

# EARTH SCIENCES

## Program Overview

The Bachelor of Arts Degree in Earth Sciences is designed specifically as a second major for students in the College of Education and Human Services who are interested in teaching earth science in high schools. The program is tailored to meet the earth science related objectives of high school education majors and to facilitate the timely completion of their dual requirements in the College of Education and Human Services and the College of Arts and Sciences. This program is not designed to prepare students for further study in science disciplines at the graduate or professional level. This major is designed to enable students to satisfy course and credit requirements from the New Jersey Department of Education for the High School Teacher of Earth Science Certificate. Additional details can be found on the NJ Department of Education certification website.

## Curriculum Overview

The curriculum for this major focuses on the interdisciplinary nature of the marine sciences by offering classes that give students a strong background in the earth science as well as in the sub-field of earth sciences that each student selects from the concentrations available. Students take introductory classes in chemistry, physics, biology, geology and the marine sciences, followed by more in-depth course work focused on the concentration selected.

## Student Learning Outcomes

Graduates of the Earth Sciences major will be able to:

1. The student can combine relevant data with scientific principles to compose an explanation of natural phenomena in earth sciences.
2. The student can use physical, chemical, and biological characteristics to identify materials or organisms that form the foundation of their discipline.
3. The student can properly use technical equipment and associated techniques to collect, organize, and interpret field data.
4. The student can identify, find, evaluate, and use information to produce scientific reports, both written and orally, for scientific research and communication.

## Honors Program in Earth Sciences

Graduation with honors in Earth Sciences is awarded in recognition of majors who have demonstrated outstanding academic ability. Enrollment in the Honors Program is by invitation of the department faculty. Eligibility requirements include a minimum GPA of 3.5 in courses required for the major and the satisfactory completion of a senior thesis or a three- or four-credit Independent Research and Study course related to their major. In addition, an honors candidate must maintain an overall minimum GPA of 3.0.

## Degree Offered

- B.A. in Earth Sciences

## Contact

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Professor

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**Program Website:** Earth Sciences (<https://www.rider.edu/academics/colleges-schools/college-arts-sciences/science-technology-math/undergraduate/earth-sciences/>)

**Associated Department:** Earth & Chemical Sciences (<https://www.rider.edu/academics/colleges-schools/college-arts-sciences/science-technology-math/faculty-departments/earth-chemical-sciences/>)

## Related Programs

- Environmental Sciences (<http://catalog.rider.edu/undergraduate/colleges-schools/arts-sciences/majors-minors-certificates/environmental-sciences/>)
- Environmental Studies (<http://catalog.rider.edu/undergraduate/colleges-schools/arts-sciences/majors-minors-certificates/environmental-studies/>)
- Education (<http://catalog.rider.edu/undergraduate/colleges-schools/education/>)

## Earth Sciences Major Requirements

(50-54 credits)

Code	Title	Credits
<b>Required Courses</b>		
ENV 100 & 100L	Introduction to Environmental Sciences and Introduction to Environmental Sciences Lab	4
ENV 220	Weather and Climate Change	3
GEO 100 or GEO 113	Earth Systems Science Environmental Geology	3
GEO 102	Earth Materials and Processes Lab	1
MAR 120	Oceanography	3
MAR 121	Introductory Oceanography Lab	1
PHY 180	Astronomy	3
CHE 120	Principles of Chemistry	3
CHE 121	Principles of Chemistry Lab	1
<b>Mathematics - Select one from the list below:</b>		<b>4</b>
MTH 105	Algebra and Trigonometry	
MTH 106	Precalculus	
MTH 210	Calculus I	
<b>Electives</b>		<b>24-28</b>
Select seven of the following:		
ENV 200 & 200L	Statistical and Computer Applications in the Natural Sciences and Statistical and Computer Applications in the Natural Sciences Lab	
ENV 205	Introduction to Geographic Information Systems	
ENV 320 & 320L	Global Biogeochemistry and Global Biogeochemistry Lab	
ENV 340	Field Methods and Data Analysis	
GEO 306 & 306L	Sedimentology and Stratigraphy and Sedimentology and Stratigraphy Lab	
GEO 350 & 350L	Soil and Surficial Processes and Soil and Surficial Processes Lab	

