SCIENCE

Science is a joint program with Pitzer College and Scripps College.

Majors in Science

CMC students may complete the following majors through the Joint Science department:

- Applied Biology
- Biology
- Biology-Chemistry
- Chemistry
- Economics and Engineering
- Environment, Economics and Politics (EEP)
- Environmental Science
- Management-Engineering (ME)
- Neuroscience
- Physics
- Science and Management

An important feature and advantage of science programs is the breadth of background provided in the humanities, economics, and government - areas in which the training of scientists and engineers has traditionally been lacking.

The majors in biology, chemistry, or physics emphasize the interrelationships of these sciences as well as their individual depths.

Interdisciplinary majors in biology-chemistry, neuroscience, the environment, economics and politics, environmental science, and science and management are available to those students whose interests overlap several fields. Pre-medical and environmental emphasis through these concentrations are particular strengths of the Joint Science Program.

CMC students have access to three joint or dual degree (3-2) programs: one in management-engineering with selected engineering schools; one in applied biology with the Keck Graduate Institute; and one in economics and engineering with Harvey Mudd College.

Astronomy

Students with an interest in astronomy or in astrophysics may take courses in the astronomy program, a joint program with the physics departments at Harvey Mudd College and Pomona College. As part of the astronomy program, the participating colleges maintain facilities at the Table Mountain Observatory, located about one hour from campus in the San Gabriel Mountains. Equipment includes a 40-inch telescope with a photometer, CCD camera, IR camera, and CCD spectrograph. No major in astronomy is available at The Claremont Colleges.

Special Options for Majors in Science

Dual Majors

Students selecting a dual major including science should discuss their program requirements with the chair or dean of the appropriate programs. Usually up to two electives in science may be waived for dual majors in science. Unless otherwise specified in this catalog or exempted by the Acting Associate Dean of the Joint Science department, science students with dual majors are required to complete a one- or two-semester thesis in science.

Please note the restrictions on honors in the major for students with a dual major under "Honors in Science" below. For further information on dual majors and the requirements of the other field of the dual major, please check the appropriate sections of this catalog.

Honors in Science

To be eligible for departmental honors in one of the science majors listed in this catalog, students must:

- achieve a minimum grade point average of 10.50 in courses in the major
- write a two-semester thesis considered of honors quality by the department (the department will base its decision on such issues as original contribution by the student, written presentation, data interpretation, effort, and initiative
- attain an average grade point average of 10.50 or better in Science 188L and 190L, including a grade of "A-" (11.00) on the written thesis, and satisfactory participation in the two semesters of Senior Honors Seminar, including attendance, posters, and oral presentations

Students with *dual major* in science who wish to be considered for *honors* in science will only receive honors if they:

- have completed all requirements for a full major in science and are granted honors, or
- qualify and receive honors in both fields of their dual major. See "Honors in the Major" for details

Sigma Xi

Sigma Xi is an international honor society for scientists and engineers. Its mission is to reward excellence in scientific research, and to foster interaction between scientists in different fields. Full membership requires demonstrated research ability, normally evidenced by publications. Undergraduates who have demonstrated an aptitude for research may be nominated by two full members to associate membership. For further information, contact the Acting Associate Dean of the Joint Science department.

General Education Requirement in Science

Every CMC student must take two courses in lab science. There are several ways to complete the requirement.

- Students may complete the requirement by taking the *first year sequence* (two courses, each with a full laboratory) in biology (Biology 43L-44L), chemistry (Chemistry 14L-15L), or physics (Physics 30L-31L or Physics 33L-34L). The requirement may also be met by taking a semester of biology (with lab) together with a semester of either chemistry (with lab) or physics (with lab).
- Alternatively, students may take *two "natural science" courses (with lab)*, one in biology (for a requirement in the biological sciences), and one either in astronomy, chemistry, or physics (for a requirement in the physical sciences). For further information, see "Natural Science Courses" below.
- Students with a score of 4 or 5 on a science *Advanced Placement* test may use the results of these exams for one of the two required science courses. Scores of 6 or 7 on a *higher level International Baccalaureate* exams may also be used for one of the two required science courses. For details, see "Credit and Placement for Advanced Placement (AP) and International Baccalaureate (IB) Exams."

A list of courses meeting general education requirements will be distributed to all students every semester. Students interested in taking science courses to meet the general education requirement in science off-campus or in summer school must receive permission from the Acting Associate Dean of Joint Science. For further information, contact the CMC registrar's office or the Acting Associate Dean of the Joint Science department.

Natural Science Courses

The "natural science" courses, numbered in the 50's, 60's, and 70's, are science courses specifically designed for non-majors. At this time, each of these courses has the equivalent of a one-half semester of laboratory requirement. To meet the general education requirement in science, students must complete one course in the biological sciences (biology at Joint Science) and one course in the physical sciences (astronomy, chemistry, or physics). Descriptions of the natural science courses can be found under the appropriate fields (astronomy, biology, chemistry, and physics).

In general, natural science courses fulfilling the science requirement:

- Elucidate the *nature of science* as a process for exploring and understanding the environment we live in, with particular attention given to understanding when it is appropriate to apply the scientific method to a problem and when it is not.
- Involve *principles of science*, which increase understanding of some of the fundamental concepts of chemistry, physics and/or biology and the manner in which these concepts interrelate.
- Involve a *college level laboratory experience*, which provides practice in confronting problems that can be analyzed by the scientific method.
- Provide *experience in quantitative reasoning and relationships*, including basic mathematical concepts, statistical relationships and work with computers.
- Explore *applications of science and technology*, which increase understanding of the relationship between basic science and technology, and how that relationship has developed and introduce the complexities involved in the application of science and technology to meet societal needs.

Study Abroad

The Joint Science department supports study abroad for science majors but for science majors a semester off-campus usually requires careful advanced planning and program selection. Science majors interested in study abroad should discuss their interest with their major advisors as soon as possible.

