*Lesson Title: Comparison of Aquatic Microbe Communities*

*Grade level=* High*\_X\_ Amount of time for this lesson = This lesson is broken down into two days: one 90 minute day for test site data collection, one 50 minute day for data analysis and research.*

Standards and Safety and Materials:

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| A. Standards - (Both Wyoming and NGSS. Number and write it out)  |  **Physical Science**:* **HS-PS1-6:** Refine the design of a chemical system by specifying a change in conditions that would produce amounts of product at equilibrium
* **HS-PS1-5:** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs
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| B. Safety Concerns: If none – “minimal safety concerns with regular class activity”  | * Since this lesson involves a small field trip to a nearby water source, please follow all the guidelines set in place for safe transportation or other methods of moving a group of students.
* Once at the site, there are concerns with the type of equipment handling that need to be addressed.
* Choose a shallow pond or stream bank for students to work on to avoid getting wet or potential drowning.
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| C. Materials (List of all materials needed for class including **technology** – like probes, tools, computer use, etc…)  |  Day One Supplies:-meter stick -measuring tape-stop watch -thermometer-secchi disc or homemade version -bright colored ball-pH meter -chemical test kits (D.O, CO2,-TDS meter (if applicable) phosphate, nitrate, sulfate) Day Two Supplies:-Internet-Chromebooks/laptops-Data Corral |

Objectives: (List them and make sure all are measurable! **Bold** the verbs. Three different levels!) Students will be able to…

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| A. SWBAT… ***use*** *a measurable verb*  |  SWBAT measure characteristics of a pond or other water site. |
| B. SWBAT…  |  SWBAT use their collected data from their water site to predict what microbes could be living in the water with use of Data Corral tool. |
| C. SWBAT…  |  SWBAT support their conclusions with articles, journals, and other research based evidence from the scientific community. |

Connections, Misconceptions, and Crosscutting Concepts:

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| A. Real world connections: (List them; e.g. Careers, Societal issues, etc…)  | People in agriculture have to be aware of the microbes in the water that can potentially be ingested when swimming or other leisurely water activities. People should also be aware that these microbes can be ingested by fish, and when consumed by humans can potentially cause a foodborne illness. It is important to recognize the strong characteristics of how these microbes survive, and which deadly microbes survive in to avoid any unwanted and severe illnesses.  |
| B. Student connections: (List them; With what do they connect? Music, food, etc…)  | Students, especially in a very country setting, often visit lakes and other water sources for fun and to fish.  |
| C. Misconceptions: (List those AAAS misconceptions related to your content)  |   |
| D. Crosscutting Concepts: (List them and explain how they are used – e.g. patterns, cause/effect, scale/proportion/quantity, systems/system models, energy/matter, structure/function, and/or stability/change)  | **Patterns:** Students will be able to see and predict patterns of how certain characteristics of an ecosystem can give way to certain microbe populations and communities. **Scale, Proportion, and Quantity:** Students will measure the chemical and/or physical characteristics of the water source. This will help them see that the proportions and specific quantities of the things they measured are required for certain microbial life to exist in these water sources.**Cause and Effect:** Students can predict and explain how certain water conditions (cause) can give rise to certain microbial types (effect).**Stability and Change:** Students can research what range of conditions their microbes can live at in a stable environment, and also outside of that stable environment, if a change in a certain condition were to arise, there would be a change in the microbe population and/or community.  |
| E. Academic Language: [List the words/prefixes/suffixes that are addressed (focus on science vocabulary as well as instructions such as analyze, compare/contrast, etc…). *What* will the teacher do? *How* does the teacher address the words/prefixes/suffixes? *How* does the teacher get students to use those words, prefixes, and/or suffixes?]  |  Microbe, transparency, secchi disc, viscosity, pH, carbon, nitrogen, oxygen, phosphate, nitrates |

Catch/*Engagement*: (Hook them quickly – use all 5 senses at different times – should be no longer than 5 minutes.)

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| Hook: How to get student/class attention  |  Write: Field Day on the board! |

Pre-test: (Same as post-test and short – to the point… **Bold** the objectives you are using – same as above!)