GEO 407 & 407L	Hydrology and Water Resources and Hydrology and Water Resources Lab
MAR 340	Marine Processes and Environments: Seminar
MAR 401 & 401L	Marine Ecology and Marine Ecology Lab
MAR 410	Physical Oceanography

**Total Credits** **50-54**

## Academic Plan of Study

The following educational plan is provided as a sample only. Rider students who do not declare a major during their freshman year; who are in a Continuing Education Program; who change their major; or who transfer to Rider may follow a different plan to ensure a timely graduation. Each student, with guidance from their academic advisor, will develop a personalized educational plan.

Course	Title	Credits
<b>Year 1</b>		
<b>Fall Semester</b>		
CMP 120	Seminar in Writing and Rhetoric <sup>1</sup>	3
MAR 120	Oceanography	3
MAR 121	Introductory Oceanography Lab	1
MTH 105	Algebra and Trigonometry <sup>1</sup>	4
PHY 180	Astronomy	3
<b>Semester Credit Hours</b>		<b>14</b>
<b>Spring Semester</b>		
CMP 125	Seminar in Writing and Research	3
GEO 100	Earth Systems Science	3
GEO 102	Earth Materials and Processes Lab	1
Social Perspectives		3
Foreign Language		3
Select one of the following:		3-4
ENV 220	Weather and Climate Change <sup>3</sup>	
BIO 116 & 116L	Principles of Biology II and Principles of Biology II Lab	
<b>Semester Credit Hours</b>		<b>16-17</b>
<b>Year 2</b>		
<b>Fall Semester</b>		
CHE 120 & CHE 121	Principles of Chemistry and Principles of Chemistry Lab	4
HIS 150	Pre-Modern World: Evolution to Revolution	3
Foreign Language		3
ENV 200	Statistical and Computer Applications in the Natural Sciences	4
ENV 200L	Statistical and Computer Applications in the Natural Sciences Lab	0
<b>Semester Credit Hours</b>		<b>14</b>
<b>Spring Semester</b>		
One Major Concentration Requirement or Elective <sup>3</sup>		3-4
HIS 151 or HIS 152 or HIS 153	World in the Modern Era: Exploration to Globalization or Contemporary World: Historical Perspectives or Cold War: A Global History	3
Social Perspectives		3

Philosophical Perspectives	3
Aesthetic Perspectives: Literature	3

**Semester Credit Hours** **15-16**

### Year 3

#### Fall Semester

ENV 340	Field Methods and Data Analysis (Or other Major Concentration Requirement or elective)	3
One Major Concentration Requirement or Elective <sup>3</sup>		4
3 Elective Courses <sup>2</sup>		9

**Semester Credit Hours** **16**

#### Spring Semester

Two Major Concentration Requirements or Electives <sup>3</sup>		6-8
3 Elective Courses <sup>2</sup>		9

**Semester Credit Hours** **15-17**

### Year 4

#### Fall Semester

Two Major Concentration Requirements or Elective <sup>3</sup>		6-8
Elective Courses <sup>2</sup>		9

**Semester Credit Hours** **15**

#### Spring Semester

Elective Courses <sup>2</sup>		9
One to Two Major Concentration Requirements or Electives if needed <sup>3</sup>		6-8

**Semester Credit Hours** **15**

**Total Credit Hours for Graduation** **120-124**

Note: Natural and Physical Science core requirements are included in the major.

<sup>1</sup> For course placement information see <https://www.rider.edu/student-life/first-year-experience/orientation/placement-testing> (<https://www.rider.edu/student-life/first-year-experience/orientation/placement-testing/>)

<sup>2</sup> Please note that elective credits may be used to complete requirements in a second major or minor.