Science Courses at the Other Claremont Colleges

Additional courses in astronomy, biology, chemistry, and physics are offered by Pomona College and Harvey Mudd College. Science majors interested in these courses are encouraged to discuss with their faculty advisor whether these courses are appropriate for them. Course descriptions and prerequisites may be obtained from the Pomona College and Harvey Mudd College catalogs.

Applied Biology

The program in Applied Biology offers CMC students interested in biology the opportunity to attend a liberal arts college for three years completing a major in a natural science, as well as the regular liberal arts curriculum. After three years, majors transfer to the Keck Graduate Institute (KGI) in Claremont for two additional years of study in applied life sciences.

At CMC, students must complete at least 24 courses, including all major and general education requirements, except for senior thesis. Students will receive their Bachelor of Arts degree from CMC upon successful completion of all requirements for the Masters degree from KGI. Students interested in this major complete summer internships at KGI after their first and second years at CMC. Students apply to KGI for admission during their junior year at CMC.

Some major requirements may be waived through placement. Some courses do have other prerequisites. *Due to the number of major requirements and the sequential nature of many required courses, students must plan their schedule carefully with their advisor. New students who plan to major in Applied Biology may enroll in five courses*. Professor Sadava is the CMC advisor for the program.

Major Requirements

The major requires a minimum of 16 courses distributed as follows:

1. **Courses (16-17 courses):**
   - **Biology 43-44. Introductory Biology**
   - **Biology 157. Cell Biology**
   - **Biology 170. Molecular Biology**
   - **Chemistry 14-15. Basic Principles of Chemistry,** or **Chemistry 29. Accelerated General Chemistry**
   - **Chemistry 116-117. Organic Chemistry**
   - **Chemistry 177. Biochemistry**
   - **Physics 33-34. General Physics**
   - **Mathematics 31. Calculus II**
   - **Mathematics 32. Calculus III**
   - **Mathematics 111. Differential Equations**
   - **Mathematics 151. Probability,** or **Biology 175. Applied Biostatistics**
   - **Computer Science 50. Introduction to Programming and Computer Tools**
   - **Computer Science 60. Object-Oriented Programming with Applications**

2. **Internships**
   In addition to the courses listed above, majors must complete a summer research internship with KGI after their freshman year, and a summer internship with an appropriate industry after their sophomore year.

Note: - *Course substitutions*: students may, with the permission of the program advisor, select substitute courses in computer science or statistics at CMC.

General Education Requirements for Applied Biology Majors

CMC majors must complete *Economics 50. Principles of Economic Analysis*, as one of the three courses in the social sciences. In addition, students in this program are urged to select a course focusing on *ethics* for one of their two humanities requirements.

BIOLOGY

The major in biology requires a minimum of 15 courses distributed according to the outline presented below. Students wishing to continue their education in biology-related graduate or professional school programs will need to supplement this basic curriculum with additional course work in the natural sciences. Several suggested programs are available and Joint Science faculty should be consulted for advice at the earliest possible opportunity.

Major Requirements

1. **Biology 43-44. Introductory Biology**
2. **Chemistry 14-15. Basic Principles of Chemistry,** or **Chemistry 29. Accelerated General Chemistry**

3. **Chemistry 116-117. Organic Chemistry**
4. **Mathematics 30. Calculus I** (should be taken before Physics)
5. **Physics 30-31. General Physics,** or
   Physics 33-34. Principles of Physics
6. **Electives: Six advanced courses in biology (numbered 100 and above),** including at least three laboratory courses. These elective courses should be selected in consultation with a Joint Science faculty member, and may be chosen so as to obtain depth in one area of biology (e.g. cellular/molecular, organismal, or population-level), or breadth across all areas.
7. **Senior Thesis in Biology:** Biology majors have several options for thesis:
   - **One-semester thesis with lab: Biology 190L. Senior Experimental Thesis in Biology**
   - **Two-semester thesis with lab: Biology 188L-190L. Senior Research-Senior Experimental Thesis in Biology;** students doing a two-semester thesis take Biology 188L during the first semester of their project and Biology 190L during the second semester. Biology 188L may not be counted as one of the six advanced elective courses in biology.
   - **One-semester thesis without lab: Biology 191. Senior Library Thesis in Biology,** an extensive library research thesis required of all majors in biology not completing Biology 188L and/or Biology 190L.

BIOLOGY-CHEMISTRY

This is a combined major at the interface of biology and chemistry which partially overlaps the requirements for those two individual majors. It is particularly appropriate for students interested in graduate work in biochemistry or molecular biology. It also provides a strong background for students interested in medical, dental, or veterinary graduate work.

Major Requirements

The major requires a minimum of 17 courses distributed as follows:

1 . **Biology 43-44. Introductory Biology**
2. **Biology 157. Cell Biology**
3. **Biology 170. Molecular Biology**
4. **Biology 177. Biochemistry**
5. **Chemistry 14-15. Basic Principles of Chemistry**, or **Chemistry 29. Accelerated General Chemistry**
6. **Chemistry 116-117. Organic Chemistry**
7. **Chemistry 121-122. Principles of Physical Chemistry**
8. **Chemistry 126-127. Advanced Laboratory in Chemistry**
9. **Physics 30-31. General Physics, or 33-34. Principles of Physics**
10. **Mathematics 31. Calculus II**
11. **Senior Thesis:** Majors have several options for senior thesis
    - **One-semester thesis with lab:**
      - **Biology 190L. Senior Experimental Thesis in Biology**, or
      - **Chemistry 190L. Senior Experimental Thesis in Chemistry**, or
      - **Physics 190L. Senior Experimental Thesis in Physics**
    - **Two-semester thesis with lab:**
      - **Biology 188L-190L. Senior Research-Senior Experimental Thesis in Biology;**
      - **Chemistry 188L-190L. Senior Research-Senior Experimental Thesis in Chemistry;**

- **Physics 188L-190L. Senior Research-Senior Experimental Thesis in Physics;** Students doing a two-semester thesis take 188Lduring the first semester of their project and 190L during the second semester.

