

Cell Osmosis—Salt-Sneezing Iguanas

Unit: Strand BIO.2: STRUCTURE AND FUNCTION OF LIFE	Utah SEEd Standard / NGSS Performance Expectation: Standard BIO.2.4 Plan and carry out an investigation to determine how cells maintain <u>stability</u> within a range of <u>changing</u> conditions by the transport of materials across the cell membrane. Emphasize that large and small particles can pass through the cell membrane to maintain homeostasis. (LS1.A)	Time: 2-3 fifty-minute class periods
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Access to all materials for this lesson: <https://byu.box.com/s/3brcxvjccc6sdz6v0p9xv9txzqqwnwtm>

Anchor Phenomenon	Marine iguana spitting saltwater Marine Iguana Expelling Salt (YouTube video) More information text on the Marine Iguana (Save this info to share with students near the end of the lesson).
Driving Question(s)	Why does the Marine Iguana need to expel salt? What is happening in the Marine Iguana's cells to help it survive in salt water? All organisms work to reach homeostasis. How is the Marine Iguana able to do so here?
Performance Task	Jigsaw Learning: Read articles about how various animals adapt to fresh and saltwater. Plan an investigation to understand how cells reach homeostasis. Perform an investigation using water beads (Orbeez).



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Lesson Summary:			
	Time	Guiding Question / Learning Objective	How are students answering the guiding question or meeting the learning objective? (Highlight the SEPs , DCIs , and CCCs in the corresponding color.)
 Engage	Day 1 5 min.	Marine Iguana Video (Eating & Swimming) Marine Iguana Video (Sneezing Salt) Q. What is the iguana doing and why?	Students view the phenomena of sneezing iguanas. They begin to question what is happening in the phenomenon.
 Explore	Day 1 15 min.	Ask Driving Questions. Read Articles. Class Discussion to explore and review cell stability, change, and homeostasis	Students will discuss how the structure and function of living things leads to stability and change in living things.
 Explain	Day 1 30 min.	Plan and design an investigation Discuss parameters (see student handout "Investigation Parameters")	Students will plan out an investigation into how water enters, exists, or remains stable inside of the water beads.
 Elaborate	Day 2 30 min	Carry out the planned investigation by keeping within the parameters outlined by the student handout.	Students will finish planning, will pass off with teacher, & then will carry out the investigation they began planning the last class period.
 Evaluate	Day 1 10 min Day 3 30 min	Evaluate the student's final proposal before the investigation occurs. Does this investigation help students understand homeostasis? Students measure and record their water beads. Answer the questions and graph their data.	Teacher will determine how well students planned & their investigation and help students understand how to increase. Teacher will evaluate the investigation the students did to evaluate how students understood the relationship between the structure and function of cells and the stability and change that cells have to maintain for life.

Three Dimensions Focused on in This Lesson		
Disciplinary Core Idea: NGSS Appendix E LS1.A Structure and function Grade 9-12 Systems of specialized cells within organisms help perform essential functions of life. Any one system in an organism is made up of numerous parts. Feedback mechanisms maintain an organism's internal conditions within certain limits and mediate behaviors.	Science and Engineering Practices: NGSS Appendix F Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled.	Crosscutting Concept: NGSS Appendix G Stability and Change – For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.
Disciplinary Core Idea: NGSS Appendix E Previously discussed cell membrane, cell transport and cell structure. Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell	Science and Engineering Practices: NGSS Appendix F Planning and carrying out investigations include investigations that use controlled and multiple variables and provide evidence to support explanations or solutions.	Crosscutting Concept: NGSS Appendix G Small changes in one part of a system might cause large changes in another part. Stability might be disturbed either by sudden events or gradual changes that accumulate over time.
Connections to Mathematics and ELA/Literacy Standards		
ELA/Literacy Standards: English Language Arts: WHST.9-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.		Mathematics Standards: N/A

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.

