HISTORY of the EARTH SYSTEMS (11:628:476, 3 credits)

Instructor
Professor Paul Falkowski

Prerequisites
Introductory courses in Chemistry, Biology, and Physics (or by permission)

Course Materials
Supplemental reading will be available through the course website

Topics
Planetary origins
Origin of elements and their distribution; origin of the ocean
Earth’s early atmosphere, radiation budget and the “faint Sun” paradox
Origins of life concepts
Fossils and geochemical biomarkers from the Archea and Proterozoic epochs
Molecular clocks and the biological inference of origins of life
The evolution of the carbon cycle/modes of nutrition
The evolution of the nitrogen cycle; Redfield ratios
The role of trace elements in regulating biogeochemical cycles
Molecular phylogeny and origin of eucaryotes
Lateral gene transfer and the origins of plastids and mitochondria
Organization of metabolic sequences
Oxygen and the evolution of photosynthesis
The impact of oxygen evolution on trace element distributions
Origins of animals and the Cambrian “explosion”
Isotopic fractionation
The pre-Cambrian extinctions and the “missing” pieces of the fossil record
Earth’s radiation budget, greenhouse gases, clouds and ice
Steffan-Boltzmann equation, climate feedbacks, and energy balance
The hydrological cycle, oceanic heat transport and thermohaline circulation
The role of the ocean in climate dynamics
Aeolian fluxes, mineral transport, weathering and feedbacks on biogeochemical fluxes
Time scales of element cycling.
Extinctions: The “Big Five,” resetting of the ocean redox system
The Triassic recovery – The “tempo” and “mode” of evolution – Theories of evolution
The concepts of natural selection and introduction to population biology
Plate tectonics and its role in genetic drift
Rates of evolution and selection mechanisms in the Cretaceous
The K/T boundary and the post impact world -
Glacial and interglacial cycles, Milankovich cycles
CO₂ and other greenhouse gases since the beginning of the Industrial Revolution
Primary production and carbon sequestration in the contemporary world
Bio-diversity, ecological homogenization, extinction / human interactions with the environment; the evolution of intelligence
The evolution of language, horizontal information transfer
Post-evolutionary theories of Earth System Science

Course Learning Goals and Assessment
The Learning Goals for the Marine Science Program are posted on our website at http://marine.rutgers.edu/main/academics/undergraduate/program-description. The learning goals for this course apply to Program Learning Goal 1 (to master the basic biological, chemical, physical, and geological principles of marine science), Goal 3 (show evidence of scientific literacy, and to communicate the information effectively both orally and in writing), and Goal 5 (evaluate contemporary global issues and the ethics of how the ocean’s resources are used).

Students completing this course will be able to:

Goal A. Explain the major processes that have shaped Earth’s environment
Instructional Activities: lectures, assigned reading
Assessment Method: performance on exams

Goal B. Evaluate climatic processes on geological time scales, the evolution of organisms, the cycling of elements, and the feedbacks between these processes
Instructional Activities: lectures, assigned reading
Assessment Method: performance on exams

Goal C. Discuss connections between various science disciplines (for example, molecular phylogeny and climatic variability)
Instructional Activities: lectures, assigned reading
Assessment Method: performance on exams

Goal D. Relate fundamental concepts in science (e.g., Stefan-Boltzmann equation, the Poisson probability function, the Nernst equation) to the developmental history of the Earth
Instructional Activities: lectures, assigned reading
Assessment Method: performance on exams

Goal E. Develop a question centered on a topic discussed in class, evaluate the relevant literature, and communicate the results in a written term paper
Instructional Activities: guidance on elements of a term paper, guidance on proper citation procedures
Assessment Method: performance on term paper

Grading
Midterm exam 30%
Term Paper 40%
Final Exam 30%