Opportunities for Undergraduate Students at BIOS

Fall Program

Bermuda Institute of Ocean Sciences
INSTITUTIONAL BACKGROUND

The Bermuda Institute of Ocean Sciences (BIOS) is a United States oceanographic research institution based in Bermuda. Founded in 1903, BIOS gained prominence after 1927 when the US National Academy of Sciences appointed the Lillie Commission to assess the needs of the US oceanographic research community. Bermuda was selected as a key “substation” because it is “truly oceanic in location” and therefore in “the best situation in the North Atlantic for investigation into the phenomena that are fundamentally characteristic of the ocean basins.”

Today, BIOS continues to conduct state-of-the-art oceanographic research with an emphasis on the North Atlantic Ocean and the coral reef platform of Bermuda. Because Bermuda is in the path of major ocean currents and in a region of significance with respect to climate change, BIOS’s research portfolio has global relevance. BIOS also leverages its core research to create unique educational programs at all levels—grade school through graduate school—many in collaboration with US universities (Princeton University, Furman University, Lehigh University, University of Rhode Island, Roger Williams University).
Bermuda is located in the sub-tropical Atlantic Ocean, some 600 miles from the coast of the USA. Located in the middle of the North Atlantic Ocean, Bermuda is uniquely situated to serve as a base for research on a variety of inland, coastal, and deep water issues of both local, national and global interest. From here, BIOS scientists can easily venture into the surrounding Sargasso Sea, one of the world’s most diverse open-ocean ecosystems. Bermuda is also home to some of the world’s most northern coral reefs, allowing researchers from around the globe an opportunity to study corals outside tropical waters.
2022 Fall Semester Program in Marine Biology

BIOS is offering a semester-long program in the fall of 2022 for marine science and biology students:

August 29 – December 9, 2022

Marine Invertebrate Zoology
Coral Reef Ecology
Research Diving Methods
Marine Biology & Oceanography Research

The 15-week fall program, taught by BIOS faculty, is for Junior and Senior students studying marine sciences who want to gain a “hands-on” introduction to marine biology in a truly immersive environment. The program consists of courses in Marine Invertebrate Zoology, Coral Reef Ecology, and Research Diving Methods, and an independent research module, Marine Biology and Oceanography Research, for which students conduct an independent, mentored research project.
Bermuda Institute of Ocean Sciences

Fall Program | Coral Reef Ecology (CRE)
Course Syllabus

COURSE LOCATION AND MEETING TIMES (subject to change due to weather and tides)

Lectures: Sunderman Room
Labs: Scott Lab
Contact: 1.5-2 full days per week for 12 weeks

Instructors: Dr. Eric Hochberg (BIOS) and Dr. Yvonne Sawall (BIOS)
Synopsis of Course Content
The Coral Reef Ecology (CRE) course studies the biology and ecology of tropical corals and coral reefs, and their interaction with the environment. This course covers the biological, physical, biogeochemical and evolutionary processes that determine reef growth, function and resilience, ranging from the organism to whole reef tracts. Topics include the processes of photosynthesis, respiration and calcification at the cellular, organismal, and community scale; biodiversity and determinants of community structure; examining trophic dynamics and species interactions; and reef resilience and acclimatization to environmental change, emphasizing processes of symbiosis, metabolism, reproduction and recruitment. Lectures will be complemented with field and laboratory exercises. Students will gain experience in coral reef research methods and monitoring of reef health, including benthic surveys, water quality analysis, and monitoring bleaching and disease. Laboratory experiments will focus on coral ecophysiology, including respiration, photosynthesis, and common coral tissue metrics.

Course Structure
The Coral Reef Ecology course is an integrated program comprised of lectures, precepts, laboratory exercises, field (snorkel and SCUBA) surveys, readings from the primary literature with attention given to active areas of research, and exercises to teach communication of science. The course typically consists of 18 lectures, 18 labs (including 10 snorkel/SCUBA dives), 6 precepts, and a workshop. The lab work includes conducting a coral ecophysiology aquaria experiment over several weeks and the results are written up in a scientific manuscript style. The various labs that are in the field culminate with a morning of oral presentations where students present their analysis and research on the data sets collected.

