

# MARINE SCIENCES (MARN)

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## **MARN 5010. Biological Oceanography. (3 Credits)**

Structure and function of marine food webs, from primary producers to top trophic levels; interaction of marine organisms with the environment; energy and mass flow in food webs; elemental cycling; coupling between pelagic and benthic environments.

**Enrollment Requirements:** Not open to students who have passed MARN 4010.

## **MARN 5012. Marine Invertebrate Biology. (3 Credits)**

Comparative examination of major adaptations and functional responses of marine invertebrates to biotic and abiotic factors in the marine environment. Field trips required.

## **MARN 5015. Techniques in Marine Molecular Biology. (3 Credits)**

Principles and technology in molecular genetics, including nucleic acid purification and manipulation, DNA fingerprinting, gene cloning and sequencing, phylogenetic analysis, and detection of gene expression.

**Enrollment Requirements:** Not open to students who have passed MARN 3015.

## **MARN 5017. Plankton Ecology. (3 Credits)**

Ecology of planktonic organisms (bacteria, protista and metazoa). The evolutionary ecology concept, methods of research, special features of aquatic habitats; adaptations to aquatic environments; population biology; predation, competition, life histories, community structure, and role of plankton in ecosystem metabolism.

## **MARN 5018. Ecology of Fishes. (3 Credits)**

General concepts in fish ecology such as distribution, feeding, bioenergetics, growth, larval fish ecology, biotic interactions, life history evolution and other contemporary research topics.

## **MARN 5019. Algae and the Marine Environment. (3 Credits)**

Fundamentals of algae, interactions of algae with the environment, and applications for environmental conservation and human uses. Introduction to the evolution and diversity of marine and selected freshwater algae and major ecological characteristics and responses to environmental variability. Applications may include utilization of algae for green energy, environmental bioremediation, food, and bioproducts.

**Enrollment Requirements:** Recommended preparation: Basic biology curriculum.

## **MARN 5030. Chemical Oceanography. (3 Credits)**

Composition, origin and solution chemistry of seawater and the marine biogeochemical cycles of salts, elements and gases. Distributions and transfer in the marine environment through chemical equilibria, rates, redox, partitioning, ocean circulation, biological cycles and crustal exchanges.

## **MARN 5032. Coastal Pollution and Bioremediation. (3 Credits)**

Overview of processes and compounds leading to pollution in the nearshore marine environment. The impact of pollution on the marine foodweb and its response is emphasized. Alleviation of pollution through metabolism of organisms, including bacteria, seagrasses and salt marshes.

## **MARN 5033. Marine and Atmospheric Processes of Global Change. (3 Credits)**

Fundamentals of marine and atmospheric processes in global biogeochemistry. Evaluation of atmospheric, biological and chemical processes that contribute to global change.

## **MARN 5036. Advanced Chemical Oceanography. (3 Credits)**

Major global biogeochemical cycles of the major elements, nutrients, gases, organic matter, and trace elements and the impact of climate change and ocean acidification. Biogeochemical cycling of toxic trace metals, and transfer of substances at the air and sediment interfaces.

## **MARN 5050. Geological Oceanography. (3 Credits)**

Concepts in geological oceanography, including the role of plate tectonics in the control of the Earth and ocean system, fundamentals of biosphere-geosphere interaction over geologic timescales, and the reconstruction of past climates using marine sediment archives.

## **MARN 5052. Paleoceanography. (3 Credits)**

Exploration of how the geologic record, geochemical proxies and model simulations can be used to understand climate change at centennial and longer timescales, with an emphasis on oceanographic processes. Topics include global overturning circulation, carbon cycle dynamics, and feedback mechanisms that govern long-term climate variability.

**Enrollment Requirements:** Not open for credit to students who have passed MARN 4052.

## **MARN 5060. Dynamic Physical Oceanography. (3 Credits)**

Introduction to a theoretical and computational understanding of physical processes that control the structure and circulation in the ocean and atmosphere. Topics include the global energy balance, thermodynamics and stability, fundamental geophysical fluid mechanics, surface gravity waves, tides and other long waves.

**Enrollment Requirements:** Recommended preparation: Undergraduate courses in Physics and Calculus and elementary computing skills.

## **MARN 5061. Advanced Dynamical Oceanography. (3 Credits)**

Ocean thermodynamics; dynamics of rotating; homogeneous fluids; ocean circulation; western boundary currents; the thermocline, oceanic fronts.