- **One-semester thesis without lab:**
  - **Biology 191. Senior Library Thesis in Biology,** or
  - **Chemistry 191. Senior Library Thesis in Chemistry**, or
  - **Physics 191. Senior Library Thesis in Physics**; The Senior Library Thesis is an extensive library research thesis required of all majors in science not completing 188L and/or 190L.

CHEMISTRY

The major in chemistry requires a minimum of 13 courses. All majors must take the Core Program, together with either Option I, which combines a chemistry major with advanced work in a second field, or Option II, an intensive-level chemistry major.

Major Requirements

1. **Core Program (9-10 courses):**
   - **Chemistry 14-15. Basic Principles of Chemistry,** or **Chemistry 29. Accelerated General Chemistry**
   - **Chemistry 116-117.Organic Chemistry**
   - **Chemistry 121-122. Principles of Physical Chemistry**
   - **Mathematics 31. Calculus II**
   - **Mathematics 32. Calculus III**
   - **Physics 30-31. General Physics,** or **Physics 33-34. Principles of Physics** (required for majors with Option II)
2. **Option I (4-6 courses)**
   - **Chemistry 126 and/or 127. Advanced Laboratory in Chemistry**
   - **Two advanced courses in a second field chosen in consultation with a faculty advisor**
   - **Senior Thesis in Chemistry:** Chemistry majors have several options for thesis:
     - **One-semester thesis with lab: Chemistry 190L. Senior Experimental Thesis in Chemistry**
     - **Two-semester thesis with lab: Chemistry 188L-190L. Senior Research-Senior Experimental Thesis in Chemistry;** students doing a two-semester thesis normally take Chemistry 188Lduring the first semester of their project and Chemistry 190L during the second semester.
     - **One-semester thesis without lab: Chemistry 191. Senior Library Thesis in Chemistry,** an extensive library research thesis required of all majors in chemistry not completing Chemistry 188L and/or Chemistry 190L.
3. **Option II (6 courses)**
   - **Chemistry 126-127. Advanced Laboratory in Chemistry**
   - **Two advanced electives in chemistry, biochemistry, molecular biology, or inter-disciplinary electives involving chemical concepts or techniques, chosen in consultation with the chemistry faculty**
   - **Senior Thesis in Chemistry:** Chemistry majors have several options for thesis:
     - **One-semester thesis with lab: Chemistry 190L. Senior Experimental Thesis in Chemistry**

- **Two-semester thesis with lab: Chemistry 188L-190L. Senior Research-Senior Experimental Thesis in Chemistry;** students doing a two-semester thesis normally take Chemistry 188Ldurıng the first semester of their project and Chemistry 190L during the second semester.
- **One-semester thesis without lab: Chemistry 191. Senior Library Thesis in Chemistry,** an extensive library research thesis required of all majors in chemistry not completing Chemistry 188L and/or Chemistry 190L.

Note: - *Mathematics 111. Differential Equations*, *Physics 35. Modern Physics*, and a course in computer science are strongly recommended for all chemistry majors.

ECONOMICS AND ENGINEERING

The new Economics-Engineering program is a dual degree program of Claremont McKenna College (CMC) and Harvey Mudd College (HMC). Students in this 5-year program, the first three at CMC and the last two at HMC, complete all CMC requirements for a full major in economics, as well as the requirements for a full major in engineering at HMC. Upon completion of all courses, students receive a Bachelor of Arts degree in economics from CMC, as well as a Bachelor of Science degree in engineering from HMC.

The program is an extension of the successful Management-Engineering (ME) program, which combines courses in economics and engineering, but does not require students to complete all major requirements. Like the ME program, the Economics and Engineering program is designed for students interested in a liberal arts education, together with a demanding curriculum in both economics and engineering. Students in the program who have completed all general education requirements at CMC are required to take at least two more courses in the humanities/social sciences at HMC, in addition to their elective courses in economics.

Students in the program spend the first three years (at least 24 courses) at Claremont McKenna College, where they complete all of CMC's general education requirement, all but three of the courses required for a major in economics, and several science and engineering courses. The science courses may be taken at Joint Science or at HMC; the engineering courses are taken at HMC. During the two years at HMC, students complete HMC's general education requirements, the requirements for the major in engineering, and the remaining electives in economics. Some courses may be used for more than one requirement. *Students who plan to major in Economics and Engineering are expected to complete five (or more) courses per semester. New students may enroll in five courses during their first semester.* Professor Higdon is the program advisor.

Transfer to Harvey Mudd College

Under a joint admissions agreement, CMC students with a grade point average of 9.50 or higher, who have completed all required courses for the program during their years at CMC, are guaranteed admission to HMC. For admission to HMC, applicants may not have any grades below B- in mathematics and science courses, and no grade lower than C in other subjects. Interested students are expected to meet with the chair of the HMC Engineering Department and a HMC admission counselor before the end of the sophomore year. Deadline for application is February 1 of the junior year.

