Lesson Plan Outline

*Lesson Title: \_\_Extremophiles\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

*Grade level =*  Can be adapted for 6th- 12th  *Amount of time for this lesson =* 150 minutes of instruction/activity

1. Standards and Safety and Materials:

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| A. Standards - (Both Wyoming and NGSS. Number and write it out) | HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.  HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.  HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.  HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.  Science and Engineering Practices   * Developing and using models * Planning and carrying out investigations |
| PB. Safety Concerns: If none – “minimal safety concerns with regular class activity” | Minimal safety concerns, but students should wear old clothes to participate in art activities.  Additionally, depending on student age, teacher may decide to heat set finished silk batiks on their own, or allow students to use the iron. |
| C. Materials (List of all materials needed for class including **technology** – like probes, tools, computer use, etc…) | - stretched silk  - fabric dye  - Resist glue  - charcoal  - paper towels/paper plates  - iron  - ice cube trays for dye or plastic palate  - pipettes or droppers for transferring dye  - paintbrushes of varying sizes  - laptops/tablets for research |

1. 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* | **Identify** the various habitats of an extremophile |
| B. SWBAT… | **Distinguish** the ways in which an extremophile has adapted to its environment |
| C. SWBAT… | **Create** a silk batik model of an extremophile, highlighting its extreme habitat in some way |

1. Connections, Misconceptions, and Crosscutting Concepts:

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| A. Real world connections: (List them; e.g. Careers, Societal issues, etc…) | Connections to geography- have students been to Yellowstone and seen the beautiful colors in the pools from the extremophiles? Have they been to a chemical pit near an old mine or extraction site? Or have they visited a glacier? |
| B. Student connections: (List them; With what do they connect? Music, food, etc…) | Connections with space! Does life exist past this planet? |
| C. Misconceptions: (List those AAAS misconceptions related to your content) | MOM002: A model is always a three-dimensional object. Therefore, pictures, diagrams, graphs, written descriptions, abstract mathematical or conceptual models are not models. (Grosslight, et. Al., Penner et al., 1997; Treagust, et al. 2002; Schwartz & White, 2005). 36% grades 6-8; 43% grades 9-12.  CEM005: There are no single-celled organisms (AAAS Project 2061, n.d.). Grades 6-8 39%; Grades 9-12 30%.  CEM045: Bacteria do not carry out essential life functions for themselves. Grades 6-8, 41%; Grades 9-12, 35%.  ENM051: Species that have no apparent, obvious, or superficial similarities have no similarities at all (see Shtulman, 2006). Grades 6-8, 39%; Grades 9-12, 32%. |
| 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) | Students will develop a silk batik model, and use this model as a basis for investigation. These questions can lead discussions as students complete their art project.  What do extremophiles use for energy? How does their environment affect their metabolic pathways?  What cell structures have they developed to be able to function is such a extreme environment?  How are they able to create and maintain homeostasis? |
| 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?] | Students will watch a video with the vocabulary, and then it will be reviewed on the board in a cold call session when students are reading the short preview on extremophiles, What are Extremophiles?, listed below. Vocabulary will be added to a word wall, or student’s personal dictionary, and students will make contributions as they complete their work. Some of this vocab may be new or review depending on grade level, and can be excluded or simplified.  Archaea  Haliophiles  Thermophiles  Acidophiles  Psycrophiles  Salinity  Pressure  pH |

1. 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 | YouTube Video on extremophiles, three options:  Tiny Extremophiles Living in Rocks! <https://www.youtube.com/watch?v=U9YoHJJLsbE>  Extremophiles: We are the Aliens  <https://www.youtube.com/watch?v=y3GF3PFNx8Y>  Why Extremophiles Bode Well for Life Beyond Earth  <https://www.youtube.com/watch?v=Bsp5JYNMAQE> |

1. 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…)! | What do all organisms need to survive?  What is the definition of a microbe?  Where do you think of when you think of extreme conditions? |