<sup>3</sup> For choices see Concentrations for List of Requirements and Electives. Courses selected should be made with approval from Earth Sciences academic advisor.

<sup>4</sup> Courses from other institutions must be reviewed and receive approval by the Department Chair.

## Courses and Descriptions

### ENV 100 Introduction to Environmental Sciences 4 Credits

Examines how ecosystems function, with emphasis on the interactions between biological organisms and their physical environment, and the chemical processes that govern these interactions. The impact of human populations on natural ecosystems is investigated in detail using case studies from history and current events. The laboratory provides for hands-on experiences and/or short field trips to local sites for a better understanding of many of the concepts discussed. Weekday and weekend field trips may be required. Three hours of lecture and one three-hour lab per week. CLAS general education areas addressed: DP, SP, GP. **Corequisite(s):** ENV 100L.

**ENV 100L Introduction to Environmental Sciences Lab 0 Credits**

This lab is a co-requisite and must be taken with the corresponding course.

**Corequisite(s):** ENV 100.

**ENV 110 Future of Natural Resources 3 Credits**

In this course, students are introduced to topics in the natural sciences through studies of human exploitation of selected natural resources (e.g. water, fisheries, mineral resources, energy, etc.). The course work includes a study of the scientific process and how it can contribute to solutions to contemporary issues. Topics covered will include factors that influence real-world decisions to manage natural resources more sustainably (e.g. political, economic, ethical factors). During the three hours of class meetings each week, lecture and exercises will be integrated. Field trips will be required. This course counts towards the fulfillment of the Disciplinary Perspectives element of the CLAS general education curriculum.

**ENV 110L Future of Natural Resources Lab 0 Credits**

This lab is a co-requisite and must be taken with the corresponding course.

**Corequisite(s):** ENV 110.

**ENV 120 Introduction to Climate Change 3 Credits**

This course offers students an overview of the human impacts on Earth's climate and emerging solutions to limit future climate change. Students will learn scientific insights into the interconnected components of Earth's climate as a system including the atmosphere, oceans, land, geology, and ice. Human effects on Earth's climate system will be contrasted with natural climate variation that preceded the industrial revolution. Students will also consider the personal, societal, and ethical implications of climate change through the lens of environmental justice.

**ENV 200 Statistical and Computer Applications in the Natural Sciences 4 Credits**

This course introduces important statistical concepts, their application, and the usage of computer technology relevant to biological, environmental, geological, and marine problems. Students will learn various graphical and statistical techniques and how to execute them on personal computers. The curriculum emphasizes the integrated nature of these techniques and their importance to meaningful data evaluation and representation. Laboratory exercises are designed to emphasize useful solutions to problems found in many scientific disciplines using computer-based methodologies. Three hours of lecture and one three-hour lab per week.

**Corequisite(s):** ENV 200L.

**ENV 200L Statistical and Computer Applications in the Natural Sciences Lab 0 Credits**

This lab is a co-requisite and must be taken with the corresponding course.

**Corequisite(s):** ENV 200.

**ENV 205 Introduction to Geographic Information Systems 3 Credits**

This course introduces the computer-based concepts and skills of Geographic Information Systems (GIS). It covers the basic GIS concepts, such as map characteristics and projections, spatial data models and analysis, and relational databases. It explores data sources, data quality, and metadata, as well as implementation and management of specific GIS projects. Hands-on experience with ArcGIS software is provided through a series of student exercises completed throughout the semester. Students will also be taught how to process both vector and raster data using ArcGIS software. The course is relevant for students from numerous disciplines in the natural sciences, social sciences, and business, which require the analysis and graphical representation of spatial data. Three hours of lecture per week.

**ENV 220 Weather and Climate Change 3 Credits**

This course introduces students to the concepts of weather and climate change. These concepts frame a continuum from short-term or daily changes in the atmosphere (meteorology) to those changes averaged over much longer periods of time (climatology). Students will learn the fundamentals of weather forecasting, the causes of natural variation in the Earth's climate, and the impact of human actions on the Earth's climate. Connections will be drawn to other current issues in the Earth system, including land use change, biodiversity, and pollution. Three hours of lecture per week.