Major Requirements:

Majors complete 21 courses while enrolled at CMC:

1. **Biology 43. Introductory Biology**

2. **Chemistry 29. Accelerated General Chemistry**
3. **Physics 33-34. General Physics**
4. **Physics 100. Computational Physics and Engineering,** or **Physics 101. Intermediate Mechanics,** or **Physics 102. Intermediate Electricity and Magnetism**
5. **Mathematics 31. Calculus II**
6. **Mathematics 32. Calculus III**
7. **Mathematics 90. Linear Algebra**
8. **Mathematics 111. Differential Equations**
9. **Mathematics 62. Introduction to Probability and Statistics (at HMC)**
10. **Economics 86. Accounting for Decision Making**
11. **Economics 101. Intermediate Microeconomics**
12. **Economics 102. Intermediate Macroeconomics**
13. **Two Level Two courses in economics (see "Economics.")**
14. **Computer Science 50. Introduction to Programming and Computer Tools,** or **Computer Science 5. Structured Programming and Problem Solving (at HMC),** or **Physics 108. Programming for Science and Engineering**
15. **Engineering 4. Introduction to Engineering Design (at HMC)**
16. **Engineering 8. Design Representation and Realization (at HMC)**
17. **Engineering 59. Introduction to Engineering Systems (at HMC)**
18. **Engineering 80. Experimental Engineering (at HMC)**
19. **Engineering Elective** (for example: 82. Chemical and Thermal Processes, 83. Continuum Mechanics, 84. Electronic and Magnetic Circuits and Devices, or 85. Digital Electronics and Computer Engineering)

General Education Requirements for Economics and Engineering Majors

For the general education requirement in the social sciences, economics and engineering majors must complete the following three courses: *Economics 50. Principles of Economic Analysis*, either *Government 20. Introduction to American Politics*, or a *history course* approved for the general education requirement, and a *psychology course*. Consult the appropriate sections of this catalog for further information on general education requirements.

ENVIRONMENT, ECONOMICS AND POLITICS

Closely associated with the Roberts Environmental Center, the Environment, Economics, and Politics (EEP) major emphasizes problems and opportunities for the real world of the 21st century. An awareness of the environmental issues has become increasingly important for anyone with a career in business or the professions. The EEP major provides students interested in economics and policy studies with a background in ecological analysis and environmental management.

Students take basic courses in biology, chemistry, economics, government and mathematics, together with advanced courses in areas such as environmental law, environment and resource economics, government and the environment, and natural resource management. In their senior year students participate in a clinic course directed toward a specific environmental project. In this clinic small groups of students work together to complete field work, analyses, report preparation and oral seminar presentations.

This major cannot be combined with economics or government as a dual major.

Major Requirements

The major requires a minimum of fifteen courses, in addition to the college's general education requirements. The following courses, or equivalents, are required:

1. **Core Requirement (8 courses)**
   - **Biology 43-44. Introductory Biology**
   - **Chemistry 14-15. Basic Principles of Chemistry,** or **Chemistry 29. Accelerated General Chemistry** (see "notes" below)
   - **Biology 137. EEP Clinic**
   - **Economics 86. Accounting for Decision Making** (see "notes" below)
   - **Economics 101. Intermediate Microeconomics**
   - **Economics 171. Environmental and Resource Economics**
2. **Topic Courses (6 courses): one from each of the following 6 groups:**
   - **- Economics 120. Statistics,** or
     - Mathematics 31. Calculus II, or
     - Biology 175. Biostatistics
   - **- Economics 102. Intermediate Macroeconomics,** or
     - Economcis 104. Foundations of Political Economy, or
     - Economics 167. Law and Economics
   - **- Biology 146. Ecology,**
     - Biology or 159.Natural Resource Management, or
     - Biology 169. Marine Ecology
   - **- Government 50. Introduction to Public Administration,** or
     - Government 121. Organization and Management
   - **- Government 111. Politics and Population,** or
     - Government 118. Practicum in Government and the Environment, or
     - Government144. Political and Social Movements
   - **- Government 119. Introduction to Environmental Law and Regulation,** or
     - Government 120. Environmental Law
3. **Senior Thesis**
   EEP majors must complete either X 190. Senior Thesis, or a senior thesis in Biology (Biology 188L and/or 190L, or Biology 191).

Notes: - ***Prerequisites:*** The following courses are prerequisites for major requirements (and may be counted for general education requirements):
- Mathematics 30. Calculus I
- Economics 50. Principles of Economics Analysis, and
- Government 20. Introduction to American Politics

- ***General Education Requirement****:* EEP majors must complete appropriate courses in *all four fields of the social sciences* as part of their general education requirements.
- ***Substitutions:*** (1) Students not planning advanced work in science may substitute environmental science and/or policy courses for Chemistry 14-15. Students must consult with the program advisor as to the appropriateness of substituted courses. (2) Students interested in additional work in ecology may substitute appropriate advanced biology courses for Economics 86, Government 50, or Government 121.

Environmental Science

Environmental Science entails the study of the natural environment and can lead to career opportunities with governmental agencies, environmental monitoring and consulting organizations, and wildlife conservation groups. Students should consult with advisors concerning their specific educational and professional goals.

The major requires twelve courses as a minimum program; students wishing to continue their education in biology-related graduate programs or to enter the job market should consult the faculty for advice at the earliest possible opportunity.

Major Requirements

1. **Biology 43-44. Introductory Biology**
2. **Chemistry 14-15. Basic Principles of Chemistry,** or
   Chemistry 29. Accelerated General Chemistry
3. **Biology 175. Applied Biostatistics, or approved statistics course**
4. **Five advanced biology courses, including:**
   - **Biology 146. Ecology,** or approved alternative
   - **Biology 159. Natural Resource Management**, or approved alternative
   - **A course in field biology**
   - **Two electives in biology,** selected in consultation with the faculty advisor
5. **Geology 50po. Environmental Geology,** or
   Geology130po. Remote Sensing of the Earth's Environment
6. **Senior Thesis in Biology:** majors may take the one- or two-semester thesis in Biology:
   - **One-semester thesis with lab: Biology 190L. Senior Experimental Thesis in Biology**
   - **Two-semester thesis with lab: Biology 188L-190L. Senior Research-Senior Experimental Thesis in Biology;** students doing a two-semester thesis take Biology 188L during the first semester of their project and Biology 190L during the second semester. Biology 188L may not be counted as one of the two advanced elective courses in biology.
   - **One-semester thesis without lab: Biology 191. Senior Library Thesis in Biology,** an extensive library research thesis required of all majors not completing Biology 188L and/or Biology 190L.

