**Summary:**
The curricula developed for use with the StepStone software provides a motivating and engaging learning environment. Specific details for using the software are provided in an accompanying “StepStone How-To” document.

The stress module covers the concepts of the nervous system, the endocrine system, homeostasis, and feedback mechanisms. Students will have the opportunity to guide their own learning through a variety of “learning objects” intended to provide critical thinking about and application of required science standards.

**Keywords:** axon, brain stem, central nervous system, cerebellum, cerebrum, dendrite, effector, gland, homeostasis, hormone, negative feedback, neuron, peripheral nervous system, positive feedback, reflex, set point, soma, stimulus, synapse

**Subject TEKS:**

* 7.12 (B) identify the main functions of the systems of the human organism, including the circulatory, respiratory, skeletal, muscular, digestive, excretory, reproductive, integumentary, nervous, and endocrine systems
* 7.13 (A) investigate how organisms respond to external stimuli found in the environment such as phototropism and fight or flight; and (B) describe and relate responses in organisms that may result from internal stimuli such as wilting in plants and fever or vomiting in animals that allow them to maintain balance.
* Biology 4 (B) investigate and explain cellular processes, including homeostasis
* Biology 10 (A) describe the interactions that occur among systems that perform the functions of regulation, nutrient absorption, reproduction, and defense from injury or illness in animals
* Biology 11 The student knows that biological systems work to achieve and maintain balance.

**NGSS:**

* MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
* LS1.D: Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories.

**Grade Level:** 6th - 8th

**Learning Objectives:**

1. Identify the structures of the nervous system
2. Describe the main functions of the nervous system
3. Investigate how organisms respond to internal and external stimuli
4. Identify the structures of the endocrine system
5. Describe the main functions of the endocrine system
6. Describe how organisms maintain balance in stable internal conditions in response to external and internal stimuli.

**Time Required:** will vary depending on lesson implementation and learning objectives chosen

**Materials:**

* Computers or tablets with internet access
* Brain Hemisphere Hat:
	+ Pattern pages printed on cardstock
	+ Tape
	+ Glue
	+ Markers, colored pencils, or similar
* Build Your Own Brain:
	+ Modeling clay in various colors
* Pipe Cleaner Neuron:
	+ Pipe cleaners of various colors
	+ Cardstock
	+ Markers
* Stress and Homeostasis Lab:
	+ Stop watch
	+ Temporal thermometer
	+ Calculator
	+ Homeostasis Math Challenge worksheet

**Background and Concepts for Teachers:**

Nervous System

The nervous system is an organ system containing a network of specialized cells called neurons that coordinate the actions of an animal (people included) and transmit signals between different parts of its body. It coordinates the body’s communication with our brain and vice versa.

The nervous system has two components: the central nervous system and the peripheral nervous system. The central nervous system consists of the brain and spinal cord. The brain is divided into two, identical hemispheres and has four different lobes based on general regions of functions. These four lobes make up the cerebrum portion of the brain. The other, smaller portion of the brain is the cerebellum, which involves controlling and planning motor movements. The basic unit of the brain is the brain cell, or neuron. It has three parts: dendrites that look like branches and receive chemical messengers called neurotransmitters, the soma which is the body of the cell and houses the organelles, and the axon which sends electrical signals onwards to other neurons by releasing its own neurotransmitters. These connections between axons to dendrites are how neurons communicate with one another.

Neurons do not undergo mitosis so damaged or dead neurons are not replaced. The spinal cord is the main pathway for information to travel to and from the brain. The spinal cord is made of long bundles of neuron axons.

The peripheral nervous system is composed of all the cranial and spinal nerves that run throughout the body. They collect sensory information from the body and send it to the brain via the spinal cord for processing.

Endocrine System

The endocrine system assists in the regulation of many body functions including growth and development and reproduction. It does this by releasing chemical messengers called hormones produced in glands.

Eight glands make up the endocrine system. The hypothalamus receives signals from the receptors located on the target organs and stimulates the pituitary gland (often called the “master” gland) to release hormones. Although the hormones circulate throughout the body, each type of hormone is targeted toward certain organs and tissues. Additionally, the endocrine system receives help from organs such as the kidney, liver, heart and gonads, which have secondary endocrine functions.

Homeostasis and Feedback Mechanisms

Homeostasis is the steady, life-maintaining conditions inside an organism, despite changes in its environment. The nervous and endocrine systems are control centers that play a vital role in maintaining homeostasis. When balance is not maintained disease or death can occur.

The nervous and endocrine systems have specific mechanisms to regulate homeostatic variables (temperature, blood sugar, etc.) called feedback loops. Negative feedback opposes changes in variables from their target values, or set points. This system acts to return a variable to its set point. For instance, when the temperature rises because of a hot day we produce sweat which will cool us down; the response was to lower the temperature to balance out the deviation of a rising temperature. Positive feedback amplifies a starting signal. The best example of positive feedback is childbirth. When labor begins, a hormone called oxytocin is released, oxytocin causes more contractions which again releases more oxytocin. This culminates in stronger contractions closer and closer together that ultimately help deliver the baby.

