History of the Earth Systems

Course Syllabus for Fall 2010

01:460:476:01 (Geological Sciences-Undergrad.)
11:628:476:01 (Marine and Coastal Sciences – Undergrad.)
16:712:560:01 (Oceanography-Grad.)
Waller Hall (WAL), Room 203, Cook Campus
Class Time: TTh 2:15 - 3:35 PM

Instructor: Dr. Paul Falkowski
Email: falko@imcs.marine.rutgers.edu
Office hours: by appt. – call 732-932-6555 ext. 244
Office location: Institute of Marine and Coastal Science bldg., Rm. 318D

Required Text: The Blue Planet: An Introduction to Earth System Science 2nd ed. By: Brian J. Skinner, Stephen C. Porter, and Daniel B. Botkin
(Textbook is available at the Cook/Douglass Co-op Bookstore)

Supplemental Reading: Earth System History By: Steven Stanley

Grading:	Mid-Term Exam	(Oct. 21)	30%
	Term Paper	(Dec. 2)	40%
	Final Exam	(Dec. 9)	30%
			100%

Term Paper:
- Undergraduates: 15 page referenced overview of any topic related to Earth System Science or History of Earth Systems
- Graduates: Different format; Paper will be in a research grant proposal style

** More detail will be discussed about these term papers

Overview:
This course integrates atmospheric, oceanographic, geological and biological concepts with a historical perspective to introduce the student to the major processes that have shaped Earth's environment. The course will examine climatic processes on geological time scales, the evolution of organisms, the cycling of elements, and the feedbacks between these processes. Prerequisites: Introductory Chemistry, Biology, and Physics (or by consultation with the Instructor).

Goals:
The primary goal of this course is to introduce upper level undergraduate and graduate science majors to the complexity of Earth as a physical/biological system. The course is aimed at challenging the student to think about connections between various science disciplines (e.g. Molecular phylogeny and climatic variability). The course will emphasize learning rigorous, fundamental concepts in science (e.g. Stefan-Boltzmann equation, the Poisson probability function, the Nerst equation) as applied to understanding radiative transfer, rates of genetic change, etc.

Philosophy:
The course will be taught as a lecture series, building from an historical perspective, and noting the contributions of specific scientists to our knowledge of Earth System Science. The course will use one primary text with supplemental reading from other texts and review articles in the primary literature. Course grades will be based on a mid-term exam (short answer and essay questions - 30% of total), a comprehensive final - (short answer and essay 30% of total), and a term paper that reviews a specific topic in Earth System Science (40% of total). The term paper for the 400 level course will be 15 page review of literature in a course topic. At the 500 level, the term paper will be modeled as a Research Proposal, and focus on an examination of competing hypotheses in Earth System Science with a detailed research plan that would reconcile the hypotheses. The course will be modeled on similar courses taught at Berkeley in Integrative Biology.

Month	Day	Topic
September	2	*Description of course structure/goals. Introduction to planetary origins/accretion origin elements & their distribution, the origin of the ocean.*
	7	*Early Earth, theories of the origin of organic matter in the universe & on Earth.*
	9	*Introduction to Earth's early atmosphere, radiation budget and the "faint Sun" paradox (part I).*
	14	*Introduction to Earth's early atmosphere, radiation budget and the "faint Sun" paradox (part II).* *Introduction to origins of life concepts: definition of life, the initial conditions redox chemistry and early metabolic sequences, the formation of organic polymers & cells.*
	16	*Fossils and geochemical biomarkers from the Archea & Proterozoic epochs - the geological record. Molecular clocks and the biological inference of origins of life.*
	21	*The evolution of the carbon cycle/ modes of Nutrition I. The evolution of the* N_2 *cycle*
	23	*Modes of Nutrition II / the Redfield ratios Introduction to bioinorganic chemistry.*
	28	*The role of trace elements in regulating biogeochemical cycles.*
	30	*Concepts of biological limiting processes in geochemistry. Molecular phylogeny & origin of eucaryotes / lateral gene transfer and the origins of plastids and mitochondria. The organization of metabolic sequences.*

Month	Day	Topic
October		
	5	***TERM PAPER Discussed*** *Oxygen & the evolution of photosynthesis – signs of life on the planet. The impact of oxygen evolution on trace element distributions. The Cambrian "explosion" / role of oxygen in the evolution of macrofauna.*
	7	***TERM PAPER Discussed (Cont'd)*** *Isotopic fractionation, Paleothemometers, paleobarometers, and paleo "depositometers". The pre-Cambrian extinctions and the "missing" pieces of the fossil record – Darwin's dilemma.*
	12	Earth's radiation budget II, greenhouse gases, clouds and ice (Earth's albedo). Steffan-Boltzmann equation, climate feedbacks, and energy balance.
	14	*The hydrological cycle, oceanic heat transport and thermohaline circulation. The role of the ocean in climate dynamics.*
	19	*Aeolian fluxes, mineral transport, weathering and feedbacks on biogeochemical fluxes. Time scales of element cycling.*

Month	Day	Topic
	21	***MID-TERM EXAM***
	26	*Extinctions: The "big five". The Permuian extinction & the resetting of the ocean redox system.*
	28	*The Triassic recovery – The "tempo" and "mode" of evolution – Theories of evolution. The concepts of natural selection and introduction to population biology.*

Month	Day	Topic
November	2	*Introduction to plate tectonics and role in genetic drift.*
	4	*Rates of evolution and selection mechanisms in the Cretaceous – Darwin, and neoDarwinism.*
	9	*The K/T boundary and the post impact world - Evolution of mammals and the evolution of intelligence.*
	11	*Glacial and interglacial cycles/ Milankovich cycles*
	16	*CO_2 since the beginning of the Industrial Revolution.*
	18	*Primary production and carbon sequestration in the contemporary world. The solubility and biological pumps, higher plant sensitivity to CO_2.*
	23	*Mapping biogeochemical cycles to the evolution of functional proteins - an introduction to structural biology and problems in contemporary evolutionary theories - the problems of predicting outcomes of climate change on biological systems.*
	25	***NO CLASS – Thanksgiving Recess***
	30	*Bio-diversity, ecological homogenization, extinction / human interactions with the environment; The evolution of intelligence.*

Month	Day	Topic
December	2	***TERM PAPERS DUE*** *The evolution of language and post-evolutionary theories of Earth System Science.* ***(Last Class Meeting before Final)*** *Discussion of term papers; Oral Summaries*
	7	***NO CLASS***
	9	**Exam** *If you need to meet with me, please make an appointment by calling 932-6555 ext. 244*