MARINE SCIENCE

Dept. Code: MSC

Marine Science

Marine Science is an interdisciplinary program dealing with the study of the world’s oceans, their physical and biological constituents, the influence of oceanic resources on human society, and the conservation and future development of these resources.

The Bachelor of Science double major in Marine Science prepares students for admission to graduate programs and for careers in teaching and research as well as for technical careers in government and private industries concerned with the oceans. The Bachelor of Science in Marine Science is a full double major program that requires a major in Marine Science through the Rosenstiel School and a second major in one of the sciences through the College of Arts and Sciences, RSMAS, or the College of Engineering. Common second majors are Biology, Chemistry, Geological Sciences, Physics, Computer Science, Meteorology and Microbiology & Immunology. Required courses for these combinations are listed within the major tab.

Second majors in Applied Physics, Biochemistry, Engineering (all disciplines), and Mathematics may be taken. Students interested in adding a second major in one of these disciplines should review the Applied Physics (http://bulletin.miami.edu/undergraduate-academic-programs/arts-sciences/physics/physics-applied-physics-bs/), Biochemistry (http://bulletin.miami.edu/undergraduate-academic-programs/arts-sciences/biochemistry-molecular-biology/biochemistry-molecular-biology-nutrition-bs/), Engineering (all disciplines) (http://bulletin.miami.edu/undergraduate-academic-programs/engineering/), or Mathematics (http://bulletin.miami.edu/undergraduate-academic-programs/arts-sciences/mathematics/mathematics-ba-bs/) pages for additional requirements. Each of the areas of concentration constitutes a rigorous program requiring 120-130 credit hours for graduation.

MSC 101. Survey of Oceanography. 3 Credit Hours.
Introduction to the oceans and their significance to mankind, encompassing geological, physical, chemical, and biological processes; man's role in and on the sea, including fisheries, pollution, and ocean management. Not for major or minor.

Components: LEC.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

MSC 102. Introduction to Weather and Climate. 3 Credit Hours.
The structure, physics, dynamics and thermodynamics of the atmosphere. Weather, weather forecasting, climate and climate change. Not for major or minor.

Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MSC 103. Survey of Modern Meteorology. 3 Credit Hours.
Dynamics and thermodynamics of the atmosphere as they relate to contemporary issues in meteorology. Overview of numerical weather prediction techniques and new technologies for monitoring weather and climate. Open to majors or minors with permission of instructor.

Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 104. Molecules of Life. 3 Credit Hours.
Molecules of Life explores the modern science of biological molecules, which occurs at the intersection of chemistry, biology, and medicine. We examine the major molecular components of the cell—proteins, nucleic acids, lipids, etc.—and illustrate the role of chemical principles in understanding their structure and function. Not for major or minor.

Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MSC 105. Shark Behavioral Ecology & Conservation Semester. 3 Credit Hours.
SUMMER SCHOLARS PROGRAM ONLY. In this course, students will learn core concepts in shark behavioral ecology and key aspects of shark biology needed for the holistic understanding and study of shark behavioral ecology and conservation. NOT FOR MAJOR OR MINOR.

Components: LEC.
Grading: GRD.
Typically Offered: Summer.
MSC 106. Marine Mammal Biology and Conservation. 3 Credit Hours.
SUMMER SCHOLARS PROGRAM ONLY. The purpose of this class is to provide an introductory overview of basic biological concepts relevant to marine mammal taxonomy, physiology, natural history, behavior, and threats/conservation. This class will be dynamic, involving lectures, discussions, review of primary literature, career guidance, guest lectures, videos/movies, and field trips. NOT FOR MAJOR OR MINOR.

Components: LEC.
Grading: GRD.
Typically Offered: Summer.

MSC 107. Life in the Sea. 3 Credit Hours.
Lectures provide an introduction to the plants and animals of the sea, including plankton, nekton and the benthos, with anthropogenic impacts. Not for major or minors.

NOT FOR ANY MSC STUDENT MAJOR OR MINOR.

Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 108. Environmental Oceanography. 3 Credit Hours.
This course will focus on environmental issues facing the oceans today, including global climate destabilization, the impact of population growth on coastal environments, marine pollution, and the state of marine fisheries. An active learning approach will be adopted, with emphasis on case studies and critical analysis. Marine environmental issues will be presented in self-contained analytical exercises. Basic math needed to quantify environmental issues will be introduced. Information and questions on sustainability will be integrated throughout the course and students will be asked to think critically about these pressing concerns. Not for major or minor.

NOT FOR ANY MSC STUDENT MAJOR OR MINOR.

Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 111. Introduction to Marine Science. 3 Credit Hours.
Geological, physical, chemical and biological processes of the world’s oceans. The role of the oceans in global dynamics and man’s role in and on the sea, including fisheries, pollution and ocean management. Enrollment limited to Marine Science/Marine Affairs majors and minors. Lecture and discussion, 3 hours. Field trips.

