

HASPI Medical Biology Lab 04

Homeostasis and Feedback

NGSS HS-LS1-3

Teacher Information



Description

a. Homeostasis and Diagnostic Tests

The majority of diagnostic tests in medicine are performed to check whether components of the body are within normal values. Essentially, they are determining whether tissues, organs, and/or systems of the body are working correctly by determining if they are maintaining homeostasis with the products they produce. The urinalysis is a very common diagnostic test. In this lab students will act as laboratory technicians, and will be performing a urinalysis on simulated urine samples that have been submitted to their lab. A short background on symptoms and reasons for urine collection for each patient is also given. Students are then required to interpret the results of the urinalysis for each patient. This activity is extended to allow students to inquire and conduct their own urinalysis.

b. Homeostasis FAIL: A System Out of Balance

Diabetes is one of the most common homeostatic imbalances and many serious health concerns arise from this condition. Students work as lab technicians to test the blood and urine of patients for glucose levels that assist in the diagnosis of diabetes. The students then fill out a patient report with recommendations and follow-up by retesting the patient's blood and urine collected a few weeks later. Students also calculate and graph glomerular filtration rates for each patient before and after.

Next Generation Science/Common Core Standards

Students who demonstrate understanding can:

HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

a. Medical Application: *The relationship of diagnostic tests to providing evidence of whether feedback mechanisms are working correctly to maintain homeostasis.*

b. Medical Application: *Diabetes is an example of what can happen to multiple systems in the body when feedback mechanisms, and therefore homeostasis, become imbalanced.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Planning and Carrying Out Investigations</p> <ul style="list-style-type: none"> Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and 1 the design: decide on 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. <p>Scientific Investigations Use a Variety of Methods</p> <ul style="list-style-type: none"> Scientific Inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. 	<p>LS1.A: Structure and Function</p> <ul style="list-style-type: none"> 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. 	<p>Stability and Change</p> <ul style="list-style-type: none"> Feedback (negative or positive) can stabilize or destabilize a system.

Connections to other DCIs in this grade-band: N/A	
Articulation to DCIs across grade-levels: MS.LS1.A	
Common Core State Standards Connections: ELA/Literacy –	
WHST.9-12.7	Conduct short as well as more sustained research projects to answer a question (including self-generated questions) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
WHST.11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

Essential Question

By the end of this activity students will be able to:

- Explain how feedback mechanisms maintain homeostasis.
- Provide examples of how feedback mechanisms maintain homeostasis within the human body.
- Explain how a homeostatic imbalance can occur.
- Recognize how diagnostic tests can diagnose homeostatic imbalances.
- Describe how the human body uses negative feedback mechanisms to maintain a normal blood sugar level.
- Explain how diabetes results from a lack of homeostatic balance.

Time

Estimated Time	Actual Time (please make note below)
Lab 04a: 50 - 55 minutes	
Lab 04b: 50 - 55 minutes	

Note: Share the actual time on the forum (www.haspi.org) or at HASPI curriculum conference

Materials

HASPI is a grant-funded project and on occasion we are able to provide supplies to participating sites. If we are unable to provide supplies, the company, item number, and approximate cost have been included.

Lab 04a. Homeostasis and Diagnostic Tests				
Supply	Provided (P) or Needed (N)	Quantity	Company/ Item #	Estimated Cost
Rapid response test strips	P	50	Medex / BTX-U101-1S100	\$16.85 (100)
Test strip indicator sheet	P	40	HASPI	cost of copies
Plastic pipettes (rinse & reuse)	P	90	Carolina/ 736984	\$5.10
Specimen cups	P	40	Amazon/ B000LX35SA	\$2.25
Ziploc bags (6x6)	P	40	Grocery	\$3.00
Patient A Urine - infection	P	30 ml	See components below	N/A
Yellow food coloring	1 drop		Carolina/ 898034	\$2.95
Sodium chloride	1.5 g		Wards/ 942 V 9806	\$3.90
Sodium phosphate dibasic	0.13 g		Wards/ 943 V 2706	\$21.60
Sodium phosphate	0.07 g		Wards/ 943 V 3406	\$13.90
Sodium nitrite	5 mg		Wards/ 981 V 1706	\$24.65
Blood meal (mix 1 g with 100 ml water)	0.25 ml		Amazon/ LA-Z35X-3QRZ	\$12.99
Distilled water	100 ml		Grocery	\$2.00