**Prerequisite(s):** GEO 100 or GEO 113 or permission of instructor.

**ENV 290 Directed Research and Study in Environmental Sciences 1-4 Credits**

Provides an opportunity for freshman and sophomore students to gain hands-on research experience in the environmental sciences. This is an individual program of study and each student will work with a selected faculty member on a topic of mutual interest. The course consists of a combination of project meetings, supervised research, and guided readings. The focus will be on formulating research questions, designing and conducting experiments, collecting the necessary data, reviewing the scientific literature as it relates to each student's research topic in weekly meetings with the instructor, and communicating the findings by writing a final project report.

**ENV 320 Global Biogeochemistry 4 Credits**

This course introduces students to global biogeochemical processes in the earth system and their influences on marine and terrestrial ecosystems. With a focus on systems thinking and interdisciplinary science, students will learn about the interactions of the biosphere, lithosphere, hydrosphere and atmosphere through elemental cycling and energy transfers. The course extends from the origin of our planet to the modern earth system and considers the anthropogenic impacts of climate change and pollution on humans and other species. Students will analyze scientific data with examples in regulatory and research settings. Students will also gain first-hand experience with field methods including sampling ocean and freshwater using various techniques and equipment and interpreting chemical data. Field trips may be required for this course. Course

**Prerequisites:** GEO 100 or GEO 113; GEO 102; CHE 120 & CHE 121.

**ENV 320L Global Biogeochemistry Lab 0 Credits**

This course introduces students to global biogeochemical processes in the earth system and their influences on marine and terrestrial ecosystems. With a focus on systems thinking and interdisciplinary science, students will learn about the interactions of the biosphere, lithosphere, hydrosphere and atmosphere through elemental cycling and energy transfers. The course extends from the origin of our planet to the modern earth system and considers the anthropogenic impacts of climate change and pollution on humans and other species. Students will analyze scientific data with examples in regulatory and research settings. Students will also gain first-hand experience with field methods including sampling ocean and freshwater using various techniques and equipment and interpreting chemical data. Field trips may be required for this course. Course

**Prerequisites:** GEO 100 or GEO 113; GEO 102; CHE 120 & CHE 121.

**ENV 340 Field Methods and Data Analysis 3 Credits**

This course will provide students with practical experience in field methods and data analyses within environmental and marine sciences. The course will apply advanced scientific methods such as field-based exercises, GIS or coding analyses, statistical analyses, and database management. Students will also complete an independent or group project focused on a relevant topic. Local field trips during lab and potentially longer trips on weekends may be required. This course earns 3 Engaged Learning points in Civic and Community Engagement (CCE.)

**Prerequisite(s):** D or better in (MTH 105, or MTH 106, or MTH 210) and GEO 100, GEO 102, ENV 100, and MAR 120; or Permission of Instructor.

**ENV 375 Environmental Biogeochemistry 3 Credits**

This course examines the biogeochemical interactions among various environmental components, including water, rock, soil, organisms, and atmosphere. Covered topics focus on the relation between the biosphere and changes in the Earth's environment and atmosphere. The transfer of energy and nutrients within terrestrial ecosystems also is explored. Case studies from various examples will be used to understand ecosystem dynamics. Long-term environmental change and present-day ecosystem restoration activities are examined in the context of biotic offsets and land-use planning. The biogeochemical cycles of some environmentally sensitive compounds and elements in natural systems, such as pesticides, mercury, and lead, also may be examined. Three hours of lecture per week.

