HIGH SCHOOL LIFE SCIENCE: SYSTEMS AND ORGANIZATION

Standards Bundle

Standards are listed within the bundle. Bundles are created with potential instructional use in mind, based upon the potential for related phenomena that can be used throughout a unit.

HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. (SEP: 2; DCI: LS1.A; CCC: Systems) [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] *[Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.]*

HS-LS1-3 Plan and carry out an investigation to provide evidence that feedback mechanisms maintain homeostasis. (SEP: 3; DCI: LS1.A; CCC: Stability/Change) [Clarification Statement: Examples of investigations could include heart rate response to exercise, stomatal response to moisture and temperature, and root development in response to water levels.] *[Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.]*

HS-LS1-4 Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. (SEP: 2; DCI: LS1.B; CCC: Systems) [*Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.]*

Content Overview

This section provides a generic overview of the content or disciplinary core ideas as an entry point to the standards.

Organisms range from one cell to many cells. Multicellular organisms arise from one cell producing two identical cells through the process of mitosis. The multiple cells produced must differentiate by manipulating genes to form the many different tissues with specific functions to make it more cost-effective to carry on the processes of life. These tissues comprise organs. Organ systems depend on each other. New cells must be made as an organism grows or to replace those that are damaged or die. Maintaining a stable internal environment in light of an ever-changing internal and external environment depends on systems of feedback mechanisms. These mechanisms can encourage (positive feedback) or discourage (negative feedback) what is going on inside an organism.

Phenomena

Phenomena can be used at varying levels of instruction. One could be used to anchor an entire unit, while another might be more supplemental for anchoring just a unit. Please remember that phenomena should allow students to engage in the SEP and use the CCC/DCI to understand and explain the phenomenon.

- Cross-section slides or photomicrographs of organs showing several different tissues.
- A cut heals forming skin cells and not muscle cells.
- When muscle cells work hard, heart rate and breathing rate increase.

- When blood sugar is low, people get hungry.
- Cells from different tissues have the same genetic makeup.
- Individuals with Marfan's syndrome often have weakened aortas.
- Arteries have elastic tissue in their walls.
- Individuals who exercise can eat more without gaining weight.
- The contractile vacuole of a paramecium has a faster rate when it's in fresh water.
- When a person gets hot, they sweat, and blood vessels dilate.
- Dogs pant when they get hot.
- Pathologists look for undifferentiated cells in biopsies of tissues.
- When someone stands on their head, their blood pressure and heart rate fall.
- All cells in an organism are genetically, but not visually and functionally identical.
- Ingesting a lot of salty food can cause a rise in blood pressure and make someone thirsty.
- Organisms that are deficient in certain minerals will eat odd things to satisfy those mineral needs. This is referred to as pica. For example, individuals deficient in iron will crave dirt.
- Lifting weights can lead to muscle hypertrophy and low use can lead to atrophy.
- Plants close their stomata and wilt during dry hot conditions.
- Corn plant leaves curl up during drought-like conditions.
- Pregnancy contractions get stronger and stronger.
- Marine iguanas have salt buildup around their nostrils.
- Cloned animals don't look exactly like the "parent" organism.

Storyline

This section aims to decode not only the DCI connections but also the SEP and CCC in a detailed account of how they possibly fit together in a progression for student learning, including both rationale and context for the bundle.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations ● Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on	**LS1.A: Structure and Function** ● Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.	**Stability and Change** ● Feedback (negative or positive) can stabilize or destabilize a system.

types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. **Developing and Using Models** ● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. ● Use a model based on evidence to illustrate the relationships between systems or between components of a system.	● Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. **LS1.B: Growth and Development of Organisms** ● In multicellular organisms' individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism.	**Systems and System Models** ● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

In this standard bundle, students develop and use models to not only describe the functions of relevant parts of systems at different levels but also the relationships that the system has with other systems. These models are at different scales - from cells and tissues to organs and organ systems. It should focus on the interdependence at different levels. When working with models, students must keep in perspective the accuracy of such models.