Patient B Urine – diabetes	P	30 ml	See components below	N/A
Yellow food coloring	2 drops		Carolina/ 898034	\$2.95
Sodium chloride	3 g		Wards/ 942 V 9806	\$3.90
Sodium phosphate dibasic	0.38 g		Wards/ 943 V 2706	\$21.60
Sodium phosphate	0.12 g		Wards/ 943 V 3406	\$13.90
Glucose	0.5 g		Wards/ 945 V 6006	\$7.70
Distilled water	100 ml		Grocery	\$2.00
Patient C Urine – dehydration	P	30 ml	See components below	N/A
Yellow food coloring	5 drops		Carolina/ 898034	\$2.95
Sodium chloride	3.5 g		Wards/ 942 V 9806	\$3.90
Sodium phosphate dibasic	0.09 g		Wards/ 943 V 2706	\$21.60
Sodium phosphate	0.09 g		Wards/ 943 V 3406	\$13.90
Distilled water	100 ml		Grocery	\$2.00
Patient D Urine – proteinuria	P	30 ml	See components below	N/A
Yellow food coloring	1 drop		Carolina/ 898034	\$2.95
Sodium chloride	1.5 g		Wards/ 942 V 9806	\$3.90
Sodium phosphate dibasic	0.13 g		Wards/ 943 V 2706	\$21.60
Sodium phosphate	0.07 g		Wards/ 943 V 3406	\$13.90
Albumin (<i>mix 1-2 g with 100 ml water</i>)	2 ml		Wards/ 944 V 3804	\$9.35
Distilled water	100 ml		Grocery	\$2.00
Patient E Urine – kidney stones	P	30 ml	See components below	N/A
Yellow food coloring	3 drops		Carolina/ 898034	\$2.95
Sodium chloride	3.5 g		Wards/ 942 V 9806	\$3.90
Sodium phosphate dibasic	0.25 g		Wards/ 943 V 2706	\$21.60
Sodium phosphate	80 mg		Wards/ 943 V 3406	\$13.90
Blood meal (<i>mix 1 g with 100 ml water</i>)	0.5 ml		Amazon/ LA-Z35X-3QRZ	\$12.99
Distilled water	100 ml		Grocery	\$2.00
Test tubes	N	50	-	-
Test tube rack	N	10	-	-
Graduated cylinder	N	5	-	-
Microscope	N	10	-	-
Slides/coverslip	N	10	-	-
Masking tape	N	10 strips	-	-
Scissors	N	10	-	-
Paper towels	N	As needed	-	-

Lab 04b: Homeostasis FAIL: A System Out of Balance				
Supply	Provided (P) or Needed (N)	Quantity	Company/ Item #	Estimated Cost
Spot plates	P	10	Boreal/ WW69508M00	\$8.40
Glucose test strips	P	60	Boreal/ WW46977M05	\$14.95
Glucose reference color chart	P	10	HASPI	cost of copies
Initial Blood A (0.2 g glucose)	P	30 ml	Wards/ 945V6006 (glucose) Carolina/89803 (red color)	\$7.70
Initial Blood B (0.5 g glucose)	P	30 ml		\$2.95
Initial Blood C (1.0 g glucose)	P	30 ml	Add glucose amount specified to 100 ml water and 5-10 drops red food coloring in dropper bottle	
Final Blood A (0.5 g glucose)	P	30 ml		
Final Blood B (0 g glucose)	P	30 ml		
Final Blood C (0.2 g glucose)	P	30 ml		
Paper towels	N	As needed	-	-

Company Contact Information:

Carolina Biological Supply www.carolina.com 800.334.5551	Ward's Science www.wardsci.com 800.962.2260	HASPI www.haspi.com Download free online	Boreal www.sciencekit.com 800.828.777
Medex Supplies www.medexsupply.com	Amazon www.amazon.com	Grocery Can be found at any local grocery store	

Common Student Misconceptions

The following is a list of possible misconceptions that students experience. Please feel free to add any additional misconceptions students experienced during this activity to be better prepared for the future use of this lab/activity.

- Students often believe negative and positive feedback mechanisms are the OPPOSITES of one another. For example, negative would be a mechanism that lowers the level of a hormone, while a positive mechanism would raise the level of a hormone. NOT TRUE. It is important to reinforce that these are completely separate mechanisms.
- While each of these activities allow students to act as lab technicians, it is important to let students know that lab techs would never actually be providing a diagnosis to patients. They simply provide test results to physicians who are licensed to provide the diagnosis.

Additional Misconception Notes:

Guiding Questions

These questions are meant to support discussion of the concept/standard.

