

Syllabus for Center for Dark Energy Biosphere Investigations (C-DEBI) Online Workshop

Course title: Beneath the Deep: The science of life below the sea floor

Semester: Fall 2013

Credit: One graduate credit for a minimum of 12 hours contact time

Dates and times: Monday November 4 - Friday December 6, 2013

This is an on-line course presented in asynchronous interactive format during two weeks, with three additional weeks for curriculum review and lesson plan development. During the asynchronous interactive component, from Monday November 4 - Friday November 15, participants may log on to the course web site at any time and post questions and comments. Scientists will respond to participants' questions and participate in discussions on the course web site during those weeks.

Course materials for educators, including background information, readings, lesson plans, and web site links, will be posted on line throughout the course. During each week of the course, additional materials and resources will be added to the course web site.

Participants earning credit must log at least 12 hours on the course web site during the course. The College of Exploration course software can be used to track individuals' time logged in to the course web site to verify hours.

Location: This is an on-line course, so participants can join from any location where they are connected to the internet.

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Course Description:

Ocean scientists are starting to explore extreme environments, and they are finding life in amazing places - even far down in the sediments and rocks of the sea floor. In this on-line course participants will learn about "intra-terrestrials," microbes that are expanding our understanding of where life can exist on earth, and even providing reference points for life in extreme environments to aid in the search for life on other planets.

During the course, participants will interact on-line with marine scientists who study microbial life in extreme ocean environments. Participants will be able to correspond with C DEBI scientists in person during the course as they learn about the hostile environments where the deep subsurface microbes survive, and the unique adaptations that allow them to persist there.

In the first week, participants will view lectures by Dr. Jan Amend and Dr. Brandi Reese, scientists from the Center for Dark Energy Biosphere Investigations (C DEBI). Dr. Amend will introduce the extreme environments where microbes are being studied and some of the surprising discoveries that have already been made. "Where microbiology gets really exciting is in the functionality of these organisms" Dr. Amend observes. "What can they do? What environments do they live in? How can we learn more about evolution by studying them?"

Dr. Reece will describe her research on the active sub-seafloor microbial community and how it interacts with the geochemical environment, including a comparison between chemosynthesis and photosynthesis. Dr. Reece comments, “It is estimated that a majority of the Earth's biomass is located within the ocean sediments, so it is cycling massive amounts of carbon and nutrients important for life.”

During week two, participants will meet Dr. John Kirkpatrick and explore the methods and technology used to sample and study microbes from the deep biosphere. They will study how the Center for Dark Energy Biosphere Investigations is contributing to our understanding of evolution and the extreme conditions at which life can survive. Participants will learn how the C DEBI team approached the problems of studying microscopic life forms miles below the ocean surface and hundreds of feet down into the ocean floor sediments.

Weeks one and two will each include keynote presentations, posted collections of resources for teaching community college or high school, individual interactive on-line discussions with scientists, and discussions with instructors on teaching ideas and materials. Participants may visit the course web site at any time during the first two weeks of the course to submit questions and participate in interactive discussions with the scientists.

In weeks three and four of the course, additional resources and lesson ideas will be posted, and participants will work with the instructor to review and learn more about the topics, and choose a topic for use with their own students. The web site will remain freely accessible after the end of the course, and participants may view or download materials at any time.

The course is designed for community college instructors and high school classroom teachers. This course will include sets of resources assembled especially for community college instructors of biology, microbiology, marine science, chemistry, and Earth science, with additional sets of resources for high school teachers of biology, integrated science, earth sciences, and technology. In addition, participants can choose to participate in a discussion forum on the topic of attracting students from underrepresented groups into science. The final week of the course will be dedicated to lesson plan development.

Participants earning credit for the course will be required to read or use specific materials, participate in on-line discussions, log at least 12 hours using course materials during the course, and submit one lesson plan by **Friday December 6, 2013**.

Learning Objectives

1. Participants will be able to describe two extreme ocean habitats where microbes have been found.
2. Participants will be able to identify two specialized instruments used to collect microbes from extreme ocean environments.
3. Participants will be able to describe how the metabolism of chemosynthetic deep ocean microbes differs from that of photosynthetic organisms.
4. Participants will be able to provide examples of how research on ocean microbes relates to health science, evolution, and the search for life on other planets.
5. Participants will be able to use information and resources about sub seafloor microbes as part of classroom lessons.

Course Expectations

Participants taking the course for credit will be expected to:

1. Log in to each “room” (page) of the on-line course web site, and spend a total of at least 12 hours logged in to the course web site by the end of the course.
2. Complete and post assignments, including responses to questions, each week.
3. Post at least one question for the scientist and one discussion comment each week.
4. Develop one lesson plan based on material presented in the course (see lesson plan guidelines below). The lesson plan will be **due Friday December 6, 2013**.
5. Communicate with the instructor at least once per week during the course.