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| Pre-test and Post-test question(s) Put the pre-test at the end of this day’s lesson plan (along with PowerPoint etc…)!  |  Pre/Post-Test Physics:* Give surface area, temperature conversion, velocity, and discharge rate practice problems

 Pre/Post-Test: Chemistry:* Give pH calculation, and chemical conversion problems (ie. Nitrate to Nitrite, Oxygen to Carbon Dioxide)
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Activity/*Exploration*: (**Bold** the verbs that match the objectives. Can have as many parts as needed – step by step directions. *(Remember: Include at least 1 science writing activity and probe activity for the unit!)*

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| Beginning of lesson  |  **Pre-Test*** See above for recommendations for your content area
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| Day One: Measuring Microbe Ecosystems |  **Physics** **Procedure**: 1. **Site Characteristics**
	1. As completely as possible, record the site information that you see visually on the top part of the provided DataSheet.
	2. Use the equipment provided to measure the following physical and chemical characteristics of the site.
2. **Dimensions**
	1. Estimate the surface are
3. **Temperature**
	1. Record the temperature of the air and surface of the water with a thermometer
		1. Be careful to note weather your temperature sites are in the sun or shade
4. **Transparency**
	1. Record the max depth
		1. Use secchi disc or homemade secchi disc to determine accurate transparency
5. **Velocity** (streams only)
	1. Record rate of velocity by having one student stand 10m upstream and drop a brightly colored ball into the water. Another student records the time it takes to get to them 10 m downstream.
	2. Find the average stream velocity by repeated 3 times

**Chemistry Procedure:**1. **Site Characteristics**
	1. As completely as possible, record the site information that you see visually on the top part of the provided DataSheet.
	2. Use the equipment provided to measure the following physical and chemical characteristics of the site.
2. **pH Test**
	1. Standardize the pH meter using a standard buffer solution to get the pH to 7.0 range
	2. Follow instructions of the meter to record pH
	3. Alternatively, you can measure pH with a chemical testing kit or pH recording tape
3. **Measure Dissolved Oxygen**
	1. There are several different ways to perform this procedure, please pick the one that fits your school the most:
		1. Titration
		2. Dissolved Oxygen Meter
		3. Using Indigo Carmine and Rhodazine D to give a broad estimate using colorimetric methods
4. **Measure Carbon Dioxide**
	1. There are several different ways to perform this procedure, please pick the one that fits your school the most:
		1. Titration
		2. Dissolved Carbon Dioxide Meter
5. **Measure Total Dissolved Solids**
	1. This can only be done with a Pocket Tester to measure the TDS
	2. If your school does not have one of these, the experiment can still be performed without this data
		1. Or simply give the students estimated data
6. **Measure Nitrate, Phosphate, and Sulfate**
	1. Each one of these requires a separate test kit
		1. Please do your own research for what will best fit your school and classroom
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| Day Two: Research of Microbe Organisms  |  **Data Corral**1. **Predict**
	1. Use Data Corral to research what potential microbes can be in the water based off of your previous day’s data.
	2. Search through similar sites and times of the year that best fit when you collected your samples and data.
2. **Research and Write**
	1. Have students pick a microbe that they can potentially find in their site based off of their collected and analyzed data
	2. Research that organism and why it would be present at the given site, both from Data Corral and from the test site from lab
	3. Present findings as a written research paper
		1. Length TBD by teacher
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| Are lecture (<11 min), lab, etc… clearly explained? Are directions and student expectations explicit? *Did you do this? Yes or No*  |   |
| PowerPoints, lab sheets, notes, answer keys, etc… included? *Did you do this? Yes or No*  |  Supplemental Materials Include:* Lab Report Template
* Data Corral Website:
	+ DataCorral.uwyo.edu
* Research Paper Template
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Review/Essential Questions/*Explanation*: (Should be closely related to pre/post tests!)

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| A. Low Level Questions – (Knowledge/Remembering and/or Comprehension/Understanding)  |  Can you measure characteristics of a pond or other water site?  |
| B. Middle Level Questions – (Application/Applying and/or Analysis/Analyzing)  | Can you use the Data Corral tool to compare results? Can you predict what microbes could potentially be in the water?How can you use the Data Corral tool to showcase your findings? |
| C. High Level Questions – (Synthesis/Evaluating and/or Evaluation/Creating)  | Can you analyze microbe data collection? Can you articulate paragraphs to showcase your findings in a scientific manner? Can you make inferences about hypothetical scenarios (ie. temperature change)?  |

Assessments (Post-test)/*Evaluation*: (**Bold** the verbs that match the objectives and are in the activity.)

