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Raymond Curriculum Study The Natural Sciences

Raymond College

RAYMOND CURRICULUM STUDY 2/17/65
THE NATURAL SCIENCES

Sir Charles Snow is only one of a great many perceptive people who are deeply concerned about the "communication gap" between scientists and non-scientists, even those who are in other respects "well-educated." However, few have had the courage and foresight to advocate the means for bridging this gap from the non-scientists' side - an intensive college-level program of studies in the sciences, designed specifically to meet this general need. To our knowledge, there are only a handful of experimental colleges which are actually trying to implement such a program.

It is the nature of the usual fragmented and optional college curriculum which has most limited progress in this area. Rigorous and encyclopedic foundation courses must be offered for departmental majors in each science; such courses are not intended to emphasize the broad perspectives, philosophy, meaning or significance of the subject. The alternative general science courses are constrained to superficiality by their briefness and by the students' varied and inadequate backgrounds, especially in mathematics.

It is the basic educational philosophy and curricular organization of Raymond College which has made it possible for us to design a program to speak directly and effectively to the Liberal Arts student. We work toward a cohesive, coherent and comprehensive understanding of science through integration of the entire three-term sequence in the general curriculum design. We need not sacrifice rigor, for our students have the prerequisite mathematical background and the general intellectual and logical maturity to use the more elegant and more powerful approach of the scientist's study of science. Since we are under no compulsion to cover all areas of each discipline uniformly we are able to achieve depth and intensity in the study of some topics by taking only a birds-eye view of other areas (a block-and-gap approach). We try to give various perspectives of science by using different approaches to different topics - historical for astronomy, philosophical for quantum mechanics, practical and contemporary for the science seminar, logical and deductive for mathematics, etc.

Our approach has been to develop a unified sequence that moves smoothly from a quantitative study of physics and the basic nature of science in the first term to a somewhat more descriptive examination of the properties and transitions of matter in the second term. This solid foundation in physical sciences makes possible a functional approach to living systems from single cells to communities in the third term.

The three terms of study are described in more specific detail in the accompanying sheets.

OBJECTIVES

The course is organized and taught in a manner designed to meet, to the extent they are not mutually exclusive, the following objectives:

a) To make the student aware of the essential rationality of the physical and biological world around him.

b) To teach both the nature of our knowledge of man's environment and the methods we have developed to obtain this knowledge.

c) To give an appreciation of the history of science and its implications for the present and the future.

d) To turn the students eyes inward and show him that he is a complex, rational, physical, biochemical animal.

e) To inclucate in the student a confidence that he can read, understand, and even enjoy technical literature.

f) To lay a sufficiently rigorous foundation that further work may be taken in a more classically oriented manner.

g) To make our students conversant with the pursuit of scientific truth as a vocation.

h) To demonstrate how our basic search for understanding of nature has led to a flowering of technology which in turn provides both the wealth and the tools that are necessary for more advanced basic research.

i) To show how social and moral problems of our society may often be both solved and created by our exploding technology.

Our entering student present an extremely wide range of background and capabilities in mathematics and sciences. We take advantage of this and partially compensate for it with our split level arrangement of the curriculum. While it is the advanced mathematics sections which move into the natural science sequence after one rather than two terms of math, we are finding that this remains an appropriate criterion for the division through the remainder of the sequence.

NL/HW/ss

NATURAL SCIENCE - FIRST TERM

Texts (Spring Term 1965): primary - Basic Concepts of Physics
Chalmers W. Sherwin

supplementary-Fundamental Laws of Physics
F.W. Constant

Topical Outline: (Spring Term 1965)

Classical Mechanics
The Restricted Theory of Relativity
Electricity
Quantum Mechanics

Several secondary topics such as:
mathematics as a practical tool of science
the philosophy of science
the sociology of science
the history of science
the methodology of science
the impact of science on society
are discussed partially as the occasion arises, sometimes with the help of facutly members from other disciplines

Course Organizations:

Two one-hour lectures to the entire class per week
Two one-hour demonstration and/or discussion sessions for each section (of 15 students) per week
One three-hour laboratory period for each section per week
(actually the "discussion" sessions might better be called question-and-clarification sessions).

Assignments:

The primary responsibility of the student is of course to understand and learn the basic subject matter through the lectures and thorough study of the text. (The pace is only about five pages per day).

Both quantitative and essay problems are assigned at irregular intervals, primarily as a learning technique.

The student keeps a laboratory notebook in which he summarizes background material for the experiments, records his own techniques and observations, analyzes his data and interprets his results.

The students are encouraged to read both primary and secondary sources on some of the secondary topics listed under the topical outline, and one-three-five page reading report is required.

Four to six examinations are given to test both comprehension of basic concepts and quantitative problem-solving skills.

Academic Standards:

The degree of sophistication and abstraction does differ significantly between the two levels on which the course is given. The upper level is fully as rigorous and quantitative as the traditional introductory course for physics majors in its approach to some topics. However this approach is not maintained monotnously throughout and our course is not equivalent to the specialists pre-professional foundation course. Tutorial study is arranged to meet the needs of students who desire more extensive foundations.

The other level of approach is very much more rigorous and quantitative and subject-matter centered than the usual general physical science course. It is more intellectual but shorter than the physics course which most colleges offer for biologists, pre-med majors, etc.

The minimum level of accomplishment expected of the students is not beyond the capabilities of anyone who sucessfully completes the mathematics sequence. In my opinion, no one has yet failed this course who gave it a reasonable try.

NL:ss
2/17/65

CHEMISTRY

GENERAL

Each student attends two lectures, two discussion sections and one laboratory session in each week. The lecture topics and laboratory experiments are listed in detail on the attached sheets.