Materials		
Handouts	Lab Supplies	Other Resources
Osmosis Investigation Student handout. Student handout—teacher rubric	• Overnight soaked or dry water beads (we used Orbeez) • High salt content water- 35g NaCl for 100 mL water • Medium salt content water- 17.5 g NaCl for 100 mL water • Deionized (no salt) water- 1 L DI water • High Sugar content water- 200 g Table Sugar for 100 mL water • Medium Sugar content water- 75 g Table Sugar for 100 mL water • Colored dyes • Scales • Cups/Beakers • Rulers • Graduated Cylinder (measure volume) • Time (up to 24 hours)	• Marine Iguana Video (Eating and Swimming video) • Sneezing Galapagos Marine Iguanas (video) • Marine Iguana Facts • Articles ○ Sharks surviving in saltwater ○ Salmon osmoregulation 1 ○ Salmon osmoregulation 2 ○ Overhydration ○ Salt Glands in Birds ○ Various Organisms surviving in saltwater • Teacher Slides- Extension/Adaption



ENGAGE

1. Ask students to record observations during both of these videos.
[Sneezing Galapagos Marine Iguana video.](#)
[Marine Iguana Video \(eating and swimming\)](#)
2. Teacher presents video of marine iguanas expelling salt (note: it is doing this through the nose, it isn't spitting, but don't tell the students this yet).
3. Ask: "What is the Iguana doing and why?"
 - Why does the Marine Iguana need to expel [salt]?
 - What is happening in the Marine Iguana's cells to help it survive in salt water?
 - All organisms work to reach homeostasis. How is the Marine Iguana able to do so here?
4. Class discussion on thoughts about what is happening.
5. Refresh about driving question – "What do you think the Iguana is doing when it sneezes and why? How does it relate to cell-membrane transport?"
6. Teacher gives each group an article to read with some data etc. You may use the ones linked below or find ones you think are better.
 - [Sharks surviving in saltwater](#)
 - [Salmon osmoregulation 1](#) or [Salmon osmoregulation 2](#)
 - [Overhydration](#)
 - [Salt Glands in Birds](#)
 - [Various Organisms surviving in salt water](#) (extra material)
7. Students will read and then discuss together and find three main points they learned from their article or things that they learned from the data. (Ex. Give students 3-5 minutes to read before group-share.)
8. Share inside their table group what their article was about. (Ex. 30-seconds each)
9. Students will discuss how those things relate to the driving question: "Why does the Marine Iguana need to expel salt?"
10. Discuss findings as a class.
11. [Marine Iguana Information](#)

Teacher Tips: For additional connections on active and passive transport, see the "Teacher Slides" in Alternative Adaptations at the bottom of this lesson. "Teacher Slides" reference:

<https://www.wsfcs.k12.nc.us/cms/lib/NC01001395/Centricity/Domain/7832/new.cell.transport.14.pptx>

4 – Relate this knowledge to past lessons: cell membrane transport, osmosis, diffusion, Why organisms need this, etc.

Discussions can be done in various ways, including group, class, or partner discussions. To help differentiate readings, teachers could have students double up.

The overhydration reading gives teachers and students opportunities for personal connection (have they or someone they know experienced this?)

Teacher can decide if you want to reveal how iguanas expel salt or wait until the end of the experiment.

Note: [Amoeba Sisters Osmosis and Water Potential](#) could be shown here as a connection to previous material.

EXPLORE



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The student will investigate how Orbeez water beads can model how cells maintain stability within a range of changing conditions by transporting materials across the Orbeez “cell membrane.”

1. Introduce the lab -- see [Student Handout](#) for instructions.
2. Students/Groups will create an experiment, which will then be peer-reviewed AND performed by a different student/group.
3. Show students all the different materials they have access to create their experiment (see “Materials Available for Investigation” in **Student Handout**).
4. Remind the students of their goal to have a fully functioning experiment by the end of class as they begin planning their investigation. The experiment will be performed the next class period.
5. If time allows, begin setting up the lab for the next day.
6. Students fill out Student Handout as they go through this process.
7. Post-experiment questions to help them connect to Iguana
8. **If possible, have students set up/begin their experiments on Day 1 after peer review.**

[Marine Iguana Information](#)

Teacher Tips:

Instead of water beads, teachers could use gummy bears, dialysis tubing, carrots, eggs (with shells removed with vinegar), or potatoes.