**Prerequisite(s):** GEO 100 or GEO 113, CHE 120, CHE 121, CHE 122, CHE 123.

**ENV 480 Senior Thesis 3 Credits**

A senior thesis is optional for environmental science majors. However, a senior thesis is required for eligibility to graduate with honors in environmental science. The topic for investigation will be chosen by the student in consultation with the faculty of the Department of Geological, Environmental, and Marine Sciences. The student must initiate consideration of a proposal to the Department. The proposal must contain a discussion of the proposed project and a timetable to be followed in the study. A departmental committee consisting of a major and minor advisor will evaluate the written paper submitted at the conclusion of the study. An oral presentation before the department at the conclusion of the semester in which the study is completed is required. Proposals must be submitted in final form no later than the end of the ninth week of the semester prior to the semester in which the study is undertaken.

**Prerequisite(s):** senior standing in the geosciences major and permission of instructor.

**ENV 490 Independent Study: Research and Creative Expression 1-4 Credits**

Immerses the student in field or laboratory research. The student learns to organize material, use the literature, make precise measurements, and obtain reproducible data. If possible, the student will publish the results or present them at a scientific meeting.

**ENV 491 Internship in Environmental Sciences 1-4 Credits**

A supervised work experience in an approved organization where qualified students gain real-world knowledge and utilize their academic training in a professional environment. Placements may be in private, public, non-profit, or governmental organizations. These can include consulting firms, regulatory agencies, advocacy groups, and educational or research institutions. Normally, 50 hours of internship per credit is required. A mutually agreed upon method of evaluation will be formalized prior to the approval of the internship by the sponsoring faculty and could include a term paper or project report and a poster presentation.

**Prerequisite(s):** 2.5 GPA and permission of instructor.

**GEO 100 Earth Systems Science 3 Credits**

Investigates the major global processes that occur on Earth. These processes can be grouped into four major systems: atmosphere, hydrosphere, lithosphere, and cosmosphere. Each system interacts with and affects the other systems creating, in a sense, a single Earth process. With this approach, the student will view the Earth as a whole, and understand that the many seemingly separate components that make up this planet are, in fact, a set of interacting processes, that operate in cycles through time, within a single global system. Three hours of lecture per week. This course counts towards the fulfillment of the Disciplinary Perspectives element of the CLAS general education curriculum.

**GEO 102 Earth Materials and Processes Lab 1 Credits**

This lab course introduces students to the origin, identification, and significance of geologic materials, processes, and landforms. Hands-on experiences with mineral and rock specimens, topographic and geologic maps, and GPS and other data collection techniques are emphasized, along with field trip and in-lab observations, measurements, and interpretations. One three-hour lab per week.

**Prerequisite(s):** concurrent enrollment in, or prior completion of, GEO 100 or GEO 113 is required.

**GEO 102SP Earth Materials and Processes Lab 1 Credits**

This lab course introduces students to the origin, identification, and significance of geologic materials, processes, and landforms. Hands-on experiences with mineral and rock specimens, topographic and geologic maps, and GPS and other data collection techniques are emphasized, along with field trip and in-lab observations, measurements, and interpretations. One three-hour lab per week. This course counts towards the fulfillment of the Disciplinary Perspectives element of the CLAS general education curriculum.

**Prerequisite(s):** concurrent enrollment in, or prior completion of, GEO 100 or GEO 113 is required.



**GEO 110 Geology of National Parks 3 Credits**

U.S. national parks highlight the geologic wonders of our country and provide us with some of the best examples of the many processes that initially formed our planet and those that continue to shape it. This course is an introduction to the geological setting of selected U.S. national parks. It provides an overview of geological concepts and relates the geology of each park to the processes that initially formed, and subsequently shaped, their characteristic landforms. Such processes include: plate tectonics, volcanic and plutonic activity, glaciation, cave formation, stream and coastal processes, and erosional processes. Consequently, students not only will understand how the physical geography of the U.S. varies from coast to coast, but also will connect these varied landscapes with the geologic processes that formed them and relate them to unique wildlife or vegetation in the parks studied.