**Vocabulary / Definitions:**

* Axon: neuron structure that carries messages away from the cell body or soma.
* Brain stem: connects the brain to the spinal cord and is made up of the midbrain, the pons, and the medulla.
* Central Nervous System: division of the nervous system made up of the brain and spinal cord.
* Cerebellum: part of the brain that controls voluntary muscle movements, maintains muscle tone, and helps maintain balance.
* Cerebrum: the largest part of the brain where memory is stored, movements are controlled, and impulses from the senses are interpreted.
* Dendrite: neuron structure that receives messages and sends them to the cell body.
* Effector: an organ or cell that acts in response to a stimulus.
* Gland: an organ which produces and releases hormones that perform a specific function in the body.
* Homeostasis: regulation of an organism’s internal, life-maintaining conditions despite changes in its environment.
* Hormone: Two or more different types of tissue working together to perform a specific function
* Negative Feedback: processes that act to oppose the stimulus, or cue, that triggers the response
* Neuron: basic functioning unit of the nervous system, made up of a cell body, dendrites, and axons.
* Peripheral Nervous System: division of the nervous system, made up of all he nerves outside the CNS; connects the brain and spinal cord to other body parts.
* Positive Feedback: processes that amplify the initiating stimuli; they move the system away from its starting state
* Reflex: automatic, involuntary response to a stimulus; controlled by the spinal cord.
* Set Point: the normal value of a physiological variable such as temperature, glucose level, blood pressure, etc.
* Soma: cell body; non-process portion of a nerve cell
* Stimulus: any internal or external change that brings about a response.
* Synapse: small space across which an impulse moves from an axon to the dendrites or soma of another neuron.

**Lesson Introduction / Motivation:**
Students begin by taking the “pre-test” in order to assess their current knowledge and understanding. This may also enable students to recognize concepts about which they would like to learn more or to which they need to pay particular attention.

The student-centered design of this module allows for multiple introduction/motivation activities. Students may begin the unit on their own by reading the “Meet a Scientist” biography or “Backpack Adventure” stories or by watching one or more “Scientist Videos”. Each of these learning objects provide students with insights into the history or application of the nervous system, endocrine system, and homeostasis as they relate to stress and should motivate students to dig deeper into required standards presented/studied later. These learning objects also contain processing questions, which can be answered and shared in class or in an on-line portfolio such as Google docs.

Alternately, teachers could introduce the module to her class by having students watch this short video of a tightrope walker crossing a gorge (<https://youtu.be/UEnkN939ZLw> ). Have students brainstorm and list all the things the tightrope walker had to do to maintain balance. Give students about 5 minutes to list how a tightrope walker maintains balance and then share ideas with the entire class. Use these ideas to introduce the concept of homeostasis and how many of our body systems must work together to maintain an internal balance. This activity incorporates the student-centered classroom philosophy, as students will be developing ideas and theories on their own as the teacher facilitates the activity.

**Exploration/Explanation:**
Students should next examine the required concepts (standards) of homeostasis, the nervous, and endocrine systems. Setting up classroom stations can promote student collaboration, problem solving, and critical thinking. Stations also provide students with a common base of experiences. These stations may include any or all of the following learning objects:

* *Essential Knowledge* – students use various types of note outlines to record information about required content from an interactive video presentation. Students can then compare and discuss their notes to ensure key concepts were obtained.
* *Backpack Adventures* – students read (independently or as a read aloud) a fictional story with factual content about key concepts and individuals related to homeostasis. Students can then answer questions, create timelines, compare fact vs. fiction, or perform other related activities to reinforce required concepts.
* *Meet a Scientist* – students read (independently or as a read aloud) a short biography about a scientist instrumental to the understanding of the impact of stress on the human body system. They will then answer questions relating to the scientist and his/her work. Students could also be asked to role-play and describe how they would have solved the problem/answered the question facing the scientist. Additionally, students could ask additional questions they have about stress, homeostasis, or the endocrine and nervous systems after reading about the scientist’s work.
* *Scientist Videos* – students learn how real scientists study the impact of stress on the body systems in various short videos describing research, careers, or other aspects of the field. Students will then answer questions and/or discuss how concepts they learn in class are applied in the real world.
* *Real Science Review* – students read an actual research article related to stress (edited to middle school readability) and then review it using the scientific method as scaffolding. For instance, students will be asked to identify the hypothesis, data collection methods, relevance, etc.
* *Practice* – students can choose various on-line activities to gain or reinforce knowledge about homeostasis, the nervous and endocrine systems. Activities include videos, matching/labeling games, flashcards, mnemonics, quizzes, etc.

Another option for utilizing this module is to have students choose either “Backpack Adventures”, “Meet a Scientist”, “Scientist Videos”, or “Real Science Review” and complete (read/watch and answer questions) accompanying activities at home. They would journal on paper or through an on-line portfolio such as Google Docs about three main ideas, provide three vocabulary words and definitions, and construct three questions. As a class or in small groups students would share information and use it to complete: note outlines, practice activities, or other class activities (see “Elaborate” section).

**Elaborate:**

* Stress and Homeostasis Lab - Students will document the effects of physical and mental stress on their body systems. (see accompanying handout for complete instructions)
* Brain Hat – students will create a paper hat model of the brain in order to better understand the structure and function of each part. (see accompanying handout for complete instructions)
* Build Your Own Brain – students will create a clay model of the brain in order to better understand the structure and function of each part.
* Pipe Cleaner Neuron - students will create a pipe cleaner model of a neuron in order to better understand the structure and function of each part.

**Assessment/Evaluation:**

The Stress Module includes a post-test, which can be used for an overall learning assessment. Other opportunities for assessment include student output at any of the learning object stations, journaling requirements as detailed in the “Explore/Explain” section above and/or any of the “Elaborate” activities. Additional assessment opportunities include:

* Brain Diagram – students will color and label the parts of the brain.
* Endocrine System Crossword Puzzle – students will complete a crossword puzzle to demonstrate their understanding of the endocrine system.
* Homeostasis Worksheet – students will identify whether negative or positive feedback is occurring in each scenario
* Nervous System Concept Map – students will describe the structure of the nervous system by completing the concept map.

Please email us your comments on this lesson:
E-mail to cvmpeer@cvm.tamu.edu
Please include the title of the lesson and what grade level to which the lesson was applied.