Unit 3 | Homeostasis in Human Body Systems

Living Environment | **20 - 25 days**

Humans are complex organisms that maintain a narrow set of internal conditions through a system of feedback and communication mechanisms between multiple organ systems. In this unit, students will explore how body systems interact to effectively monitor and respond to both internal and external environmental changes. Students complete both Making Connections (a NY State required lab) and a human thermoregulation laboratory, both of which focus on skills of experimental design.

How does the human body respond to internal and external changes in its environment? How do body systems interact to maintain a dynamic equilibrium?

UNIT STORYLINE SNAPSHOT

Anchor Phenomenon: Marathon Runner Collapse!

The NYC Marathon takes place on an unexpectedly hot day. Shortly after completing the race, one of the finishers collapses and dies.

Performance Task: Marathon Runner Problem

Dynamic Equilibrium & Feedback: Thermoregulation

5E Instructional Model Plan

How do humans regulate and maintain body temperature?

Dynamic Equilibrium & Feedback: Glucose Regulation

5E Instructional Model Plan

How do humans regulate and maintain glucose levels?

Dynamic Equilibrium & Feedback: Regulation of Circulation & Respiration

5E Instructional Model Plan

How do body systems interact to maintain homeostasis?

Dynamic Equilibrium & Feedback: Regulation of Water Balance

3E Instructional Model Plan

How do humans regulate and maintain water levels?

PLANNING RESOURCES

- Knowledge and Enduring Understandings
- Storyline and Pacing Guide
- Common Core Standards
- NY State Regents Exam Readiness
- NY State Science Standards
- Unit Vocabulary

KNOWLEDGE AND ENDURING UNDERSTANDINGS

Knowledge: (Students will know. . .)	Enduring Understandings

High priority content - required	Mid-priority content - recommended	Low-priority content - not required	
• Interaction of all human body systems (Std. 4, Key Idea 1 - PI 1.2) • Dynamic equilibrium and feedback (Std. 4, Key Idea 5 - PI 5.3)	• levels of organization in humans (Std. 4, Key Idea 1 - PI 1.2) • human adaptations and comparison to other species (thermoregulation, water regulation, etc.) (Std 4, Key Idea 3 - PI 3.1)	• toxins vs. pathogens causing disease (Std. 4, Key Idea 5 - PI 5.2)	• The human body contains multiple organ systems that function to maintain biological processes • Human body systems interact to maintain a stable internal environment • Feedback mechanisms enable the human body to respond to internal and external stimuli • As a species, humans have adapted to diverse environmental conditions

✦Storyline and Pacing Guide

Upcoming Webinar
Sunday, November 18 | 6-7:30pm

Learn more about the Unit 3 storyline and curriculum components. Plan with colleagues.

Register here

	Time	Teacher Resource	Driving Questions	What students figure out *Ideas that contribute to student thinking about the anchor phenomenon and performance task*

	**Launch Anchor Phenomenon**	**1 Day**	**Link**	*Why would a marathon runner collapse and/or die after running a race?*	• Long distance runners and athletes sometimes collapse for seemingly unknown reasons • There can be many different reasons why someone can collapse during exercise (heart attack, overheating, etc)
	**Introduce Performance Task**	**1-2 Days**	**Link**	*How can we interpret medical data to predict why a runner would collapse and die?* *What additional information do we need to collect in order to make an informed hypothesis on why a runner would collapse?*	• Medical data (such as heart rate and blood pressure) for individuals may help us understand what may have gone wrong by, comparing runners' data with known normal ranges • A better understanding of how body systems interact to maintain homeostasis during exercise may help us understand why a runner may collapse
	**Thermoregulation**	**5-6 Days**	**5E Plan**	*How do humans regulate their internal body temperature?* *How do our bodies not overheat when exercising?* *How does the external (environmental) temperature impact internal (body) temperature?*	• Humans (and other endothermic organisms) are able to maintain a relatively stable internal temperature, even under changing external temperatures • Maintaining a relatively stable body temperature is an example of dynamic equilibrium • Human body systems use feedback mechanisms in order to maintain a dynamic equilibrium • Based on the evidence available, the marathon runner most likely did not collapse due to overheating

Return to the performance task and engage students in revising their initial response to the Marathon Runner Problem, based on the new evidence and ideas generated in the Thermoregulation instructional sequence.

Revisit the **Unit Driving Question Board** - are there questions that have been addressed in these instructional sequences? -- have new questions been brought to the forefront?

	Glucose Regulation	**5-6 Days**	5E Plan	*How do humans regulate their blood glucose levels?* *Why can humans go long periods of time, or exercise vigorously without eating?*	• Human body systems use feedback mechanisms in order to maintain a dynamic equilibrium in terms of blood glucose levels • The hormone insulin, produced by the pancreas, is secreted into the bloodstream in response to elevated blood glucose • Insulin enables glucose to enter cells • The hormone glucagon (also produced in the pancreas) is secreted into the bloodstream in response to low glucose levels and stimulates the liver to release glucose (by breaking down stored glycogen) • Multiple body systems interact in order to maintain homeostasis in terms of blood glucose levels • Based on the evidence available, the marathon runner most likely did not collapse due to low (or high) blood glucose levels

Return to the performance task and engage students in revising their initial response to the Marathon Runner Problem, based on the new evidence and ideas generated in the Glucose Regulation instructional sequence.

Revisit the **Unit Driving Question Board** - are there questions that have been addressed in these instructional sequences? -- have new questions been brought to the forefront?