**GEO 113 Environmental Geology 3 Credits**

Examines the fundamental premise that "society exists by geologic consent subject to change without notice" by studying a number of important global geologic processes and cycles, and the hazards and/or resources they present to individuals, societies, and the natural environment. Topics discussed include earthquakes, volcanism, stream flooding, coastal erosion, global climate change, and global water, soil, mineral, and energy resources. Cost/benefit considerations, hazard mitigation concepts, economic and political ramifications, and interactions among the lithosphere, hydrosphere, atmosphere, and biosphere also are presented. The course is designed to give non-science majors a deeper appreciation and understanding of the basic scientific concepts involved, as well as individual and societal connections to the global geologic environment, leading to better, more informed business, political, policy, and personal decisions. This course counts towards the fulfillment of the Disciplinary Perspectives element of the CLAS general education curriculum.

**GEO 168 Mesozoic Ruling Reptiles 3 Credits**

This course provides an introduction to the vertebrate groups that dominated the land (Dinosaurs), the seas (Mosasaurs, Plesiosaurs, Pliosaurs, Tylosaurs, and Ichthyosaurs) and the skies (Pterosaurs, Pterodactyls) during the Mesozoic Era (65-250 million years ago). Students study the diversity of skeletal architectures and their reconstructed function and the often controversial, inferred anatomy, physiology, reproductive strategy, habit, and social behaviors of these animals that are different from mainstream reptiles, birds, and mammals. They also learn about the paleogeographical, and paleoclimatological conditions that facilitated the evolutionary rise to dominance and diversification of these vertebrate groups and the debated causes of their eventual extinction. These topics also serve to illustrate how the scientific approach works and how competing hypotheses are evaluated. Three hours of lecture per week. Weekend field trips may be required.. This course counts towards the fulfillment of the Disciplinary Perspectives element of the CLAS general education curriculum.

**GEO 290 Directed Research and Study in Geosciences 1-4 Credits**

Directed Research and Study in Geosciences will provide an opportunity for freshman and sophomore students to gain hands-on research experience in the geosciences. This is an individual program of study and each student will work with a selected faculty member on a topic of mutual interest. The course consists of a combination of project meetings, supervised research, and guided readings. The focus will be on formulating research questions, designing and conducting experiments, collecting the necessary data, reviewing the scientific literature as it relates to each student's research topic in a weekly meetings with the instructor, and communicating the findings by writing a final project report.

**GEO 306 Sedimentology and Stratigraphy 4 Credits**

The principles of weathering, erosion, transportation, and deposition of sediment are the focus of this course. Sediment characteristics are examined to identify the processes involved in transporting grains and the specific environment in which the grains were deposited. Students will learn how to collect, analyze, and interpret sedimentary data and how to interpret surface and subsurface stratigraphic data using various techniques, such as lithostratigraphic, biostratigraphic, and geophysical, correlations. Field trips will expose students to different sedimentary environments and provide opportunities for students to learn how to conduct fieldwork. Three hours of lecture and one three-hour lab per week. Weekend field trips may be required. Prerequisite(s): GEO 100. **Corequisite(s):** GEO 306L.

**GEO 306L Sedimentology and Stratigraphy Lab 0 Credits**

This lab is a co-requisite and must be taken with the corresponding course.

**Corequisite(s):** GEO 306.

**GEO 350 Soil and Surficial Processes 4 Credits**

This course examines the physical, chemical, hydrological, and biological aspects of soil and their relation to geomorphologic development. Specific topics include descriptions of soil texture and structures, soil classification, soil colloids, soil redox and pH, and their effect on vadose zone water chemistry. Soil genesis and erosion controls, microbiology/ecology, nutrient cycles, and modern soil pollution from sludge and pesticide applications, as well as domestic and industrial chemical spills, also are discussed. The lab portion of the course introduces the basic techniques of soil analysis, both physical and chemical, and field survey methods. Three hours of lecture and one three-hour lab per week. Prerequisite(s): GEO 100 or GEO 113, and GEO 102.

**Corequisite(s):** GEO 350L.

**GEO 350L Soil and Surficial Processes Lab 0 Credits**

This lab is a co-requisite and must be taken with the corresponding course.