Course Outline

Week 1 Extreme environments in the ocean and other areas; physical and chemical factors in extreme environments; the sub-seafloor microbial community and how it interacts with the geochemical environment; chemosynthesis vs. photosynthesis.

Interactive discussions with Dr. Jan Amend and Dr. Brandi Reece, C-DEBI at University of Southern California, Los Angeles

Curriculum materials: Readings, lesson plans, activities, and resources will include background on microbes and domains of life; ocean zones and habitats; the chemistry of deep ocean microbial life; and characteristics of extreme ocean environments.

Week 2 How life in the deep biosphere is studied; how microbes survive in the extreme conditions found there; microbial evolution; relevance of C DEBI research for studying human health and the search for life on other planets.

Interactive discussions with Dr. John Kirkpatrick, C-DEBI at University of Rhode Island Graduate School of Oceanography

Curriculum materials: Readings, lesson plans, activities, and resources will focus on the deep biosphere; how scientists first learned of life below the sea floor; how microbes are being used to study evolution; how scientists ask and answer questions using technology; and how to find student-friendly information and lessons about these microbes.

Course Materials

Web sites for C DEBI project and scientists:

Center for Dark Energy Biosphere Investigations <http://www.darkenergybiosphere.org/>

C DEBI scientists <http://www.darkenergybiosphere.org/about/who.html>

References and resources for teaching about ocean observing systems: this is a basic list; an extensive annotated list of relevant web sites will be posted each week of the course.

Adopt a Microbe http://adoptamicrobe329.blogspot.com/p/adoption-center_18.html

C-MORE Center for Microbial Oceanography Research and Education

Microbial life in the water, with a focus on linking genetic similarity to similar environments
<http://cmore.soest.hawaii.edu/education.htm>

Introducing microbial life “What microbe am I?”

<http://cmore.soest.hawaii.edu/education/teachers/index.htm>

Tagging a microbe

<http://oceanleadership.org/education/deep-earth-academy/educators/classroom-activities/grades-9-12/tagging-a-microbe/>

"Is Life Thriving Deep Beneath the Seafloor? Recent discoveries hint at a potentially huge and diverse subsurface biosphere". By Carl Wirsén, Oceanographer Emeritus Biology Department Woods Hole Oceanographic Institution

http://www.usc.edu/org/cosee-west/Nov30_2011/2004Life%20beneath%20sea%20floor.pdf

"Evolution in Action: a 50,000-Generation Salute to Charles Darwin" By Richard E. Lenski

http://www.usc.edu/org/cosee-west/Nov30_2011/Evolution%20Lenski.pdf

"Colonization of subsurface microbial observatories deployed in young ocean crust" By Beth N. Orcutt, Wolfgang Bach, Keir Becker, Andres T. Fisher, Michael Hentscher, Brandy M. Toner, C Geoffrey Wheat and Katrina J Edwards

http://www.usc.edu/org/cosee-west/Nov30_2011/Microbiol_2011_Orcutt.pdf

Three Domains of Life

http://www.usc.edu/org/cosee-west/Nov30_2011/Three%20domains%20of%20life.pdf

Redox Tower

http://www.usc.edu/org/cosee-west/Nov30_2011/Redox%20Tower.pdf

Center for Microbial Ecology at Michigan State University

<http://commtechlab.msu.edu/sites/dlc-me/>

<http://microbezoo.commtechlab.msu.edu/zoo/>

American Museum of Natural History

<http://www.amnh.org/nationalcenter/infection/index.html>

An informative 2-minute animation about ocean microbes

<http://thew2o.net/ocean-space/>

Resources for teaching about microbes

<http://serc.carleton.edu/microbelife/k12/LIMW/teaching.html>

The oceanography society special issue on ocean microbes

http://tos.org/oceanography/issues/issue_archive/20_2.html

Teaching ideas about marine bacteria

http://www1.coseecoastaltrends.net/modules/marine_bacteria/access_classroom_resources/

Animation of drilling and installing a CORK

<http://www.youtube.com/watch?v=stqhtI-N7eg>

Two short films of CORKs and deployment

<http://www.darkenergybiosphere.org/resources/toolbox.html>

Design specifications of the FLOCS <http://www.darkenergybiosphere.org/resources/toolbox.html>

Course requirements

1. Participants will be required to develop one lesson plan based on material from the course. A complete description of the components of the lesson plan will be provided for participants during the course.
2. Participants will submit their lesson via email by **Friday December 6, 2013**.
3. Participants must post responses to all questions posted weekly in the credit section of the course web site.
4. Participants will be expected to review resources and post their own suggestions for resources on the course web site.
5. Participants must submit at least one question and one comment for discussion to the presenting scientist each week.

Grading criteria

1. The lesson plan will count for 70% of the grade
2. Class participation including posting questions and comments each week will count for 15% of the grade.
3. Responses to weekly credit questions will count for 15% of the grade.

Please contact Pat Harcourt at pharcourt@gmail.com 508 215-9641 with questions or for more information