NGSS Support Guide

STC	**Human Body Systems**
	Grades 6-8

Background

In 2013 the Washington State Legislature adopted the *Next Generation Science Standards* as the 2013 Washington State Science Learning Standards. The *Next Generation Science Standards* are built upon a *"three-dimensional"* vision of science learning that exists at the intersection of the *Science and Engineering Practices*, the *Crosscutting Concepts*, and the *Disciplinary Core Ideas*. The Office of the Superintendent of Public Instruction established a multi-year transition timeline and plan to achieve full implementation by the Spring of 2018. Informed by this transition plan, regional LASER science materials centers decided to bring together experienced teachers to provide guidance to those who shared their instructional materials about how best to begin moving to this new paradigm of science learning while still using their existing instructional materials. This guide is one product of that work.

What this Guide Is

The writers of this guide want to help you put the kids in the driver's seat of engaging in science – a key shift in the *Next Generation Science Standards*. They intend this guide to provide you with ideas on how best to build student capacity to work as a scientist or engineer using the *Science and Engineering Practices*; on how best to think about the learning by engaging students in using the *Crosscutting Concepts*; and all while engaging in the content ideas that already exist within this instructional material.

This guide does not align this instructional material to the Next Generation Science Standards, but it assists teachers in aligning instruction and student experiences with the goals of the Next Generation Science Standards. **This guide does not** represent a re-write of the instructional material, neither does it present newly-developed material. It is meant to help you adjust your use of your existing unit toward a more "*three-dimensional"* approach to learning. It is strongly recommended that you have an understanding of the shifts envisioned by the NGSS by familiarizing yourself with the Framework for K-12 Science Education. If you would like more information on the Disciplinary Core Ideas that are the focus of the New Plants kit, please read Life Science Core Idea 1.A.

Directions for Using this Guide

Before teaching this unit, please refer to the NGSS Transition Support Guide to review the *Science and Engineering Practices* and *Crosscutting Concepts* for each investigation. The guide highlights what the teacher and student does in each investigation to support the *Science and Engineering Practices* and *Crosscutting Concepts* that are already implicit in the instructional materials. If you need support on using *Science and Engineering Practices* refer to Appendix F and for *Crosscutting Concepts* refer to Appendix G in the *Next Generation Science Standards.* For example, this kit in particular focuses a great deal on the Crosscutting Concept of Systems and Systems Models, and the Practice of Developing and Using Models. Teachers should review the information in the Framework and Appendices on these two dimensions. While every attempt has been made to make explicit connections to a *Practice* or *Crosscutting Concept* as a unifying theme for each part of the unit, some lessons deviate from the theme and emphasize different *Practices* or *Crosscutting Concepts*. This is noted by a change in the label, which is printed in bold.

Science and Engineering Practice
Developing and Using Models Develop a model to describe unobservable mechanisms.
Obtaining, Evaluating and Communicating Information Students are researching a disease or career of their choice.
Students evaluate the limitations of the model to replicate the process of breathing.

For example, in this unit, Developing and Using Models is the most explicit Practice that students are engaged with in learning the Core Ideas. However, in some lessons, other Practices (such as Obtaining, Evaluating and Communicating Information) are more closely aligned to the intent of the lesson. This is noted by a change in the practice, which is then printed in bold.

Heads-Up/Things you might need in order to use this guide

Before you teach this kit, it is important to recognize that a major misconception of middle school students is that the body contains cells, rather than the body being made up of cells. While this kit does not directly teach the concept of the composition of multicellular organisms, you will want to be cautious of emphasizing misconceptions that may already exist. The guide references the use of Page Keeley's Formative Assessment Probes for Uncovering Student Ideas in Primary Science (2011 NSTA Press). Check in your school or district science library, or contact your Science Materials Center for this resource. It is assumed that students are using science notebooks in middle school to organize their work. If you would like information of using science notebooks in the classroom, refer to the LASER Science Notebooking website at www.sciencenotebooks.org . Investigations have been adapted to include a written performance assessment. If you are unfamiliar with Claims-Evidence-Reasoning (CER) as a method for writing in science, please contact your Science Leadership teacher or Regional Science Coordinator. An engineering modification is suggested in Lesson 17. The suggested lesson plan can be found at the NSTA Learning Center website http://learningcenter.nsta.org/ .