Students carry out investigations on feedback mechanisms. These investigations look at how the body maintains stable environments when the environment is constantly changing. Carrying out these investigations requires students to determine the methods and procedures needed to collect reliable data. Students need to provide reasoning for the methods, tools to collect the data, and the accuracy of their methods.

Part of developing the knowledge of the hierarchical organization present in a living system is also knowing how those systems arise from one cell--by dividing and differentiating. Models can be used to illustrate and explain how daughter cells receive identical genetic information yet can become different cells and tissues with different functions. These models can also be used to show the relationships between the systems and levels, as well as homeostasis. Cell division is necessary to provide for the growth and repair needed to maintain a complex microorganism.

Formative Assessment

Formative assessment is crucial because all learners benefit from timely and focused feedback from others. It promotes self-reflection, self-explanation, and social learning. It can also make learning more relevant. Each of the questions below might be used throughout the formative assessment process. Specific

prompts may focus on individual practices, core ideas, or crosscutting concepts, but, together, the components need to support inferences about students' three-dimensional science learning as described in a given bundle, standard, or lesson-level performance expectation.

SEP Planning and Carrying Out Investigations

- Ask testable questions about how skin and muscle cells look different but are genetically identical.
- After watching the rate of a contractile vacuole in a paramecium, construct an explanation for why the rate increases when pure water is placed in its environment.
- Explain how to collect data that will determine if standing on your head affects heart rate.
- After reading accounts of individuals who have fallen through the ice and survived after being submerged for an extended time, identify variables that would be helpful to collect data on to further understand why the individuals survived.

SEP Developing and Using Models

- After performing two different models for mitosis, explain which one is better for explaining how two daughter cells are genetically identical.
- Create a model to show how a parent cell gives rise to daughter cells with the same number of chromosomes.
- Develop a model to show how malfunctioning cells in the pituitary gland have effects of bone and muscle cells in such diseases as gigantism.
- Create a model of a negative feedback (e.g., body temperature) mechanism properly labeling the effectors, control center, and sensors and showing how the body warms up and cools down.

CCC Stability and Change

- Present evidence to support your claim for what would happen when growth hormone is not regulated via a negative feedback loop.
- Why would the system to clot blood have to be finely regulated to not happen too easily or too slowly?

CCC Systems and System Models

- What are the consequences of malfunctioning nerve cells on muscle action?
- Explain what type of feedback loop is needed to regulate blood sugar levels citing evidence.
- A malfunction in what part of the body temperature feedback loop would cause the system to become unstable.
- Use the temperature feedback loop to predict what would happen if the body was covered in gold paint such as what happened in a James Bond movie.

Performance Outcomes

These are statements of how students use knowledge and are similar to the standards in how they blend DCI, SEP, and CCC, but at a smaller grain size. These are potential outcomes for instruction as it plays out in lessons and activities in the classroom. It is important to also think of these as smaller outcomes that build toward the larger goal of mastering the standards.

- **Explain** possible mechanisms causing cancerous tissues to have different *patterns* of growth than normal tissues.
- **Design an investigation** to test the *effects* of jumping jacks on several components of the temperature regulation system.

- From a **designed experiment** to determine the *effects* of different concentrations of salt water on regulating water content in lettuce cells. Identify the controlled variables, dependent, and independent variables.
- **Explain** from evidence the *similarities and differences* between lipid and cartilage cells from the same organism.
- **Develop a model** to show how the pancreas regulates blood sugar to include inputs and outputs that will raise and lower blood sugar.
- When **conducting an experiment** on the effects of putting your foot into ice water on heart rate, explain the reasoning for the pattern in heart rate you see.
- **Communicate** how adult cells from belly fat could potentially be used to produce and replace an injured knee ligament to restore *proper function*.
- **Engage in an argument** for which type of cell, cord blood stem cells or red bone marrow, would be best for a bone marrow transplant to *stabilize* a patient's immune system.