



Grade 9 Sample Lesson Plan: The Endocrine System

Objectives/Goals

- Students will learn about the glands and functions of the endocrine system. Students will consider these functions in their own lives and will be able to identify the the connections to disease.

Materials

- Handouts, Internet access for video clips and information.

Procedure

- Introduce the endocrine system to students, e.g.,:
The endocrine system is network of glands that produce and release hormones. Hormones are chemical substances that help control many important body functions, including the body's ability to change calories into energy that powers cells and organs. The endocrine system influences how your heart beats, how your bones and tissues grow, even your ability to make a baby. It plays a vital role in whether or not you develop diabetes, thyroid disease, growth disorders, sexual dysfunction, and a host of other hormone-related disorders. (Source: WebMD <http://www.webmd.com/diabetes/endocrine-system-disorders#1>)
- Additionally, ensure that students know that the endocrine system works in concert with the nervous system to regulate body activities.
The nervous system acts through electrical impulses and neurotransmitters to cause muscle contraction and glandular secretion).

There are two types of glands in the endocrine system, exocrine glands that take their secretions to the surface through ducts that exit the body (e.g., mammary, sebaceous, sweat, and glands that secrete digestive enzymes), and endocrine glands, the seven sets of gland secrete different hormones directly into the blood (they do not have ducts that carry their secretions to the surface and out of the body); the endocrine hormones are carried throughout the body where they influence cells that have receptor sites for that particular hormone (source: National Cancer Institute (NCI) SEER Training Modules <https://training.seer.cancer.gov/anatomy/endocrine/glands/>).

- Show students illustrations of the glands and where they are located in the body (e.g., using the following NCI illustration) or have them view illustrative videos readily available online (e.g., KidsHealth.org How the Endocrine System Works https://www.youtube.com/watch?v=HXPCQBD_WGI&index=17&list=PLRmb5AxU-JXgajvrrcozhkhMeSWa0XI0Z or the Khan Academy's Introduction to the Endocrine System https://www.youtube.com/watch?v=f_Z1zsR9IFM)
- Review the functions of the endocrine glands (e.g., :
 - (1) *Pituitary gland – located at the bottom or base of the brain; master gland; secretes hormones that control all other glands, and hormones that regulate growth*
 - (2) *Thyroid gland – it is located below the voice box; it secretes a hormone that controls the rate at which the body burns energy and uses food (nutrients)*
 - (3) *Parathyroid – controls the growth of bones and the amount of calcium in your body*
 - (4) *Pancreas – it is both a duct and ductless gland; secretes a hormone called insulin that regulates how the body uses and stores sugars (glucose); when the pancreas does not produce enough insulin, a person may have a illness called diabetes (potential complications of diabetes include heart disease, stroke, kidney disease, and blindness). Diabetes can be controlled with medication, nutrition, and exercise.*
 - (5) *Adrenal glands – secrete three stress hormones: adrenaline – the fight or flight hormone-which, especially when a person is frightened or angry or nervous, causes rapid heartbeat and breathing and a surge in energy; norepinephrine – which also causes arousal and supports the body's response to stressful situations; and cortisol – commonly known as the stress hormone- which typically helps to maintain fluid balance and blood pressure but when chronically released can lead to serious health issues (e.g., suppresses immune system, increases blood pressure and sugar, contribute to obesity)(*

(6) Ovaries – female reproductive; controls maturation and reproduction in females including voice change, breast growth, menstruation, and hair (puberty)

(7) Testes – male reproductive; controls maturation and reproduction in males including voice change, hair, muscle development (puberty)

Sources: *The Endocrine System, Who is In Control Here; The Stress Hormones Explained*

- Review information on endocrine disorders so students can identify how these disorders contribute to chronic diseases (e.g., National Institute of Diabetes and Digestive and Kidney Diseases: <https://www.niddk.nih.gov/health-information/endocrine-diseases>).
- Engage students in activities and scenarios so they can relate to the impact of the endocrine system on their daily lives.
 - (1) Have students engage in a 2-minute physical activity that makes them sweat. Have them report how they felt. Summarize that, similar to a ‘thermostat,’ the endocrine system senses the body is heating up and makes sweat to cool the body.
 - (2) The endocrine system also functions as a ‘smoke alarm’. Have students read the attached article, *Fight or Flight*, to better understand the fight or flight response that is triggered through the endocrine system (<http://psychcentral.com/lib/fight-or-flight/>). Ask students to share other examples from their own fight-or-flight experiences. What individual and societal factors contribute to stress and how can these stressors be addressed?
 - (3) Have students engage in web research and write a report on the impact of society and behavior on the three stress hormones, and their role in the development of chronic disease. Identify articles to get students started (e.g., *Adrenaline, Cortisol, Norepinephrine/The Stress Hormones Explained* http://www.huffingtonpost.com/2013/04/19/adrenaline-cortisol-stress-hormones_n_3112800.html and *Cortisol, Its Role in Stress, Inflammations, and Implications for Diet Therapy* <http://www.todaysdietitian.com/newarchives/111609p38.shtml>).
- Refer students to <https://organdonor.gov/index.html> and ask them to work in groups to do a brief presentation on
 - Reasons to donate <https://organdonor.gov/statistics-stories/statistics.html#growing> ,
 - Who is eligible to donate <https://organdonor.gov/about/donors.html>, and
 - How to register to donate (e.g. signing up online or through a local department of motor vehicles <https://organdonor.gov/register.html>).

Health Smart Virginia Sample Lesson Plan

- Knowledge quizzes can supplement the lesson. A sample knowledge quiz that illustrates the reach of endocrine hormones is included at the end of this unit plan. The NCI also provides a full online training and quiz on the endocrine at: <https://training.seer.cancer.gov/anatomy/endocrine/glands/>

Assessment Idea

- Quality of student participation in discussion.
- Quality of student reports/presentations on stress hormones and organ donation
- Changes in pre/post performance on knowledge quizzes.

References

- Department of Health and Human Services, Organ Donation Site <https://organdonor.gov/index.html>
- National Cancer Institute <https://training.seer.cancer.gov/anatomy/endocrine/>
- National Institute of Diabetes and Digestive and Kidney Diseases: <https://www.niddk.nih.gov/health-information/endocrine-diseases>
- Articles:
 - Adrenaline, Cortisol, Norepinephrine/The Stress Hormones Explained*
http://www.huffingtonpost.com/2013/04/19/adrenaline-cortisol-stress-hormones_n_3112800.html
 - Cortisol, Its Role in Stress, Inflammations, and Implications for Diet Therapy*
<http://www.todaysdietitian.com/newarchives/111609p38.shtml> .
 - Fight or Flight* (<http://psychcentral.com/lib/fight-or-flight/>)
 - Web MD Endocrine Systems Disorders*
<http://www.webmd.com/diabetes/endocrine-system-disorders#1>
- YouTube Videos:
 - KidsHealth.org *How the Endocrine System Works*
https://www.youtube.com/watch?v=HXPCQBD_WGI&index=17&list=PLRmb5AxU-JXgajvrrcozhkhMeSWa0XI0Z
 - Khan Academy's *Introduction to the Endocrine System*
https://www.youtube.com/watch?v=f_Z1zsR9IFM

Handout

The next page includes a handout for the lesson. The handout is designed for print use only.

Fight or Flight

 psychcentral.com/lib/fight-or-flight/

May 17, 2016

Consider this stressful situation: At a meeting for which you have thoroughly prepared, the chair criticizes you and accuses you of failing to attend to tasks that were, in reality, someone else's responsibility. As all eyes turn on you, you feel your face getting hot, your jaw tightening, and your fist clenching. You would not shout or hit anyone—doing so would only make things worse. But you feel like shouting or striking out.

Now consider another stressful situation: You walk into class a few moments late, only to find everyone putting books and notes away—apparently preparing for a test you did not realize had been scheduled for today. Your heart seems to stop, your mouth is dry, your knees feel weak and you momentarily consider hurrying back out the door. Your life is not really in danger, and running away will not solve your problem—so why should you feel a physical urge to escape?

These two scenarios illustrate the two poles of the **fight-or-flight response**, a sequence of internal processes that prepares the aroused organism for struggle or escape. It is triggered when we interpret a situation as threatening. The resulting response depends on how the organism has *learned* to deal with threat, as well as on an *innate* fight-or-flight "program" built into the brain.

The learned fight response

Evidence that the fight response can be learned is seen, for example, in studies showing that reactions to a perceived insult are strongly dependent on culture. In the United States the learned fight response has been nurtured in the "culture of honor" that developed in the South—which some experts believe may account for the southern states' much higher murder rate in comparison to the northern states.⁽¹⁾ Learning can also affect our internal responses to stress. For example, in a study of patients with high blood pressure (which can be a stress response), those who took placebos along with their medication for high blood pressure maintained a healthy blood pressure after the medication was removed, as long as they continued taking the placebo.⁽¹⁾⁽²⁾

This suggests that their expectation that the placebos would control their blood pressure was enough to reduce the emergency response of the blood vessels.

While the fight or flight response clearly can be learned, it also involves an innate reaction that operates largely outside consciousness. This was first recognized in the 1920s by physiologist Walter Canon, whose research showed that a threat stimulates a sequence of activities in an organism's nerves and glands. We now know that the hypothalamus controls this response by initiating a cascade of events in the autonomic nervous system (ANS), in the endocrine system and in the immune system.⁽⁴⁾

As you will recall, the autonomic nervous system regulates the activities of our internal organs. When we perceive a situation as threatening, this judgment causes the hypothalamus to send an emergency message to the ANS, which sets in motion several bodily reactions to stress. This response is helpful when you need to escape a hungry bear or confront a hostile rival.

It served our ancestors well, but it has a cost. Staying physiologically on guard against a threat eventually wears down the body's natural defenses. In this way, suffering from frequent stress—or frequently *interpreting* experiences as stressful—can create a serious health risk: an essentially healthy stress response can become *distress*.

Adapted from Psychology, Third Edition, by Philip G. Zimbardo, Ann L. Weber and Robert Lee Johnson.

References

1. Nisbett, R. E. (1993). "Violence and U.S. regional culture." *American Psychologist*, 48, 441 -449.
2. Ader, R., & Chohen, N. (1975). "Behaviorally conditioned immuno-supression." *Psychosomatic Medicine*, 37, 333 -340.
3. Suchman, A. L. and Ader, R. (1989). "Placebo response in humans can be shaped by prior pharmacologic experience." *Psychosomatic Medicine*, 51, 251.
4. Jansen, A. S. P., Nguyen, X. V., Karpitskiy, V., Mettenleiter, T. C., & Loewy, A. D. (1995, October 27). "Central command neurons of the sympathetic nervous system: Basis of the fight-or-flight response." *Science*, 270, 644 -646.

Name:

Date:

I didn't know that!

Please answer each question with true or false (not T or F). This is not a graded test. I just want to see what you already know!

- _____ 1. Hormones can make you grow to be nine feet tall.
- _____ 2. Hormones can affect your ability to taste salty foods.
- _____ 3. Hormones can make you very sensitive to high-pitched sounds.
- _____ 4. Hormones cause a young man to begin to grow facial hair.
- _____ 5. Hormones can help fight stress.
- _____ 6. Hormones determine what color eyes you have.
- _____ 7. Hormones can cause you to be allergic to milk.
- _____ 8. Hormones can make your heart beat faster when you are scared.
- _____ 9. Hormones can soothe you.
- _____ 10. Hormones can cause your hands to tremble when you are nervous.
- _____ 11. Hormones affect how much energy you have.
- _____ 12. Hormones affect how fast or slow you read.
- _____ 13. Hormones tell your body how fast it should grow.
- _____ 14. Hormones give you the strength and energy to fight or run when in a dangerous situation.
- _____ 15. Hormones cause your voice to change, especially in boys.
- _____ 16. Hormones can make twins become triplets before they are born.
- _____ 17. Hormones tell your body how to swallow.
- _____ 18. Hormones help control when you sleep and when you wake.

ANSWER KEY TO PRE-QUIZ

<http://inside.mines.edu/~nstambac/Body%20Systems%20Lesson%20Plan.pdf>

Name:

Date:

I didn't know that!

Please answer each question with true or false (not T or F). This is not a graded test. I just want to see what you already know!

- True 1. Hormones can make you grow to be nine feet tall.
- False 2. Hormones can affect your ability to taste salty foods.
- False 3. Hormones can make you very sensitive to high-pitched sounds.
- True 4. Hormones cause a young man to begin to grow facial hair.
- True 5. Hormones can help fight stress.
- False 6. Hormones determine what color eyes you have.
- False 7. Hormones can cause you to be allergic to milk.
- True 8. Hormones can make your heart beat faster when you are scared.
- True 9. Hormones can soothe you.
- True 10. Hormones can cause your hands to tremble when you are nervous.
- True 11. Hormones affect how much energy you have.
- False 12. Hormones affect how fast or slow you read.
- True 13. Hormones tell your body how fast it should grow.
- True 14. Hormones give you the strength and energy to fight or run when in a dangerous situation.
- True 15. Hormones cause your voice to change, especially in boys.
- False 16. Hormones can make twins become triplets before they are born.
- False 17. Hormones tell your body how to swallow.
- True 18. Hormones help control when you sleep and when you wake.