- Have students reflect on how their bodies react to situations. Examples may include: hunger, thirst, emergency, exercise, etc.
- How do the words "negative" and "positive" explain each of the feedback mechanisms they represent?
- What substances do you think can be tested for in urine? Why is a urinalysis such an effective test?
- What is happening to your blood glucose level when you haven't eaten in a long period of time? What if you've just eaten large amounts of candy?
- How many students have family members with diabetes? If they have taken steps to manage diabetes, how has their lifestyle changed and how could it change further?

The Task/Response System

Through multiple discussions and suggestions HASPI has decided to use the task/response system for lab procedures and directions. The response column can be utilized to:

- Provide space for answers to questions provided in the task column
- Provide space for data/observation records
- Provide images to help relay a step
- Support reinforcement of the standards/concepts immediately during the lab investigations
- Any other way you see fit to use it

Additional Information

Information	Page #	Location
Lab 04a: Homeostasis and Diagnostic Tests		
The supplies purchased to create simulated urine are enough to create GALLONS of urine and can be used year after year. The biological agents (blood meal, glucose, and albumin) should be added immediately before use as they can degrade and possibly mold.	N/A	Materials/Supplies
Since there are 5 urine samples, it is best to place each urine sample throughout the classroom with its own graduated cylinder to prevent any cross-contamination. Shake each urine sample vigorously before the lab.	Page 162	Part A Step 2
Both urine and glucose test strips are not cheap. Having students cut the test strips in half (long-wise) doubles your supply and saves money, but is not necessary.	Page 163	Part A Step 3
Students will likely not see crystals, but small detritus from the blood meal should be present in the microscopic evaluation of patients A and E.	Page 163	Part A Step 5
Part B is optional. Just make sure to reinforce that students DO NOT return any of the supplies! Expect most of the student urinalyses to be normal, but also let them know that their diet can have a large impact on the results.	Pages 163-164	Part B
Lab 04b: Homeostasis FAIL: A System Out of Balance		
It is suggested that the three initial samples are placed out for student use first, and the final samples are not provided until the students show you the completed treatment plan for each patient.	Pages 172-173	Part A
Dropper bottles or plastic pipettes are needed to transfer the simulated blood samples to the spot plates.	Page 173	Part A Step 3
Students will need a chance to research or be provided with research on the best treatment regimen for individuals with Type 1, Type 2, or pre-diabetes to complete the treatment plans.	Page 174	Part A Treatment Plan

Resources and References

- Cohen, R.M. and Sadler, L. 2006. Diabetes and the Body: Pancreatic Function. NetWellness. <http://www.netwellness.org/healthtopics/diabetes/pancreasdiabetes.cfm>.
- Freudenrich, C. 2001. How Your Kidneys Work. Discovery Fit & Health. <http://health.howstuffworks.com/human-body/systems/kidney-urinary/kidney.htm>.
- Martin, T. and Baustian, M. 2003. Interpreting Medical Tests: What's in Urine? Cornell Institute for Biology Teachers, pp. 1-9.
- McClellan, W. and Young, B. 2009. The Kidneys and How They Work. National Institutes of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, NIH Publication No. 09-3195.
- Neo/SCI. Urinalysis and Disease Identification Investigation. www.neosci.com.
- Stalheim-Smith, A., Gaines, R., and Robinson, S. 1993. Laboratory Manual for Understanding Human Anatomy and Physiology, West Publishing.
- Weber, C. 2008. High Blood Pressure & Diabetes – A Positive Feedback Loop. <http://highbloodpressure.about.com/od/highbloodpressure101/a/feedbackloop.htm>.

Images (in order of appearance)

- http://cnx.org/content/m45989/latest/106_Pregnancy-Positive_Feedback.jpg
- http://bio1152.nicerweb.com/Locked/media/ch40/40_21HypothalamThermost.jpg
- http://media.tumblr.com/tumblr_ljolvaDdJ21qf00w4.jpg
- <http://boringem.org/wp-content/uploads/2012/12/urinalysis.jpg>
- <http://boringem.org/wp-content/uploads/2012/12/urinalysis.jpg>
- http://bio1152.nicerweb.com/Locked/media/ch45/45_12GlucoseHomeostasis.jpg
- <http://pre-diabetes.insulitelabs.com/>
- http://pre-diabetes.insulitelabs.com/images/cell_ir_01.jpg
- <http://media.mercola.com/Assets/images/infosite/diabetes/leading-complications-diabetes.jpg>
- <http://www.life-enhancement.com/images/LEM1209glomerulus3661.jpg>
- <http://www.unckidneycenter.org/images/diabetesgraphic.jpg>