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| A. Formative: (Check for learning in class?) e.g. Oral questions?  |  Oral questions after day one of the data collection and analysis, as well as through results of the pre/post test.  |
| B. Post-test: ( “Same as pre-test”; Compare w/pre-test to inform teaching!)  |  Calculations based off of given content area.  |
| C. Summative: (Check for final learning/understanding) – e.g. Students turn in **constructed** project and **take** 20 question multiple choice test.  |  Students must write a TBD page paper on their chosen organism from Data Corral that could potentially be in the water of the test site based off of similar environmental, chemical and/or physical conditions of the water. The parameters of the paper can be set as follows or modified to fit the current discipline and setting of the classroom:1. Must be well-documented with at least 2 peer reviewed sources which support the data collected from the student
2. Must contain a clear connection as to why the student chose the organism from Data Corral to be used as their main focus based off the data they collected and analyzed from the test site
3. Must contain at least one diagram of collected parameters from the test site
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| D. Explain how the data informs tomorrow’s teaching. For example, “The class post-test average must be a 80% or the next class begins with a 10 minute review/discussion of today’s material followed by another post-test of the same material.”  |  Each of the days in this lesson build on each other. The information assimilated in Day One will fuel the students research through Data Corral as well as the test site. The data collection on Day One will ultimately lead them to the development of their research paper that will be turned in on the last day of the unit plan.  |

Timeline for your lesson:

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| A. Catch 2 min B. Pre-test 3 min C. Activity – 4 parts 40 min D. Review and Post-test 8 min Add/change as needed  |  This lesson is modified to fit one 90 minute for the data collection on day one, followed by one 50 minute day for data analysis and research.  Please plan and modify your lesson accordingly to your school schedule and classroom setup. |

Enrichment/*Elaboration*: (Include one enrichment activity for students that might finish early)

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| What enrichment activities are offered for students in this lesson (beyond what is taught)?  |  Students can possibly write up a condensed paragraph of their research paper to submit to the school newspaper, or class journal if applicable.  |

IEP Accommodations/Differentiation/Diversity: What accommodations will you use to support struggling learners?

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| What accommodations are used to support struggling learners?  |  Students will work in groups, so students who are struggling with their content will have a change to work at their Zone of Proximal Development and this learn at a higher level than they would if they were working alone.  Students who need more time completing the research and writing portion of the lesson can be given extra time either before or after school with help from the teacher to find sources that will support their group’s plan.  |

**Lab Report Template (focused for Physics, modify and adapt how you see fit)**:

Team Members: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (you)

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Data Sheet 1: Site Characteristics

Site Number: \_\_\_\_\_\_\_\_\_ Locality: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

State: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ County: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Time: \_\_\_\_\_\_\_\_\_\_\_\_

Water Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Sky Conditions: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Vegetation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Bottom: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Air Temp: \_\_\_\_\_\_\_\_\_°C\_\_\_\_\_\_°F Surface Water Temp: \_\_\_\_\_\_\_\_°C \_\_\_\_\_\_\_°F

Transparency: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Color: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Max. Depth (pond): \_\_\_\_\_\_\_\_\_\_\_meters Stratified: yes ( ) no ( )

Thermocline depth\_\_\_\_\_\_\_\_m.

Stream Width (m): 1\_\_\_\_\_, 2\_\_\_\_\_, 3\_\_\_\_\_, 4\_\_\_\_\_, 5\_\_\_\_\_. Ave. Width: \_\_\_\_\_\_\_\_

Stream Depth (m): 1\_\_\_\_\_, 2\_\_\_\_\_, 3\_\_\_\_\_, 4\_\_\_\_\_, 5\_\_\_\_\_. Ave. Depth: \_\_\_\_\_\_\_\_

Stream Cross Section (m): \_\_\_\_\_\_\_\_\_\_

Velocity of Flow (distance = 10 m):

Trial 1: \_\_\_\_\_\_\_\_\_\_ sec. Trail 5: \_\_\_\_\_\_\_\_\_\_ sec.

Trial 2: \_\_\_\_\_\_\_\_\_\_ sec. Ave. \_\_\_\_\_\_\_\_\_\_\_ sec.

Trial 3: \_\_\_\_\_\_\_\_\_\_ sec. Ave. \_\_\_\_\_\_\_\_\_\_\_ m/sec.

Trail 4: \_\_\_\_\_\_\_\_\_\_ sec.

Discharge Rate (ave. cross section x ave. velocity): \_\_\_\_\_\_\_\_\_\_m3/sec.

**Research Paper Template:**

Paragraph of Your Collected Data from Test Site

Paragraph of Collected Data from Dara Corral

Paragraph of How the Two Are Related

Paragraph of What Microbe is Chosen: Who, What, Why, When, Where, How

Paragraph(s) of Stability and Change: What would happen to your organism if certain factors in your water source would change? What is the potential range of environmental conditions that your microbe can live in? What do you predict would happen if your organism was completely removed from the water source ecosystem (cause and effect)?

Conclusion

References