Course Requirements and Policies
- Field work will consist of boat work and the ability to work comfortably in the water with a mask and snorkel. Those who are SCUBA certified will be able to undertake fieldwork underwater and learn scientific diving skills (subject to completion of all BIOS as well as any home institution requirements).
- On-time attendance and completion of all assignments are required; Late assignments of any kind will not be accepted. The only exceptions to these policies are extenuating circumstances, to be considered on a case by case basis.
- If you are absent from a class, it is your responsibility to make up the missed materials.
- Any impropriety on exams, quizzes or written projects will constitute grounds for failing the course.
Grading Criteria
There is one quiz during the course on identification of reef biota. There is one lab report in the format of a short scientific paper summarizing the lab experiment, and one oral presentation summarizing data collected during fieldwork. A half-day workshop will be held that includes mini presentations. There are both a mid-term exam and a final exam that includes a cumulative section. The participation grade includes listening and participating in lectures and discussions, reading the required readings and lab protocols before lab and field trips, completion of all labs and data gathering, and entering all required data to the class spreadsheets by the assigned day and time.

Example grading contract:
Quiz 10%
Workshop 10%
Lab Report 15%
Presentation 15%
Mid-term Exam 20%
Final Exam 20%
Participation 10%
TOTAL: 100%

Reading Material
There is no set textbook for CRE. The following textbook is recommended for an overview before and during the course but it is not required: The Biology of Coral Reefs, edited by Sheppard, Davy and Pilling, Oxford University Press, 2009. There are copies available in the University Programs office for loan. BIOS’s library has an extensive collection of appropriate literature. Reading material from current literature will be assigned during the course.

Learning Outcomes
• Describe the principles of biotic and abiotic control on coral reef ecosystem structure and function.
• Describe the biology and physiology of corals and their interaction with the environment.
• Describe threats to coral reefs and management strategies.
• Describe the processes of reef resilience and acclimatization.
• Demonstrate a familiarity with laboratory protocols commonly used to describe and monitor coral function.
• Demonstrate a familiarity with basic coral reef research methods, including benthic surveys and water quality assessment.
• Demonstrate an understanding of the analytical and statistical methods commonly applied to reef science data, including interpretation and communication.
COURSE LOCATION AND MEETING TIMES (subject to change due to weather and tides)

Lectures: Sunderman Room
Labs: Scott Lab
Contact: 1.5-2 full days per week for 12 weeks

Instructor: Dr. Samantha de Putron (BIOS)
Synopsis of Course Content
Marine Invertebrate Zoology (MIZ) studies the diversity, biology and ecology of marine invertebrates. The comparative diversity of animal forms is investigated from a morphological and phylogenetic perspective through presentation of base concepts for each of the main invertebrate phyla. Course emphasis is on the morphology, development, physiology and life strategies of these invertebrates and their functional roles, interactions and adaptations within different ecosystems with a particular focus on tropical and sub-tropical taxa. Lectures are complemented with hands-on laboratory exercises and field trips to a variety of easily accessible, tropical marine habitats, including coral reefs, mangroves, seagrass beds, open ocean (planktonic) and rocky shores. Major environmental characteristics in the different habitats and the responses of the resident invertebrates will be examined and discussed, including anthropogenic threats and global climate change.

Course Structure
PART I: The Basics to Exploration: Diversity across a range of phyla
- Phylogenetics and evolution.
- Basic structure - morphology, development and growth.
- Physiology and life strategies - including feeding, reproduction, locomotion, symbioses.
- Importance - roles in ecosystems, communities, science.

PART II: Marine Invertebrates as Components of Communities:
- The role of marine invertebrates within, and adaptations to their ecosystem: coral reefs, rocky intertidal, planktonic, mangrove and seagrass communities.
- Response and resilience to environmental changes and anthropogenic threats.
- Applicative issues and management

The course is an integrated program consisting of lectures, precepts, discussions, field work (including snorkel/SCUBA) and lab work. Typically there are 24 lectures or discussion sessions, 6 precepts and 20 labs.

Course Requirements and Policies
- Some field work will be from a boat and the ability to work comfortably in the water with a mask and snorkel. Those who are SCUBA certified will be able to undertake fieldwork underwater and learn scientific diving skills (subject to completion of all BIOS as well as any home institution requirements).
- On-time attendance and completion of all assignments; late assignments of any kind will not be accepted. The only exceptions to these policies are extenuating circumstances, to be considered on a case by case basis.
- If you need to be absent from a class, it is your responsibility to make up the missed materials.
- Any impropriety on exams, quizzes or written projects will constitute grounds for failing the course.
Grading Criteria
Lecture/lab exams: The mid-term and final exams primarily cover material covered in lectures. The mid-term also has a small lab component.
Lab/field notebooks: Students will be provided with notebooks (binders) for all lab and field assignments. The assignments and worksheets will be posted in advance of the lab/field trip. Notebook entries typically include hand written observations, species lists, drawings of observed organisms and a short description of morphology and special attributes. Class data (such as abundances, diversity, size frequency) are typically collated to spreadsheets and the analyzed data are added to the notebooks. Grading of notebooks are on completeness (accurate and comprehensive responses to worksheets), presentation and organization.
Participation: The participation grade includes listening and participating in lectures and discussions, reading the required readings and lab protocols before lab and field trips, completion of all labs and data gathering, and entering all required data to the class spreadsheets by the assigned day and time.