Requisite: Marine Science Major or Minor.

Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

MSC 112. Introduction to Marine Science Lab. 1 Credit Hour.
Laboratory and field exercises to accompany Marine Science.

Pre/Corequisite: MSC 111. And Marine Science Major or Minor.

Components: LAB.
Grading: GRD.
Typically Offered: Fall.

MSC 115. Tropical Marine Biology. 3 Credit Hours.
A field and lecture study of selected marine environments around South Florida, with emphasis on the interaction between organisms and the geological, physical, and chemical environment. Summer Scholars Program Only.

Components: LEC.
Grading: GRD.
Typically Offered: Summer.

MSC 121. Ocean Currents. 3 Credit Hours.
Ocean Currents will be a comprehensive, multi-disciplinary course on the history, geography, socio-economics, and physics of ocean currents. The importance of ocean currents to socioeconomics, weather, climate, transport of fish larvae and pollutants, distribution of plankton and fish, military operations, and shipping will be illustrated using many examples. The history of ocean current observations, detailed maps of ocean circulation and its variability, and the evolution of instruments, and theories from ancient to modern times will be detailed. The discovery and the most important observations of the major ocean currents will be discussed. There will be also lectures on modern ocean circulation theory. NON-MSC MAJORS ONLY For non- MSC majors.

Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MSC 172. Special Topics in Marine Science. 2-6 Credit Hours.
Content varies by semester and is indicated in parentheses following course number and title in class schedule.

Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.
MSC 180. Seminar in Marine Science. 1 Credit Hour.
Seminars in current research as conducted by Marine Science faculty and graduate students. This course is intended as an introduction for first year students to contemporary research topics.
Pre-requisite: MSC 111.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MSC 190. Studies in Marine Science. 1-5 Credit Hours.
For transfer courses taken at other institutions that have no direct equivalents at UM
Components: LEC.
Grading: GRD.

MSC 191. Studies in Marine Policy. 1-5 Credit Hours.
For transfer courses taken at other institutions that have no direct equivalents at UM.
Components: LEC.
Grading: GRD.

MSC 203. Foundations of Computational Marine Science. 4 Credit Hours.
The course provides a basic introduction to Computational Marine Science. The course will use Python as a programming language and will illustrate its use in problem solving and exploratory data analysis in the Marine Sciences. Programming topics covered include the language syntax and construct, variables, flow control, functions, software design and object-oriented programming.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 204. Environmental Statistics. 3 Credit Hours.
This introductory course provides an overview of parametric and nonparametric statistics with an emphasis on applications in the analysis of environmental data. (Not open to students with credit in BIL311 or equivalent).
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

MSC 205. Mathematical Methods for Marine Science. 3 Credit Hours.
This course is meant to provide students with the mathematical tools required to pursue advanced topics in Marine Science. Not available for credit for students with major or minor in Mathematics.
Pre-requisite: MTH 162 Or MTH 172 And MSC 111.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MSC 215. Chemical Oceanography. 3 Credit Hours.
An introduction to the chemistry of the oceans. Descriptive chemical oceanography of the components of ocean waters (metals, gases, organic compounds and nutrients). Biogeochemical cycles in oceanic systems.
Pre-requisite: MSC 111 and (CHM 112 or CHM 121).
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

MSC 216. Chemical Oceanography Laboratory. 1 Credit Hour.
Chemical and physical methods in chemical oceanography. Analytical and instrumental techniques used to determine density, salinity, chlorinity, dissolved oxygen, nutrients and components of the carbonate system. Corequisite: MSC 215.
Pre/Corequisite: MSC 215 and Prerequisite: CHM 113.
Components: LAB.
Grading: GRD.
Typically Offered: Fall & Spring.

MSC 217. Physical and Chemical Processes in Coastal Ecosystems. 3 Credit Hours.
This course is primarily intended for students enrolled in the Marine Affairs program to serve as an introduction to the role of physical and chemical processes in estuarine and coastal ecosystems in the context of the management of estuarine and coastal waters. Students will provide reviews of case studies in preparation for future management decisions that will require knowledge of coastal physical and chemical processes. Prerequisites: MSC 111 AND MSC 230.
Pre-requisite: MSC 111 and MSC 230 and (CHM 111 or CHM 121).
Components: LEC.
Grading: GRD.
Typically Offered: Spring.
MSC 218. Biological Oceanography. 3 Credit Hours.
This course will examine energy flow in marine ecosystems, the biogeochemical cycles that control them, the wide variety of types of communities and ecosystems in different parts of the ocean, and the changes they have undergone over geological timescales. 
Prerequisite: MSC 111.
Components: LEC. 
Grading: GRD. 
Typically Offered: Spring.

