

Using authentic data to analyze genetic variation in Antarctic sea stars.

Research Theme: To help students be able to generate and analyze their own questions in order to make relevant connections between concepts in biology.

Lesson Rationale: We chose this lesson so that students can interact with authentic science data as a way of introducing the connection between genetics and evolution. Students will see an example of evolutionary evidence. Students will also gain insight into the process of scientific questioning practices and collaboration.

Context of lesson:

Prior learning: Students will know that genes control the expression of traits. Students know how to construct cladograms in order to see and connect genotypic and phenotypic relationships.

Subsequent learning: This lesson is an introduction to evolutionary relationships.

Relevant Next Generation Science Standards:

Disciplinary Core Idea LS3.B: Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.

Key NGSS Science and Engineering Practices

#1 - Asking Questions and Defining Problems

#4 - Analyzing and Interpreting Data

Research Lesson - Instructional Sequence

	Learning Activities	Anticipated Student and Teacher Responses	Points to notice
A	Attention Grab/Warm up: “Imagine you are a researcher in Antarctica, what would you study? What would you want to ask Dr. Wilson?”	Students likely to mention snow/ice/penguins/polar bears. Teacher charts student responses on the board.	What research topics do students come up with?
B	PowerPoint and video of research expedition: Antarctica, the ship, the sampling process, and Antarctic invertebrates.	Students watch and ask questions	Do students understand that the lesson they are engaging in today is based on “real” science?
C	Teacher passes out a set of Antarctic invertebrate photos to each group. Students observe pictures of 5 different Antarctic invertebrates.	What kind of observations can you make about the organisms in these pictures? 1. What characteristics do they share, 2. What is different about them? EXTENSION OF WARM-UP “What I observe” Students share out responses.	Do students mention adaptations to Antarctic environment?
D	Project the essential question at front of room: “If you wanted to know how related these organisms are from different sampling sites, what questions would you ask? What might you ask Dr. Wilson?” Look at “BOX A” Questions SET “A” Pictures	“Question generating process” -Students first write responses individually on 4 boxes document and put a “box” around their “best answer” -Chart paper given out and students replicate “4 boxes” in large format -Students chart their best question onto CHART PAPER BOX A. - Student share their individual best questions verbally with group - Groups come to consensus and box their one “best question” as a group. SHARE OUT and/or CHART RESPONSES AS A CLASS	<i>What kinds of questions do students ask: about physical appearance? What do they ask about genetics? What do they ask about physical distance between sampling sites? (students are recording in box A)</i>

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E	Teacher passes out a set of sea stars photos to each group.	<p>“Now look at the sea stars...”</p> <p>If you wanted to know how related sea stars are what questions would you ask? Think About This...</p> <ul style="list-style-type: none"> • What observations can you make about them • What characteristics do they share • What is different about them <p>“Question generating process” repeated: -Students write responses individually and chose personal “best question.” -Students chart their questions/response onto CHART PAPER BOX B and share verbally. -Students come to consensus and box their best question. -Students GALLERY WALK and examine questions from each group, while reflecting on their own questions.</p>	(what are students recording in box B on their own paper chart, what are students talking about during gallery walk?)
F	Set of sea star photos – arranging visually (If end of day 1, exit slip: “What questions did you hear or read from others and how do they compare to your own?”)	Arrange the 5 photos of the sea stars based on how they <u>visually</u> appear to be related. Draw a diagram to represent your sea star arrangement on the back of the “4 boxes” document.	
End of day 1 for classrooms on a traditional bell schedule (~60 min periods)			
G	Pass out Genetic Data table (one data table per student)	<p>“Now look at the data of the sea stars. What information does this table tell you?”</p> <p>Student annotate the data table</p> <p>“Question generating process” repeated: -Students write responses individually and chose personal “best question.” -Students chart their questions/response onto CHART PAPER BOX C and share verbally. -Students come to consensus and box their best question.</p> <p>SHARE OUT and/or CHART AS A CLASS</p>	

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H	Questions Based on Genetic Data table	<ul style="list-style-type: none"> - Using the data, physically group sea stars based on how related they are. (as a group) - Clarify that the smaller the number on the data table, the closer the genetic linkage between sea stars. - Rearrange your previous grouping of sea stars if necessary. Draw a diagram to represent this arrangement on the back of the "4 boxes" paper under "hypothesis 2" 	
I	HAND OUT MAP Note: Have students keep sea stars arranged on table.	<p>Compare your grouping of the sea stars that you made on the table to their location on the map.</p> <ul style="list-style-type: none"> • What do you notice about the genetic data and their location on the map? • What questions do you now have? • What are you surprised about? What matches your prediction and what questions do you still have. <p>"Question generating process" repeated: -Students write responses individually and chose personal "best question." -Students chart their questions/response onto CHART PAPER BOX D and share verbally. -Students come to consensus and box their best question.</p> <p style="text-align: center;">SHARE OUT and/or GALLERY WALK</p>	
J	CONCLUSION IN BOX E	<p>Have students put a box around their best piece of evidence. Have each person share their own best piece of evidence.</p> <p>Question: "Based on your observations, data, and questions which sea stars are more closely related. Cite 3 pieces of evidence."</p> <p>A few students come to the front of the room to display their written conclusion under the document camera and to read their conclusion out loud to the class.</p>	<i>Box E is the conclusion of the lesson.</i>
K	Exit Slip/Reflection (Individual)	<p>Which questions do you think helped build your conclusion? Why do you think this?</p> <p>Concluding Questions: How might these questions relate to the idea of "how organisms change over time"</p>	On separate partial page.