1. 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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| 1. Beginning of lesson | Hook: YouTube Video |
| 1. Middle of lesson | Have students read the short introductions found here:  What are Extremophiles?  <https://lco.global/spacebook/what-are-extremophiles/>  If students are late high school, this is an abstract options for practicing reading scientific writing:  Extremophiles: An Overview of Microorganism from Extreme Environment <https://www.researchgate.net/publication/261547855_Extremophiles_An_Overview_of_Microorganism_from_Extreme_Environment>  Student should complete an KWL chart, or continue one from a previous lesson on microbes. What do they know about salinity, pressure, temperature, and pH? Where do they find examples of each extreme environment? Create a classwide chart on the board listing examples of extreme environments.  What do they want to know? Students may need guidance here. What do these microbes do for food, or how do they keep their cytoplasm from freezing or boiling? This discussion complexity may vary based on grade level.  Have students create groups of three. Each group should pick one of the geographic areas and explain what type of extremophile they would likely find there. At this point, they should research the species that live there and select an image.  The lesson will transition into the art segment. Instructor will introduce silk batik method and have students gather their materials from the back of the classroom after receiving initial oral instructions on completing the silk batik steps. They will receive written directions additionally for them to refer back to as they complete the project. They will be allowed to experiment with the silk and dye as they figure out a way to crop their photo to create a group image. Students should spend the rest of this class period drawing out an outline, creating resist lines, and experimenting with the sampler silk batik.  Depending on if this is a block period, students can then complete some additional research as they wait for the resist to dry. Otherwise, their art can dry until the next period.  After drying, they will paint their silk batik and complete their research/ presentation. The silk will need to dry after painting, and then be rinsed and dried again before being heat set. Depending on the timing, students can either present in class, or if it makes more sense timewise while they wait for aspects of their project to dry, they can create a video of their presentation to show on the final day.  Another website resource that might help students as they begin with their general research is:  What are Microbes?  <http://learn.genetics.utah.edu/content/microbiome/intro/> |
| 1. End of lesson | Students will present their art and corresponding research in either an in-class presentation or in a video. |
| 1. Are lecture (<11 min), lab, etc… clearly explained? Are directions and student expectations explicit? *Did you do this? Yes or No* |  |
| 1. PowerPoints, lab sheets, notes, answer keys, etc… included? *Did you do this? Yes or No* |  |

1. 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) | What is an extremophile?  What are some examples of extreme environments? |
| B. Middle Level Questions – (Application/Applying and/or Analysis/Analyzing) | How does the existence of extremophiles suggest there might be life in space?  What adaptations are easier to make: adaptations to pH or salinity, or to extreme temperature or pressure? Why?  Why are most extremophiles from archaea? |
| C. High Level Questions – (Synthesis/Evaluating and/or Evaluation/Creating) | What might an extremophile need to be able to thrive in space?  What adaptations would you give an extremophile that you wanted to send to Mars? The moons of Saturn or Jupiter? |

1. 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? | Why are extremophile important?  Why are most extremophiles from archaea? |
| B. Post-test: ( “Same as pre-test”; Compare w/pre-test to inform teaching!) | What do all organisms need to survive?  What is the definition of a microbe?  Where do you think of when you think of extreme conditions? |
| C. Summative: (Check for final learning/understanding) – e.g. Students turn in **constructed** project and **take** 20 question multiple choice test. | Constructed project/presentation will be assessed according to attached rubric, which will include a finished art project, a peer evaluation, and a class presentation or video. |
| 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.” | Students KWL charts will be reviewed during class time to check for understanding, to direct students research, and/or discussions that might be carried out during the art activity. |

1. Timeline for your lesson:

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| A. Catch 4 min  B. Pre-test 3 min  C. Activity – 4 parts around 120 min  D. Review and Post-test 8 min  Add/change as needed | Time will depend on presentations and number of groups. It will also depend on period length. |

1. 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 elaborate on their presentation, and follow one of the following interest topics at the digression of the instructor:  -they can design their own extremophile used adaptations they’ve researched to create an extremophile that may be able to live in space  -they can explain where else in the universe (on what planet or moon) their focus microbe may exist. Why would it be well suited to live there?  -they can look into the extreme conditions theorized to exist at the beginning of life on earth and research the connection between archaea then and archaea now. |

1. 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 be placed in groups that will set them up for success. Since this group work/research will free the instructor up to roam the room, they can provide additional support as needed. Students can be encouraged to delegate different tasks within the presentation as is appropriate to the student’s specific needs. |

Resources:

Microbes: <https://docs.google.com/document/d/1aWNJjY0nEErwvJ0yzO9LqThKU8R6TSdwx7Y92dEZMe0/edit?usp=sharing>

Worksheet and Rubrics for Project and Presentation:

<https://docs.google.com/document/d/15qcj39YWsLGRXGoOfBP7JBwO33STda0R7ZWWFBpCi8g/edit?usp=sharing>

This Google doc can be copied and modified for use to accompany this lesson.

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