MSC 220. Climate and Global Change. 3 Credit Hours.
The Earth’s climate system and the role of natural and anthropogenic processes in shaping climate change.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

MSC 222. The Earth’s Climate: Past and Future. 3 Credit Hours.
This course will provide undergraduate students majoring in geological sciences, as well as enthusiastic non-majors, with the foundation to better understand climate change on geological to human timescales. The natural processes that control the earth’s climate will be discussed, with special attention to the climate of the Holocene, and the potential influence climate may have played on human civilizations. Finally, the expected climate shifts and feedbacks will be discussed based on the outcome of climate models for the next century.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

MSC 230. Introduction to Marine Biology. 3 Credit Hours.
Prerequisite: (BIL 150 or BIL 160) and (CHM 111 or CHM 121).
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

MSC 232. Introduction to Marine Biology Laboratory. 1 Credit Hour.
Ecology, physiology, and behavior of marine organisms in south Florida marine habitats.
Pre/Corequisite: MSC 230. or BIL 230. and Prerequisite: BIL 151 or BIL 161.
Components: LAB.
Grading: GRD.
Typically Offered: Fall.

MSC 240. Introduction to Marine Geology. 3 Credit Hours.
The principal marine geological environments of the world, their substrate, their sediments, their flora and fauna, and their evolution through time.
Prerequisite: GSC 110 Or GSC 111 Or permission of instructor.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 300. Water Resources: History, Management, and Policy. 3 Credit Hours.
An overview of the issues and problems surrounding the management of aquatic resources in the broadest sense including water quality of natural waters, drinking water, water pollution, water quantity and supply issues, watershed management, wetland protection, and coastal management. We will explore the available strategies to wisely manage the various aquatic resources, policy options and their socio-economic aspects, legal frameworks, and institutional arrangements.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MSC 301. Introduction to Physical Oceanography. 3 Credit Hours.
Application of the laws of physics to the study of the properties and circulation of the world's oceans and atmosphere.
Prerequisite: MSC 111. And MTH 162. Or MTH 172.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.
MSC 302. Introduction to Physical Oceanography Lab. 1 Credit Hour.
Laboratory exercises and field work on basic fluid mechanics applicable to the ocean. These include buoyant convection and double diffusion, methods for measuring flows, gravity wave experiments in the lab and field, diffusion studies and rotating tank investigations as an analog for planetary flows.
Prerequisite: MSC 301 or ATM 405. Or Co-requisite: MSC 301 or ATM 405.
Components: LAB.
Grading: GRD.
Typically Offered: Spring.

MSC 310. Living Resources of the Ocean. 3 Credit Hours.
Marine fish and shellfish of major commercial and recreational value: biology, techniques of harvesting, and resource management.
Prerequisite: MSC 230.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MSC 313. Coastal Law. 3 Credit Hours.
Basic doctrines and public policy related to the use and regulation of the United States coastal zone and seabed.
Junior Standing.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 317. Earth's Biogeochemistry. 3 Credit Hours.
Outstanding features of planet Earth, including its vast oceans, climate and atmosphere, are strongly impacted by life. Scientists investigate these impacts, such as ocean acidification, variable atmospheric CO2 concentrations, coastal anoxia, and permafrost melting, through their biogeochemical dynamics. The first part of the course covers the relevant microbial and chemical reactions that occur in the atmosphere, on land, in freshwaters and in the oceans. The second part links this mechanistic understanding to a large-scale, synthetic view of global biogeochemical cycles. These are considered in the context of global change.
Prerequisite: CHM 112 or CHM 121.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MSC 318. Ecological Genetics. 3 Credit Hours.
This course will provide a thorough understanding of genetics (allele frequencies, heritability, recombination, QTL, the effect of migration and demography). Pre-requisites: BIL150/151 AND BIL160/161
Prerequisite: BIL 150 and BIL 160 and BIL 151 or BIL 152 or BIL 153 and BIL 161 or BIL 162.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.
MSC 319. Research Fundamentals. 1 Credit Hour.  
Research Fundamentals will provide an introduction to academic research methods including basic laboratory techniques, data analysis, and scientific communication. Students will read the primary literature and both analyze data and communicate results using multiple formats. The course emphasizes active learning (discussions, working with peers, writing, etc.) and is directed toward early stage undergraduate students interested in pursuing research.  
Prerequisite: MSC 204 Or MTH 224.  
Components: LEC.  
Grading: GRD.  
Typically Offered: Fall.

MSC 321. Scientific Programming in the Atmospheric Sciences. 3 Credit Hours.  
An introduction to scientific programming in a linux environment using the FORTRAN 90/95 language with specific applications to Meteorology.  
Prerequisite: CSC 120.  
Components: LEC.  
Grading: GRD.  
Typically Offered: Spring.