Endocrine Disorders

The endocrine system is a network of glands that produce and release hormones that help control many important body functions, including the body's ability to change calories into energy that powers cells and organs. The endocrine system influences how your heart beats, how your bones and tissues grow, even your ability to make a baby. It plays a vital role in whether or not you develop diabetes, thyroid disease, growth disorders, sexual dysfunction, and a host of other hormone-related disorders.

Glands of the Endocrine System

Each gland of the endocrine system releases specific hormones into your bloodstream. These hormones travel through your blood to other cells and help control or coordinate many body processes.

Endocrine glands include:

- **Adrenal glands:** Two glands that sit on top of the kidneys that release the hormone cortisol.
- **Hypothalamus:** A part of the lower middle brain that tells the pituitary gland when to release hormones.
- **Ovaries:** The female reproductive organs that release eggs and produce sex hormones.
- **Islet cells in the pancreas:** Cells in the pancreas control the release of the hormones insulin and glucagon.
- **Parathyroid:** Four tiny glands in the neck that play a role in bone development.
- **Pineal gland:** A gland found near the center of the brain that may be linked to sleep patterns.
- **Pituitary gland:** A gland found at the base of brain behind the sinuses. It is often called the "master gland" because it influences many other glands, especially the thyroid. Problems with the pituitary gland can affect bone growth, a woman's menstrual cycles, and the release of breast milk.
- **Testes:** The male reproductive glands that produce sperm and sex hormones.
- **Thymus:** A gland in the upper chest that helps develop the body's immune system early in life.
- **Thyroid:** A butterfly-shaped gland in the front of the neck that controls metabolism.

Even the slightest hiccup with the function of one or more of these glands can throw off the delicate balance of hormones in your body and lead to an endocrine disorder, or

endocrine disease.

Causes of Endocrine Disorders

Endocrine disorders are typically grouped into two categories:

- Endocrine disease that results when a gland produces too much or too little of an endocrine hormone, called a hormone imbalance.
- Endocrine disease due to the development of lesions (such as nodules or tumors) in the endocrine system, which may or may not affect hormone levels.

The endocrine's feedback system helps control the balance of hormones in the bloodstream. If your body has too much or too little of a certain hormone, the feedback system signals the proper gland or glands to correct the problem. A hormone imbalance may occur if this feedback system has trouble keeping the right level of hormones in the bloodstream, or if your body doesn't clear them out of the bloodstream properly.

Increased or decreased levels of endocrine hormone may be caused by:

- A problem with the endocrine feedback system
- Disease
- Failure of a gland to stimulate another gland to release hormones (for example, a problem with the hypothalamus can disrupt hormone production in the pituitary gland)
- A genetic disorder, such as multiple endocrine neoplasia (MEN) or congenital hypothyroidism
- Infection
- Injury to an endocrine gland
- Tumor of an endocrine gland

Most endocrine tumors and nodules (lumps) are noncancerous. They usually do not spread to other parts of the body. However, a tumor or nodule on the gland may interfere with the gland's hormone production.

Types of Endocrine Disorders

There are many different types of endocrine disorders. Diabetes is the most common endocrine disorder diagnosed in the U.S.

Other endocrine disorders include:

Adrenal insufficiency. The adrenal gland releases too little of the hormone cortisol and sometimes, aldosterone. Symptoms include fatigue, stomach upset, dehydration, and skin changes. Addison's disease is a type of adrenal insufficiency.

Cushing's disease. Overproduction of a pituitary gland hormone leads to an overactive adrenal gland. A similar condition called Cushing's syndrome may occur in people,

particularly children, who take high doses of corticosteroid medications.

Gigantism (acromegaly) and other growth hormone problems. If the pituitary gland produces too much growth hormone, a child's bones and body parts may grow abnormally fast. If growth hormone levels are too low, a child can stop growing in height.

Hyperthyroidism. The thyroid gland produces too much thyroid hormone, leading to weight loss, fast heart rate, sweating, and nervousness. The most common cause for an overactive thyroid is an autoimmune disorder called Grave's disease.

Hypothyroidism. The thyroid gland does not produce enough thyroid hormone, leading to fatigue, constipation, dry skin, and depression. The underactive gland can cause slowed development in children. Some types of hypothyroidism are present at birth.

Hypopituitarism. The pituitary gland releases little or no hormones. It may be caused by a number of different diseases. Women with this condition may stop getting their periods.

Multiple endocrine neoplasia I and II (MEN I and MEN II). These rare, genetic conditions are passed down through families. They cause tumors of the parathyroid, adrenal, and thyroid glands, leading to overproduction of hormones.

Polycystic ovary syndrome (PCOS). Overproduction of androgens interfere with the development of eggs and their release from the female ovaries. PCOS is a leading cause of infertility.

Precocious puberty. Abnormally early puberty that occurs when glands tell the body to release sex hormones too soon in life.

Testing for Endocrine Disorders

If you have an endocrine disorder, your doctor may refer you to a specialist called an endocrinologist. An endocrinologist is specially trained in problems with the endocrine system.

The symptoms of an endocrine disorder vary widely and depend on the specific gland involved. However, most people with endocrine disease complain of fatigue and weakness.

Blood and urine tests to check your hormone levels can help your doctors determine if you have an endocrine disorder. Imaging tests may be done to help locate or pinpoint a nodule or tumor.

Treatment of endocrine disorders can be complicated, as a change in one hormone level can throw off another. Your doctor or specialist may order routine blood work to check for problems or to determine if your medication or treatment plan needs to be adjusted.

Fight or Flight

Consider this stressful situation: At a meeting for which you have thoroughly prepared, the chair criticizes you and accuses you of failing to attend to tasks that were, in reality, someone else's responsibility. As all eyes turn on you, you feel your face getting hot, your jaw tightening, and your fist clenching. You would not shout or hit anyone—doing so would only make things worse. But you feel like shouting or striking out.

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2. Ader, R., & Chohen, N. (1975). "Behaviorally conditioned immuno-supression." *Psychosomatic Medicine*, 37, 333 -340.
3. Suchman, A. L. and Ader, R. (1989). "Placebo response in humans can be shaped by prior pharmacologic experience." *Psychosomatic Medicine*, 51, 251.
4. Jansen, A. S. P., Nguyen, X. V., Karpitskiy, V., Mettenleiter, T. C., & Loewy, A. D. (1995, October 27). "Central command neurons of the sympathetic nervous system: Basis of the fight-or-flight response." *Science*, 270, 644 -646.

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Adrenaline, Cortisol, Norepinephrine: The Three Major Stress Hormones, Explained

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Sarah Klein



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Thanks to the work of our sympathetic nervous system, the “fight or flight” system that takes over when we’re stressed, when you see your boss’s name in your inbox late at night, your body reacts like there’s a lion on the loose.

Behind the wide range of both physical and mental reactions to stress are a number of hormones that are in charge of adding fuel to the fire.

Adrenaline

What It Is: Commonly known as [the fight or flight hormone](#), it is produced by the adrenal glands after receiving a message from the brain that a stressful situation has presented itself.

What It Does: Adrenaline, along with norepinephrine (more on that below), is largely responsible for the *immediate* reactions we feel when stressed. Imagine

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you're trying to change lanes in your car, says Amit Sood, M.D., director of research at the Complementary and Integrative Medicine and chair of Mayo Mind Body Initiative at Mayo Clinic. Suddenly, from your blind spot, comes a car racing at 100 miles per hour. You return to your original lane and your heart is pounding. Your muscles are tense, you're breathing faster, you may start sweating. That's adrenaline.

Along with the increase in heart rate, [adrenaline also gives you a surge of energy](#) — which you might need to run away from a dangerous situation — and also focuses your attention.

Norepinephrine

What It Is: A hormone similar to adrenaline, released from the adrenal glands and also from the brain, says Sood.

What It Does: The primary role of norepinephrine, like adrenaline, is arousal, says Sood. "When you are stressed, you become more aware, awake, focused," he says. "You are just generally more responsive." It also helps to shift blood flow away from areas where it might not be so crucial, like the skin, and toward more essential areas at the time, like the muscles, so you can flee the stressful scene.

Although norepinephrine might seem redundant given adrenaline (which is also sometimes called epinephrine), Sood imagines we have both hormones as a type of backup system. "Say your adrenal glands are not working well," he says. "I still want *something* to save me from acute catastrophe."

Depending on the long-term impact of whatever's stressing you out — and how you personally handle stress — it could take anywhere from half an hour to a couple of days to return to your normal resting state, says Sood.

Cortisol

What It Is: A steroid hormone, commonly known as [the stress hormone](#), produced by the adrenal glands.

What It Does: It takes a little more time — minutes, rather than seconds — for you to feel the effects of cortisol in the face of stress, says Sood, because the release of this hormone takes a multi-step process involving two additional minor hormones.

First, the part of the brain called the [amygdala](#) has to recognize a threat. It then sends a message to the part of the brain called the [hypothalamus](#), which releases corticotropin-releasing hormone (CRH). CRH then tells the pituitary gland to release adrenocorticotrophic hormone (ACTH), which tells the adrenal glands to produce cortisol. Whew!

In survival mode, the *optimal* amounts of cortisol can be life saving. It helps to maintain fluid balance and blood pressure, says Sood, while regulating some body functions that aren't crucial in the moment, like reproductive drive,

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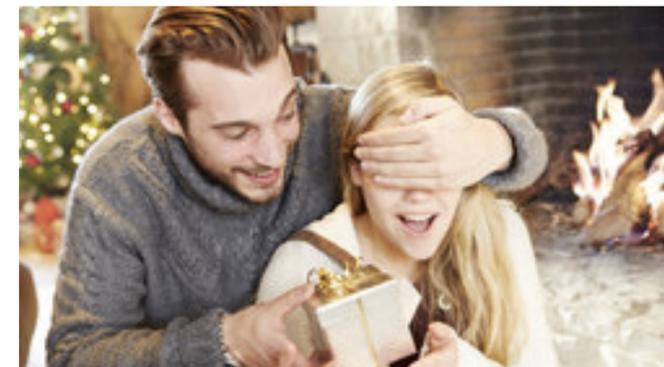
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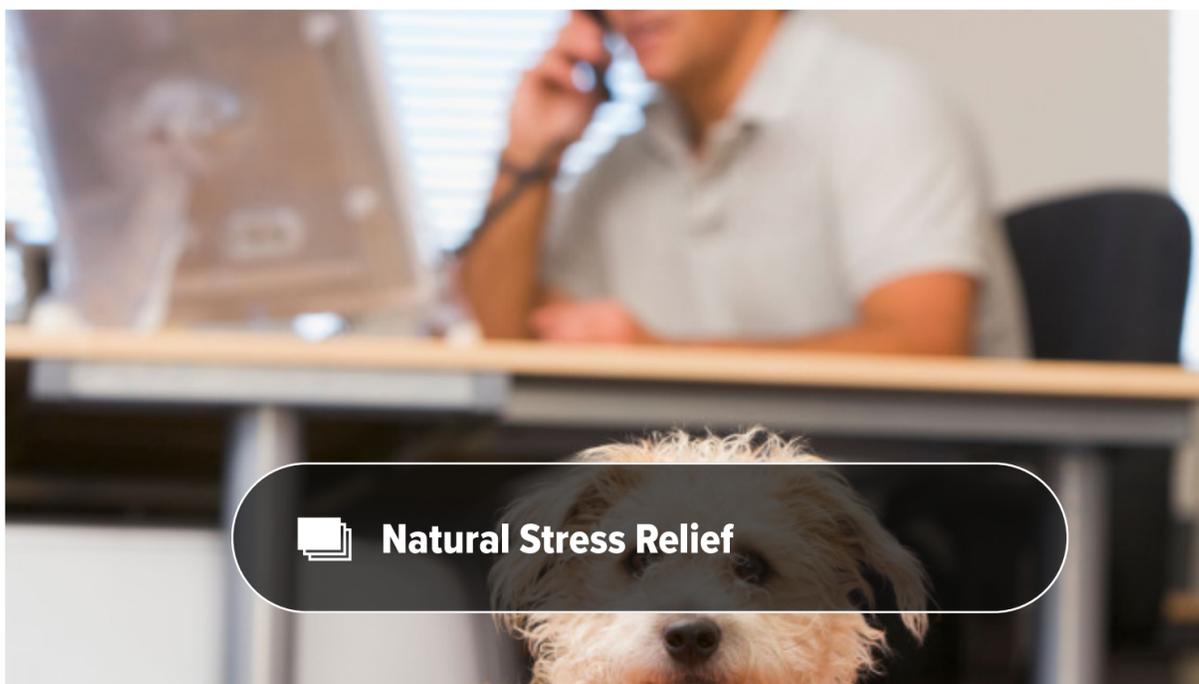
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But when you stew on a problem, the body *continuously* releases cortisol, and [chronic elevated levels can lead to serious issues](#). Too much cortisol can suppress the immune system, increase blood pressure and sugar, decrease libido, produce acne, contribute to obesity and more.

“Ducks walk out of a lake, flap their wings and they fly off,” says Sood. “When you face something stressful, particularly if it’s not likely to repeat or doesn’t have a huge long-term impact, you want to be able to shake it off and move on with life.”

Of course, he adds, estrogen and testosterone are also hormones that affect how we react to stress, as are the neurotransmitters dopamine and serotonin. But the classic fight-or-flight reaction is mostly due to the three major players mentioned above. How do you react to stress? Let us know in the comments.

