LRES 557/MB 547: Thermal Biology in Yellowstone National Park
Essential Learning Expectations and Questions

Learning outcomes:

a. Students will learn about and be prepared to teach the following topics: Review different life forms and the physical and chemical habitats that define their environment.
b. Understand what biodiversity is and the importance of its role in the Greater Yellowstone Ecosystem.
c. Understand at a basic level the ecology of a variety of life forms in thermal habitats,
d. Experience characterizing several geothermal habitats.
e. Recognize the fundamental principles of thermal biology, in addition to the methods of chemical, physical and biological analyses,
f. Recognize the function of microbial energy and biotechnology that pertains to extremophiles.
g. Utilize observational techniques and hands-on activities appropriate for science educators,
h. Use well planned questioning strategies appropriate for students and subjects taught,
i. Use formative assessment tools to create more meaningful learning experiences for students.

Course Materials:
Living Colors: Microbes of Yellowstone National Park

Course work:
This five day course will expose students to range of microbiology topics and labs. Students will experience a two day, overnight, field trip to Yellowstone. At the end of the course, students will present their lesson plan and share how they plan to use the curriculum materials and student activities.

Grading Scheme:
35% Class participation
15% Student work collected throughout course
50% Final project

100-90 is an A, 80-89 is a B, 70-79 is a C, 60-69 is a D, less than 60 is an F

Essential Learning Expectations (ELE) I:

j. Review different life forms and the physical and chemical habitats that define their environment.
k. Understand what biodiversity is and the importance of its role in the Greater Yellowstone Ecosystem.

Essential Questions *ELE* I:

- How do systems, structures (form and function) and behavior patterns of organisms enable them to survive and interact with their environment?
- How is life interdependent on the earth's conditions or other life?
- What is the significance of the 3 branches of life? Why should all science instruction be "modernized" to include Archaea?
- When we say biological tolerance, are we using a human bias to make this somewhat subjective?
- What are the 3 Principles that biodiversity relies upon?
- There are many environmental challenges facing the world today. How significant is species extinction in the face of these other issues?
- Why is it important to conserve biodiversity? What are the consequences if we don't?
- What would happen if the microbes disappeared from Earth?

- What would happen to the microbes if we disappeared from Earth?
- In what ways do organisms indirectly affect biological communities?

Essential Learning Expectation II:

a. Understand at a basic level the ecology of a variety of life forms in thermal habitats,
b. Experience characterizing several geothermal habitats.

Essential Questions *ELE* II:

- How do microbes alter chemicals in specific ways?
- What gives an extremophile its unique qualities?
- What gives bacteria its unique qualities?
- What gives archaea its unique qualities?
- Why are their adaptations unique?
- How do chemical environments interact with these microbes?
- How is it that microbes may offer insight into past and to life on other planets?
- How can we use what we understand about the biology to do novel chemistry that we can't do otherwise?

Essential Learning Expectations III:

a. Recognize the fundamental principles of thermal biology, in addition to the methods of chemical, physical and biological analyses,
b. Recognize the function of microbial energy and biotechnology that pertains to extremophiles.

Essential Questions *ELE* III:

- How do developments in science and technology affect our lives and where we live?
- How does our understanding of chemical, biological and physical science help us explain the connections among matter, time, space & energy?
- Is this intrusive research? How can you manage something if you don't know what it is?
- How can microbes be used to affect people's lives now?

Essential Learning Expectations IV:

a. Utilize observational techniques and hands-on activities appropriate for science educators,
b. Use well planned questioning strategies appropriate for students and subjects taught,
c. Use formative assessment tools to create more meaningful learning experiences for students.

Essential Questions *ELE* IV:

Consider the following questions and discussions that might be appropriate for a class you have taught in the past or a class you may be teaching in the future:

- How did life begin, how has it changed and how might it change in the future?

- Why is it necessary for people to familiarize themselves with the complexity of the Earth's organisms and its enormous variety of ecosystems?

- How is interdisciplinary problem-solving now necessary when asking fundamental questions from myriad disciplines e.g. biologists, microbiologists, geomicrobiologists, physicists, ecologists, virologists, etc?

- In the developed world, where the majority of people live in urban and suburban environments, a sense of alienation from wild nature is quite common. Given that this is the case, how difficult is it for people to feel alarmed about the perilous state of the Earth and its disappearing species,

encroaching oceans, and melting ice caps? What sort of leap of the imagination do people have to make to become committed environmentalists? Do most people in America think about how their consumer behaviors, for instance, affect people, animals, and nature in biologically threatened areas of the developing world?

- The question of whether or not we should up our efforts to save the biodiversity we still have may very well come down to an aesthetic appeal if it is to have any impact on a person that does not care for other species. Do you prefer to live in a natural world, and do you think future generations should continue to have that option, or are you okay with the increasingly synthetic world that we build ourselves, discarding the prosaic remnants of Darwin's grand idea as we barrel along?

- Are you hopeful/doubtful about the future of biodiversity? Why do you feel this way?

- Why is it important to conserve biodiversity? What are the consequences if we don't?

- Are some species more critical to conserve than others, and how can we (or ***who*** are ***we*** to) make those decisions?

- Do you think our world leaders are prepared to deal with the challenges in conserving biodiversity? Can we turn this global challenge into opportunity?

- What do you see as the role of "citizen scientists," such as Earthwatch volunteers, in the future of conservation?