#1 – To support IEP students, pair them with a more advanced student. Additionally, working in teams of 2-4 to both write and peer review the procedures may result in better learning and investigation design.

#2 – Prior student experience setting up an investigation will dictate the time required for this activity in class. It's beneficial for the same group to peer-review AND perform the experiment.

#3 – Students will perform and peer review each other's experiments individually or as a group

#4 --Depending on class size and time, the other student can perform an active peer review of the procedure by going back to the original writer of the experiment for clarification. Alternatively, if you have more time, you may want to have a different student perform a peer review before delivering it to the student who will perform the experiment.

#5 20-28 liters is the maximum quantity of water for the average individual in a 24-hour period. Students could be encouraged to find this amount out for themselves (paired with overhydration reading).

EXPLAIN

The student will investigate how Orbeez water beads can model how cells maintain stability within changing conditions by transporting materials across the Orbeez “cell membrane.”

1. Student Handout needs to guide the investigation.
2. Discuss the importance of staying within the parameters of the investigation while still being creative and following the investigation planned by the student/s.
3. Reminders:
 - Place the water beads in different solution environments.
 - It is important to gather quantifiable data, such as weighing water beads before and after sitting in various concentrations of salt, sugar, or food coloring.

Teacher tips:

Students may benefit from sharing their investigation and procedures with another group before starting, which will help them refine their thinking and procedures.



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EVALUATE

Potential Start of Day 2 or 3

Background: The evaluation process must occur throughout the investigation process by the teacher and the students performing the written investigation. The data needs to be obtained and evaluated.

1. Give students time to evaluate their dependent variables, including weighing their water beads, measuring diameters, etc.
2. Students need to record their results, potentially by filling out or creating a table or a graph.
3. Students will fill out the post-investigation questions.
4. Students should be reminded how their water beads represent (model) a cell membrane and movement in and out of the cell. Additionally, students should be asked to question how this might relate to the Marine Iguanas (see Student Handout).
5. Ask students what experiments worked and which “didn’t work.” Talk about what it means to “not work.” Scientists often obtain results that “don’t work.” These results help them create their next experiment (the repeat process.) Maybe they need to change their process or what they measure as an outcome. Ask if they have an idea for their next experiment or if they would change their hypotheses or questions for the next time.

A possible extension could include having the students learn to graph their data on their computer and then present their data to the class in a Powerpoint. Students with similar experiments might do a combined presentation. What can be learned if they look at the data they each obtained? Can their results be averaged (Why or why not)? What can be known overall from experiments performed by the entire class?

ELABORATE

Defining and Understanding the data from the student investigation. Finding what worked and what didn’t and perhaps making time to do the lab again with new, better parameters. I.e. failing and learning from it, until success is obtained.

Explaining the data from your investigation

[Marine Iguana Information](#)

Category III, D. = Assessing student proficiency using testing results and repetition.
*This may not be possible with limited class time. Good time management may make it possible.



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POSSIBLE EXTENSION / ALTERNATIVE ADAPTATIONS

- Have students consider additional possible conditions wherein they could use water beads.
- Have students perform the same investigation using other materials, such as potatoes, gummy bears, etc.
- Students could research different cell types and which type of membrane proteins they have.
- Keep jigsaw groups of five students for the four readings to pair up lower-level readers with higher-level readers.
- Have students bring in material they would be interested in testing with the water beads (ex., soda pop, vinegar, monster drink, etc.)
- Have students look at diabetes insipidus. The body cannot use osmosis well, so it expels water instead.
- [Teacher Slides](#)- Adaptation

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