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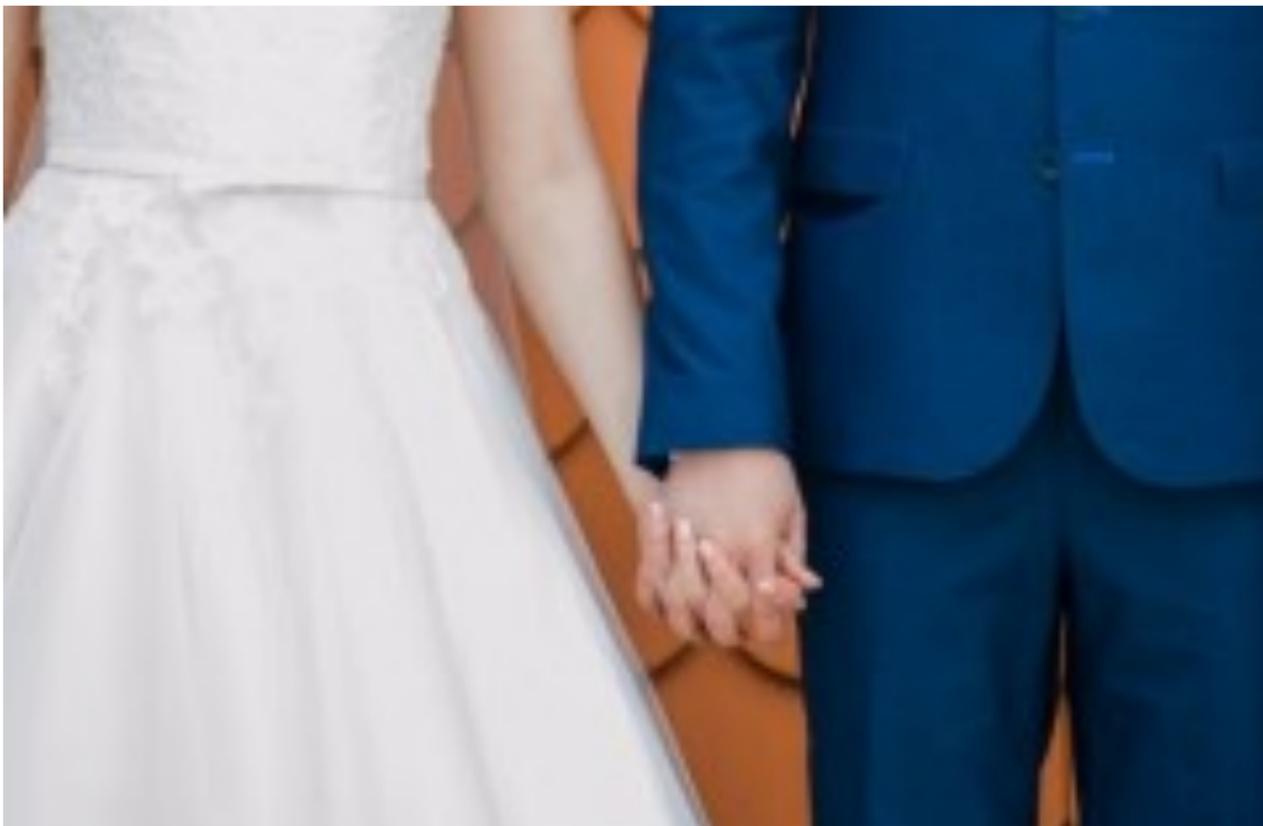
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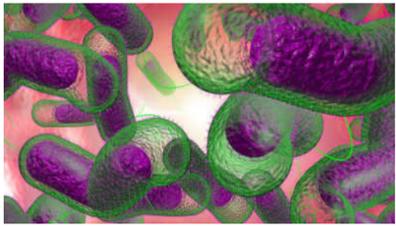
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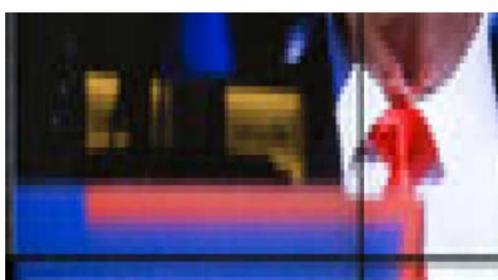
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Cortisol — Its Role in Stress, Inflammation, and Indications for Diet Therapy

By Dina Aronson, MS, RD

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Cortisol, a glucocorticoid (steroid hormone), is produced from cholesterol in the two adrenal glands located on top of each kidney. It is normally released in response to events and circumstances such as waking up in the morning, exercising, and acute stress. Cortisol's far-reaching, systemic effects play many roles in the body's effort to carry out its processes and maintain homeostasis.

Of interest to the dietetics community, cortisol also plays an important role in human nutrition. It regulates energy by selecting the right type and amount of substrate (carbohydrate, fat, or protein) the body needs to meet the physiological demands placed on it. When chronically elevated, cortisol can have deleterious effects on weight, immune function, and chronic disease risk.

Cortisol (along with its partner epinephrine) is best known for its involvement in the “fight-or-flight” response and temporary increase in energy production, at the expense of processes that are not required for immediate survival. The resulting biochemical and hormonal imbalances (ideally) resolve due to a hormonally driven negative feedback loop. The following is a typical example of how the stress response operates as its intended survival mechanism:

1. An individual is faced with a stressor.
2. A complex hormonal cascade ensues, and the adrenals secrete cortisol.
3. Cortisol prepares the body for a fight-or-flight response by flooding it with glucose, supplying an immediate energy source to large muscles.
4. Cortisol inhibits insulin production in an attempt to prevent glucose from being stored, favoring its immediate use.
5. Cortisol narrows the arteries while the epinephrine increases heart rate, both of which force blood to pump harder and faster.
6. The individual addresses and resolves the situation.
7. Hormone levels return to normal.

So what's the problem? In short, the theory is that with our ever-stressed, fast-paced lifestyle, our bodies are pumping out cortisol almost constantly, which can wreak havoc on our health. This whole-body process, mediated by hormones and the immune system, identifies cortisol as one of the many players. But isolating its role helps put into context the many complex mechanisms that lead to specific physiological damage.

Whole-Body Effects of Elevated Cortisol

Blood Sugar Imbalance and Diabetes

Under stressful conditions, cortisol provides the body with glucose by tapping into protein stores via gluconeogenesis in the liver. This energy can help an individual fight or flee a stressor. However, elevated cortisol over the long term consistently produces glucose, leading to increased blood sugar levels.

Theoretically, this mechanism can increase the risk for type 2 diabetes, although a causative factor is unknown.¹ Since a principal function of cortisol is to thwart the effect of insulin—essentially rendering the cells insulin resistant—the body remains in a general insulin-resistant state when cortisol levels are chronically elevated. Over time, the pancreas struggles to keep up with the high demand for insulin, glucose levels in the blood remain high, the cells cannot get the sugar they need, and the cycle continues.

Weight Gain and Obesity

Repeated elevation of cortisol can lead to weight gain.² One way is via visceral fat storage. Cortisol can mobilize triglycerides from storage and relocate them to visceral fat cells (those under the muscle, deep in the abdomen). Cortisol also aids adipocytes' development into mature fat cells. The biochemical process at the cellular level has to do with enzyme control (11-hydroxysteroid dehydrogenase), which converts cortisone to cortisol in adipose tissue. More of these enzymes in the visceral fat cells may mean greater amounts of cortisol produced at the tissue level, adding insult to injury (since the adrenals are already pumping out cortisol). Also, visceral fat cells have more cortisol receptors than subcutaneous fat.

A second way in which cortisol may be involved in weight gain goes back to the blood sugar-insulin problem. Consistently high blood glucose levels along with insulin suppression lead to cells that are starved of glucose. But those cells are crying out for energy, and one way to regulate is to send hunger signals to the brain. This can lead to overeating. And, of course, unused glucose is eventually stored as body fat.

Another connection is cortisol's effect on appetite and cravings for high-calorie foods. Studies have demonstrated a direct association between cortisol levels and calorie intake in populations of women.³ Cortisol may directly influence appetite and cravings by binding to hypothalamus receptors in the brain. Cortisol also indirectly influences appetite by modulating other hormones and stress responsive factors known to stimulate appetite.

Immune System Suppression

Cortisol functions to reduce inflammation in the body, which is good, but over time, these efforts to reduce inflammation also suppress the immune system. Chronic inflammation, caused by lifestyle factors such as poor diet and stress, helps to keep cortisol levels soaring, wreaking havoc on the immune system. An unchecked immune system responding to unabated inflammation can lead to myriad problems: an increased susceptibility to colds and other illnesses, an increased risk of cancer, the tendency to develop food allergies, an increased risk of an assortment of gastrointestinal issues (because a healthy intestine is dependent on a healthy immune system), and possibly an increased risk of autoimmune disease.^{4,5}

Gastrointestinal Problems

Cortisol activates the sympathetic nervous system, causing all of the physiologic responses previously described. As a rule, the parasympathetic nervous system must then be suppressed, since the two systems cannot operate simultaneously. The parasympathetic nervous system is stimulated during

quiet activities such as eating, which is important because for the body to best use food energy, enzymes and hormones controlling digestion and absorption must be working at their peak performance.

Imagine what goes on in a cortisol-flooded, stressed-out body when food is consumed: Digestion and absorption are compromised, indigestion develops, and the mucosal lining becomes irritated and inflamed. This may sound familiar. Ulcers are more common during stressful times, and many people with irritable bowel syndrome and colitis report improvement in their symptoms when they master stress management.⁵ And, of course, the resulting mucosal inflammation leads to the increased production of cortisol, and the cycle continues as the body becomes increasingly taxed.⁴

Cardiovascular Disease

As we've seen, cortisol constricts blood vessels and increases blood pressure to enhance the delivery of oxygenated blood. This is advantageous for fight-or-flight situations but not perpetually. Over time, such arterial constriction and high blood pressure can lead to vessel damage and plaque buildup—the perfect scenario for a heart attack. This may explain why stressed-out type A (and the newly recognized type D) personalities are at significantly greater risk for heart disease than the more relaxed type B personalities.⁶

Fertility Problems

Elevated cortisol relating to prolonged stress can lend itself to erectile dysfunction or the disruption of normal ovulation and menstrual cycles. Furthermore, the androgenic sex hormones are produced in the same glands as cortisol and epinephrine, so excess cortisol production may hamper optimal production of these sex hormones.⁵

Other Issues

Long-term stress and elevated cortisol may also be linked to insomnia, chronic fatigue syndrome, thyroid disorders, dementia, depression, and other conditions.^{4,5}

Assessing Cortisol Levels

The adrenal stress index (ASI), a salivary test, is the preferred test for adrenal function and a well-accepted, noninvasive, reliable indication of cortisol levels.⁷⁻¹⁰ However, a trained professional should interpret the results because factors such as age, gender, timing with the menstrual cycle, pregnancy, lactation, smoking, medications, medical conditions, caffeine and alcohol consumption, caloric intake, and other test results (particularly related hormone tests such as sex hormone levels) will contextualize the significance and meaning of the measurement.^{9,10}

The ASI is available as a home kit. Four saliva samples are taken at specific times and then shipped to a laboratory for analysis. Conveniently, in addition to measuring the adrenal hormones cortisol and dehydroepiandrosterone, the same test also measures antibodies to gliadin, often used as a marker for intestinal inflammation, Candida infections, and sensitivity to gluten-containing grains. (Note that this test cannot diagnose gluten sensitivity definitively.)⁷

A blood cortisol test is available, but it is considered inferior to the salivary test for three reasons: It tests cortisol levels only at one given point in time, which provides less information than levels at four times (which reveals important imbalances); the blood test itself (or simply going to the doctor) can stress a person enough to cause a cortisol surge; and it is considered less sensitive because it measures the total hormone level as opposed to specific components.⁵

The Good News

So far, it may seem as though stressed-out folks are destined for failed health despite their best intentions. Fortunately, there is much we can do for our clients (and ourselves) to reverse the path of

destruction. The best approach to keeping cortisol levels at bay is mastering stress management and optimizing diet.

Stress Management

First, regardless of our scope of practice, we can always recommend strategies for effective stress management. Books such as Woodson Merrell's ***The Source*** have some powerful yet commonsense, evidence-based advice for de-stressing and regaining optimal health. Some strategies include getting more and better quality sleep, breath work, acupuncture, cardio/resistance/relaxation exercises, and addressing psychological/emotional issues. Minimizing stress may require a team approach; we can acknowledge its importance and leave the details to the experts.

The Anti-Inflammatory Diet

Systemic inflammation, as noted previously, causes elevated cortisol levels. If we can naturally decrease inflammation in the body and minimize stress, decreased cortisol levels should follow, resulting in decreased chronic disease risk and improved wellness. The biochemical processes leading to and abating inflammation are complex and multi-faceted, but as experts in diet and lifestyle, we can make a significant difference.

Like any diet designed to manage a condition, there is no one perfect anti-inflammatory diet. However, based on known properties of foods and clinical research, we can devise a generally low-inflammatory diet and tweak it over time. Obviously, maximizing the anti-inflammatory foods and minimizing the proinflammatory ones is a big step toward controlling inflammation. Incidentally, dietary strategies for controlling inflammation may also help with adrenal support in general, since diet can directly affect adrenal burden (eg, cortisol is released in response to metabolic demands).