Note: - A semester abroad or summer study in field ecology is strongly recommended.

Management-Engineering

The Management-Engineering program is designed for students who want a liberal arts background, an emphasis on economics and management, and an engineering major. The students spend their first three years (at least 24 courses) at Claremont McKenna College, where they take mathematics, science, economics, management, and general education courses. The major requires completion of thirteen courses at CMC. Some major requirements may be waived due to placement. *New students who plan to major in Management-Engineering may enroll in five courses*. Professor Higdon is the program advisor.

Major Requirements

1. **Physics 33-34. General Physics**

2. **Physics 35. Modern Physics**
3. **Chemistry 14. Basic Principles of Chemistry**
4. **Mathematics 31. Calculus II**
5. **Mathematics 32. Calculus III**
6. **Mathematics 110. Introduction to Engineering Mathematics (preferred), or Mathematics 111. Differential Equations**
7. **One advanced science course, Physics 101. Intermediate Mechanics (preferred), or Physics106. Introduction to Circuits and Applications, or Physics 107. Materials Science**
8. **Economics 86. Accounting for Decision Making**
9. **Economics 101. Intermediate Microeconomics**
10. **Economics 102. Intermediate Macroeconomics**
11. **Two Level Two courses in economics** (see "Economics.")

Notes: - Chemical engineers should also take *Chemistry 15*, *Basic Principles of Chemistry*, and *Chemistry 116-117. Organic Chemistry*, or *Chemistry 121-122. Principles of Physical Chemistry*

- *Computer Science 50. Introduction to Programming and Computer Tools*, or *Computer Science 60. Object-Oriented Programming with Applications*, or *Physics 108. Programming for Science and Engineering*, are strongly recommended.

General Education Requirements for Management-Engineering Majors

For the general education requirement in the social sciences, management-engineering majors must complete the following three courses: *Economics 50. Principles of Economic Analysis*, either *Government 20. Introduction to American Politics*, or a *history course* approved for the general education requirement, and a *psychology course*. Consult the appropriate sections of this catalog for further information on general education requirements.

NEUROSCIENCE

The program in Neuroscience is an interdisciplinary program of the five Claremont Colleges. The major program draws on courses offered by all five Colleges. This major provides preparation for graduate work in biology, psychology, neuroscience, as well as preparation for medical school, or a profession in the health sciences – although admission to particular advanced degree programs is likely to require some additional course work.

The major in Neuroscience requires as a minimum the completion of sixteen courses as outlined below. All majors must complete the Core Courses together with one of two tracks: the Cellular and Molecular Track, or the Cognitive and Behavioral Track. Both tracks include a set of required courses together with electives drawn from one of the two groups listed below. Many elective courses are advanced courses with prerequisites. Particular combinations of electives should be discussed with a faculty member in neuroscience. **Alternative courses may be substituted in several cases for the courses listed below.** Students must obtain prior approval for any course substitutions from Professor Copp or Professor Chase.

Major Requirements

1. **Core Requirement (4-5 courses),** including:
   - **Psychology 95/Biology 95. Foundations of Neuroscience**
   - **Biology 43-44. Introductory Biology**

- **Chemistry 14-15. Basic Principles of Chemistry,** or
  Chemistry 29.Accelerated General Chemistry

2. Tracks:

Cellular and Molecular Track:

a. Required Courses (6 courses):

- **Chemistry 116. Organic Chemistry**
- **Biology 149. Neurobiology**
- **Biology 170. Molecular Biology,** or
  Biology 157. Cell Biology, or
  Chemistry 177. Biochemistry
- **Mathematics 30. Calculus I** (or higher), or
  Psychology 114. Introduction to Statistics for Psychologists, or
  Biology 175. Applied Biostatistics
- **Two-semester Senior Thesis: Biology 188L-190L. Senior Research-Senior Experimental Thesis in Biology;** normally the topic should be related to neuro science.

b. Elective Courses (5 courses): to be selected from Groups A and B listed below; no more than two courses may be selected from Group B.

- **Group A (3-5 courses)**
  - *Biology 115hm. Neurobiology*
  - *Biology 144po. Comparative Endocrinology*
  - *Biology 154. Animal Behavior*
  - *CSCI 152hm. Neural Networks*
  - *Neuroscience 102po. Neuroethology: Mechanism of Behavior*
  - *Psychology 96. Introduction to Neuropsychology*
  - *Psychology 146. Physiological Psychology*
  - *Psychology 148pi. Neuropharmacology and Behavior*
- **Group B (no more than 2 courses):**
  - *Biology 131. Vertebrate Physiology, or*
    Biology 132. Comparative Physiology
  - *Biology 143. Genetics*
  - *Biology 151. Developmental Biology*
  - *Biology 157. Cell Biology*
  - *Biology 170. Molecular Biology*
  - *Chemistry 117. Organic Chemistry*
  - *Chemistry 121 or 122. Physical Chemistry*
  - *Chemistry 177. Biochemistry*
  - *Physics 30-31. General Physics, or*
    Physics 33-34. Principles of Physics

Students may not count required courses listed in Group B for both a required course and a Group B elective course.