**Corequisite(s):** GEO 350.

**GEO 407 Hydrology and Water Resources 4 Credits**

This course introduces the principles that govern both surface water and groundwater flows that have applications to societal water needs. Surface water topics cover the basics of the hydrologic cycle, the processes of precipitation, evapotranspiration, runoff, and infiltration, and various factors affecting water supply and water quality issues in a modern watershed. Groundwater topics examine the principles that govern flow through a porous medium and the basics of well hydraulics under different pumping conditions that community development requires. Laboratory exercises will give students hands-on experience with the delineation of watersheds, analysis of precipitation data, and flow contaminant transport modeling. The field portion of the laboratory includes runoff and stream discharge measurements, as well as hydraulic conductivity estimations from both slug and pumping tests. Three hours of lecture and one three-hour lab per week. Prerequisite(s): GEO 100 or GEO 113, GEO 102, and MTH 105 or higher.

**Corequisite(s):** GEO 407L.

**GEO 407L Hydrology and Water Resources Lab 0 Credits**

This lab is a co-requisite and must be taken with the corresponding course.

**Corequisite(s):** GEO 407.

**GEO 480 Senior Thesis 3 Credits**

A senior thesis is optional for geosciences majors. However, a senior thesis is required for eligibility to graduate with honors in geosciences. The topic for investigation will be chosen by the student in consultation with the faculty of the Department of Geological, Environmental, and Marine Sciences. The student must initiate consideration of a proposal to the Department. The proposal must contain a discussion of the proposed project and a timetable to be followed in the study. A departmental committee consisting of a major and minor advisor will evaluate the written paper submitted at the conclusion of the study or other approved venue. An oral presentation before the department at the conclusion of the semester in which the study is completed is required. Proposals must be submitted in final form no later than the end of the ninth week of the semester prior to the semester in which the study is undertaken.

**Prerequisite(s):** senior standing in the geosciences major and permission of instructor.

**GEO 490 Independent Study: Research and Creative Expression 1-4 Credits**

Immerses the student in field or laboratory research. The student learns to organize material, use the literature, make precise measurements, and obtain reproducible data. If possible, the student will publish the results or present them at a scientific meeting.

**GEO 491 Internship in Geosciences 1-4 Credits**

A supervised work experience in an approved organization where qualified students gain real-world knowledge and utilize their academic training in a professional environment. Placements may be in private, public, non-profit, or governmental organizations. These can include consulting firms, regulatory agencies, advocacy groups, and educational or research institutions. Normally, 50 hours of internship per credit is required. A mutually agreed upon method of evaluation will be formalized prior to the approval of the internship by the sponsoring faculty and could include a term paper or project report and a poster presentation.

**Prerequisite(s):** 2.5 GPA and permission of instructor.

**MAR 120 Oceanography 3 Credits**

In this course, students will investigate the geological, chemical, physical, and biological processes that shape the ocean. Emphasis will be placed on how these processes interact with each other and with human populations. These interactions influence important global phenomena that impact all our lives, including weather and climate, the distribution of marine organisms and other natural resources, and coastal processes. Understanding these phenomena will enable students to make more informed decisions and contribute to serious global marine issues. Students will learn through a combination of hands-on exercises designed to foster a deeper understanding of the scientific content as well as the scientific process, practical experiences with real data, readings, and some lectures. CLAS general education areas addressed: DP & GP.

**MAR 121 Introductory Oceanography Lab 1 Credits**

This lab course introduces students to the fundamental aspects of geological, chemical, physical and biological oceanography. Students learn through inquiry-based, hands-on exercises and activities using actual data collected in the lab and in the field. Independent projects and local field trips during lab and on weekends may be required. One three-hour lab per week. This course counts towards the fulfillment of the Disciplinary Perspectives element of the CLAS general education curriculum.