Since lifestyle factors are generally the most significant modulators of inflammation, nutrition professionals can make a huge difference in our clients' and patients' overall health.⁴ The following is a general list of diet and lifestyle factors believed to be the most significant contributors to inflammation:

- high glycemic load;
- saturated and trans fatty acids;
- caffeine;
- alcohol in excess;
- insufficient intake of micronutrients and antioxidants;
- a low-fiber diet;
- a sedentary lifestyle; and
- overweight.⁴

To minimize inflammation, the following are recommended:

- a low glycemic load diet;
- elimination of trans fats and minimal intake of saturated fats;
- elimination or reduction of caffeine;

- alcohol in moderation or not at all;
- boosting consumption of whole plant foods to maximize intake of fiber, antioxidants, and phytonutrients: with vegetables, fruits, whole intact grains, nuts, seeds, and beans;
- meeting recommended intake of omega-3 fatty acids (may be best measured as a ratio to omega-6 fatty acids);
- regular exercise; and
- probiotics, if warranted.

Clearly, these are merely guidelines. Therapeutic nutritional recommendations need to be customized for each individual's condition, preferences, and goals.

Note that while medications such as nonsteroidal anti-inflammatory drugs temporarily alleviate inflammation, hundreds of studies have demonstrated that long-term use can cause damage over time and even exacerbate systemic inflammation.

Summary

Cortisol is a fascinating hormone that is important to nutrition science on many levels. Understanding the science behind it, including its behaviors and relationships to other biochemical components, the immune system, and health outcomes, is crucial to our success in treating people who seek dietary intervention for stress, illness, fatigue, and other common complaints.

Implementation of targeted dietary and lifestyle approaches is an extremely powerful way to reduce stress, minimize inflammation, and reduce the risk for illness and chronic disease. True, the many biochemical processes involving cortisol and other hormones, stress, and inflammation and their impact on health and disease risk are complex and elaborate. The therapeutic diet and lifestyle strategies, however, are not. The more we learn about the way the body responds to the demands placed on it, as well as its extraordinary healing power, the more we are valued as professionals who can effectively change people's lives by improving health, inspiring change, and increasing longevity.

— *Dina Aronson, MS, RD, owns Welltech Solutions, a nutrition and technology consulting company.*

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Topic: Feedback Mechanism Activity

Summary: Students will model how the endocrine system uses feedback mechanisms to maintain homeostasis.

Goals & Objectives: Students will be able to understand a negative feedback loop. Students will be able to describe how the human body regulates blood sugar.

Standards: CA Biology 9i. *Students know* that hormones (including digestive, reproductive, osmoregulatory) provide internal feedback mechanisms for homeostasis at the cellular level and in whole organisms.

Time Length: 60 minutes

Prerequisite Knowledge: Hormones, endocrine system, glucose, pancreas, liver.

Materials:

- Sand
- Scissors
- Sugar or candy
- Butcher paper
- Cardboard box: length of sides at least 40 cm
- Paper towel or toilet paper cardboard tubes
- 100 ml Graduated cylinders
- Masking tape

Lab Setup:

Lever: Cut a flat plane, 40 cm long by 5 cm wide, from the cardboard box. Halfway across the length (20 cm) place the tube perpendicular to the length of the plane. You can cut the tube into two if it is longer than the width of the board. Take a section of butcher paper and tape to the desk. This will enable easy clean up. Tape the tube to the butcher paper. Place the lever onto the tube so that the lever is balanced, with the paper towel tube as its fulcrum.

Labels: Cut out the labels. Put sand in the graduated cylinders and tape the label “Pancreas” on the side of each cylinder. Tape the label “Insulin” on the left side of the board. Tape the label “Glucagon” on the right side of the board. Tape the label blood stream in the center of the board. Place the “Low Blood Sugar” label underneath the insulin side of the lever and tape to the butcher paper. Place the “High Blood Sugar” underneath the glucagon side of the lever and tape to the butcher paper.

Testing: Test your first lever to make sure that students are able to drop sand onto one side and cause the lever to go down. Then drop sand onto the other side. Does the lever come back up? Sand is supposed to fall off the sides, representing hormones falling out of circulation.

Procedures:

1. Explain to students how negative feedback loops help keep your body in homeostasis. Give examples of negative feedback loops like insulin and glucagon. Explain how your body increases and decreases the amount sugar in the bloodstream by converting glucose into glycogen or fat and vice-versa.
2. Students are going to model how your pancreas maintains blood sugar levels. Explain to the students that the sand is hormones and that they come from the pancreas. Their goal is to maintain a balance in blood sugar. When blood sugar is high, the pancreas releases insulin and glucagon is inhibited. When blood sugar is low, the pancreas releases glucagon and insulin is inhibited.
3. Demonstrate to students how they will try to model the endocrine system. Their goal is to keep the lever in balance--“preferred blood sugar level.” When the lever touches the high blood sugar, more “insulin” hormones must be added to the insulin side. When the lever touches the low blood sugar side, more “glucagon” hormones must be added to the glucagon side.
4. The students start the activity by eating some sugar. A small chocolate candy will get their attention. Now their blood sugar will rise. They must add insulin from the pancreas bowl to the left side of the lever.
5. The sand or “hormones” that fall off the lever demonstrates that peptide hormones are degraded by liver cells and are no longer in the blood stream. Students continue the balancing act until the lever is in balance.

Accommodations: Students who are not able to participate can instruct their partner to add hormones to the lever and how much to add. Students with an IEP can take the handout home if they need extra time, not create the graph, and/or answer on half of the question in the analysis section.

Evaluation:

The 13 analysis questions are worth 2 points each, for a total of 26 points.

Feedback Mechanisms Lab

Problem Statement:

Feedback mechanisms detect the amount of hormones in the blood stream and then adjust the production or release of more of these hormones.

Hypothesis:

If we provide the right amount of sand to each side of the lever, then we can model how the human body maintains hormone levels in the blood stream.

Prerequisite Knowledge: Hormones, endocrine system.

Materials:

- Sand
- Candy or sugar
- Lever
- 2 Graduated cylinders

Procedures:

1. You are going to model how your pancreas maintains blood sugar levels. To do this, you will use sand, a lever, a graduated cylinder, and a clock. Pretend that the sand is like hormones and they come from your pancreas, the graduated cylinder. You will put the sand on the lever to act as if hormones that regulate blood sugar are added to the blood stream. Placing sand on one side of the lever is like adding insulin and placing sand on the other side is like adding glucagon to the bloodstream. Your goal is to maintain a narrow range of blood sugar (70mg to 110mg), which in your case the lever should be near balanced. When blood sugar is high, the pancreas releases insulin and glucagon is inhibited. When blood sugar is low, the pancreas releases glucagon and insulin is inhibited.

2. Before starting, check to see if the lever is balanced and if not; balance it with your fingers. You start the activity by eating some sugar. This increases the sugar in your bloodstream. Now start adding a small amount of sand/insulin to the insulin side of the lever. Watch to see what happens to the lever. If the lever hits the table, your simulated blood sugar level is too low and now it is time to add glucagon. Try to balance your blood sugar level.

3. When sand falls off the lever, it is acting like the hormones have been degraded. You will continue the balancing act until the lever is in balance.

Analysis: Use complete sentences and explain your reasoning.

1. Independent Variable _____

Dependent Variable _____

2. What initially happens when you eat a candy bar or a lot of sugar? _____

3. What is released after your blood sugar level is too high? _____

4. Insulin decreases blood glucose by accelerating facilitated diffusion of glucose across cell membranes. How does insulin affect blood sugar levels?

5. What organ in the human body releases insulin? _____

6. What is the name of the gland, found in the organ above, that is used for the blood sugar concentration?

7. Which cells in the pancreas secrete insulin? _____

8. What is released after your blood sugar level is too low? _____

9. Glucagon accelerates a process called *liver glycogenolysis* in which glucose stored in the liver is released into the blood stream. How does glucagon affect blood sugar levels?

10. Which cells in the pancreas secrete glucagon? _____

11. When insulin is released to the blood stream, the release of glucagon is inhibited.

What does inhibition mean? _____

12. Insulin is a peptide (linked amino acids) hormone. How do peptide hormones work?

13. Since insulin and glucagon are not brought into a cell, why do their concentrations in the blood stream not increase forever?

Low Blood Sugar

High Blood Sugar

Blood Stream

Pancreas

Insulin

Glucagon

The Endocrine System: Who is in Control Here?

Grade Level or Special Area: 5th Grade Science

Written by: Jan Guyer, Academy of Charter Schools, Denver, Colorado and Ernie Carroll, Lincoln Academy, Arvada, Colorado

Length of Unit: Ten lessons, 40 minutes each

I. ABSTRACT

This fifth grade unit examines the Endocrine System, glands, and hormones of the human body. Students will study the location of all of the glands and their function. Students will also learn about the pituitary gland and its function in relation to all other glands of the body. Students will do several hands-on activities to demonstrate their understanding of the content of this unit. They will learn about key scientists and their discoveries as well as some dysfunctions that can occur.

II. OVERVIEW

A. Concept Objectives

1. Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment. (Colorado Standard 3: Life Science)
2. Students understand that science involves a particular way of knowing and understanding common connections among scientific or natural processes. (Colorado State Standard 6: Life Science)
3. Students will know something may not work as well or at all, if a part of it missing, broken, worn out, mismatched, or misconnected.
4. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.

B. Content from the *Core Knowledge Sequence*, page 128

1. Science: The Endocrine System
 - a. The human body has two types of glands: duct glands (such as the salivary glands), and ductless glands, also known as endocrine glands.
 - b. Endocrine glands secrete (give off) chemicals called hormones. Different hormones control different body processes.
 - c. Pituitary gland: located at the bottom of the brain; secretes hormones that control other glands, and hormones that regulate growth.
 - d. Thyroid gland: located below the voice box; secretes a hormone that controls the rate at which the body burns and uses food.
 - e. Pancreas: both a duct and ductless gland; secretes a hormone called insulin that regulates how the body uses and stores sugar; when the pancreas does not produce enough insulin, a person has a sickness called diabetes (which can be controlled).
 - f. Adrenal glands: secrete a hormone called adrenaline, especially when a person is frightened or angry, causing rapid heartbeat and breathing.

C. Skill Objectives

1. Students will identify vocabulary particular to this unit.
2. Students will identify characteristics of living things and how they function.
3. Students will be able to take notes and organize information.
4. Students will follow directions in order to demonstrate and understanding of the location of the glands in reference to other organs of the body.
5. Students will label accurately all the glands of the endocrine system.
6. Students will identify the location of all glands and accurately match them to the appropriate area of the body or organ they are near on a quiz.

7. Students will identify the changes that occur as people mature.
8. Students will demonstrate an understanding of each gland's function.
9. Students will compose a Rap song, story, or poem explaining the location and function of all parts of the endocrine system either individually or in a group.
10. Students will identify the changes or problems that may occur if hormones don't function properly and how this might affect a person's life.
11. Students will understand how scientists use technology to do scientific investigation.
12. Students will describe contributions to the advancement of science made by people in different cultures and at different times in history.
13. Students will demonstrate an understanding of the information taught in this unit.
14. Students will develop test taking and study skills.

III. BACKGROUND KNOWLEDGE

- A. For Teachers
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 6. Deborah Vlad and Lisa Browning, The Endocrine System and Changes in Human Adolescence. Core Knowledge Summer Writing Institute Unit 1998. www.ckcolorado.org
- B. For Students
 1. Nervous system (Grade 3)
 2. Body Systems (Grades 2, 3, and 4)
 3. Reproduction of Plants and Animals unit (Grade 5)
 4. Note taking skills
 5. Dictionary skills
 6. Be able to work in a small group
 7. Study skills

IV. RESOURCES

- A. *It's Time To Learn About Diabetes* by Jean Betschart, MN, RN, CDE (Lesson Six)

Lesson One: Introduction to the Endocrine System

- A. *Daily Objectives*
 1. Concept Objective(s)
 - a. Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment. (Colorado Standard 3: Life Science)
 2. Lesson Content
 - a. Introduction to the endocrine system, the human body has two types of glands; duct glands and ductless or endocrine glands.
 3. Skill Objective(s)
 - a. Students will identify vocabulary particular to this unit.
 - b. Students will identify characteristics of living things and how they function.
 - c. Students will be able to take notes and organize information.

