Science Assessment System
Through Course Task

Osmoregulation

Grade Level:
9, 10, 11, 12

Phenomena:
Osmoregulation in Fish

Science & Engineering Practices:
Developing and Using Models
Engaging in Argument from Evidence

Crosscutting Concepts:
Stability and Change

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in collaboration with teachers from Kentucky schools and districts.

Preparing to implement Through Course Tasks in the Classroom

What is a TCT?

- TCTs are 3-dimensional tasks specifically designed to get evidence of student competency in two dimensions, Science and Engineering Processes (SEPs) and Crosscutting Concepts (CCC), untethered from Performance Expectations (PEs)/standards. Tasks are sense-making experiences.
- Tasks are to be used formatively. The goal is for both students and teachers to understand areas of strength and improvement for the SEP(s) and CCC assessed within the task.

How do I facilitate a Through Course Task (TCT)?

- TCT facilitation is a collaborative process in which teacher teams calibrate understanding of the expectations of the task and refine strategies to be used during task facilitation.

Before the task:

1. Complete the TCT as a learner – compare understanding of task through the lens of success criteria (identified in the task) in order to understand expectations.
   Success criteria include:
   - What is this task designed to get evidence of?
   - What is the task asking the students to do?
   - What might a student response look like?
2. Identify the phenomenon within the task. Consult resources to assure teacher teams have a deep understanding of associated science concepts.
3. Collaborate to generate, review and refine feedback questions during facilitation.
4. Identify potential "trouble spots" and plan for possible misconceptions.

During the task:

5. Collect defensible evidence of each student's competencies in 3-dimensional sense-making for the task.
6. Ask appropriate feedback questions to support student access and engagement with the task in order to elicit accurate evidence of student capacities.

After the task:

7. Reflect on the task as a collaborative team.
8. Review student work samples to identify areas of strength and areas of need.
9. Determine/plan next steps to move 3-D sense making forward through the strengthening of the use of SEPs and CCCs.

Using the materials included in this packet:

- **Task Annotation:**
  - The task annotation is a teacher guide for using the task in the classroom. Additionally, the annotation gives insight into the thinking of developers and the task overall.

- Each task has science and engineering practices, disciplinary core ideas, and crosscutting concepts designated with both color and text style:
  - **Science and Engineering Practices**
  - *Disciplinary Core Ideas*
  - Crosscutting Concepts
- **Student Task:** The materials to be used by students to complete the TCT.

Osmoregulation Task Annotation

After using the model to understand *the effects of the environment on osmoregulation in salmon*, **make a claim** as to the stability of a fish/aquarium system using **evidence from the model to support that claim.**

Phenomenon within the task

All organisms have mechanisms designed to maintain stable internal conditions, within a functional limit, in order to survive. This task uses to context of osmoregulation in salmon, which have the ability to survive in both freshwater and saltwater environments. Students will use their understanding of osmosis and homeostatic mechanisms to analyze models that demonstrate water movement based upon environmental salinity.

How the phenomenon relates to DCI

This task connects strongly to LS1.A: Feedback mechanisms maintain a living system's internal conditions within certain limits allowing it to remain alive and functional even as external conditions change within some range.

What information/data will students use within this task?

The task provides information relating to varying mechanisms of osmoregulation within fish. There is also a brief explanation about osmotic conditions for the fish. A table compares environmental conditions and homeostatic reactions fish living in the identified environments. Also included is a model showing the movement of water and ions in salmon living in a fresh or salt water environment. Students may also draw upon their understanding of feedback loops (stable vs unstable conditions) and the role of active transport of molecules within cells as the organisms works to maintain a homeostatic environment.

Ideas for setting up the task with students

In the development of this task for use as a TCT, the task developer's students had investigated osmosis and homeostatic mechanisms using models to explain water movement and salinity. They used various models and data analysis to investigate homeostasis within their own body systems. (e.g., kidney, kidney function, formation of urine). At the time students engaged with this task, they were able to use models to explain osmoregulation and homeostasis in various organisms. Therefore, teachers may wish to consider students' ability to understand and use models.

The models provided show the movement of water and ions in salmon as these fish move from freshwater (during spawning) to salt water. Students may not know, or understand, the physiological processes that salmon undergo during this transition. They should, however, be able to interpret the model, understanding the directionality and meaning of the arrow sizes.

Because of the nature of this task, group or whole class discussion about the salmon models may not produce the evidence this task is designed to provide. Teacher teams may develop a set of questions or “hints” that may assist students in thinking about how the components of the system are portrayed in the model (i.e., What does it mean when there are small arrows and the large arrows?). However, teachers may determine that, through observation, that students are struggling to understand the process of osmosis through the model, a small group/class discussion may be necessary. Teachers should note the issues observed so that these may be taken into account when looking at student work for this task.