MSC 323. Invertebrate Zoology. 4 Credit Hours.  
Biology of invertebrates, with emphasis on tropical and subtropical marine forms. Field work and combined lecture-laboratory sessions.  
Prerequisite: MSC 230.  
Components: LEC.  
Grading: GRD.  
Typically Offered: Spring.

MSC 324. Biology of Fishes. 3 Credit Hours.  
Selected topics on the ecology and physiology of fishes. Lectures on reproduction, respiration, osmoregulation, sense systems, hormonal control.  
Prerequisite: MSC 230.  
Components: LEC.  
Grading: GRD.  
Typically Offered: Offered by Announcement Only.

MSC 325. Biological Oceanographic Techniques. 3 Credit Hours.  
Field sampling for plankton biomass and productivity; benthic biomass, and of selected physical parameters. Applications of molecular techniques and remote sensing to oceanographic problems.  
Prerequisite: MSC 230.  
Components: LAB.  
Grading: GRD.  
Typically Offered: Offered by Announcement Only.

MSC 326. Marine Genomics. 4 Credit Hours.  
Intensive Lecture/laboratory course with emphasis on using genomic tools to address an independent research project of importance in the marine sciences.  
Corequisite: MSC 463.  
Components: LAB.  
Grading: GRD.  
Typically Offered: Fall.

MSC 327. Marine Animal Neurophysiology and Behavior. 4 Credit Hours.  
This course will look at neural and endocrine systems in a variety of marine animal invertebrate and vertebrate models and how these systems work together to control elements of physiology, sensation and perception of the environment and behavior.  
Prerequisites: BIL 230 or MSC 230, and BIL 255.  
Components: LEC.  
Grading: GRD.  
Typically Offered: Fall.

MSC 328. Introduction to Aquaculture. 3 Credit Hours.  
This course will provide an introduction to the field of aquaculture, which represents one of the fastest growing industries in food production in the worlds and is a field that offers exciting job opportunities in science, business, marketing, resource management, and socioeconomics. This course will provide students with a sound background in aquaculture prior to engaging in higher-level courses in this field.  
Prerequisites: MSC 111 and MSC 230 or Co-requisite: MSC 230.  
Components: LEC.  
Grading: GRD.
MSC 329. Marine Vertebrate Zoology. 3 Credit Hours.
The course will be a comprehensive examination of the form and function of the vertebrate lineage of marine animals from early chordates to the evolution of cartilaginous and bony fish and the emergence of tetrapods, those that evolved from marine ancestors and have since returned to the seas. A comparative point of view will be used to assess the anatomy and physiology of each taxonomic group as well as behavioral and ecological adaptations related to their life history. Specifically, the course will cover the emergence of the vertebrate body plan and the evolution of fish from agnathans through modern teleosts, as well as the tetrapod lineage of marine reptiles, marine birds, and marine mammals. We will examine critical points in vertebrate evolution where genome-wide duplication events occurred as well as instances of convergent evolution in various lineages. Prerequisite: MSC 230.

Components: LEC.
Grading: GRD.

MSC 333. Ocean Human Health. 3 Credit Hours.
The focus of this course is on the present, future, and potential effects of oceanic processes and marine organisms on human health and wellbeing and on human impacts on the marine environment. Prerequisite: MSC 230 or BIL 230.

Components: LEC.
Grading: GRD.

Typically Offered: Spring.

MSC 340. Ocean Policy. 3 Credit Hours.
Analysis of ocean policy issues in US fisheries, marine conservation and marine protected areas, marine pollution, coastal management and regulation of offshore oil and gas activities. Prerequisite: MSC 111 and MSC 313 Or MSC 314 and Junior Standing.

Components: LEC.
Grading: GRD.

Typically Offered: Fall.

MSC 341. Sunken Ships and Submerged Sites: An Introduction to Underwater Archaeology. 3 Credit Hours.
The course serves to provide an overview of underwater archaeology, covering general concepts, methods, field techniques, time periods and their associated unique sites and discoveries, as well as an introduction to professional application in preservation, management, and how popular media plays a role in public education and outreach. Note: There is no SCUBA diving component to this class. Requisite: MSC 111 AND Junior Standing.

Components: LEC.
Grading: GRD.

Typically Offered: Spring.

MSC 342. Decision Making and the Environment. 3 Credit Hours.
A basic, critical appreciation of interdisciplinary decision theory as applied to natural resources management. Specific goals include comprehension of: decision making under uncertainty, evolutionary social science, managing common pool resources, and behavioral economics. Junior Standing.

Components: LEC.
Grading: GRD.

Typically Offered: Spring.