- B. *Materials*
1. Teacher generated Power Point, *Who is in Control Here?* (Appendix B)
 2. Hormone pre-assessment “*I didn’t know that!*”-copy one class set (Appendix A)
 3. Vocabulary for unit, (Appendix C)
 4. Maureen Auman’s T-notes for Lesson One (Appendix D)
 5. Projector or connection for TV to display the Power Point
 6. Computer or laptop with Power Point software and presentation
 7. Overhead screen
- C. *Key Vocabulary*
1. Endocrine system – a system of glands that chemically controls the functions of cells, tissues, and organs through secretion of hormones; it has eight glands including the thymus (which is discussed in sixth grade)
 2. Hormones – a chemical product made by an endocrine gland
 3. Glands – produce and secrete hormones, there are two kinds; ductless which are endocrine, and duct type that are exocrine
 4. Endocrine – they are ductless, they secrete hormones directly into the blood stream without passing them through a tube or duct
 5. Exocrine – they have ducts, they secrete substances onto the surfaces of body tissues such as, the pancreas, sweat glands, and salivary glands
- D. *Procedures/Activities*
1. Introduce the unit with this story. “You are skateboarding in a neighborhood park. Out of the corner of your eye you see a large, vicious looking dog lunging at you. He is growling, barking and showing his teeth. Suddenly he breaks free from his leash and comes straight toward you. Your heart begins to pound, your hands get sweaty and your muscles tighten up. You grab your skateboard and race to your parent’s car. As you slam the door, the dog jumps up against the window. You are safe now but your heart is still pounding.” In this unit we will learn how the endocrine system can help with a quick response to danger and how it slowly turns you from a child to a pre-adolescent to an adult.
 2. Show the teacher produced Power Point: *Who is in Control Here?* (Appendix B) (this is optional).
 3. Hand out the hormone pre-assessment “*I didn’t know that!*” (Appendix A). Allow ten to fifteen minutes for students to mark their responses and then collect the papers.
 4. Say to students: “Now that you have an idea of what we will be learning, let’s find out what the endocrine system does.”
 5. Pass out paper for students to use for note taking for Lessons One and Two.
 6. Students will prepare their papers according to the note taking practice in your class. We will be using Maureen Auman’s T-note procedures (Appendix D).
 7. Say to students: “On the left column of your paper put the word endocrine and on the right column we will be defining what the endocrine system is. In the human body there are several systems that control it. All of these systems have a major job to do such as getting oxygen, digesting food, or disposing of waste. Two systems control the body and its functions. One you learned about in third grade called the nervous system. The second system is the endocrine system. Please write this definition in the right column: It is a system of glands. It chemically controls the functions of cells, tissues and organs through secretion of hormones. It includes 7-8 glands.”
 8. Say to your students, “Bullet the next space on the right column. Write, the glands produce and deliver their chemical products directly to the blood stream. “

9. Say to your students, “Write on the left column, hormones, and on the right side, they are the chemical products.”
 10. Say to your students, “Write on the left column, glands, and on the right side write, produce and secrete hormones. Failure can result in serious illness or even death. There are two main kinds: ductless (endocrine) and duct (exocrine).”
 11. Say to your students, “Write on the left column; endocrine glands - and on the right side write, ductless, they secrete hormones directly into the blood stream without passing them through a tube or “duct”.”
 12. Say to your students, “Write on the left column, exocrine glands –and on the right side write, duct, they secrete substances onto the surfaces of the body tissues through “ducts”. Next bullet is examples: salivary glands, pancreas, and sweat glands.”
- E. *Assessment/Evaluation*
1. Homework tonight is to complete the definitions on their vocabulary sheets: endocrine system, hormones, gland, secrete, excretion, endocrinology. Please note students will need to look up secrete, endocrinology, and excretion in the dictionary. They will be able to use their notes for the other definitions (Appendix C).

Lesson Two: Location of Endocrine Glands in the Body

- A. *Daily Objectives*
1. Concept Objective(s)
 - a. Students know and understand the characteristics of living things, the processes of life, and how living things interact with each other and their environment. (Colorado Standard 3: Life Science)
 2. Lesson Content
 - a. The human body has two kinds of glands duct and ductless.
 - b. Location of all endocrine glands in the human body.
 - c. Endocrine glands secrete (give off) chemicals called hormones.
 - d. Different hormones control different body processes.
 3. Skill Objective(s)
 - a. Follow directions in order to demonstrate an understanding of the location of the glands in reference to other organs of the body.
 - b. Label accurately all the glands of the endocrine system.
- B. *Materials*
1. Appendix C - vocabulary worksheet
 2. Students T-notes from Lesson One
 3. A sponge (soft)
 4. Glass bowl of water
 5. Overhead of Appendix E *Location, Location, Location* + class set of Appendix E
 6. Screen
 7. Overhead markers
 8. Overhead projector
 9. Appendix F (key for Appendix E)
 10. Class set of (Appendix G), *Putting It All Together* + key
 11. Each student should have colored pencils to complete Appendix G worksheet
- C. *Key Vocabulary*
No new words added for this lesson
- D. *Procedures/Activities*
1. Say to your students, “Yesterday we began to work on our vocabulary sheets. Let’s go over the definitions you had to look up. Please correct them as we go.”

The first word is secrete; ask for a student definition. Tell the students what it means if necessary: to produce and release hormones. “The next word is endocrinology, does anyone know what this means?” It means: the study of the endocrine system. The final word was excretion; does anyone know the meaning of this word?” It means, releasing fluid and other waste materials. Excretion is not always a waste like in tears and over sweating.”

2. Say: “I am going to do a simple demonstration to show you the difference between two words we discussed yesterday, ducts and ductless glands. We will be studying the endocrine glands which are ductless, but we need to understand the difference.”
3. Now demonstrate for the students using a sponge and a container of water how your body is the sponge and when squeezed the fluid (water) is excreted. The porous parts of the sponge are the ducts of a gland (like sweat glands.) Fill the sponge with water (so it doesn’t drip) and then lightly squeeze so the fluid drips out of the “pores or ducts” of the sponge.
4. Say to your students, “We will now learn about the ductless glands of the endocrine system.” “Take out your notes from yesterday.” On the left side write transportation. On the right side write that hormones or chemical products are transported to different cells of the body through the blood stream without the use of ducts.”
5. Using an overhead of Appendix E titled *Location, Location, Location* pass out copies of this appendix for students to fill in as you explain the locations of the different glands. See Appendix F for a key of all of the locations of the glands. Say to the students the name of each gland as you and the students label them and explain that the thymus is considered an endocrine gland, but we will not learn about it until 6th grade.
6. After discussing and labeling the location of all glands, go back to the Pituitary Gland and under the name write “Master Gland”. Inform students it is the gland that controls all of the glands. For Parathyroid write - regulates calcium. Also point out they are what appears to be little “holes” on the worksheet. They are actually by the Thyroid. For Thyroid write - controls use of food and energy. Under Adrenal write -responds to being frightened or nervous. For Pancreas - balances amount of sugar in body. The Ovaries control all changes in females and testes control all changes in males. At this point I also label the worksheet “It” and explain that on all worksheets students must label both female and male reproductive parts! ☺
7. Please note, after labeling all parts especially the male and female reproductive parts we have a brief discussion on being mature and using scientific terms. I also point out the ovaries are on the inside of the body as are all other glands, but the testes are on the outside. This usually helps all the children understand the locations of all parts.
8. Announce there will be a quiz over the location of the glands tomorrow.

E. *Assessment/Evaluation*

1. Pass out Appendix G titled, *Putting It All Together: The glands of the endocrine system and organs of the body*. Students are to use the “key” at the bottom to color all the organs and glands to see how they relate to one another in the body. Students must use colored pencils to complete the worksheet, being sure all colors are different.

Lesson Three: Location of Endocrine Glands in Relation to Other Organs of the Body

A. *Daily Objectives*

1. Concept Objective(s)
 - a. Students know and understand the characteristics of living things, the processes of life, and how living things interact with each other and their environment. (Colorado Standard 3: Life Science)
 2. Lesson Content
 - a. Different hormones control different body processes. They are: Pituitary, thyroid, pancreas, adrenal glands.
 3. Skill Objective(s)
 - b. Identify the location of all glands and accurately match them to the appropriate area of the body or organ they are near on a quiz.
- B. *Materials*
1. Prepare Location Bingo game cards for students, (Appendix I), 30 copies
 2. Appendix J clues information sheet or cards for Location Bingo (one copy for teacher use)
 3. Appendix H “*Location, Location, Location Quiz*”, copy enough for each student
 4. Appendix F – Key of “*Location, Location, Location Quiz*”
- C. *Key Vocabulary*
No new vocabulary introduced
- D. *Procedures/Activities*
1. Say to your class, “Before we take our quiz we are going to play a short review game called *Location Bingo*.” Pass out blank “Bingo” cards and have students choose any spot as a ‘free square’; write ‘free’ in that square. Then ask students to randomly fill in the rest of the blanks with these terms or phrases: pituitary gland, endocrine, exocrine, duct, ductless, thyroid gland, parathyroid gland, adrenal, pancreas, ovaries, testes, reproductive, master gland, hormones, chemical products, sweat glands, male, female, and blood.
 2. Give students dots or beans to use as pieces to cover a word as clues are read. Read clues and students are to cover words they believe answer the clues. Students may only get a bingo horizontally or black out because of the uneven number of squares. Play until you feel students are ready for the quiz. Give out small tokens, treats, or “prizes” for students getting black out.
 3. Collect cards and beans.
 4. Pass out quizzes.
- E. *Assessment/Evaluation*
1. The students are given Appendix K – “*Location, Location, Location Quiz*”.

Lesson Four: What is a Hormone and What Does It Do?

- A. *Daily Objectives*
1. Concept Objective(s)
 - a. Students know and understand the characteristics of living things, the processes of live, and how living things interact with each other and their environment. (Colorado Standard 3: Life Science)
 2. Lesson Content
 - a. Endocrine glands are: pituitary, thyroid, pancreas, and adrenal glands.
 - b. Different hormones control different body processes, cells, and glands. Body functions including reproduction, hair growth (loss), maturation, development, handling fears and excitement, growth, bone strength, rate sugar and food is burned.
 3. Skill Objective(s)
 - a. Students will be able to take notes and organize information.
 - b. Students will identify vocabulary particular to this lesson.

c. Students will identify the changes that occur as people mature.

B. *Materials*

1. Cabbage juice solution for teacher demonstration
2. Cotton balls in four different colors
3. Eight clear “junior size” baby food size jars
4. Box of baking soda (the more you add, the more color change you get)
5. 6 ounces vinegar
6. 4 ounces lemon juice
7. T-notes for this lesson
8. 6 quart or larger sauce pan
9. Wooden spoon
10. Stove
11. 2 cup measuring cup

C. *Key Vocabulary*

1. Hormones – a chemical product made by an endocrine gland

D. *Procedures/Activities*

1. Say to your students, “We have been using the words chemical products and hormones. Today we will be talking about what a hormone is and what it does.”
2. **Prepare your teacher demo no earlier than a day before you need it.** Cut a head of purple cabbage in half and separate the leaves. Place the leaves in a pot with two quarts of cool water. Heat the pot gently until the water is a deep purple (about 20-25 minutes). Allow the juice to cool and store it in a covered container. Squeeze the juice from a fresh lemon into one of the jars. In a second jar place 2 or 3 fluid ounces of vinegar. In a third jar place 4 fluid ounces of water and a tablespoon of baking soda. Stir well until the soda is dissolved. In a fourth jar put four ounces of water and three tablespoons of soda. Stir until as much of soda is dissolved as possible. (Please note: the cabbage juice will change a variety of colors in response to the strength of the acids and bases. More dramatic changes happen when stronger acids and bases are used, but vinegar, lemon juice, and baking soda are safer to use.) Next, put about four fluid ounces of cabbage juice in each of four jars. **Play with the solutions before the demo.**
3. DEMO: Hold up one of the jars of cabbage juice so all the students can see the original color. Say to the students, “This represents the human body.” Dip a cotton ball in one of the four prepared solutions. Say to the students, “The cotton ball can represent any endocrine gland, say the Pituitary.” Hold the ball over the over the first glass filled with cabbage juice and say, “The gland has made a hormone and now it is released in the body.” Gently squeeze the cotton ball and swirl the cabbage juice jar gently to mix. The color will change from the deep purple. Tell your students, “This is an example of how chemical products, (hormones), when told to go to work, change the body. The pituitary is telling other glands to go to work.” Using a second ball of a different color, ask for the name of another endocrine gland and repeat the process. Tell your students, “The _____ gland has been told by the Pituitary to go to work. We have just seen how _____ gland sent its hormone through the blood stream to change cells. For example to tell the cells to grow larger, or grow hair, or to mature.” If you have prepared properly, the “body” will react differently and each jar will be a distinct color. Therefore you could actually demonstrate each gland sending hormones through the “blood stream” to go to work. You will have colors that will cover the spectrum. Therefore each color (jar) will represent visually a different gland and hormone working and changing!

4. Say to students: “We will now take a few notes, please get out your T-notes,” or give out more paper if students need it.
5. Say to students: “On the left side write, hormones – job. On the right side write, to control the bodily functions, regulate levels of substances within the body and blood stream, and to control growth. The pituitary controls all other glands and their hormones. It sends out hormones to instruct other glands to activate (to get to work).” (You may want to paraphrase these notes for the students.)
6. On the left side of the T-notes tell students to write - what hormones control. On the right side write – reproduction, hair growth (loss), maturation, development, handling fears and excitement, growth, bone strength, rate sugar and food is burned. (Discuss each one as they are listed). Go into as much detail as your school allows about maturation and reproduction.

E. *Assessment/Evaluation*

1. Students will write a paragraph to explain how hormones affect the body, how they move through the body (two ways through ducts or ductless through the blood stream), and which gland controls all other glands and hormones.

Lesson Five: Functions of Each Gland (this lesson may need to be divided into two class periods)

A. *Daily Objectives*

1. Concept Objective(s)
 - a. Students know and understand the characteristics of living things, the processes of life, and how living things interact with each other and their environment. Colorado Standard 3: Life Science.
2. Lesson Content
 - a. Different hormones control different body function.
3. Skill Objective(s)
 - a. Students will identify vocabulary particular to this lesson/unit.
 - b. Students will demonstrate an understanding of each gland’s function.
 - c. Students will compose a RAP, story, or poem explaining the location and function of all parts of the endocrine system either individually or in a group.
 - d. Students will be able to take notes and organize information.