Example grading contract:
Lab Book, Mid-term: 20%
Lab Book, Final: 20%
Exam, Mid-term: 25%
Exam, Final: 25%
Participation: 10%
TOTAL: 100%

Reading Material
There is no set textbook for MIZ. BIOS’s library has an extensive collection of appropriate literature including the following reference books, which are very useful for MIZ:


You can review these books in the library and, also, copies of the above books, along with the very valuable local identification books, will be stored in Scott Lab for your use.

Learning Outcomes
- Recognize and describe the characteristic features of the main invertebrate phyla covered.
- Discuss relationships between the major phyla from morphological and phylogeneitic perspectives.
- Describe the abilities and limitations to physiological processes and life strategies imposed by different body ‘architectures’.
- Describe the interactions among the various invertebrates within the different phyla and their roles within and adaptations to their environment across a range of communities.
- Appreciate environmental and anthropogenetic threats to marine invertebrates, as well as the application of their ecology in the management of natural resources.
- Develop a range of skills including practical and observational skills, record keeping, scientific drawing, data collection in lab and field (including in-water surveys), data analysis and interpretation.
COURSE LOCATION AND MEETING TIMES (subject to change due to weather and tides)

Lectures: Sunderman Room
Labs: Scott Lab
Contact: 1.5 days per week for 8 weeks

Instructor: Kyla Smith, BIOS Dive Safety Officer and Small Boats Manager
Synopsis of Course Content
Given the usefulness and increasingly common employment of SCUBA as a research tool for marine scientists, students possessing underwater research qualifications will enjoy a competitive advantage. The Research Diving Methods (RDM) course aims to familiarize students with the fundamentals of scientific diving, both theoretical and practical. Research methods and practices are taught in class by BIOS’s Dive Safety Officer, and then subsequently rehearsed on SCUBA during open-water sessions in the field. Underwater research techniques imparted include: navigation, search and recovery procedures, systems of data acquisition whilst underwater, and more specific survey methods such as estimation of populations. By the end of the semester, students will be qualified Science Divers, as defined by the American Academy of Underwater Sciences, of which BIOS is an organizational member. During the course students will also have the option to elect into further specialist PADI qualifications, such as Advanced Open Water and Rescue Diver.

Prerequisites: Students must already be SCUBA certified by a nationally-recognized agency, prior to arriving at BIOS. In order to be permitted to dive at BIOS, you must complete, and return to the Dive Safety Officer, various forms and meet certain medical safety standards, which will require physical examination from a health practitioner. The student dive package, including all such forms and supplemental information, can be downloaded from the BIOS website.

Course Structure
Theory (including but not limited to):
- Diver emergency care training.
- Dive rescue.
- Physics and physiology of diving.
- Introduction to diving environments, including specialized environments and conditions.
- Decompression theory and its application.
- AAUS dive regulations and history.
- Underwater scientific methods and data gathering techniques (including, but not limited to, quadrating, transecting, mapping, collecting, identification and survey techniques).
- Handling high pressure cylinders.

Practical (including but not limited to):
- Checkout dive.
- Search and recovery.
- Rescue diving.
- Navigation.
- Application of underwater scientific methods and techniques (in conjunction with CRE and MIZ courses).
- Mapping project
Course Requirements and Policies
- SCUBA certification is an essential requirement.
- On-time attendance and completion of all assignments are required; late assignments of any kind will not be accepted. The only exceptions to these policies are extenuating circumstances, to be considered on a case by case basis.
- If you are absent from a class, it is your responsibility to make up the missed materials.
- Any impropriety on exams, quizzes or written projects will constitute grounds for failing the course.

Grading Criteria
Example grading contract:
Module Quizzes: 35%
Final Exam: 35%
Term-time Assignments: 20% (usually 3 but subject to change)
Participation: 10%
TOTAL: 100%

Reading Material
- AAUS self-study theory modules.
- PADI Advanced Open Water, Rescue, and O2 Provider manuals.
- Emergency First Response participant material.