Cognitive and Behavioral Track:

a. Required Courses (at least 7.5 courses):

- **Psychology 30. Introductory Psychology**
- **Psychology 123sc-123Lsc. Cognitive Neuroscience (with lab)** or
  Psychology 171po. Human Neuropsychology
- **Psychology 146L. Physiological Psychology**
- **Psychology 110 and 111L. Research Methods (1.5 credits)**
- **Mathematics 30. Calculus I** (or higher), or

Psychology 114. Introduction to Statistics for Psychologists, or
Biology 175. Applied Biostatistics

- **Two-semester Senior Thesis: Biology 188L-190L. Senior Research-Senior Experimental Thesis in Biology;** normally the topic should be related to neuro science.

b. Elective Courses (4 courses): to be selected from Group C and Group D listed below; no more than 2 courses may be selected from Group D; one course may be selected from the courses listed under the Cell Molecular Track (see above).

- **Group C (2-4 courses)**
  - *Psychology 96. Introduction to Neuropsychology*
  - *Psychology 114pi. Human Neuropsychology*
  - *Psychology 106pi. Perception*, or
    Psychology 160po. Perception and Cognition
  - *Course in Neural and Behavioral Development*
  - *Psychology 121sc. Language and the Brain*
  - *Psychology 124sc. Sensation and Perception*
  - *Psychology 162po. Memory*
  - *Psychology 65. Behavioral Psychology*, or
    Psychology 143po. Behavioral Neuroscience
  - *Psychology 188pi. Seminar in Physiological Psychology*
  - *Psychology 192pi. Seminar in Neuropsychology*
  - *Psychology 180wpo. Biological Basis of Psychopathology*
- **Group D (no more than 2 courses)**
  - *Philosophy 135. Philosophy of Mind*
  - *Psychology 70. Abnormal Psychology*
  - *Psychology 125pi. Developmental Cognitive Neuroscience*
  - *Psychology 126pi, 105hm, or 161hm. Cognition*
  - *Psychology 180fpo. Seminar in Cognition Psychology*, or
    Psychology 180ipo. Seminar in Electrophysiology of Cognition, or
    Psychology 180jpo. Seminar on Topics of Cognitive Neuroscience
  - *Psychology 110sc. Child Development*, or
    Psychology 108po. Child Psychology, or
  - *Psychology 199pi. Seminar in Child Development*
  - *Psychology 125po. Psychology of Women*
  - *Psychology 111sc. Adolescent Psychology*
  - *Psychology 120sc. Cognitive Development*, or
    Psychology 154pi. Cognitive Development, 120sc
  - *Psychology 150. Child Psychopathology*
  - *Psychology 144shm.Culture and Psychobiology of Pain*

For course offerings, prerequisites, and availability, please check the appropriate college catalogs and the Schedule of Courses.

Note: - Mathematics 31 (or higher), or an advanced statistics course is recommended for all majors

PHYSICS

The Physics major places a strong emphasis on computational and numerical techniques while still retaining the core material common to all physics majors. Many problems which are not readily solvable using traditional analytic methods will be incorporated into the program, and the solutions will involve numerical integration, computer modeling, and other numerical techniques introduced in the classroom and laboratory. *New students who plan to major in physics may enroll in five courses.*

Major Requirements

1. **Physics 33-34. General Physics**
2. **Physics 35. Modern Physics**
3. **Physics 100. Computational Physics and Engineering**
4. **Physics 101. Intermediate Mechanics**
5. **Physics 102. Intermediate Electricity and Magnetism**
6. **Physics 108. Programming for Science and Engineering,** or **Computer Science 50. Introduction to Programming and Computer Tools,** or another computer science course chosen in consultation with a faculty advisor.
7. **Physics 114. Quantum Mechanics: A Numerical Methods Approach**
8. **Physics 115. Statistical Mechanics with Numerical Approach and Application**
9. **Senior thesis in Physics:** Physics majors have several options for thesis:
   - **One-semester thesis with lab: Physics 190L. Senior Experimental Thesis in Physics**
   - **Two-semester thesis with lab: Physics 188L-190L. Senior Research-Senior Experimental Thesis in Physics;** students doing a two-semester thesis take Physics 188L during the first semester of their project and Physics 190L during the second semester.
   - **One-semester thesis without lab: Physics 191. Senior Library Thesis in Physics,** an extensive library research thesis required of all majors in physics not completing Physics 188L and/or Physics 190L;
   - in addition, physics majors may choose to complete **Biology 188L-190L. Senior Research-Senior Experimental Thesis in Biology, or Chemistry 188L-190L. Senior Research-Senior Experimental Thesis in Chemistry.**

Notes: - Mathematics 31, 32, or 111 are prerequisites for several advanced physics courses.
- Chemistry 14 and Mathematics 110 are recommended.

SCIENCE AND MANAGEMENT

This program is designed to provide students with a solid background in science as well as a grounding in managerial skills. The major requires a minimum of eighteen courses in addition to the college's general education requirements. Majors complete a core program of eleven courses together with one of four sequences, each consisting of seven courses. Some major requirements may be waived due to placement. *New students who plan to major in Science and Management may enroll in five courses.*

Major Requirements

1. **Core Program (minimum of 11 courses):**

- **Chemistry 14-15. Basic Principles of Chemistry**, or **Chemistry 29, Accelerated General Chemistry**
- **Physics 33-34. General Physics (for Physics or Chemistry track),** or **Physics 30-31. Principles of Physics (for others)**
- **Mathematics 30. Calculus I**
- **Computer Science 50. Introduction to Programming and Computer Tools**
- **Economics 86. Accounting for Decision Making**
- **Economics 101. Intermediate Microeconomics**
- **Economics 102. Intermediate Macroeconomics**
- **Economics 151. Strategic Cost Management**
- **Internship or Practicum**
- **Senior Thesis in Science:** Majors have several options:
  - **One-semester thesis with lab (Senior Experimental Thesis) in Biology (Biology 190L), Chemistry (Chemistry 190L), or Physics (Physics 190L)**
  - **Two-semester thesis with lab (Senior Research-Senior Experimental Thesis) in Biology (Biology 188L-190L), Chemistry (Chemistry 188L-190L), or Physics (Physics 188L-190L).** Students doing a two-semester thesis normally take 188L during the first semester of their project.
  - **One-semester thesis without lab (Senior Library Thesis): Biology 191, Chemistry 191, or Physics 191.** This extensive library research thesis is required of all majors in science not completing 188L and/or 190L.