For More Information

If you have questions about this guide or its content, please direct your inquiry to your science materials center, or Regional Science Coordinator.

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Publisher	Kit Title	Grade Level
STC	Human Body Systems	Middle School

***Formative Assessment Probe suggested for use with this Kit – 'Human Body' from Uncovering Students Ideas in Life Science, pg. 141. (Keeley, 2011).

Part 1	Classroom Instruction	Science and Engineering Practice	Crosscutting Concept	Helpful Modifications
The Digestive System	What the student does	**Developing and Using Models** Students develop models –based on evidence – of simple systems with certain and less predictable factors.	**Systems and Systems Models** Models can be used to represent systems and their interactions – such as inputs, processes and outputs – and energy, matter and information flows within systems.	Use the formative assessment probe suggested above prior to any instruction. Facilitate discussion with students on their responses – do not correct misconceptions yet. Students should keep in their notebooks and revisit periodically.
Lesson 1 – Human Body Mapping (Preassessment)	What the student does	Students use their prior knowledge in groups to develop an initial model of the human body.	Students are able to construct a definition of systems and connect this to prior knowledge of other systems (school systems, computers systems, cell phone systems).	Help students to extend their thinking by including the reflective question "Why did we organize the organs the way we did?" and/or "Describe how you decided where to place the organs in your model." Be sure not to correct initial models or definitions of systems. This lesson should not be graded, and should be used formatively to adjust your instruction based on student needs.
Lesson 2 – Moving Through the Digestive Tract	What the student does	Students are using the model of the digestive system with a focus on peristalsis. Students can use the model to describe how food moves along the digestive tract when it's held horizontally. They then can explore how this movement of food changes in a non-horizontal tract	Discuss the limitations of the model. (Tennis ball stays the same size the entire time.) How does the structure of the model relate to its function (straight digestive tract is not a direct model to human digestion).	Anchor the lesson using the driving question "What happens to food as it moves along the digestive tract?"

		(more closely modeling the human digestive tract).		
Lesson 3 – Exploring Carbohydrates	What the student does	Through the practice of **Conducting an Investigation**, students collect data to use as the basis for evidence to answer the question referenced to the right.	**Cause and Effect** Students can explore the effects of a low-carb or no-carb diet.	Use Fact-First-Questioning to stage the lesson: Why does the body need to convert starch into sugar? Use pg. 29 for students to gather text-based evidence to support their answers.
Lesson 4 – Digestion in the Mouth	What the student does	Through the practice of **Conducting an Investigation**, students should be able to use the model to describe the unobservable mechanism of chemical digestion.	Describe how the systems of chemical and mechanical digestion work together. Students can describe these systems in terms of inputs, processes and outputs and where there is overlap.	Use Fact-First-Questioning to stage the lesson: Why do we need to chew our food?
Lesson 5 – Digestion in the Stomach	What the student does	Students are engaged in the practice of **Conducting an Investigation**, but should be aware that they are modeling a phenomenon that cannot be observed.	Within the subsystem of the stomach, how do the components interact? Again, students can describe in terms of inputs (proteins) – process (gastric juices break down) and output (what is left).	Connection to Common Core Math 6.G - Solve real-world and mathematical problems involving area, surface area, and volume.
Lesson 6 – Diffusion and Active Transport	What the student does	After students have used the model of diffusion, ask them to brainstorm how they can use this model to predict what happens to food as it progresses through the digestive system.	Students can identify that the structure of the small intestine is related to its function, and that the small intestine is a small component of a larger system.	N/A

