

## HS-LS1-3

Students who demonstrate understanding can:

- 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.]

The performance expectation above was developed using the following elements from *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p><b>Planning and Carrying Out Investigations</b> Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.</p> <ul style="list-style-type: none"> <li>Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in 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.</li> </ul> <hr style="border-top: 1px dashed #ccc;"/> <p style="text-align: center;"><b>Connections to Nature of Science</b></p> <p><b>Scientific Investigations Use a Variety of Methods</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p><b>LS1.A: Structure and Function</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p><b>Stability and Change</b></p> <ul style="list-style-type: none"> <li>Feedback (negative or positive) can stabilize or destabilize a system.</li> </ul>

### Observable features of the student performance by the end of the course:

1	Identifying the phenomenon under investigation				
	a Students describe the phenomenon under investigation, which includes the following idea: that feedback mechanisms maintain homeostasis.				
2	Identifying the evidence to answer this question				
	a Students develop an investigation plan and describe the data that will be collected and the evidence to be derived from the data, including: <table border="1" style="margin-left: 20px;"> <tbody> <tr> <td>i.</td> <td>Changes within a chosen range in the external environment of a living system; and</td> </tr> <tr> <td>ii.</td> <td>Responses of a living system that would stabilize and maintain the system's internal conditions (homeostasis), even though external conditions change, thus establishing the positive or negative feedback mechanism.</td> </tr> </tbody> </table>	i.	Changes within a chosen range in the external environment of a living system; and	ii.	Responses of a living system that would stabilize and maintain the system's internal conditions (homeostasis), even though external conditions change, thus establishing the positive or negative feedback mechanism.
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	b Students describe why the data will provide information relevant to the purpose of the investigation.				
3	Planning for the investigation				
	a In the investigation plan, students describe: <table border="1" style="margin-left: 20px;"> <tbody> <tr> <td>i.</td> <td>How the change in the external environment is to be measured or identified;</td> </tr> <tr> <td>ii.</td> <td>How the response of the living system will be measured or identified;</td> </tr> </tbody> </table>	i.	How the change in the external environment is to be measured or identified;	ii.	How the response of the living system will be measured or identified;
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	iii.	How the stabilization or destabilization of the system's internal conditions will be measured or determined;
	iv.	The experimental procedure, the minimum number of different systems (and the factors that affect them) that would allow generalization of results, the evidence derived from the data, and identification of limitations on the precision of data to include types and amounts; and
	v.	Whether the investigation will be conducted individually or collaboratively.
4	Collecting the data	
	a	Students collect and record changes in the external environment and organism responses as a function of time.
5	Refining the design	
	a	Students evaluate their investigation, including:
		i. Assessment of the accuracy and precision of the data, as well as limitations (e.g., cost, risk, time) of the investigation, and make suggestions for refinement; and
		ii. Assessment of the ability of the data to provide the evidence required.
	b	If necessary, students refine the investigation plan to produce more generalizable data.