2. Sequences: All majors must complete one of the following four sequences:

a. Chemistry Sequence (7 courses)
- Chemistry 116-117. Organic Chemistry
- Chemistry 121-122. Principles of Physical Chemistry
- Chemistry 126. Advanced Laboratory in Chemistry
- Advanced chemistry course
- Mathematics 31. Calculus II

b. Physics Sequence (7 courses)
- Physics 35. Modern Physics
- Physics 101. Intermediate Mechanics
- Chemistry 121-122. Principles of Physical Chemistry
- Mathematics 31. Calculus II
- Mathematics 32. Calculus III
- Mathematics 111. Differential Equations

c. Biotechnology Sequence (7 courses)
- Chemistry 116-117. Organic Chemistry
- Biology 43-44. Introductory Biology
- Biology 143. Genetics
- Biology 157. Cell Biology, or Biology 170. Molecular Biology
- Biology 177. Biochemistry

d. Environmental Sequence (7 courses)
- Mathematics 31. Calculus II
- Biology 43-44. Introductory Biology
- Biology 146. Ecology
- Chemistry 70. Land, Air, and Ocean Science
- Economics 120. Statistics
- Conservation Biology course

General Education Requirements for Science and Management Majors

For the general education requirement in the social sciences, Science and Management majors must complete the following three courses: *Economics 50. Principles of Economic Analysis*, either *Government 20. Introduction to American Politics*, or a *history course* approved for the general education requirement, and *Psychology 37. Organizational Psychology*. Consult the appropriate section of this catalog for further information on general education requirements.

The Faculty

Professors: Black, Copp, Fucaloro (on leave, second semester), Guthrie, Higdon, Morhardt, Naftilan, Sadava, Tanenbaum (Acting Associate Dean), and Zanella; Associate Professors: Gould (on leave, AY), Hatcher-Skeers, Justice, Landsberg, McFarlane (on leave, second semester), and Preest (on leave, AY); Assistant Professors: Armstrong, Baduini (on leave, second semester), Edwalds-Gilbert (on leave, second semester), Poon (on leave, AY), Purvis, Tang (on leave, second semester), Wiley, and Williams; Visiting Assistant Professors: Bastin, Coleman, Elmore, Karnovsky, Reich; Lecturers: Dershem, Moeur, and Schenk

Courses

ASTRONOMY

1po. Introductory Astronomy.
A non-mathematical survey of modern astronomy, emphasizing new and exciting observational results from space and ground-based observatories, and how they shape contemporary understanding of the formation and evolution of the universe and solar system. Topics cover all aspects of modern astronomy, including planetary, stellar, and extragalactic astronomy. Includes a laboratory component with telescopic observational exercises and computer simulations of various astronomical situations. No prerequisites. Second semester. Penprase.

3po. Life in the Universe.
Interdisciplinary seminar on origin of life on Earth and possibility for life elsewhere in the universe. Emphasizes individualized and group research and learning. Topics include the creation of the universe and cosmology, the evolution of galaxies and stars, the interstellar medium and the formation of solar systems, the origin and evolution of life on Earth, and the search for extrasolar planets and extraterrestrial life and intelligence. First semester. Jarrett.

6po. Archeoastronomy and World Cosmology.
A survey of the development of astronomy and cosmology around the world and the relationship of astronomy to the cultures of societies ancient and modern. Explores the role of astronomy and cosmology in organizing society and culture, and in interpreting time and space. Additional topics include details of the cosmological systems of the ancient Mesoamerican, Greek, and Chinese civilizations, and a non-mathematical exploration of modern scientific cosmology. First semester. Penprase

62po. Introduction to Astrophysics.
Introduction to astrophysics with emphasis on topics of interest to students with a strong background in introductory physics. Topics include astronomical coordinate systems, celestial mechanics, solar physics, stellar structure, stellar evolution, and cosmology. Prerequisites: Physics 30-31, or equivalent. Offered jointly with HMC and Pomona College. Second semester. Penprase

66L. Elementary Astronomy.
A survey of modern astronomy, emphasizing the interrelationships among phenomena. The subject matter includes the solar systems, stars and stellar systems, galaxies, and cosmology. Enrollment limited. Laboratory fee $30. First and second semester. Naftilan

101po/hm. Observational Astronomy.
A course emphasizing techniques of visual, photographic, and electronic observations of astronomical objects. Discussion of infrared and radio astronomy, as well as space-based UV and X-ray astronomy. Includes preparation for and data reductions of observations. Also includes original astronomical observations using both the Brackett Observatory and the 1-meter telescope at Table Mountain.

Prerequisites: Astronomy 62po; and Physics 30-31, or equivalent, or permission of instructor. Offered jointly with HMC and Pomona College. First semester. Penprase, Erin

120po. Star Formation and the Interstellar Medium.
A survey of the formation of stars and planets in the universe, the galactic interstellar medium, and the theoretical and observational aspects of understanding the conditions and evolution of matter in the galaxy. One-half course credit. Prerequisites: Astronomy 1po, 62po, or 66; Physics 101po; and Mathematics 90, or equivalent. Offered jointly with HMC and Pomona College. Second semester. Penprase

121po. Cosmology and Extragalactic Astrophysics.
Examination of large-scale structure of the universe and evolution of the universe from Big Bang to present epoch. Topics include: alternate cosmologies, dark matter, cosmic background radiation, and formation and evolution of galaxies and cluster of galaxies. One-half course credit. Prerequisites: Astronomy 1po, 62po, or 66; Mathematics 90, or equivalent. Offered jointly with HMC and Pomona College. (Not offered in 2003-2004.)