**Enrollment Requirements:** MARN 5060.

## **MARN 5064. Air-Sea Interaction. (3 Credits)**

Processes controlling the exchange of momentum, heat and mass across the air-sea interface. Topics include atmospheric and oceanic stratification, wind-wave-current interaction, wave breaking, bubble generation, heat budgets, flux parameterizations and instrumentation.

**Enrollment Requirements:** MARN 5060.

## **MARN 5065. Physical Oceanography. (3 Credits)**

Overview of physical properties and dynamics influencing the oceans and coastal waters. Descriptions of global water property distributions, surface mixed layer, pycnocline, surface heat fluxes, and major ocean currents. Introduction to dynamics of ocean circulation, waves, tides, and coastal circulation.

## **MARN 5066. River Influences on the Marine Environment. (3 Credits)**

Influences of rivers on estuaries, coastal and open ocean water properties, energy budgets and ecosystems including inputs of buoyant waters, sediments and pollutants and variability from storms, seasons, human alterations and climate change. Recommended preparation: calculus and general physics.

**Enrollment Requirements:** Recommended preparation: Calculus and general physics.

## **MARN 5068. Ocean Fluid Dynamics. (3 Credits)**

Physical processes controlling the circulation and mixing of the ocean focusing on small scale processes with short time scales. Topics include fundamental fluid mechanics, thermodynamics, turbulence, waves, wave-current interactions, and air-sea interaction.

**MARN 5200. Oceanographic Data Analysis. (3 Credits)**

Programming, data input/output, and graphing with advanced scientific analysis software. Analysis of temporal and spatial patterns in oceanographic datasets using multivariate regression, harmonic analysis, Fourier and wavelet transforms, empirical orthogonal functions, and three-dimensional mapping.

**MARN 5201. Oceanographic Expedition. (4 Credits)**

Development of skills with modern and traditional methods used in making physical, chemical, biological and geological observations at sea from the R.V. Connecticut. Students should be prepared for a three-day or longer expedition. Instrumentation, methods, data analysis and synthesis will be conducted in pre- and post-cruise seminars. May be repeated to a maximum of six credits with a change of topic.

**Enrollment Requirements:** Instructor consent.

May be repeated for a total of 8 credits

**MARN 5202. Models of the Ocean Carbon Cycle. (4 Credits)**

Introduction to the chemical/biological reactions and transport dynamics of ocean models with the focus on attribution of anthropogenic carbon in the global ocean. Quantitative topics include mass balances, the coupled dynamics of oceans and the atmosphere as biogeochemical systems, and parameterizations of important biogeochemical processes.

**Enrollment Requirements:** Not open for credit to students who have passed MARN 4202Q.

**MARN 5210. Experimental Design in Marine Ecology. (4 Credits)**

Introduction to experimental design and data analysis for marine biology and ecology. Analysis and visualization of experimental data using the statistical software package R. Topics include analysis of variance, replication and pseudoreplication, factorial designs, and significance testing.

**Enrollment Requirements:** Not open for credit to students who have passed MARN 4210Q.

**MARN 5500. Professional Development in Marine Sciences. (3 Credits)**

Survey of practical skills required for professional integration into the scientific community, including proposal writing, scientific and public presentations, manuscript preparation and publication, scientific peer review, resume building, and interview skills.

**MARN 5501. Marine Sciences Seminar. (2 Credits)**

Intensive reading, evaluation and critical discussion of current interdisciplinary topics presented at weekly departmental research seminars. May be repeated for credit.

May be repeated for a total of 6 credits

**MARN 5798. Variable Topics in Acoustical Oceanography. (1-6 Credits)**

Explores foundational principles of underwater acoustics with applications to ocean systems. Topics may include scattering from water column phenomena (e.g., bubbles, rough surfaces, turbulent microstructure, biota), high frequency signal propagation, sonar systems (single beam, multibeam, side scan sonar), or other subjects based on student need/interest. With a change in content, may be repeated for credit.

May be repeated for a total of 12 credits

**MARN 5812. Seminar in Marine Biodiversity and Conservation. (3 Credits)**

Critical examination of state-of-the-art research, policy and regulatory frameworks of marine conservation biology and associated environmental, cultural, and socio-economic implications. Topics may include aquaculture, endangered species, strandings, biomedicine, ocean pollution, and marine protected areas. Research projects to be conducted at Mystic Aquarium.