MSC 345. Economics of Natural Resources and the Environment. 3 Credit Hours.
A comprehensive overview of the economics of national, international, and global environmental problems. A unifying theme throughout is sustainable development defined as "maximizing the net benefits of economic development while maintaining the services and quality of natural resources over time". We will use economic reasoning to examine causes and consequences of environmental and resource problems, and measures for dealing with them. Prerequisite: ECO 211.

Components: LEC.
Grading: GRD.

Typically Offered: Spring.

MSC 346. Climate Science and Policy. 3 Credit Hours.
The scientific evidence for, and the projected consequences of, climate change. The political and geo-engineering responses to the problem. Prerequisite: MSC 111. Or ATM 103. Or ECS 111. And Requisite: Junior Standing.

Components: LEC.
Grading: GRD.

Typically Offered: Spring.
MSC 347. Polar Science and Policy. 3 Credit Hours.
The course will address the physical, chemical, and biological properties of the polar oceans, atmosphere, and coastal regions. The interactions between ocean, ice, atmosphere, and land will be discussed in detail, not only in terms of local relationships, with cross-disciplinary linkages, but also with emphasis on the influence the Polar Regions exert on the global climate, biogeochemical cycles, ecosystems and local human populations. Prerequisite: MSC 111 and MSC 230.

Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MSC 350. Survey of Marine Mammals. 3 Credit Hours.
The biology, physiology, natural history, behavior, and conservation of marine mammals. Prerequisite: MSC 230 or BIL 230.

Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 351. Climate, Oceanography, and Biogeography of the Galapagos. 3 Credit Hours.
This course and its companion describe the climate, oceanography of the Galapagos Islands, and explore the ways the physical environment has influenced biodiversity on the islands. This field intensive course sequence is part of the Galapagos semester abroad program.

Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 352. Biophysical Dynamics in the Ocean: Biogeography and Evolution of the Galapagos. 3 Credit Hours.
Course expands aspects of bio-physical description of the Galapagos in comparison with other systems. Emphasis on identification of flow regimes in various settings based on winds and buoyancy forcing and characterization of the resulting biological niches. Analysis focuses on scales and components of the resulting biogeography. Biological aspects covered include bioenergetics and reproduction in relation to their role in evolution. This field intensive course sequence is part of the Galapagos semester abroad program.

Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 355. Limnology. 3 Credit Hours.
This course is an introduction to the physical, chemical, and biological properties of freshwater ecosystems. It is intended as an upper level course for juniors and seniors. It emphasizes the ecological process of lakes, rivers, and to less extent, streams. The role of watershed processes is considered in the context of management of rivers and estuaries. Case studies integrate the scientific understanding of freshwater ecosystem function with management decisions. Applied aspects of freshwater systems are included. Prerequisite: MSC 230.

Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MSC 364. Life in Moving Fluids. 3 Credit Hours.
The physical characteristics of air and water are described in relation to various flow phenomena that play a part in life functions. Adaptations of form and function reflect the very different properties of the media (air and water) of terrestrial and aquatic life. Energy conversion and transfer limit form and function and enable a wide variety of survival strategies. Prerequisite: MSC 230 Or BIL 360.

Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 365. Tropical Coastal Ecosystems: Lab and Field Methods. 1 Credit Hour.
This course will provide students with the theory and application of field sampling methods used to document status and trends in the health of coral reef, seagrass, and mangrove ecosystems. Students will learn about sampling theory, sampling methods, sampling equipment, and species identifications using a combination of classroom and field activities. This 1-credit course is designed as a companion to MSC 366 where theory detailed in this class is put to practice to design and execute a targeted, small-scale sampling program for the coastal ecosystems found in South Florida. Lectures will be complemented with field activities to be carried out at sites around Key Biscayne and at the UM Broad Key station. Pre/Corequisite: MSC 366.

Components: LAB.
Grading: GRD.
Typically Offered: Fall.
MSC 366. Tropical Coastal Ecosystems. 3 Credit Hours.
This course will provide a comprehensive background on the ecology, conservation, and restoration of the three main tropical coastal ecosystems: Mangroves, Seagrasses, and Coral Reefs. The first part of the course will consist of a review of ecological theory, followed by lectures on the dynamics of the three ecosystems, including diversity, community structure, stress ecology, management tools, and novel restoration paradigms. Classes will be complemented by student presentations, in-class activities, and media-outreach projects. Readings for this class will include a required textbook and papers from the primary literature. Grades will be based on exams, quizzes, in-class projects, and student presentations.
Prerequisite: MSC 230 or BIL 230.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 370. Current Research in Marine Biology: Seminars and Discussion. 2 Credit Hours.
These discussions and seminars comprising a 2 cr course provide well-prepared undergraduate students interested in marine research with an introduction to graduate student-presented science in the specialization of marine biology.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MSC 371. Readings in Marine Science. 1-3 Credit Hours.
Library research with faculty supervision. Bibliography to be submitted in preparation for laboratory and/or field research project. (No more than 6 credits in total from MSC371, MSC411, and MSC412 can be counted towards the MSC major or minor requirements.)
Permission of Instructor.
Components: DIS.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.