**MAR 290 Directed Research and Study in Marine Sciences 1-4 Credits**

Provides an opportunity for freshman and sophomore students to gain hands-on research experience in the marine sciences. This is an individual program of study and each student will work with a selected faculty member on a topic of mutual interest. The course consists of a combination of project meetings, supervised research, and guided readings. The focus will be on formulating research questions, designing and conducting experiments, collecting the necessary data, reviewing the scientific literature as it relates to each student's research topic in a weekly meetings with the instructor, and communicating the findings by writing a final project report.

**MAR 340 Marine Processes and Environments: Seminar 3 Credits**

This course is designed as a seminar course. Therefore, students will learn to lead class discussions, to analyze and critique peer-reviewed journal articles, and to enhance their presentation skills. Students will interpret graphical, spatial, and numerical data to support their positions. Content will emphasize the interactions among marine processes, biological features, and geologic landforms.

**Prerequisite(s):** A minimum grade of D in MAR 120 and GEO 100 or GEO 113.

**MAR 401 Marine Ecology 4 Credits**

The purpose of this course is to introduce students to fundamental principles in ecology, as it relates to marine systems. Topics include the marine environment and its influence on the organisms living there; biodiversity and speciation; factors regulating population dynamics in marine systems; larval and fisheries ecology; species interactions such as predation, competition, and symbiosis; factors regulating productivity and energy flow in marine systems; and marine conservation. Hands-on laboratory exercises will provide students with the opportunity to design and conduct experiments related to marine ecology, and to collect, analyze, and interpret data from those experiments. Ecosystem modeling will also be introduced. Three hours of lecture and one three-hour lab per week. Weekend field trips may be required.

**Prerequisite(s):** D or better in MAR 120 and either BIO 115 or 116.

**MAR 401L Marine Ecology Lab 0 Credits**

This lab is a co-requisite and must be taken with the corresponding course.

**Corequisite(s):** MAR 401.

**MAR 410 Physical Oceanography 3 Credits**

Introduction to the physical aspects and processes of the oceans and their influence on marine ecosystems and Earth processes. Topics include distribution of salinity and water temperature and their effect on water movement, the oceanic heat budget, atmospheric and oceanic interactions, ocean currents including surface and deep water circulation, waves, tides, and medium- to small-scale circulation features. Throughout the course, emphasis is placed on how these physical processes affect the biology and chemistry of the ocean. Three hours of lecture per week. Weekend field trips may be required.

**Prerequisite(s):** MAR 120.

**MAR 480 Senior Thesis 3 Credits**

A senior thesis is optional for marine sciences majors. However, a senior thesis is required for eligibility to graduate with honors in marine sciences. The topic for investigation will be chosen by the student in consultation with the faculty of the Department of Geological, Environmental, and Marine Sciences. The student must initiate consideration of a proposal to the Department. The proposal must contain a discussion of the proposed project and a timetable to be followed in the study. A departmental committee consisting of a major and minor advisor will evaluate the written paper submitted at the conclusion of the study or other approved venue. An oral presentation before the department at the conclusion of the semester in which the study is completed is required. Proposals must be submitted in final form no later than the end of the ninth week of the semester prior to the semester in which the study is undertaken.

**Prerequisite(s):** senior standing in the marine sciences major and permission of department chair.

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Immerses the student in field or laboratory research. The student learns to organize material, use the literature, make precise measurements, and obtain reproducible data. If possible, the student will publish the results or present them at a scientific meeting.

**MAR 491 Internship in Marine Sciences 1-4 Credits**

A supervised work experience in an approved organization where qualified students gain real-world knowledge and utilize their academic training in a professional environment. Placements may be in private, public, non-profit, or governmental organizations. These can include consulting firms, regulatory agencies, advocacy groups, and educational or research institutions. Normally, 50 hours of internship per credit is required. A mutually agreed upon method of evaluation will be formalized prior to the approval of the internship by the sponsoring faculty and could include a term paper or project report and a poster presentation.

**Prerequisite(s):** 2.5 GPA and permission of instructor.