B. *Materials*

1. Students T-notes from previous lessons
2. Vocabulary worksheet(s) from previous lessons
3. Class set of Appendix L – worksheet titled “*Glands at Work*”
4. Class set of rubric (Appendix K) for Rap, story, or poem assignment

C. *Key Vocabulary*

1. Pituitary gland – located at the bottom or base of the brain; master gland; secretes hormones that control all other glands, and hormones that regulate growth
2. Thyroid gland – it is located below the voice box; it secretes a hormone that controls the rate at which the body burns energy and uses food (nutrients)
3. Parathyroid – controls the growth of bones and the amount of calcium in your body
4. Pancreas – it is both a duct and ductless gland; secretes a hormone called insulin that regulates how the body uses and stores sugars (glucose); when the pancreas does not produce enough insulin, a person may have a illness called diabetes (which can be controlled)

5. Adrenal glands – secrete a hormone called adrenaline, especially when a person is frightened or angry or nervous, this causes rapid heartbeat and breathing, as well as, sweaty palms
6. Ovaries – female reproductive; controls maturation and reproduction in females including voice change, breast growth, menstruation, and hair (puberty)
7. Testes – male reproductive; controls maturation and reproduction in males including voice change, hair, muscle development (puberty)

D. *Procedures/Activities*

1. This is a long lesson that may need to be divided into two class periods.
2. Students will begin by continuing T-notes. See Appendix D for an example. Using the above vocabulary words students will list the vocabulary word on the left and the definition on the right side. Be sure to discuss each word and definition fully as students are given the notes. Be sure to be sensitive to parents, students and your school’s policies when discussing maturation, puberty, and reproduction. This unit is not intended to discuss or teach these topics.
3. After discussing in detail every gland and its function have students go back to their notes and on their own or with a partner draw quick line drawings to help them remember each gland and its function. For instance for Pituitary maybe a drawing of a stick figure with a whip or a stick figure with a badge or a picture of the brain. For the Parathyroid draw a milk carton and write CALCIUM on it. Adrenal can be a picture of the example at the beginning of the unit a stick figure with a fierce dog chasing it, or a beating heart. You may want to develop more of these mnemonic devices on your own, have your students create them, or create them as a class. Another idea is to draw large poster size 11” x 17” depictions for display in your classroom.
4. Next, break students into groups or ask students if some would rather work alone to write a story, poem or Rap completely explaining the locations of all of the glands, vocabulary words, and the functions of the glands. Pass out Appendix K, the rubric for the Rap, poem or story to use while explaining the assignment. It is suggested that students have 15 minutes over the next three days to work together and be ready to present the Rap, poem, or story to the class on a day you specify. Stress they may have to work outside of class to complete this assignment.

E. *Assessment/Evaluation*

1. Copy one copy of Appendix L worksheet “*Glands At Work*” for each student to be given as homework. Students will match the gland with its location, then the location to the function. Tell students to pay close attention to the instructions.
2. Rap, Poem, and story assignment. Copy one copy of Appendix K rubric to be used when assigning Rap, Story, or Poem assignment.

Lesson Six: Some Dysfunctions

A. *Daily Objectives*

1. Concept Objective(s)
 - a. Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with EACH
 - b. Something may not work as well or at all, if a part of it is missing, broken, worn out, mismatched, or misconnected.
2. Lesson Content
 - a. Different hormones control different body processes and there may be problems of glandular or hormonal dysfunctions.
3. Skill Objective(s)

- a. Students will identify the changes or problems that may occur if hormones don't function properly and how this might affect a person's life.
- B. *Materials*
1. Students T- notes from previous lessons
 2. Pictures from either the power point or *Encarta Online* of midgets, goiters, gigantism, and a normal and abnormal pancreas (you may choose to collect other images from other sources, these are the ones we found on *Encarta*)
 3. Copy of the soft-cover book, *It's Time To Learn About Diabetes* by Jean Betschart, MN, RN, CDE
- C. *Key Vocabulary*
No new key vocabulary
- D. *Procedures/Activities*
1. Remember the images we saw in the Power Point? Some of us laughed. I'd like to read the book *It's Time to Learn About Diabetes* to you. Then say, "It is obvious that sometimes things don't work the way we want them to. Sometimes that happens to our bodies too. In the story, Mike has diabetes, which we just learned is a dysfunction of the pancreas and the hormone insulin."
 2. Hold up a picture of a midget and the very tall man. Explain we may find these images to be different, strange and even funny. But when we understand that differences people have, may be caused by the person's hormones, we can understand why they look different. Very tall or very short people have problems with too much or too little growth hormones in the Parathyroid gland or Pituitary gland.
 3. Hold up the image of the person with the goiter. Explain to your students that this person may have a dysfunctional Thyroid gland. Problems with the thyroid gland can cause a variety of weight problems.
 4. Knowing this information can make us more understanding of people with physical handicaps. I'm sure we all have seen or know someone that is blind, deaf, or have other handicaps. These are more uncommon types of handicaps, but still can affect a person's life.
 5. On the board, make two columns. On the left, write: goiter, midget/gigantism, and diabetes. On the right, have the students come up with a list of ways these dysfunctions can affect a person's life.
 6. Using the list have students write a paragraph or two explaining in personal narrative, expository, or from third person point of view how one dysfunction would affect their life if they had this dysfunction or a character in their story had this dysfunction. Ask students to be specific and give lots of examples or scenarios. For instance, will they be teased by others, will they have difficulties finding clothing, homes, jobs, will they have difficulty in school or with their health? Students need to tell why.
- E. *Assessment/Evaluation*
1. Using Maureen Auman's rubric (Appendix M), score the writing assignment given to students about possible dysfunctions.

Lesson Seven: Key Core Scientists

- A. *Daily Objectives*
1. Concept Objective(s)
 - a. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
 2. Lesson Content

- a. Teach students about 3 important scientists of the time that made discoveries about the endocrine system, dysfunctions, and medicine to help people with these dysfunctions.
3. Skill Objective(s)
 - a. Students will understand how scientists use technology to do scientific investigation.
 - b. Students will describe contributions to the advancement of science made by people in different cultures and at different times in history.
- B. *Materials*
 1. Copy class set of fact sheet, *Who's in Control Here? Who Helped Figure IT Out?* on three scientists: Percy Julian (Core figure), Sir Frederick Banting, and Charles Best (Appendix N)
 2. 8 ½" by 11" sheet of plain paper for each student
 3. Colored pencils
 4. Several postage stamps to show students of famous people as examples for their scientist stamp
 5. Class set of Rubric (Appendix O), for Stamp activity
- C. *Key Vocabulary*
No new key vocabulary
- D. *Procedures/Activities*
 1. Say to your students, "Yesterday we discussed a few of the dysfunctions that can happen with hormones or glands." "There have been many medical discoveries that have found cures, medicines, and even surgery that can help people live a normal life even with these dysfunctional glands."
 2. Hand out the fact sheet, *Who's In Control Here? Who Helped Figure IT Out?* (Appendix N) and go over it with your students.
 3. Remind students that often stamps are produced to depict a famous person's achievements in their life. You will be making a stamp of one of the scientists we have discussed. You must use pictures or symbols and very few words on the front of the stamp to show important details about the scientist you choose. Color is required. Be sure your stamp looks real. On the back of your "stamp" write why you chose the pictures or symbols and words on the front of your stamp. Write this in paragraph form. Use Appendix O to discuss the criteria for this lesson.
 4. **EXTENSION ACTIVITY:** Bring in a glucometer and show how blood sugar levels are measured. Someone who has been trained, (a nurse or doctor), should only do an actual blood draw sample. Also, a guest speaker would be another excellent extension activity. The speaker could be a nurse, doctor, or a person with diabetes.
 5. **EXTENSION ACTIVITY:** Have a volunteer student take the background information on one of the three scientists and develop and present to the class a "First" person report on their background and how they made their discoveries. (Great for G. T. learners).
- E. *Assessment/Evaluation*
 1. Grade the "stamp" activity. Rubric is Appendix O.

Lesson Eight: Putting It All Together – A Review Game

- A. *Daily Objectives*
 1. Concept Objective(s)

- a. Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with EACH other and their environment. (Colorado State Standard 3: Life Science)
 2. Lesson Content
 - a. Review for final test.
 3. Skill Objective(s)
 - a. Students will demonstrate an understanding of the information taught during this unit.
- B. *Materials*
 1. Blank copy of parts and outline shape to enlarge for preparation of “game” pieces and “game” board (Appendix P)
 2. Overhead projector
 3. Three-foot long piece of project paper in tan or white to trace outline of figure
 4. Black permanent marker
 5. Overhead of Appendix P
 6. Enlarged “game” pieces (pieces of each gland) (Appendix P)
 7. Seven 3” x 5” index cards with one gland written largely on each card
 8. Definitions or function sheets (See Appendices L and D) use the information to make 3” x 5” index cards with the location and/or function of each gland
 9. Masking tape or Velcro
- C. *Key Vocabulary*
No new key vocabulary
- D. *Procedures/Activities*
 1. **Prepare your “Game” board and “Game” piece cards before actual game is to be played.** You will be using Appendix P overhead and large project paper to trace the figure onto the project paper. First, place the overhead on the projector and tape the large paper on a flat surface wall. Turn on the overhead and project the figure onto the paper. Pull the overhead back until you have the size you want for your game board. Now trace onto the paper the projected image by outlining the figure.
 2. To make “game” pieces, enlarge the glands also on Appendix P to a size to “fit” the game board you just made.
 3. To make the 3” x 5” index cards, use appendices that have information and facts to make as many cards as you’d like to use for reviewing for the test. Also, you may like to use the actual test, (Appendix Q) to make these cards. Suggested cards: names of all glands, location information, function of each gland (all on a different card). You may have as many as 21 – 28 cards. The game board and all pieces and cards should be laminated.
 4. **TO PLAY THE GAME:** Say to your students, “Today we are going to play a game to review for the Endocrine Test I will be giving you tomorrow.” “This outline figure will be our “game board”. We will be using this board to play our game. We will divide into two teams. The object of the game is to place the gland pieces, the definition or fact card and information cards about each gland’s location in the proper place. Place the “game board” on a flat wall space. Place two chairs facing the game board. Divide the class into two teams. Students will take turns from each team to come to one of the chairs. The teacher will show a gland or read the information from a card out loud. When a student thinks they have an answer, the student rings a bell, and the first person to ring the bell gets the first chance for 2 points. Each team member will have a turn to first place the gland pieces in the proper place on the game board (use Velcro or tape on the back of laminated pieces so they will adhere to the game board, but can be

moved easily.) The person who thinks they know where to place the piece will ring the bell. If he/she is correct, they will earn 2 points for their team. If it is not in the correct place, the second team may move it and if correct it is worth 1 point. If neither person is correct then the next person on each team will have a chance for 2 points and then 1 point if incorrect. The process continues until ALL glands are on the board in their proper place. Then we will begin with the cards that have other information such as, location, definitions, or functions of the glands. In the case of these informational cards, the person that knows where it goes must ring the bell; this person will have a chance to place the card by the correct gland. If he or she gets it correct the first time will get 2 points, if they are incorrect then the other team will have a chance for 1 point. If both are incorrect I will place it in the correct place for NO points for either team. The game continues until the end of the 40-minute class period, or all cards are gone.

5. Assignment for the day is to write a summary of all the parts, functions, and locations of all glands in the endocrine system. Students must completely explain all they have learned. This can be homework, or time can be given in class.

E. *Assessment/Evaluation*

1. Write a summary of the parts of the endocrine system, the glands and their functions. Students should be able to completely explain what they have learned.

Lesson Nine: Assessment (Culminating Activity will precede the Assessment)

A. *Daily Objectives*

1. Concept Objective(s)
 - a. Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with EACH other and their environment. (Colorado State Standard 3: Life Science)
2. Lesson Content
 - a. Assessment on endocrine unit, vocabulary and concepts taught.
3. Skill Objective(s)
 - a. Students will demonstrate their understanding of the unit by successfully taking a test and passing with 85% accuracy.

B. *Materials*

1. Class set of Assessment/Test , *Taking Control of the Endocrine System Assessment* (Appendix Q)
2. Key for Assessment (Appendix R)

C. *Key Vocabulary*

No new vocabulary will be introduced.

D. *Procedures/Activities*

1. Hand out Assessment, (Appendix Q) – *Taking Control of the Endocrine System Assessment*, read directions, answer any questions students may have. Give full class period to complete the assessment. To modify this assessment for special needs, give a word box.

E. *Assessment/Evaluation*

1. TEST

V. CULMINATING ACTIVITY

- A. “Putting It All Together” – This can be an in or out-of-class assignment, copy class set of rubric, (Assessment S).
- B. **Procedure:** Each student will need a 4 foot piece of butcher/project paper, markers, crayons or colored pencils, pencils, erasers, their T-notes, vocabulary sheets.

- C. Students will be required to do the following: Trace around “a” body that is about the same size as their body. Use a black marker to outline the body. Draw glands into the body outline. Place them in the correct location AND clearly label them, be sure they are the appropriate size (scale) for the size of the body they have traced. They may not trace the worksheets. Label each gland clearly (spelling counts), Draw a straight line from the gland to the outside edge (beyond the traced outline). Below each labeled gland tell what jobs the gland does. Be sure to tell the pituitary gland is the master gland and that it controls all other glands. It tells all glands/hormones to do their jobs. Now the fun part: Add hair, eye color, and other details to make your “model” more interesting. Be sure you don’t distract from the informational part of the model.

