients that come into play to bring it into balance.

Our circadian rhythm: you will hear that term a lot. This is a chart; a rough estimate of the way cortisol rhythms and pulsates throughout the day. Let's start with 6:00 to 8:00 AM; it basically peaks then it comes back down in the late afternoon or evening and then it is at its lowest at midnight.

What you see is a lot of people have really high levels of the cortisol at 12 AM or in the evening when you do these tests, and that's what causes a lot of the insomnia that you are going to see.

Here is a little overview and a hint of what is to come. The importance of stress on heart rhythm, and how the interactions between the different hormone families affect each other, so this affects the way the heart beats. The top is when someone is in frustration: the heart is erratically beating. When they are in appreciation, just look at that wave, and you can see how calming and soothing that is. Teaching people how to do their mini vacations, their *Heart Math,* which you all know how to do.

This is another chart that shows how stress affects the immune system. There is an antibody that is called secretory IgA, which lines the digestive tract, the throat, the sinuses, and the lungs. It protects those surfaces; it protects the body from invaders. When someone goes into anger, their secretory IgA levels drop for many hours afterwards. That is here. That means that they are at more risk of immune problems, diseases, or the latest bug that is going around. When they do five minutes of care, they actually have a little bit of an increase in IgA during the process of those five minutes. Then it drops back down and that it raises back up and stays in an increased position for many hours thereafter.

Let's take a look at our sleep hormone family because a lot of people you see will be having problems with sleep. Those hormones include melatonin secreted by the pineal, which promotes deep sleep and also supports the immune system. We find that people with low levels of melatonin are at higher risk for breast cancer.

Growth hormone (we talked about that a little bit before) produced by the posterior pituitary; it peaks about an hour after a person falls asleep for the night, and promotes growth, repair, and fat burning. Cortisol, produced by the adrenal cortex; high levels of it disrupts sleep. If somebody is stressed, watching a movie, you know one of those ‘shoot ‘em up, bang 'em up’ movies right before they go to bed; or even if they are watching TV right before they go to bed, the light going into their brain not only inhibits melatonin but it also stimulates stress. Eating right before bed can do the same thing.

Leptin has a very specific peek and valley that we will talk about when we talk about blood sugar. It is produced by the fat cells. It is supposed to peak right in the middle of the night to promote fat burning. If someone is not getting adequate sleep, or they are going to bed too late, or they are interfering with their hormone levels by eating too close to bedtime, the leptin does not peak in the middle of the night and fat burning does not happen. You know as well as I, that there are a lot of people who are trying really hard to drop weight, but it is just not happening because of these hormone imbalances.

Progesterone promotes sleep. A lot of times folks are given progesterone at bedtime to help them fall into a deeper sleep. Estrogen on the other hand does not promote the sleep but it will improve the quality of the sleep. Testosterone is impacted by sleep. If a person deprived of sleep, the levels of testosterone are going to go lower. Insulin disrupts growth hormone and the sleep pattern. If someone eats within three hours before going to bed and stimulates an insulin rise, that peak of growth hormone does not happen. Finally glucagon is important during sleep because it helps to keep the blood sugar steady while a person is sleeping.

In terms of how all of this works together, we go through a lot more detail about sleep; we have a whole section about sleep in our *Blood Sugar Balancing* module because it is so important, and so disrupted by blood sugar imbalance. We talked about these hormones: insulin/glucagon, cortisol/DHEA, growth hormone, leptin/ghrelin, melatonin, estrogen/progesterone, and testosterone. These are all important to help a person have a good night's sleep.

Let's look briefly at the reproductive hormone family. We have got pregnenolone, which is at the top, the mama or grandmother of them all, produced by the adrenal cortex, and is the precursor of everything including the stress hormones. Progesterone is produced by the ovaries, but also in small amounts by the adrenal cortex. It is important for the buildup of the lining of the uterus; every month when a person is right before their period, progesterone levels rise and it thickens the lining in preparation for a fetus to implant. It also protects from estrogen. We go into that module, we talk about estrogen receptors, the different kinds, and how progesterone can protect against the damaging effects of estrogen when there is sufficient (progesterone).

Estrogen, produced by the ovaries and the adrenal cortex, is responsible for female traits, proliferation of breasts and ovulation. When the breasts gets bigger towards the middle to end of the cycle, it is estrogen. When the estrogen levels drop the breasts go back to normal. Also estrogen stimulates ovulation.

Testosterone is important. It is produced in the testes in the male, and in the adrenal cortex in both male and female. Females have small levels of testosterone but stress will impact it, especially in the female's levels of testosterone, because there is only one place that it is produced. It is responsible for male traits, but in females is responsible for being able to build muscle when doing a lot of heavy-duty exercise. It is responsible for sex drive.

FSH and LH are secreted by the anterior pituitary. They are responsible basically for stimulating the sex organs: in females, FSH stimulates the follicle to mature, and sperm to mature in males.

LH triggers ovulation in females, and triggers the production of testosterone in males. GnRH (gonadotropin-releasing hormone), secreted by the hypothalamus, is intended to stimulate the anterior pituitary to produce LH and FSH. Again, all of these are in a negative feedback loop meaning when the levels go up, the releasing hormones go down. Thyroid hormone is involved in the maturation of the egg, and the metabolic rate of all of the systems, glands, and body parts involved in reproduction.

Cortisol is involved in reproduction in that excess cortisol depletes all of the precursors. We have another chart we'll look at about that. HCG (human chorionic gonadotropin) is produced by the embryo and it feeds back to the body: 'hey keep up the levels of progesterone, there is a baby growing in here.' When there are problems in pregnancy and miscarriage, there could be a problem with the body's ability, or the fetus' ability, to make the HCG; or it could be a problem with the body perceiving the right levels of HCG.