**Enrollment Requirements:** Not open to students who have passed MARN 3812.

**MARN 5830. Seminar in Oceanography. (2 Credits)**

Readings and discussions of current literature in oceanography. Topics vary each semester: Biological, Chemical, Physical, Geological. May be repeated for credit.

May be repeated for a total of 8 credits

**MARN 5895. Special Topics. (1-6 Credits)**

A new or pilot course offering in Marine Sciences. May be repeated with a change of topic.

May be repeated for a total of 24 credits

**MARN 5896. Research. (1-6 Credits)**

Field and laboratory research covering selected topics of marine sciences.

May be repeated for a total of 15 credits

**MARN 5898. Variable Topics in Chemical Oceanography. (1-6 Credits)**

With a change in content, may be repeated for credit.

May be repeated for a total of 12 credits

**MARN 5899. Independent Study. (1-6 Credits)**

Independent study under the direction of a faculty member.

May be repeated for a total of 24 credits

**MARN 6001. Mathematical Models in Marine Sciences. (2 Credits)**

Examples of the formulation of quantitative models of marine systems with a review of some particularly useful mathematical methods (differential equations, operational methods, numerical solution techniques), emphasizing the computation of predictions.

**Enrollment Requirements:** Nine graduate credits in MARN courses.

**MARN 6002. Mathematical Models in Marine Sciences: Practicum. (2 Credits)**

Individual term projects relating to mathematical modeling in the marine sciences.

May be repeated for a total of 8 credits

**MARN 6003. Modeling Biogeochemical Cycles in the Coastal Ocean. (3 Credits)**

Development of skills with modern and traditional methods of simulating marine biogeochemical cycles of nutrients, oxygen, carbon, and carbonate within a simplified physical model environment. Experience using Nutrient, Phytoplankton, Zooplankton, and Detritus (NPZD) models with and without gas exchange. Knowledge of different model formulations and tracers, evaluation of model results, sensitivity analyses, tracer budgets, and development of new parameterizations in biogeochemical simulations.

**Enrollment Requirements:** Recommended Preparation: Physical Oceanography, Biological Oceanography, Chemical Oceanography, Geological Oceanography.

**MARN 6010. Advanced Biological Oceanography -- Pelagic Processes. (3 Credits)**

Pelagic communities, ecosystem structure and function, bioenergetic constraints, population dynamics, consequences of global climate and environmental change, and advances in the field driven by technological innovation.

**MARN 6011. Advanced Biological Oceanography - Benthic Processes. (3 Credits)**

Physical and physiological constraints on the benthos, benthic-pelagic coupling, species interactions, community assembly and dynamics, and anthropogenic impacts.

**Enrollment Requirements:** MARN 5010 or instructor consent.

**MARN 6012. Marine Genomics. (3 Credits)**

Concepts and principles of Genomics and other forms of -omics (transcriptomics, proteomics, metabolomics), resources and methods of analyses, and recent advances in biological oceanography and marine biogeochemistry achieved through the -omic approach.

**Enrollment Requirements:** MARN 5010 or instructor consent.

**MARN 6031. Stable Isotope Biogeochemistry. (3 Credits)**

Overview of important stable isotopic systems used to study biogeochemical cycling of bioactive elements. Focus will be on carbon, nitrogen, and oxygen isotopic systems with an introduction to sulfur, silicic acid, and trace metals.

**Enrollment Requirements:** MARN 4030W or 5030 or instructor consent.

**MARN 6032. Environmental Organic Chemistry I. (3 Credits)**

Environmental factors governing the processes that determine the fate of organic compounds in natural and engineered systems. Quantitative assessments based on thermodynamic principles of the environmental behavior of organic compounds. Topics include multimedia partitioning between air, water, and particles; photochemical and biodegradation models.

**Enrollment Requirements:** MARN 5030 or instructor consent.

**MARN 6034. Trace Elements in Aquatic Ecosystems. (3 Credits)**

Global biogeochemical cycles of trace elements and their impact on ecosystem function and biogeochemistry. Trace elements include required (nutrient), potentially toxic, metals and metalloids. Topics include biogeochemical tracers, reaction rates, chemical speciation, equilibria, solubility, oxidation-reduction, adsorption, complexation, and relationships to the marine food web and human activity.

**Enrollment Requirements:** MARN 5030 or instructor consent. Not open for credit to students who have passed MARN 5995 when offered as Trace Elements and Isotopes.

**MARN 6088. Variable Topics. (1-6 Credits)**

With a change in content, may be repeated for credit.

May be repeated for a total of 24 credits