VI. HANDOUTS/WORKSHEETS

- A. Appendix A: *I didn’t know that!* And Key
 B. Appendix B: Power Point Slides
 C. Appendix C: *Key Vocabulary Endocrine Unit*
 D. Appendix D: Sample T-Notes
 E. Appendix E: *Location, Location, Location*
 F. Appendix F: *Location, Location, Location – KEY*
 G. Appendix G: *The Glands of the Endocrine System and the Major Organs of the Body: Putting It All Together*
 H. Appendix H: *Location, Location, Location Quiz*
 I. Appendix I: Bingo Card
 J. Appendix J: Bingo Clues for Teacher
 K. Appendix K: Oral Presentation of Rap, Story, or Poem Rubric
 L. Appendix L: *Glands At Work*
 M. Appendix M: Writing Rubric
 N. Appendix N: *Who’s In Control Here? Who Helped Figure IT Out?*
 O. Appendix O: Rubric for Stamp Project
 P. Appendix P: Review Game Sheet
 Q. Appendix Q: *Taking Control of the Endocrine System – Assessment*
 R. Appendix R: *Taking control of the Endocrine System – Assessment KEY*
 S. Appendix S: *Putting It All Together Project Rubric*

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Appendix A, page 1

Name:

Date:

I didn't know that!

Please answer each question with true or false (not T or F). This is not a graded test. I just want to see what you already know!

- _____ 1. Hormones can make you grow to be nine feet tall.
- _____ 2. Hormones can affect your ability to taste salty foods.
- _____ 3. Hormones can make you very sensitive to high-pitched sounds.
- _____ 4. Hormones cause a young man to begin to grow facial hair.
- _____ 5. Hormones can help fight stress.
- _____ 6. Hormones determine what color eyes you have.
- _____ 7. Hormones can cause you to be allergic to milk.
- _____ 8. Hormones can make your heart beat faster when you are scared.
- _____ 9. Hormones can soothe you.
- _____ 10. Hormones can cause your hands to tremble when you are nervous.
- _____ 11. Hormones affect how much energy you have.
- _____ 12. Hormones affect how fast or slow you read.
- _____ 13. Hormones tell your body how fast it should grow.
- _____ 14. Hormones give you the strength and energy to fight or run when in a dangerous situation.
- _____ 15. Hormones cause your voice to change, especially in boys.
- _____ 16. Hormones can make twins become triplets before they are born.
- _____ 17. Hormones tell your body how to swallow.
- _____ 18. Hormones help control when you sleep and when you wake.

Appendix A, page 2
KEY

Name:

Date:

I didn't know that!

Please answer each question with true or false (not T or F). This is not a graded test. I just want to see what you already know!

- True 1. Hormones can make you grow to be nine feet tall.
- False 2. Hormones can affect your ability to taste salty foods.
- False 3. Hormones can make you very sensitive to high-pitched sounds.
- True 4. Hormones cause a young man to begin to grow facial hair.
- True 5. Hormones can help fight stress.
- False 6. Hormones determine what color eyes you have.
- False 7. Hormones can cause you to be allergic to milk.
- True 8. Hormones can make your heart beat faster when you are scared.
- True 9. Hormones can soothe you.
- True 10. Hormones can cause your hands to tremble when you are nervous.
- True 11. Hormones affect how much energy you have.
- False 12. Hormones affect how fast or slow you read.
- True 13. Hormones tell your body how fast it should grow.
- True 14. Hormones give you the strength and energy to fight or run when in a dangerous situation.
- True 15. Hormones cause your voice to change, especially in boys.
- False 16. Hormones can make twins become triplets before they are born.
- False 17. Hormones tell your body how to swallow.
- True 18. Hormones help control when you sleep and when you wake.



The Endocrine System: “Who’s in Control Here?”

By: Mr. Carroll and
Mrs. Guyer

What is the Endocrine System?

- A system of glands that helps the body function.
- It contains a group of glands that release hormones into the body.

Various Parts of the Endocrine System

- Pituitary Gland
- Thyroid Gland
- Parathyroid Gland
- Pancreas Gland
- Adrenal Gland
- Reproductive Glands
 - Ovaries
 - Testes

Pituitary Gland

- This gland is located at the base of your brain.
- It’s called the “Master Gland.”
 - It controls the growth of your whole body.
- It secretes a hormone called ACTH which controls almost all your other glands.



Parathyroid Gland

- *This gland is located in the neck.
- *It controls the calcium levels in your body.
- *It secretes the hormone called parathyromone which is necessary for normal bone growth.



Thyroid Gland

- This gland is located near the voice box.
- It controls how fast your body uses energy which controls your weight.
- It secretes the hormone thyroxin which controls the rate at which your body burns and uses energy.

Appendix B, page 2

Adrenal Gland

- This gland is located at the top of your kidneys.
- It controls the rate at which your heart beats and your breathing due to being frightened or nervous.
- It secretes the hormones cortisone and adrenaline which increases your heartbeat and breathing when your frightened or nervous.



Pancreas Gland

- This gland is located near your liver.
- It helps control the amount of sugar in your body.
- It secretes the hormone insulin which controls the level of sugar in your body.

Reproductive Glands

- Female gland: Ovaries
 - It is located in the lower abdomen of females
 - It controls maturation and pregnancy.
 - IT secretes the hormone estrogen which controls voice and body changes.

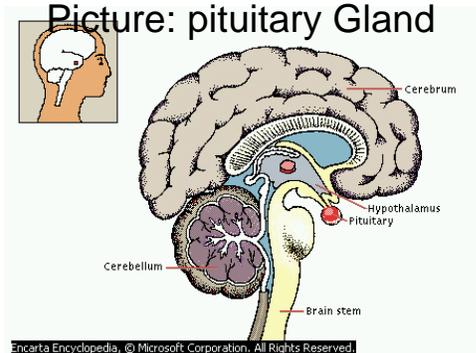


Reproductive Glands (cont.)

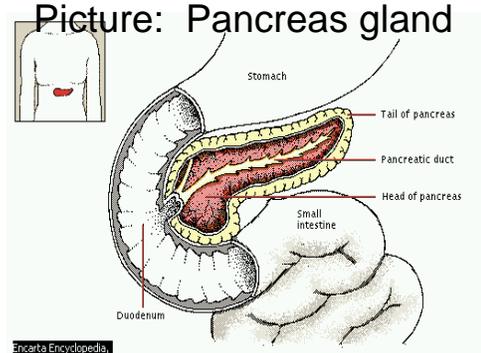
- Male Gland: Testes
 - This gland is located outside of the body of males.
 - It controls maturation and male characteristics.
 - It secretes the hormone testosterone which controls voice change and hair growth.



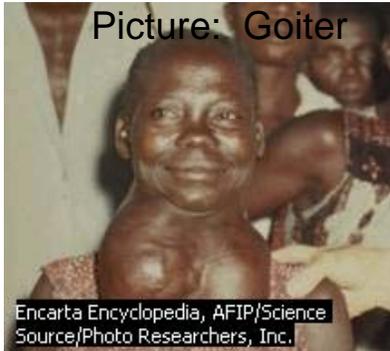
Picture: pituitary Gland



Picture: Pancreas gland



Appendix B, page 3



Picture: Gigantism



In a Nut Shell



- The Endocrine System includes glands and body tissue that control, secrete and produce hormones to make your body function the way it does.
- If the organ and hormones do not produce the regulated amount of chemicals to your body, it may result in an abnormality to your body.

Appendix C, page 1

Name:

Date:

Key Vocabulary Endocrine Unit

Please define each of the following words. Spelling counts.

1. **Endocrine system** –

2. **Hormones** –

3. **Glands** –

4. **Endocrine glands** –

5. **Exocrine glands** –

6. **Pituitary gland** –

7. **Thyroid gland** –

8. Parathyroid gland –

9. Pancreas gland

10. Adrenal gland –

11. Ovaries –

12. Testes –

Appendix D, page 1
Sample T-Notes

Name:
Date:

ENDOCRINE UNIT

INTRODUCTION TO ENDOCRINE SYSTEM

Endocrine	<ul style="list-style-type: none">• it is a system of glands• it chemically controls the functions of cells, tissues, and organs through secretion of hormones. It includes 7 – 8 glands glands produce and deliver their chemical products directly to the blood stream
hormones	<ul style="list-style-type: none">• they are the chemical products
glands	<ul style="list-style-type: none">• produce and secrete hormones• failure can result in serious illness• failure can result in death• 2 kinds: ductless – ducts
endocrine glands	<ul style="list-style-type: none">• ductless• secrete hormones directly into the bloodstream without passing them through a tube or “duct”
exocrine gland	<ul style="list-style-type: none">• has ducts• secrete substances onto the surfaces of the body tissues through ducts• IE – salivary glands, pancreas, and sweat glands
transportation	<ul style="list-style-type: none">• the movement of hormones through the blood stream to cells with out ducts
hormones	<ul style="list-style-type: none">• control body functions (how parts work)• regulates levels of substances in the body and blood stream so there isn’t too much or not enough)• controls growth• pituitary controls all glands and all hormones• pituitary tells all other glands to “get to work” send hormones out

Appendix D, page 2

what hormones control	<ul style="list-style-type: none">• reproduction, hair growth or loss, maturation, voice changes, development, increase sweat, handle fear and excitement, growth, bone strength, and the rate sugar is burned.
Pituitary	<ul style="list-style-type: none">• located at the base of the brain• secretes hormones that controls all other glands, and hormones that regulate growth
Thyroid gland	<ul style="list-style-type: none">• located below the voice box in the neck• secretes a hormone that controls the rate at which the body burns energy and uses food or nutrients
Parathyroid gland	<ul style="list-style-type: none">• near the thyroid – in the neck area• controls the growth of bones, and the amount of calcium in your body
Pancreas gland	<ul style="list-style-type: none">• both a duct and ductless kind of gland• secretes hormone called insulin that regulates how the body uses sugar – glucose• when the pancreas does not produce enough insulin, a person may have an illness called diabetes it can be controlled• located between the kidneys
Adrenal glands	<ul style="list-style-type: none">• located on the top of each kidney• secretes a hormone call adrenaline, especially when a person is frightened or angry or nervous, causing rapid heartbeat and breathing.
Ovaries	<ul style="list-style-type: none">• female reproductive; controls maturation and reproduction in females including voice change, breast growth, menstruation, and hair (puberty to old age)• located inside the body of the lower abdomen
Testes	<ul style="list-style-type: none">• located outside the body of the lower abdomen• male reproductive; controls maturation and reproduction in males including voice change, hair, muscle development (puberty to old age)

Appendix E
Location, Location, Location

Name _____

Date _____

Appendix F
Location, Location, Location

Name _____

Date _____

Appendix G
THE GLANDS OF THE ENDOCRINE SYSTEM AND THE MAJOR ORGANS OF THE
BODY-PUTTING IT ALL TOGETHER

Name _____

Date _____

Use the color key code to color in the organs
And glands listed below:

1. HEART-----purple
2. THYMUS GLAND-----orange
3. PARATHYROID GLAND-----pink
4. THYROID-----brown
5. PITUITARY GLAND-----turquoise
6. PINEAL GLAND-----light brown
7. ADRENAL GLAND-----red
8. PANCREAS-----light green
9. OVARIES-----yellow
10. TESTES-----dark green
11. BRAIN AND SPINAL CORD----gray
12. TRACHEA AND BRONCUS----blue
13. LUNGS-----light blue
14. STOMACH-----green
15. KIDNEYS-----light purple

Appendix H
Location, Location, Location QUIZ

Name _____

Date _____

Appendix I

LOCATION BINGO

G	L	A	N	D

G	L	A	N	D

Appendix J, page 1

LOCATION BINGO TEACHER INFORMATION

TEACHERS PLEASE NOTE: You may use this information sheet or make game cards to play *Location Bingo* with your students.

Game cards may be nice for students to use as callers.

Instructions for the game: Read a clue or definition, (the answer is included) to the students. They are to cover the word on their *Location Bingo* cards they feel matches the clue or definition you have read. Keep the clues in order so children can read back their answers to you. Because the *Bingo* cards are not perfect squares, bingo can only happen horizontally or as a blackout.

When students have a bingo they should call out GLAND!

Pituitary gland – Located near the base of the brain. Master Gland that controls all other glands and their functions.

Thyroid gland – Located below the voice box. This gland's hormone controls the rate at which the body burns energy and uses nutrients.

Parathyroid – It is in the neck area near the thyroid gland. Calcium makes bones strong, and this gland controls the amount of calcium in your bones and how they grow.

Pancreas – It is located between the kidneys. This gland's hormone, insulin regulates how the body uses glucose.

Adrenal gland – These are located at the top area of the kidneys. Adrenaline flows when you are scared, nervous, or angry from this gland.

Ovaries – These glands are located inside a female's body. These are the reproductive parts of females.

Testes – These glands are located outside the male's body. These are the reproductive parts of males.

Endocrine – The overall system of glands that are located throughout the body.

Exocrine glands – These have ducts and include sweat glands, salivary gland. They are located in various parts of the body some are near the pancreas.

Duct – These are the exocrine glands.

Ductless – These are the endocrine glands.

Pancreas – It is located between the kidneys and has the adrenal on it. It is an organ.