The discussion sections are given over to the following topics:
1) Discussion and clarification of textual and lecture materials
2) Demonstrations of problem solving
3) Demonstrations of molecular models
4) Discussion of laboratory work.
5) Discussion of library assignments
6) Texts and other evaluative procedures

The texts are Gregg, General Chemistry and Fieser and Fieser, Organic Chemistry.

In the previous two terms a term paper of ten to fifteen pages on a topic of the students choice was required. This term we are using a series of lesser assignments as an experimental alternative.

LABORATORY EXPERIMENTS

1) Determination of the molecular weight of carbon dioxide
2) Grahams law of diffusion
3) pH - hydrogen ions
4) Weight relationships in chemical reactions
5) Separation - Gas/solid - Sublimation
6) Separation - Solid/liquid - Crystallisation
7) Separation - Gas/liquid - Distillation
8) Separation - Liquid/liquid - Solvent-extraction
9) The synthesis of ethylene
10) Synthesis of Thiokol A - a synthetic rubber
11) Synthesis of glucose perta-acetate
12) Inorganic analysis
13) Synthesis of bakelite
14) Construction of molecular models
15) Melting points
16) Colorimetric analysis

HW:ss

CHEMISTRY (contd.)

LECTURE TOPICS

Lecture 1	The organization of the course, its objectives and requirements.
Lecture 2	The concepts of atomic and molecular orbitals
Lecture 3	The periodic table of the elements
Lecture 4	The bonding capabilities of the elements of the first two periods. The conic, covalent and co-ordinate bonds.
Lecture 5	The states of matter
Lecture 6	Descriptive inorganic chemistry. Selected examples illustrating the rationality of properties in terms of the theoretical concepts introduced to date.
Lecture 7	Electrolytes. Collegative properties. Debye Huckel theory.
Lecture 8	Redox reactions.
Lecture 9	The role of chemists in our society. a) Industrial b) Research institutions c) Teaching
Lecture 10	A brief introduction to thermodynamics
Lecture 11	The element carbon - the alkanes
Lecture 12	The oxygen carbon bond. Alcohols carbonyls and carboxyls
Lecture 13	The π (pie) bond. A re-examination of the carbonyl group and an introduction to alkenes and berzere.
Lecture 14	Organic nitrogen compounds
Lecture 15	Selected descriptive material excemplifying concepts of the past five lectures.
Lecture 16	An introduction to polymers with empahsis on the vinyl series
Lecture 17	Basic carbohydrate chemistry
Lecture 18	Carbohydrate metabolism I
Lecture 19	Carbohydrate metabolism II
Lecture 20	The energy metabolism of the cell with empahsis on the role of elctron transport and ATP.
Lecture 21	The amino acids and protein structure
Lecture 22	DNA Structure and function
Lecutre 23	Protein synthesis and the role of RNA
Lecture 24	The chemistry of the primaeval earth and the origin of life on earth.

RAYMOND COLLEGE NATURAL SCIENCE SEQUENCE

THIRD TERM

TOPIC OUTLINE

I. A Definition of "Living"

A. Cell structure and levels of organization

B. The nature of environment and adaptation

II. Maintenance of the Individual--Problems of living systems.

A. Transformation of substances

1. Feeding
2. Ionic and osmotic balance

B. Transformation of energy

1. Autotrophic nutrition
2. Heterotrophic nutrition

C. Response of the individual to a changing environment

1. Categories of response--adaptation
2. Machinery of response--structure and function of the nervous system--hormones
3. Perception--biological transducers
4. Integration of response

III. Maintenance of the Population

A. Growth and repair

B. Reproduction

C. Interactions of populations

IV. The Origin of the Type

A. Transmission of information

1. The gene concept
2. Mitosis

B. Altering the information

1. Crossover and recombination
2. Meiosis--the importance of diploidy
3. Mutation

C. Evolution, a phenomenon of populations

1. Gene pool
2. Speciation, selection and isolation
3. The origin of higher categories.
4. Phylogeny

LABORATORY INVESTIGATIONS

1. Field trip to the Calaveras River, collection of organisms.
2. Environmental effects (temperature, salinity, 02 tension) on the respiratory movements of aquatic organisms. 2 periods.
3. Gas exchange measured in a variety of ways of germinating bean seeds, land snails and fish. 2 periods.
4. Photosynthesis and transpiration.
5. Digestion
6. Dissection of the fetal pig. 3 periods.
7. Field trip to the Pacific Marine Station. I weekend.
8. Tropisms
9. Development of the worm, Mersierella, and the bean.

READINGS

1. Text: Weisz Elements of Biology
2. Scientific American Offprints
3. Programmed texts: Kormondy, Introduction to Genetics
   McGuigan, Biological Basis of Behavior
4. Laboratory instructions:

   mimeo hand-outs
   Walker's Dissection of the Fetal Pig
   misc. labs from Abramoff & Thomson, Lab.
   Outlines in Biology
5. Beck, Modern Science and the Nature of Life.
6. 13 paperbacks on a variety of specific aspects of life science at a more detailed level than the text. Students will read and report on one or two.

SCHEDULE OF CLASS TIMES

Two lectures are given each week to the whole class. These lectures lay a theoretical background for the block of material being covered and/or quickly cover material between the blocks so as to give continuity. Each student has one afternoon of laboratory work. A discussion preceeds the lab in which the techniques and equipment are demonstrated, the theory is explained and related materials is demonstrated. The day following the laboratory another discussion is held to analyze the laboratory data, the students exchange results and criticize procedure. Student questions and discussion are encouraged at any point. It is hoped that with more space the two discussion hours can be consolidated into one afternoon block of time in the laboratory.