	Circulation & Respiration	**5-6 Days**	**5E Plan**	*How do necessary substances, such as oxygen and glucose, move throughout the body and go to where they are needed?* *How do the respiratory and circulatory systems work together to maintain homeostasis, particularly during strenuous exercise?* *How can we design an experiment to investigate the impact of exercise on maintaining homeostasis?*	• Gas exchange occurs at the lungs • The circulatory system transports substances (including gases, glucose, hormones, etc) throughout the body • During exercise, the circulatory and respiratory systems interact in order to maintain a dynamic equilibrium (homeostasis) • Based on the evidence available, the runner most likely did not collapse due to a lack of oxygen (asthma, etc) or circulatory problem (heart attack, etc)

Return to the performance task and engage students in revising their initial response to the Marathon Runner Problem, based on the new evidence and ideas generated in the Circulation and Respiratory system instructional sequence.

Revisit the **Unit Driving Question Board** - are there questions that have been addressed in these instructional sequences? -- have new questions been brought to the forefront?

	Regulation of Water Balance	**2-3 Days**	**3E Plan**	*What is the importance of water? How does it help maintain life processes?* *How do humans regulate fluid / water levels in the body?* *How does water move into and out of cells?*	• Water is essential for many bodily functions including temperature regulation and waste removal • The movement of water in and out of cells is a passive process called osmosis • In osmosis, water moves towards a higher solute concentration - this has important implications for cells as they may become either plasmolyzed (water drawn out) or burst (too much water moves in) • Water and solute concentrations in the blood are regulated in the kidney • Consuming too much water too quickly can cause an imbalance in solute and and water concentrations leading to a condition called hyponatremia • Based on the evidence, the marathon runner most likely did not collapse due to dehydration -- but did suffer from hyponatremia
	Complete Culminating Task	**1-2 Days**	**Link**	*Why would a marathon runner collapse and/or die after running a race?*	• Based on the available evidence, the marathon runner that collapsed and died was suffering from hyponatremia

✦NY State Regents Exam Readiness

Regents Topics (from 1996 standards)	**Historical Coverage** (over the last 5 administrations of LE Regents)[1]	**More Details** ***How is this addressed in the unit?***

[1] Regents Tool; Awesome table

Dynamic equilibrium and biochemistry	6%	Biochemical processes and their importance in maintaining homeostasis is a consistent thread across all of the 5E plans in this unit (**Performance Indicator 5.1**). The concept of dynamic equilibrium (homeostasis) is introduced in the first 5E plan, Human Thermoregulation, and is reviewed and discussed in each plan thereafter.
Human body structure and function	4%	This unit builds on the prior units, which introduced the idea that organelles perform specific functions that enable life processes for the cell and the organism. In this unit, student build on these ideas, in order to understand how complex, multicellular organisms, such as humans require coordination between cells, tissues, and organs to maintain homeostasis (**Performance Indicator 1.2**).
Standard 1: Analysis, Inquiry, & Design	4%	In the 5E, Circulatory and Respiratory Systems, students use the experimental design process in completing the *Making Connections* state laboratory activity. The 5E plan on Thermoregulation also provides an opportunity for students to revisit experimental design within this unit. Experimental design, analysis, and inquiry are spiraled throughout the remainder of the course.
NYS Lab: Diffusion Across A Membrane	3%	In the Water Balance 5E, students complete the second portion of this required lab (the first part was completed in Unit 2).
NYS Lab: Making Connections	3%	In the Circulatory and Respiratory System 5E plan, students complete this required laboratory.
		Unit 3 Regents Item Bank

New York State Science Standards

NY State MST Standards (1996) *This unit was designed to address the following NY State 1996 Standards.*	**NGSS/NYSSLS (2017)** *As designed, this unit works towards the following NYSSLS/NGSS Performance Expectations, with partial alignment.*

Key Idea 1: Living things are both similar to and different from each other and from nonliving things. PI 1.2 Describe and explain the structures and functions of the human body at different organizational levels (e.g., systems, tissues, cells, organelles). **Key Idea 5: Organisms maintain a dynamic equilibrium that sustains life.** PI 5.2 Explain disease as a failure of homeostasis PI 5.3 Relate processes at the system level to the cellular level in order to explain dynamic equilibrium in multicelled organisms. New York State Core Curriculum Standards Crosswalk - Living Environment	**HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.** [Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate 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-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.** [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.]

✦Common Core Learning Standards

Reading	Writing

9-10.R.ST.2 **Reading: Key Ideas and Details** Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. **9-10.R.ST.3** **Reading: Key Ideas and Details** Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks attending to special cases or exceptions defined in the text. **9-10.R.ST.9** **Reading: Integration of Knowledge and Ideas** Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.	**9-10.W.HST.10** **Writing: Range of Writing** Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences. **9-10.W.HST.10** **Writing: Text Types and Purposes** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

✦Unit Vocabulary

Consider using this list to guide the Explain or Elaborate portions of the 5E plans, and use it as reference for peer to peer

vocabulary based discussions.

Domain Specific		Tier 2
cell	circulation	Structure
tissue	coordination	Function
organ	digestion	Process
organ system	bias	Identify
homeostasis	conclusion	Describe
dynamic equilibrium	observation	Explain
feedback mechanism	control	State
stimulus	control group	Synthesis
response	data	
metabolic/ metabolism	dependent variable	
insulin	experimental design	
glycogen	experimental group	
carbohydrates	hypothesis	
proteins	independent variable	
small intestine	peer feedback	
hormone	peer review	
target cell/organ	problem	
	results	

[Click here to access the 2016-2017 version of this unit plan]