Appendix J, page 2

Reproductive – These are located in the abdomen area of both men and women. The ovaries are inside the female’s body; the testes are the external parts of a male’s anatomy.

Master gland – It is located in the base of the brain. It is called the pituitary gland.

Hormones – Hormones are in all of the glands. Some travel through out the body in the bloodstream or are excreted through ducts.

Chemical products – (see hormone) these are hormones.

Sweat glands – Part of the exocrine system located under arms, behind knees, forehead, (almost all parts of the external organ called the skin).

Female – Also known as the ovaries these are located inside the female’s abdomen.

Male – Also known as the testes these are located inside the male’s abdomen.

Blood – All over our bodies, the transportation system for many hormones.

Appendix K
Rubric for Oral Presentation of Rap, Story, or Poem

	Advanced ()	Proficient ()	Partially Proficient ()	Unsatisfactory ()	Score
Organization	Presentation is organized, flows well, & all group members obviously understood their part and did their part – rap sung, story or poem done in interesting way	All members participate, some parts may not flow with other parts, the song/poem or rap was practiced	1-2 members obviously did not participate or did not practice – presentation doesn't flow	Presentation is not practiced – 1-2 members carry the presentation – it is obvious all members did not participate	
Content	Provided in depth coverage of the topic – includes key vocab. and all parts/functions the Endocrine System	All key vocab. is included, 1-2 parts or functions may be vague – all parts included	1-2 key vocab. and/or 1-2 parts of the endocrine system is missing or unclear	Some work is done, but many key vocab. words or parts are missing – the presentation is disjointed	
Style	Presentation was creative – it was easy to teach the class and for the class to learn – class responded enthusiastically	The information was presented in an interesting way, the class was able to learn the song, rap or poem – they liked it	The class had a difficult time learning the poem, story or rap – they were frustrated	The story, poem or rap was very difficult for the class to learn – or for the group to teach – the group was not prepared	
Grammar/Mechanics	The written component met all criteria – it was clear what part each member had – very few if any mistakes	The written part was turned in all members /jobs were included – 1-2 criteria or mistakes were made	The written part had mistakes – or some members of the group did not clearly identify what they did	The written portion was poorly done, filled with mistakes – some members clearly did not participate	
TOTAL SCORE (OF ____ POSSIBLE)					

Appendix L

“GLANDS AT WORK” WORKSHEET

Name _____

Date _____

1. Draw a line from the name of the gland to its picture.
2. Draw a line from the picture of the gland to its function.

Gland	Function
thyroid●	●controls other glands and body growth
pituitary●	●controls the amount of calcium in your blood
parathyroids●	●controls how fast your body uses energy
adrenals●	●helps the immune system fight infection
thymus●	●affects the kidneys and helps the body react to emergency situations
ovaries●	●controls the body's level and use of sugars
pancreas●	●produces changes in the female body
testes●	●produces changes in the male body

Appendix M

Rubric for Essay, Paragraph, and Report

	Advanced ()	Proficient ()	Partially Proficient ()	Unsatisfactory ()	Score
Organization	<p>***In depth topic sent. addresses prompt or topic & includes key words – highly interesting</p> <p>*** Reasons, details, and facts strongly support topic sent.</p> <p>*** Affective examples & elaboration used</p> <p>***Strong conclusion</p>	<p>*** Topic addresses prompt uses key words</p> <p>*** Reasons details and facts are clear</p> <p>*** Transitions used</p> <p>*** Good examples and explain details and facts</p> <p>*** Solid conclusions</p>	<p>** Attempts topic sentence</p> <p>** Need more details or facts</p> <p>** Reasons, details and facts don't support topic or are confusing</p> <p>** Few weak examples (no reds to support topic)</p> <p>** Weak conclusion – mostly repeats topic sentence</p>	<p>*** topic sentence doesn't match paragraph or is missing/unclear</p> <p>*** reasons, details, facts unclear, not related / off topic</p> <p>*** no transitions</p> <p>*** no examples or explanations of details and facts</p> <p>*** no/ or incorrect conc.</p>	
Content	<p>*** Quality and quantity of information educates or entertains the reader</p> <p>*** Intriguing or highly interesting examples to support facts and details</p> <p>*** Fully develops prompt</p>	<p>** All information relates to the topic statement</p> <p>** Examples and explanation support details and facts/helps the reader understand the info.</p> <p>** Clearly addresses the</p>	<p>** Information wanders or repeats</p> <p>** Few examples or very little explanation</p> <p>** Details or facts NOT explained</p> <p>** Accurate, but prompt not developed</p>	<p>*** not enough information or info. unclear</p> <p>*** examples inaccurate, confusing, or omitted</p> <p>*** off prompt or no clear connection to prompt</p>	
Style	<p>*** A variety of sentence structures (simple, compound, complex)</p> <p>*** RICH words, good vocab, good word choice, use figurative lang.</p> <p>*** Style of parag. uses specific words and sent. structure that reflect purposes</p>	<p>** At least 2 different sent. structures (compound, simple, complex), variety in way sent. begin</p> <p>** Familiar/ordinary words fit the topic sent. uses descriptive words effectively</p> <p>** Style of parag. answers the prompt</p>	<p>** 1-2 fragments or run-on sent.</p> <p>** Basic words/boring word choices</p> <p>** Style of parag. fits the purpose, but is not developed</p>	<p>*** MANY fragments or run-ons</p> <p>*** several short choppy sent.</p> <p>*** repeated words or phrases</p> <p>*** no clear purpose in writing</p>	
Grammar/Mechanics	<p>*** Very few errors in capitalization, usage, punctuation, spelling</p>	<p>** Some errors, but they do not interfere with the understanding of the material/writing</p>	<p>** Several errors that SLOW down the reader, make reading difficult</p>	<p>*** Filled with errors that INTERFERE with reading, can't understand the writing</p>	
TOTAL SCORE (OF _____ POSSIBLE)					

Appendix N

Who is in Control Here? Who helped figure it out?

Scientist Fact Sheet

1. **Sir Frederick Grant Banting** – Born 1891 and died 1941 in a plane crash on his way to England to take a job during WWII. He was born in Alliston, Ontario, Canada. Won the Nobel laureate (International Prize for Medical Research) in 1922 when he and another scientist, Charles Best, founded pancreatic hormone insulin to treat diabetes. He was a physician, physiologist, and a researcher. He was made Knight of the British Empire in 1934. In 1922 while working at the University of Toronto, in the laboratory of a physiologist John James Richard Macleod and with the assistance of Charles Best made the dramatic discovery of insulin. He won the Nobel Prize for his discovery and they also awarded it to Mcleod, but Sir Banting didn't feel that Mcleod should get the award. He therefore shared his share of the award (\$\$) with Charles Best. Otherwise Mcleod got half of the money awarded and Charles Best and Banting shared the other half.
2. **Charles Herbert Best** – Born 1899 died 1978. He was a physiologist and Nobel laureate, who discovered the pancreatic hormone insulin that is used to treat the disease diabetes. He co-discovered insulin with Sir Francis Banting (see above). In 1932 he established the Banting-Best Department of Medical Research at the University of Toronto after Sir Francis had died.
3. **Percy Lavon Julian** – Born in 1899, he was the grandson of a former slave. He died in 1975. He was a student, a professor and a researcher. One day he found a water leak in a tank of soybean oil and created a strange byproduct. This turned out to be used to manufacture the male and female hormones. His most famous discovery was finding a way to make the hormone cortisone. This hormone was found to treat rheumatoid arthritis, which is a very painful illness. Natural cortisone had to be made from the adrenal glands of oxen and cost hundreds of dollars per drop. Julian's discovery lowered the price of the hormone to pennies per ounce. He earned over 100 chemical patents and many awards.

Appendix O
Rubric for Who Helped Figure IT Out? Stamp Project

	Advanced ()	Proficient ()	Partially Proficient ()	Unsatisfactory ()	Score
Organization	the stamp looks like a real stamp – It is attractive and well organized with all required components	The stamp is missing 1-2 components or doesn't have all important info. about scientist	3-4 components are missing, stamp is not well organized	too many missing components – it does not look like a real stamp at all	
Content	All important info. on scientist is depicted with symbols or pictures – very few words are used	stamp has too many words – not enough symbols or pictures used – all info included but looks a bit cluttered	too many words used, not enough symbols or pictures used – not completely thought out	more words than pictures or symbols used – unclear what symbols may mean	
Style	very neat and colorful – creative and well developed – symbols make sense	neat – colorful, but symbols or pictures meaning may be a bit confusing or unclear	messy – symbols or pictures unclear – difficult to understand their meaning	work appears rushed, not thought out – symbols and pictures are very difficult to understand	
Grammar/ Mechanics	very neat – very, very few mistakes	1-2 mistakes	man mistakes make it hard to understand meaning of symbols or what they are	very disorganized, messy or words spelled wrong or symbols hard to decipher	
TOTAL SCORE (OF ____ POSSIBLE)					

Appendix P

THE ENDOCRINE SYSTEM

Name _____

Date _____

Appendix Q, page 1

Name:

Date:

Taking Control of the Endocrine System – Assessment

- In one or two sentences, define and explain completely the job of the endocrine system.
- Which hormone helps you react when you are excited, frightened or nervous?

- Which of the following hormones regulates (controls) the level of sugar in the blood?
 - adrenaline
 - insulin
 - testosterone
- Explain the two major differences between the endocrine and exocrine systems.
- Match the gland with its approximate location in the human body.

_____ pituitary	a. top of the kidneys
_____ pancreas	b. below the voice box
_____ testes	c. at the base of the brain
_____ thyroid	d. in the neck
_____ parathyroid	e. lower abdomen, male
_____ adrenal glands	f. lower, abdomen, female
_____ ovaries	g. between the kidneys
- Which gland, also known as the Master Gland, produces hormones that control other glands, regulate growth, and balance the amount of water in the body?
 - pituitary
 - pancreas
 - thyroid
 - adrenals
- Which gland is responsible for production of hormones that are necessary for normal bone growth and for regulating (controlling) the calcium level in the body?
 - thyroid
 - parathyroid
 - pituitary
 - ovaries

Appendix Q, page 2

8. Which gland is responsible for producing hormones that help females mature?
- | | |
|------------|------------|
| a. testes | b. thyroid |
| c. ovaries | d. thymus |
9. A _____ is a tissue or organ that produces and secretes hormones to all cells of the body.
10. _____ are chemical products made in the glands which help the body work properly.
11. List all seven glands of the endocrine system: _____,
_____, _____, _____,
_____, _____, _____.
- EXTRA CREDIT: Name the eighth gland _____
11. Name one of the key scientists we discussed and what they discovered.
12. Name the two ways that hormones move through the body.
13. Tell me four changes that happen because of hormones in your body.
14. Tell me two dysfunctions (problems) that happen when a hormone or gland does not work properly. Identify the gland or hormone causing the problem.

Appendix R, page 1

KEY

Name:

Date:

Taking Control of the Endocrine System – Assessment

1. In one or two sentences, define and explain completely the job of the endocrine system.

A system of glands. Its chemicals control the functions of cells, tissues, organs by secreting hormones. There are seven glands—ducts and ductless.

2. Which hormone helps you react when you are excited, frightened or nervous?

adrenalin

3. Which of the following hormones regulates (controls) the level of sugar in the blood?

a. adrenaline b. insulin c. testosterone **(insulin)**

4. Explain the two major differences between the endocrine and exocrine systems.

Exocrine has ducts endocrine secretes hormones directly into the blood stream – it is ductless

5. Match the gland with its approximate location in the human body.

C	pituitary	a.	top of the kidneys
G	pancreas	b.	below the voice box
E	testes	c.	at the base of the brain
B	thyroid	d.	in the neck
D	parathyroid	e.	lower abdomen, male
A	adrenal glands	f.	lower, abdomen, female
F	ovaries	g.	between the kidneys

6. Which gland, also known as the Master Gland, produces hormones that control other glands, regulate growth, and balance the amount of water in the body?

a. pituitary c. thyroid **(pituitary)**
b. pancreas d. adrenals

7. Which gland is responsible for production of hormones that are necessary for normal bone growth and for regulating (controlling) the calcium level in the body?

a. thyroid b. pituitary **(parathyroid)**
c. parathyroid d. ovaries

Appendix S

Putting IT All Together Project Rubric

Advanced ()	Proficient ()	Partially Proficient ()	Unsatisfactory ()	Score
traced body of person close to child's own size – glands to scale – in proper location	Organized, glands may not be to scale or 1-2 seem to be in wrong locations or close to proper location	body traced is misshapen – glands are not to scale (body too large/glands too small)	body not traced to size, glands in wrong place or missing – glands not large enough or small enough	
all glands correctly labeled with correct information about the gland -, maybe a key used – very detailed	All information is given – 1-2 criteria or information may be unclear or missing	more than 2 parts missing – some explanation missing	glands are labeled, but lots of explanation may be missing	
All directions followed – all glands drawn to scale – all glands in correct location – glands clearly labeled/function explained	1-2 criteria missing	3 –5 criteria missing or project very difficult to understand	project done, but lots of details or criteria missing	
very neat, colorful, attractive to look at easy to read	neat, colorful, well written 1-2 spelling errors may exist	bit messy – labeling may be hard to read – color still used	very messy, labeling difficult to read, no color used	
TOTAL SCORE (OF ____ POSSIBLE)				

	Organization	Content	Criteria Met	Neat/Colorful	
--	---------------------	----------------	---------------------	----------------------	--