MSC 372. Special Topics in Marine Science. 1-6 Credit Hours.
Content varies by semester and is indicated in parentheses following course number and title in class schedule.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MSC 373. Writing the GRFP and Graduate School Applications. 1 Credit Hour.
Writing the GRFP (graduate research fellow proposal) and Graduate School Applications is a practical course for undergraduate students interested in applying to graduate school next year or in the future. We will review NSF guidelines for the GRFP and both discuss and implement the steps for this proposal and graduate school applications. Basic tips on writing will be covered. Students will write a two page research statement and three page personal statement for the GRFP and then will modify these statements to use in graduate school applications. Students will be involved in reading and providing constructive criticisms to their fellow classmates. (No more than 3 credits in total from MSC370-level courses can be counted towards the MSC major or minor requirements).
Requisite: Junior or Senior Standing.
Components: DIS.
Grading: SUS.
Typically Offered: Fall.

MSC 380. Field Studies in Marine and Aquatic Science. 1-4 Credit Hours.
Field course to selected marine, estuarine and/or aquatic sites in the United States and abroad. Travel fee may be required.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MSC 381. Marine Field Ornithology. 1-4 Credit Hours.
Waterbirds such as seabirds, shorebirds, and wading birds are key components of the marine ecosystem, including pelagic, coastal, and estuarine communities. As ecological indicators waterbird abundance provides a proxy for the health of these environments. Waterbirds have also served as important model systems for studies of behavior, evolutionary biology, and ecological theory. This course will provide an introduction to waterbird biology and conservation, including a variety of different field trips to waterbird communities.
Components: LEC.
Grading: GRD.
Typically Offered: Offered by Announcement Only.

MSC 390. Advanced Studies in Marine Science. 1-5 Credit Hours.
For transfer courses taken at other institutions that have no direct equivalents at UM.
Components: LEC.
Grading: GRD.
MSC 391. Advanced Studies in Marine Policy. 1-5 Credit Hours.
For transfer courses taken at other institutions that have no direct equivalents at UM.
Components: LEC.
Grading: GRD.

MSC 401. Ocean Dynamics. 3 Credit Hours.
This course provides an introduction to the mathematical description of fluid flows in the ocean. Topics covered include a review of vector calculus, conservation equations, the Euler and Navier-Stokes equations, flow kinematics, Eulerian and Lagrangian descriptions of fluid flows, vorticity dynamics, rotation effects including the Coriolis force and geostrophy, wind forcing, an introduction to turbulence, surface gravity waves, stratification and internal waves.
Prerequisites: MSC 301 and MTH 162 and PHY 202 or equivalent; and Pre or Corequisite: MTH 211 or MTH 310.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MSC 402. Ocean Acidification. 3 Credit Hours.
Ocean Acidification is the ongoing decrease in the pH of the Earth’s oceans, caused by the uptake of carbon dioxide (CO2) from the atmosphere. In this course students will learn about its impacts on important biogeochemical and biological processes.
Prerequisites: MSC 215 and MSC 216 and Pre or Corequisite: MSC 218.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MSC 403. Marine Environmental Toxicology. 3 Credit Hours.
This course will provide an introduction to the principles of environmental toxicology with an emphasis on marine ecosystems, considering a variety of different classes of toxicants, how they can impact marine organisms, the scientific methods used to assess impacts, and the regulatory frameworks used to monitor and manage their release to the environment.
Prerequisite: BIL 255 and (CHM 112 or CHM 121).
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MSC 404. Marine Organismal and Environmental Health. 1 Credit Hour.
This 1-credit course will complement salt water semester courses. (Must have taken MSC403 or MSC333 and either MSC466 or MSC326 and MSC463). Students will be required to collect and analyze samples, interpret their findings and present them in a formal laboratory report due two weeks after the trip. Students will also be required to give a presentation they have prepared before the trip and attend two seminars on Marine Organismal and Environmental Health topics.
Pre/Corequisite: MSC 327 or MSC 333 or MSC 403 or MSC 466 or MSC 326 and MSC 463.
Components: LAB.
Grading: GRD.
Typically Offered: Fall.

MSC 410. Marine Conservation Science. 3 Credit Hours.
Nature of marine biodiversity, what threatens it, and what can be done to recover the biological integrity of estuaries, coastal seas, and oceans. Topics include: distinctive aspects of marine populations and ecosystems; threats to marine biological diversity, singly and in combination; place-based management of marine ecosystems; and the human dimensions of marine conservation.
Junior Standing.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 411. Research in Marine Science. 1-3 Credit Hours.
Individual, independent research projects with faculty supervision. A formal written report is required. (No more than 6 credits in total from MSC371, MSC411, and MSC412 can be counted towards the MSC major or minor requirements.)
Requisite: Junior or Senior Standing.
Components: THI.
Grading: SUS.
Typically Offered: Fall, Spring, & Summer.