Lesson 7 – Surface Area and Absorption	What the student does	In this lesson, students are both **Using a Model** scientifically (modeling the inside of small intestine) but also Modeling with Mathematics – a practice of CCSS. Be sure to make this connection explicit.	Students can describe the small intestine in terms of its role as a subsystem of the digestive system. The concept of **Structure and Function** is also quite explicit in this lesson. Students can discuss how the structure of the small intestine aids in the function of absorption.	Connection to Common Core Math 6.G – Solve real-world and mathematical problems involving area, surface area, and volume.
Lesson 8 – Digestive System Assessment	What the student does	The assessment asks students to **Plan and Conduct and Investigation** using a Model of enzymes in the mouth.	Students can connect system by reflecting and describing why enzymes in the mouth are important as part of the digestive system.	N/A
Throughout Part 1:	What the teacher does	• Present an overarching question for the study in Part 1 (How does the digestive system support other systems in the body, for example?) • Teacher asks probing questions to facilitate interpretive thinking.	• Teacher provides a guiding question, asks probing questions of students throughout investigation and inquiry, and facilitates class discourse to deeply explore the topic of the digestive system and its subsystems. • Teacher uses the specific language of systems, i.e. system, subsystem or **substructure**, **function**.	• Leave the preassessment posters mounted on the wall throughout the unit – allow students to make changes periodically using sticky notes. • Use the reflective and anchor questions to have students construct a Claims-Evidence-Reasoning explanation for the overarching question (How does the digestive system support other systems in the body, etc?)

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Part 2	Classroom Instruction	Science and Engineering Practice	Crosscutting Concept	Helpful Modifications
The Respiratory and Circulatory System	What the student does	**Developing and Using Models** Develop a model to describe unobservable mechanisms.	**Systems and Systems Models** Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.	
Lesson 9 – Anchor Activity	What the student does	**Obtaining, Evaluating and Communicating Information** Students are researching a disease or career of their choice.	N/A	In the interest of time, this lesson can be skipped as it is not well integrated with the rest of this part. Alternatively, this lesson could be moved to the end of the unit as an ELA/Social Studies integration.
Lesson 10- Assessing Breathing Models	What the student does	Students evaluate the limitations of the model to replicate the process of breathing.	Students are able to determine which parts of their models correspond to the parts of the respiratory system.	
Lesson 11 –How Much Air Can You Exhale?	What the student does	Students are able to use the model of the lungs to make predictions about lung capacity and the factors that affect lung capacity.	Students are able to discuss how changes in lung capacity can affect their breathing. Certain inputs into the respiratory system can limit the capacity of lung output.	

Lesson 12 – Recipe for Energy – Cellular Respiration	What the student does	Students use the candle model to replicate the idea of 'burning' energy. Be sure to discuss explicitly the limitations of this model and how it relates to actual oxidation in the body.	**Energy and Matter** Students connect the idea of cellular respiration to the cycling of matter; energy takes the form of heat.	The key idea begins to take form that for the body to use food as energy, the food must be digested into molecules that are then absorbed and transported to cells.
Lesson 13 – Releasing Energy from Food	What the student does	Students will recognize that similar to other investigations, they are using the food in this lab as a model of food energy.	**Energy and Matter** Students are able to relate the energy intake to energy output.	'Calorie' is a source of many misconceptions for students. Be sure to spend adequate time drawing out students preconceived ideas of calories and building an agreed-upon definition as a class. Temperature probes are available for checkout from your SMC Center.
Lesson 14 – The Pumping Heart	What the student does	Students should use the model of the heart to predict the direction of the flow of blood through the heart based on structure of the heart, with particular attention to the arteries, valves and double-pump action.	**Structure and Function** Students are able to discuss the way an object is shaped often determines many of its properties and functions.	
Lesson 15 – Factors Affecting Heart Rate	What the student does	**Planning and Conducting Investigations** Students design the inquiry in small groups focused on one of the variables.	**Stability and Change** Conditions that affect the stability and the factors that control changes in heart rate should be discussed.	
Lesson 16 – The Heart Meets Resistance	What the student does	Students are again using a model of the heart to determine the effect of a narrower diameter tube on the performance of the cardiovascular system.	The model is used to understand and predict the behavior of the heart under constricting conditions. Students should be able to apply understanding of how this feedback affects the subsystem of the heart and the overall system of the human body.	