Students will benefit from working with other models representing osmosis, osmoregulation and homeostasis before completing the TCT. Case studies can be used to stimulate discussion on the why and how of the importance of homeostasis. Students could also design investigations about osmoregulation using different organisms (plants) or different solutions (dialysis tubing - simulating cells). In thinking about modeling, students should be made aware that assumptions may be made when using or interpreting a model. This may be the case when students are making a claim about a freshwater fish being placed in salt water.

In a classroom beyond biology, osmosis is talked about with types of solutions. This could be used in an integrated science classroom or a chemistry classroom to provide connections to biology. This could be investigated by using a variety of solution type activities already used such as a gummi or egg lab.

Intent of the Task for Assessment

This task was designed to determine if students can use models to develop an understanding of the effects of the environment on the homeostatic process of osmoregulation and then apply that understanding to a new situation. In this task, students are asked to use model in order to predict what will happen in a new, but related, situation, explaining their predictions using data from the model provided. Students will use the cross cutting concept of stability and change in order to make a claim as to the stability of the defined system of the goldfish in the saltwater aquarium. Students may bring in past classroom experiences to make sense of the model provided.

The cross-cutting concept of stability and change describes how a system reacts to outside forces. Thus, identifying the system boundaries, as well as the inputs and outputs, are important. In this task, the system is defined as the saltwater tank, to include the goldfish, water and ions. In predicting the effect of the saltwater on the goldfish, students will identify how the substances move within the system and the effect of this movement on the goldfish. At high school, students should understand, and relate, the role of feedback loops in the stability or instability of a system.

While this task focuses on the cross cutting concept of stability and change, the cross cutting concepts of cause and effect and systems and system models are also present. The understanding of how one component of a system (a cause) interacts with and results in a change (an effect) is the basis of stability and change. Therefore, teachers may also gather evidence of students' ability to identify cause/effect relationships as well as system models as students identify evidence from the salmon model in support of their claim.

Success Criteria

Evidence of Learning Desired based on Progression from Appendices

Developing and Using Models

- Use a model based on evidence to predict the relationships between systems.**-**

Developing and Using Models

- Use a model to predict the relationships between components of a system.

Stability and Change

- Feedback (positive or negative) can stabilize or destabilize a system.

Success Criteria

Part A:

Student identification of saltwater vs. freshwater is supported by evidence provided in the model. Evidence should relate the movement of water and ions as related to environmental conditions and the process of osmosis.

Part B:

Student claim is related to the environmental effects of the defined system. Support for the claim comes from the model whereby students describe the relationships between the components (fish, water, ions).

- Evidence should also address, directly or indirectly, the concept of feedback mechanisms within the system that are working together in an attempt to reach equilibrium (stability).

Possible Student Responses

***Part A:** "Salmon A - freshwater; according to the salmon model water moves into the salmon showing the fish is hypertonic to its surroundings. Salmon B - saltwater; according to the salmon model water is consumed by the salmon and is released through the skin showing the fish is hypotonic to its surroundings."

Part B: "The system's environment will become unstable. When Emily puts the goldfish into the saltwater tank, the fish will attempt to maintain an internal homeostatic environment (stable state) the way it does in model (a). The salt water has a higher concentration of salt than the fish has in its body Because of the desire to maintain a stable environment, the water will move out of the fish at a higher rate than it will take in. As shown in model (a), freshwater fish only take in a little water. This will cause the fish to dehydrate."

> "The system will be unstable. When Emily puts a goldfish into a saltwater tank it will actively take up water and sodium through its gills and secret large amounts of urine, as shown in model (a). A freshwater fish in a salty environment is assumed to continue its normal mechanisms for homeostasis. The fish would lose water at a high rate and dehydrate because of the positive feedback occurring within the system."

*Part A information is provided for teachers in order to assist in gauging student use of the SEP of Modeling as used in Part A of this task.

Other information teacher teams might find useful when preparing to use this task in the TCT process

The key to the success of this task is students' basic understanding of (movement of particles based on gradient/diffusion). If students are unfamiliar with, or have limited understanding of, osmosis, teachers may wish to provide other diagrams or images that show the effect of water/ion movement in organisms. Students may need help in understanding the concept of stability as applied to the concept of homeostasis and osmoregulation.

This task could be used after cell transport is taught.

Extensions and/or other uses after the task is implemented

This is a good place to discuss feedback loops within the human body systems. It is also a good place to talk about gas exchange in plants and plants' response to drought and flood conditions. Some teachers may also wish to apply this understanding to desalination, or the conversion of saltwater into freshwater.

Students may wish to further investigate how salmon osmoregulate throughout their life.

Through Course Task – Osmoregulation

Fish have evolved ways that help maintain an internal balance of water and salts (ions) in their body fluids (osmoregulation). The mechanisms that help maintain that balance are controlled by a number of physical and physiological differences, such as the excretory system (kidneys). Because of these differences some fish are able to survive only in freshwater, some only in saltwater and some in both freshwater and saltwater.