MSC 412. Undergraduate Thesis in Marine Science. 1 Credit Hour.
Students will write a formal thesis summarizing the results of independent research carried out under faculty supervision.
MSC 411 AND Senior Standing.
Components: THI.
Grading: GRD.
Typically Offered: Fall, Spring, & Summer.
MSC 415. Coral Reef Science and Management. 3 Credit Hours.
The interdisciplinary nature of coral reef science and management: biological, environmental, ecological and socioeconomic aspects of coral reef
science, coral reef management problems and approaches at local to global scales, and the implications of climate change for coral reef science and
management.
Prerequisite: MSC 230.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MSC 417. Marine Biota and Biogeochemical Cycles. 3 Credit Hours.
The distribution of dissolved particulate materials in the sea is not uniform in time or space. Variability in these reflects the diverse biological sources,
transformations, and sinks of chemical constituents in the sea. This course focuses on the role of marine organisms in marine biogeochemical
cycling, with particular emphasis on the marine carbon and the nutrients. We visualize and query the ocean system using publicly available global
ocean data sets and the application Ocean Data View. The material is presented as a capstone bringing together the physical, chemical and biological
dynamics of the ocean as a single system.
Prerequisite: MSC 215.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 418. Climate Law. 3 Credit Hours.
Climate Law evaluates the interactions between climate and the law, with an emphasis on existing laws and the gaps in current legislation related
to the climate environment. The course will analyze court cases, domestic and foreign laws, treaties, and international conventions. In addition, the
course will examine how climate manipulation requires an international model for the future.
Prerequisite: ATM 220 or MSC 220 and Junior Standing.
Components: LEC.
Grading: GRD.

MSC 419. Microbial Geochemistry of the Ocean. 3 Credit Hours.
An overview of how microbes respond to and modify the chemistry of the ocean, focusing on the geochemical consequences and signatures of
microbial activity in the ocean. Microbes form the base of the food chain and are responsible for essential chemical transformations that control
important processes on Earth, including the production of atmospheric oxygen, and the consumption of carbon dioxide and transformation to organic
carbon which fuels the rest of life in the ocean. This course will build a quantitative framework for understanding the chemical inputs and outputs of
microbial metabolism, and the role these microbial processes play in controlling chemical fluxes in the ocean. This will address how biological origins,
metabolic reworking, and physical phase influence the distribution and fluxes of organic matter in the marine carbon cycle on both short and long
timescales.
Prerequisite: MSC 111 and MSC 215 and BIL 150 or BIL 160.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 420. Political Ecology of the Galapagos. 3 Credit Hours.
This field course in the Galapagos National Park offers a rare chance to examine the human interactions in this highly politicized landscape of
conservation. Students practice the political ecology approach for doing ethnographic field work and explore how it can lead to wiser resource
management. Part of UGalapagos semester.
Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

MSC 421. Terrestrial Biology and Adaptations of the Galapagos.. 3 Credit Hours.
This course will examine the terrestrial plant and animal life of Isabela Island, discuss the biology and how it adapted to life on Isabela. Through
field and laboratory exercises we will explore the power of organisms’ DNA in shaping life into unique forms like those famously present in today’s
Galapagos. Part of UGalapagos semester.
Components: LEC.
Grading: GRD.

MSC 422. Marine Ecology of the Galapagos. 3 Credit Hours.
This course focuses on marine ecosystems of the Galapagos, emphasizing near-shore environments. Topics will include how the unique location and
oceanography of the Galapagos have shaped the species composition of resident and migrant marine animals. The role of genetic drift, local habitat
characteristics and natural selection on marine ecosystems will be examined. This is a field intensive course with time spent in intertidal, near-shore
and off-shore island environments. Part of UGalapagos semester.
Components: LEC.
Grading: GRD.
Typically Offered: Spring.
MSC 423. Marine Conservation Biology and Fisheries of the Galapagos. 3 Credit Hours.
The Galapagos are located in a uniquely productive area of the sea, which has allowed the development of rich and unique marine biota. The first week of the course will carry the students through the dynamic, climatic, and oceanographic circumstances that determine the unique character of the Galapagos. The second week will cover scientific evaluation of the threats to the marine biodiversity of the Galapagos, focusing on sharks, penguins, sea turtles and other at-risk species and habitats. Part of UGalapagos semester.

Components: LEC.
Grading: GRD.
Typically Offered: Spring.