Prolactin, produced by the posterior pituitary, is responsible for lactation (milk production). Oxytocin, on the other hand, also from the posterior pituitary, is responsible for milk letdown, and uterine contraction, really important during delivery of the baby. Pitocin is a synthetic oxytocin that helps stimulate labor and it is used quite frequently. Oxytocin is also important for bonding: Intended for the bonding of mother to baby, and also of bonding between people in sexual situations or sensual situations. Women in community tend to produce more oxytocin when they have that support, nurturing, and love of each other. It is a really important, feel-good kind of hormone.

Let's just look back at that same picture we looked at before and see that which is circled in orange are the sex hormones. Cholesterol is the precursor, pregnenolone is at the top, and you can see that cortisol (circled in purple) is being a hog. It is being greedy. It is stealing away some of the hormone precursors and you are not going to make enough estrogen, testosterone, progesterone, and also DHEA as well. That leads to low sex drive, infertility, poor periods, painful menstruation, and a whole host of other things. So think stress, think adrenals, when you are dealing with someone who is presenting with male-female problems and sex drive deficiencies. This is an overview picture to show you how important nutrition is, in all this metabolism. I promise you we will go into more detail about this later. You can see that estrone, estriol, and estradiol are your three main estrogens – E1, E2, and E3.

The protective one is estriol. Estriol is the most protective. Estrone is the most problematic, but it is worse when it gets converted downstream to 4-hydroxy estrone in the absence of magnesium. Where you really want estrone to be produced is to go down to estradiol so it can then go down to estriol and the protectives. Estrone can also be converted downstream to 2-hydroxy estrone, and that is improved by things called DIM and indol-3 carbonyl, which are extracts from cruciferous vegetables, or cruciferous vegetables.

Exercise can help. Isoflavones from flax and soy it can be helpful, although some people have problems with soy. Omega-3 fats are important, and it is important to have enough progesterone. If you have deficiencies of any, or all of these, in the green, and an excess of the red, like pesticides, alcohol and high-fat diet (usually the high-fat, processed fat diet), you are going to end up with less of the 2-hydroxy and more of the 4-hydroxy; so protective metabolite.

On the other hand, the estrone can go down to estradiol and do its functions there, or it can go down to estrone that can lead to another dangerous metabolite, which usually is a quick intermediate on the path to estriol. If someone is obese, or they have hypothyroidism, pesticides in their diets, Cimetidine, which is an antacid medication (acid-blocker medication), they will have more of the 16-alpha-hydroxy, which is dangerous.

There are some tests that Meridian Valley runs that we will go into more detail later on, that will help you understand the ratio between the 16s and the 2s, and how much at-risk a person is. In the absence of iodine, you get more of that 16-hydroxy because less is converted into estriol, which is protective. When we look at this in more detail later, we will look at the estrogen quotient: your E3 (estriol), divided by your E1 (estrone) + E2 (estradiol). That number should be one or more. When it is too low, when it is below one, you end up at high risk, so your person is at high risk. Again, we will go into this in more detail later. I am just giving you an overview.

It is another way to look at estrogen metabolism. It might be slightly easier for you to see. The toxic 16s and the 4s: BBQ and charred meats can create more of a metabolism towards those, toxins in the environment, and other things. The protective ones, the 2-hydroxy estrone and estradiol, protective when you have enough cruciferous vegetables and some of the isoflavones from soy. When you have an increased ratio, or when your 2:16 ratio is less than two, there is an increased cancer risk and we will look at this in more detail later.

To give you an overview of the male hormones: cholesterol gets converted to pregnenolone. This is a shortcut a lot of intermediates are taken out, down to DHEA. Pregnenolone also gets converted to progesterone, which have an effect and can be converted to androstenedione down to estrone, to testosterone and then DHT. You can see testosterone can also be converted to estrone. We will look at aromatase inhibitors and things like that when we go into more detail about this. The point is it is complicated and the male hormones and the female hormones are very intertwined. The last thing I want to say is male pattern baldness is usually attributed to excess testosterone. People say men with high testosterone are more prone to male pattern baldness, but it is actually DHT, which we are supposed to have very moderate amounts of. When that gets excessive, men get more baldness.

They may actually have less free and available testosterone, and some of the symptoms that go with it like lack of motivation and sex drive, but be bald because their testosterone is being converted downstream to DHT, which can be a dangerous metabolites as well, and increases the risk of prostate cancer. Again, we have a very long module about sex hormones that will have everything you need to know. This is just an overview so you are familiar with the terminology.

Finally let's take a look at the organ-specific hormone family. I am just going to do a brief overview of these and then we will go into more detail as appropriate in the appropriate modules. Erythropoietin, secreted by the kidney, stimulates red blood cell production. Thymosin, produced by the thymus gland, stimulates glucose release from glycogen and synthesis from amino acids and fats. Parathyroid hormone from the parathyroid glands, they actually increase the blood calcium. Calcitonin, which is opposite, is produced by the thyroid and reduces blood calcium. Blood calcium has a really tight control, because these two hormones control it.

ADH (antidiuretic hormone), produced by the posterior pituitary, is involved with the retention of fluid. Natriuretic peptide is produced by the heart and induces the release of urine. Angiotensin, produced by the liver, is responsible for vasoconstriction and release of aldosterone. Brain natriuretic peptide, produced by the heart, reduces blood pressure. Finally thrombopoietin, produced by the liver, kidneys, and striated muscle; and produces platelets. All of these have a part to play. Generally, you will not have to look at these for most cases, but when you are dealing with really severe cases and trying to understand, you may need to resort to learning more about these particular hormones.

This concludes our talk on hormone families and the relationships between the various hormones for the Institute of Nutritional Endocrinology. I am Dr. Ritamarie Loscalzo.