Lesson 17 – Assessment	What the student does	N/A	N/A	**Designing Solutions – Engineering Alternative Assessment** Use the 'No Ordinary Coronary' lesson plan from NSTA's Learning Center to have students apply their learning of the cardiovascular system to design a tool to clear a blocked artery and place a stint in a cardiac patient.
Throughout the investigation	What the teacher does	• Teacher is explicit about the use of modeling to explain unobservable phenomenon. • Teacher asks probing questions to facilitate interpretive thinking. • Teacher facilitates class discourse to relate components of the models to larger systems in the body.	• Teacher provides a guiding question, asks probing questions of students throughout investigation and inquiry, and facilitates class discourse to deeply explore the connections between the subsystems of the human body.	• Revisit the preassessment posters allowing students to make changes using sticky notes or other revisions. • Use the reflective and anchor questions to have students construct a Claims-Evidence-Reasoning explanation for the overarching question (How does the cardiovascular system support other systems in the body. Etc?)

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Part 3	Classroom Instruction	Science and Engineering Practice	Crosscutting Concept	Necessary Modifications
The Musculoskeletal System	What the student does	**Developing and using models** Create a model to describe and /or predict phenomena.	**Structure and Function** The way an object is shaped or structured determines many of its properties and functions.	
Lesson 18 – The Musculoskeletal System, An Overview	What the student does	Students should be able to draw comparisons between the chicken wing and the human arm, and be able to articulate the relationship between these two.	The structure of the chicken wing (and the human arm) is related to its function.	While it is important that students are able to identify the structures in the model, be sure to extend this thinking to how these structures relate to the function. Perhaps having students' documents in a T-chart or other graphic organizer.
Lesson 19- Joints and Movement	What the student does	Students are actually developing a model, as opposed to using a model. The key difference is that students are able to describe how the arm works in relation to the function of opposing pairs.	A strong indicator of understanding structure and function is the ability to relate to another example from a completely different study. Ask students where else they have seen opposing pairs operate to complete a task, or where else a hinge or pivot joint can be found outside the animal (human) body.	

Lesson 20 – Muscle Size and Strength	What the student does	**Analyzing and Interpreting Data** By analyzing the data, students should be able to answer the driving question "what is the relationship between muscle size and strength?"	Students are able to discuss the relationship of size to strength in terms of the structure and function of the arm muscles. Students should also be able to extend this thinking to other muscle groups in the body.	Force sensors may be available from your Science Materials Center for use in this lesson.
Lesson 21 – Exploring Muscle Fatigue	What the student does	**Analyzing and Interpreting Data** By analyzing the data, students should be able to answer the driving question "why do muscles experience fatigue? What might have to happen for the system to recover?"	**Systems and Systems Models** When a muscle experiences fatigue, what types of feedback are experienced by the system? How would one adjust the inputs to rebalance the system?	Focus the lesson by having students attempt to construct an explanation for the question "What is a cramp?"
Lesson 22- The Body in Balance	What the student does	Refocus on the practice of using a model, in this case to replicate the phenomena of homeostasis. Be sure to indicate the limitations of this model.	Apply the logic of analyzing homeostasis from the perspective of a system (input-process-output-feedback). Students should be able to discuss if the body is an open or closed system.	
Throughout the investigation:	What the teacher does	• Teacher is explicit about the use of modeling to explain unobservable phenomenon. • Teacher asks probing questions to facilitate interpretive thinking. • Teacher facilitates class discourse to relate components of the models to larger systems in the body.	• Teacher provides a guiding question, asks probing questions of students throughout investigation and inquiry, and facilitates class discourse to deeply explore the connections between the subsystems of the human body.	• Revisit the preassessment posters allowing students to make changes using sticky notes or other revisions. • Use the reflective and anchor questions to have students construct a Claims-Evidence-Reasoning explanation for the overarching question (How does the musculoskeletal system support other systems in the body, etc?)