MSC 424. Origin and Geology of the Galapagos Islands.. 3 Credit Hours.
This course will explore the origin and geology of volcanic oceanic islands, using the Galapagos Islands as a natural laboratory. Though all share a common origin in plate tectonic theory, each island presents a host of environments that originate in the processes of volcanic action, erosion and hydrology. Individual islands therefore develop distinctive ecosystems within which organisms interact and evolve. The emphasis of this course will be to lay out the underlying geological processes that have led to the formation of the islands and to their present state, and then to explore the ways the physical environment has influenced adaptation and biodiversity. Part of UGalapagos semester.

Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

MSC 425. Galapagos Community-Based Research and Service. 2 Credit Hours.
Individual, civic engagement activities identified in consultation with the people, national park and local government of Puerto Villamil, Isla Isabela, as part of the marine science semester program in the Galapagos Islands. Student research and service is faculty supervised and concluded by submission of a formal written report. This course may not be counted towards the MSC elective requirement for majors or minors.

Components: PRA.
Grading: CNC.
Typically Offered: Fall & Spring.

MSC 427. Field experience in the Galapagos. 2 Credit Hours.
Three week Summer I field course explores the flora, fauna, geology, and society of the Galapagos Islands.
Prerequisite: MSC 111 or ECS 111 or Permission of Instructor.

Components: PRA.
Grading: GRD.
Typically Offered: Summer.

MSC 432. Comparative Ecology of Terrestrial and Marine Systems. 3 Credit Hours.
A comparison of various biotic and abiotic controls on terrestrial and marine ecosystems is undertaken. The course stresses proximate mechanisms and underlying evolutionary processes. Analysis methods and models of various ecosystems are compared and critiqued. Issues involved in sustainability and conservation of resources are discussed in relation to agriculture, fisheries and forestry. The importance of biodiversity and climate change in the future of ecosystems is stressed.
Prerequisite: MTH 162. And BIL 330. Or ECS 232.

Components: LEC.
Grading: GRD.

MSC 460. Spatial Applications in Marine Science. 3 Credit Hours.
The concepts and marine applications of Geographic Information Systems. Every class period will entail short class lectures and hands on computer based GIS exercise on marine science related issues. Students will learn how to use ArcGIS Desktop or Arc Pro.
Prerequisite: MSC 111 and MSC 112 and Requisite: Junior Standing.

Components: LEC.
Grading: GRD.
Typically Offered: Fall & Spring.

MSC 462. Marine Biomedicine. 3 Credit Hours.
The course will cover diverse bioactive molecules that are derived from marine sources ranging from sponges to sharks. The isolation and characterization of these compounds as well as their potential application in clinical medicine and human health will be reviewed. The class will also cover marine-derived factors used in biotechnology and marine animal models used in biomedical research with an emphasis on marine immunology.
Prerequisite: BIL 255 and (CHM 112 or CHM 121).

Components: LEC.
Grading: GRD.

MSC 463. Marine Conservation Genetics. 4 Credit Hours.
This course seeks to integrate lectures, fieldwork and laboratory genetics to enhance an understanding of biodiversity, genetic diversity, and current conservation issues.
Corequisite: MSC 326.

Components: LEC.
Grading: GRD.
Typically Offered: Fall.
MSC 464. Marine Comparative Immunology Lab. 1 Credit Hour.
The laboratory course will cover immunology techniques used in the assessment of immune function and immune reactivity in diverse marine taxa from sponges to fish to mammals.
Prerequisite or Co-requisite: MSC 465.
Components: LAB.
Grading: GRD.
Typically Offered: Fall.

MSC 465. Marine Comparative Immunology. 3 Credit Hours.
The course will cover immune function in diverse marine taxa from sponges to fish and the evolution of innate and adaptive immune mechanisms from a comparative point of view, with an emphasis on shark and fish immunology. Adaptations related to living in a microbe-rich marine environment will be highlighted. Potential applications of research findings will be addressed with respect to conservation and aquaculture. The role of invertebrate and vertebrate models in the study of the evolution of the immune system and applications for human health and medicine will be discussed.
Prerequisite: BIL 255.
Components: LEC.
Grading: GRD.
Typically Offered: Fall.

MSC 466. Environmental Physiology: Oxygen, Water, and Ionoregulatory Stress. 4 Credit Hours.
This is an intensive laboratory course that combines and elaborates on concepts learned in BIL 360. Topics will include homeostasis, interactions with the external environment, and life with limited oxygen and water. Lectures will be highly discussion-based; students will be expected to read primary research articles as suggested by the professor before lecture to foster participation in those discussions and form hypotheses about accompanying laboratory. Each lab will be written up as a formal laboratory report (i.e., Introduction, Materials and Methods, Results and Discussion).
Prerequisite: BIL 255.
Components: LAB.
Grading: GRD.
Typically Offered: Fall.