One such physical difference is gill cells. Gill cells in many fish species contain ion pumps. Because of the difference in concentration gradient, these pumps actively regulate the flow of the ions (such as sodium and potassium) into or out of the fish, depending on the environment in which it lives. Fresh water contains low concentrations of ions, so the gill cells actively pump in water. Salt water, however, contains high concentrations of ions, so the gill cells actively pump out the excess ions.

Salmon belong to a group of fish called euryhaline fish, which are those that can live in a variety of water salinities from freshwater to saltwater. They are born in freshwater, spend most of their life in saltwater but return to freshwater to spawn (reproduce). Each environment presents different challenges for these fish. Luckily, though, euryhaline fish have the ability to osmoregulate in different salinities.

Saltwater Fish vs Freshwater Fish Conditions

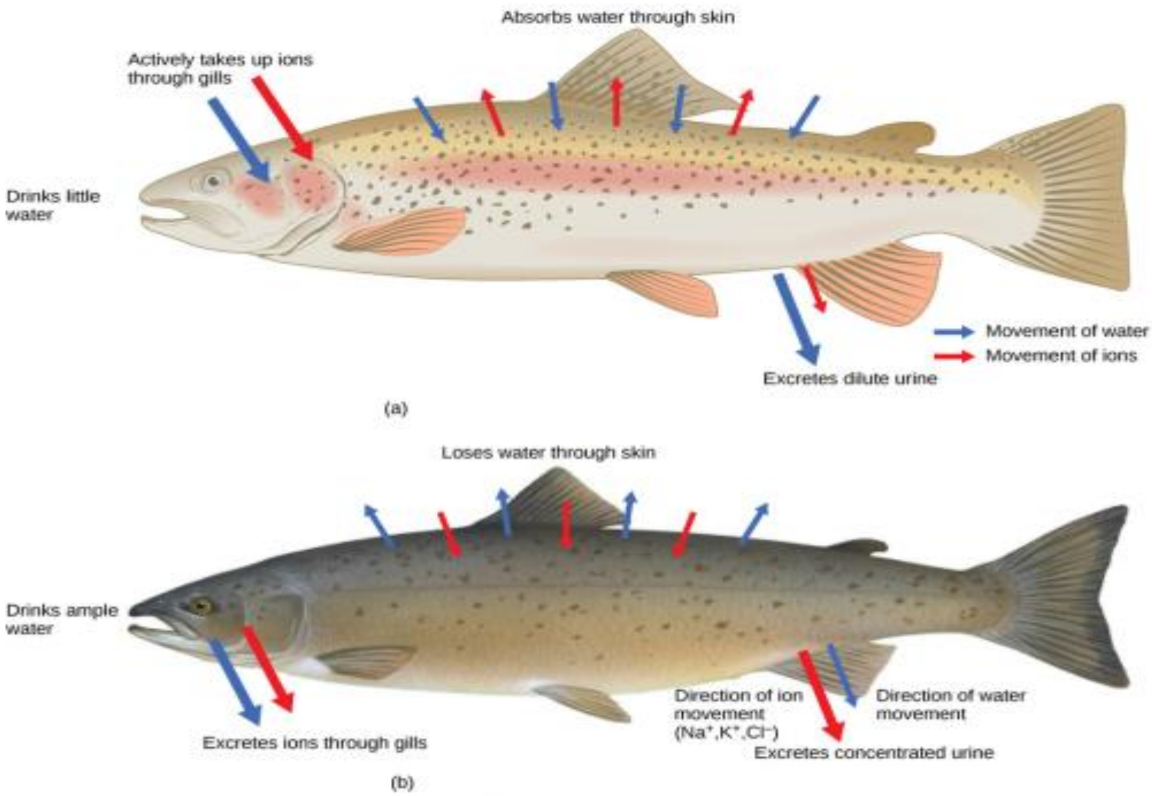
Saltwater Fish	**Freshwater Fish**
Fish is hypotonic to their surroundings	Fish is hypertonic to their surroundings
Water molecules diffuse out of the blood from gills	Water molecules diffuse into the blood from gills
Water is hypertonic	Water is hypotonic
Low volume of urine	High volume of urine

Osmosis Definition:

A process by which molecules of water (a solvent) tend to pass through a semipermeable membrane from a less concentrated solution into a more concentrated one, thus equalizing the concentrations on each side of the membrane.

The model below shows the movement of water and ions in salmon as their body undergoes osmoregulation.

Osmoregulation in Salmon



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Osmoregulation in Salmon

Osmoregulation Assessment:

<u>Part A</u>

Use the evidence and models provided to identify which salmon (a) or (b) represents saltwater salmon and which represents freshwater salmon. Explain your choices based on the provided evidence and your understanding of osmosis.

Salmon A: ____

Explanation:

Salmon B: ____

Explanation:

Part B

Emily won a goldfish at the fair. She plans to put the goldfish, which is not a euryhaline fish, in the saltwater tank at her house since that is the only tank she has. What claim can you make about the stability of this system (the goldfish in the saltwater tank)? Provide evidence from the model to support your claim. Identify any assumptions you may have made in the use of the information as evidence.