Learning Outcomes
- To become confident and skilled at underwater multi-tasking and using SCUBA as a tool to further scientific research.
- To become a fully qualified scientific diver as defined by the American Academy of Underwater Sciences.
- To be fully prepared to design and execute scientific projects requiring SCUBA as an essential element.
Bermuda Institute of Ocean Sciences

Fall Program | Marine Biology & Oceanography Research
Course Syllabus

COURSE LOCATION AND MEETING TIMES (subject to change due to weather and tides)

Lectures and Workshops: Sunderman Room; Labs: Scott Lab and individual mentors’ labs
Contact: 22 full days

Instructor:
Workshops: Dr. Samantha de Putron, Dr. Andrew Peters
Projects: Dr. Eric Hochberg, Dr. Yvonne Sawall, Dr. Samantha de Putron (potential for other faculty and research specialists to be involved)
Synopsis of Course Content
The Marine Biology and Oceanographic Research (MBOR) course is structured to provide a research internship experience as well as professional development in research. Each student will select, research, and then pursue a research topic, thereby having the opportunity to carry out independent research. Professional development is provided through course lectures and workshops with topics including scientific research ethics, communication (oral, science writing, and public/media outreach), proposal writing, experimental design, data presentation and statistics, conducting research, and careers in science. Students gain valuable experience in communicating science through submission of a research proposal, oral and poster presentations, as well as a final scientific paper.

Course Structure
The first 12 weeks (0.5-1 days/week) include an overview, workshops, and talks by the BIOS fall interns on their research. The project instructors and any other BIOS faculty and Research Specialists available to mentor MBOR student(s) in their labs, will give presentations on their research, available equipment, and potential projects. Students then meet with potential mentors. Each student then submits a research proposal abstract (dart proposal) outlining their chosen project and mentor, and their research ideas. Assigned mentors and the course instructors will then provide guidance and work with the student to further develop their project. Students have some time to prepare for their project (i.e. further literature review, experimental set up, animal collection) before spending the last 3 weeks of the semester full time dedicated to conducting their research project. Professional development continues as students submit a full research proposal, present an introduction/methods and final oral presentation, and submit a final paper in a research paper format suitable for publication in an appropriate journal. Students are expected to keep weekly time sheets and record daily activities in their lab notebooks as demonstration of effort. Interaction with mentors and instructors will be frequent to review progress and assist.

Course Requirements & Policies
- On-time attendance and completion of all assignments are required; late assignments of any kind will not be accepted. The only exceptions to these policies are extenuating circumstances, to be considered on a case by case basis.
- If you do need to be absent from a class, it is your responsibility to make up the missed materials.
- Any impropriety on exams, quizzes or written projects will constitute grounds for failing the course.
- This course includes independent research and you will be required at times to use careful initiative and manage your own time in order to complete your research. You should spend at least 22 full days (8 hours/day) on this course over the semester and more hours in the evenings and weekends as necessary to complete your research project (planning, literature review, execution, clean-up) and all assignments. During the semester that is dedicated full time to this course (last 3 weeks), you should discuss a learning contract with your project instructor(s)/mentor(s) that stipulates the number of required meetings and the student-instructor contact hours. If you need more instructor assistance then that is fine but it is your responsibility to request this in good time.
Grading Criteria
Several of the scheduled workshops will have graded assignments (either completed in class or for submission). There are no exams during the course. Students will submit one research proposal and one final research paper. There will be three presentations: an introduction talk, a virtual poster (methods and initial results-as applicable), and a final talk. Students will keep a lab notebook throughout the course and this will be considered with the participation grade, which is for overall effort.

Example grading contract:
- MBOR Workshops: 10%
- Research Proposal: 10%
- Introduction/Methods Talk: 10%
- Final Talk: 20%
- Final Research Paper: 30%
- Overall Effort/Lab Notebook: 20%

TOTAL: 100%

Reading Material
Readings will be determined by mentor-led independent research throughout the term.

Learning Outcomes
- Provide students with an understanding of the role of science in society, the ethical conduct of science, and a preview of a career in science.
- Provide students with an insight into ongoing research in marine biology and oceanographic research, and information about a variety of research techniques.
- Demonstrate the ability to perform a relevant literature review to support a research topic and proposal, and develop the scientific inquiry to form appropriate objectives and methodology.
- Demonstrate the correct conduct of research, including time management and planning, problem-solving skills, critical thinking, and maintenance of proper research records.
- Working collaboratively with others at many levels: peers, research staff and faculty.
- Demonstrate the ability to communicate scientific results through presentations and a written paper.
- Through constructive reflection on the research experience, students will be able to identify what was learned and use the experience to better inform future educational and career goals.