122po. Stellar Structure and Evolution.
A rigorous treatment of stellar atmospheres and radiative transfer. Topics include spectral line formation, stellar energy generation, evolution on and away from the main sequence, and the internal structures of stars and other self-gravitating objects. One-half course credit. Prerequisites: Astronomy 1po, 62po, or 66; Mathematics 90; and Physics 101po. Atomic and Nuclear Physics Physics, or equivalent. Offered jointly with HMC and Pomona College. Second semester. Penprase

123po. High-Energy Astrophysics.
Analysis of the results of new ultraviolet, X-ray, and gamma-ray observations, and the astrophysical processes that produce high-energy photons. Topics include: active galactic nuclei, black holes, neutron stars, supernova remnants, and cosmic rays. One-half course credit. Prerequisites: Astronomy 1po, 62po, or 66; Mathematics 111; and Physics 101po. Atomic and Nuclear Physics, or equivalent. Offered jointly with HMC and Pomona College. (Not offered in 2003-2004.)

124po. Planetary Astrophysics.
The physics and chemistry of the planets, their natural satellites, and the small bodies of the solar system. Topics include: evolution and dynamics of planetary atmospheres, planetary interiors, alteration processes on planetary surfaces, systems. One-half course credit. Prerequisites: Astronomy 1po, 62po, or 66; Mathematics 90; and Physics 101po. Atomic and Nuclear Physics Physics, or equivalent. Offered jointly with HMC and Pomona College. (Not offered in 2003-2004.)

BIOLOGY

43. Introductory Biology.
This course covers the basic principles of cellular and chemical biology. These are then used as background for a discussion of genetics, evolution, and animal behavior. Laboratory fee $50. First semester. Justice, Sadava, Wiley

44. Introductory Biology.
Topics discussed in lecture, and demonstrated in laboratory, include structure, function and evolution of plant and animal forms, physiology of plant and animal systems, and the principles of ecology. Required field trips. Laboratory fee $50. Second semester. Guthrie, Karnovsky

56. Genetics of Human Disease.
The course will examine various aspects of human heredity and social and ethical implications of the Human Genome Project. Topics include basic genetic mechanisms, the identification and characterization of "disease genes," and the social and political uses of genetic information. Enrollment limited to 45. Laboratory fee $30. (Not offered in 2003-2004.)

57. Concepts in Biology.
This course is an introduction to college-level biology and deals with evolution, ecology, inheritance, biotechnology, anatomy, and physiology. Course work will include lectures, student-lead discussions, and laboratories. Discussions will cover topics such as the biology and ethics of gene therapy, conservation, science and the media, and use of animals in research. Enrollment limited to 45. Laboratory fee $30. First semester. Reich

62. Environmental Science.
A course dealing with environmental and organismal structure and human interactions with the environment. The course broadly covers resources and pollution as well as political, economic and psycho-

logical approaches to environmental problems. Enrollment limited to 45. Laboratory fee $30. Second semester. Guthrie

64. The Living Sea.

Over three quarters of the earth's surface is covered in oceans, and much of the world's life exists in the seas. Moreover, humans are having a greater impact on sea life than in any other time in human history. This course will explore the unique habitats of the marine environments and the plants and animals that live there. The course will look at the chemical, physical and geological interactions that create the habitats and enable organisms to live where they do. Finally, the course will take a look at human interaction with these habitats. Fisheries management, pollution, aquaculture, and whaling policies will be among the topics covered. Enrollment limited to 45. Laboratory fee $30. (Not offered in 2003-2004.)

71. Biotechnology.

An examination of the basic concepts of molecular biology and their applications for human welfare. Topics include cell biology and division, genetics, DNA and proteins, DNA manipulation, immunology, reproduction and agriculture. Exercises include chromosome analysis, genetic screening, cloning, and testing for mutagens. Enrollment limited to 45. Laboratory fee $30. First semester. Sadava

75. Environment of Southern California.

An introduction to the physical and biological aspects of this area's environment, their interrelationships, and human impact. Topics include geology, earthquakes, weather and climate, biological communities of the deserts, mountains, and coast, and land management issues. A mandatory weekend field trip will be done. Enrollment limited to 45. Laboratory fee $30. (Not offered in 2003-2004.)

95jt. Foundations of Neuroscience.

An introduction to the nervous system and behavior that explores the philosophical and historical development of the most fundamental issues in neuroscience. Emphasis will be placed on the experiments and methodology that most influenced our understanding of the nervous system, and the close relationship between technological advances and the development of neuroscience. Topics include study of the mind/body problem, localization of brain function, neural representation of knowledge, and consciousness. Laboratory study of the chemical, electrical, and cognitive functions of the nervous system will be included. Also listed as Psychology 95. Team-taught by The Claremont Colleges Neuroscience faculty. First semester. Copp and Staff

131. Vertebrate Physiology.

Lectures and laboratory exercises focus on mechanisms of physiological regulation with a major emphasis on humans. Topics to be covered include circulation, respiration, regulation of extra-cellular water and electrolytes, the senses, and neural and hormonal communication. Prerequisites: Biology 43, 44; Chemistry 14 and 15, or 29. Enrollment limited to 18. Laboratory fee $50. Second semester. Copp

132. Comparative Physiology.

An investigation of fundamental physiological processes including circulation, respiration, movement, digestion, and neural and endocrine communication, in animals with an emphasis on vertebrates. Some topics in the physiology of plants will also be discussed. Attention will be given to how an organism's physiology reflects adaptation to its environment. Prerequisites: Biology 43, 44; Chemistry 14 and 15, or 29. Laboratory fee $50. (Not offered in 2003-2004.)

137. EEP Clinic.

Students work as a team on a specific project each semester which involves an examination of political and economic aspects of environmental issues. The course involves library research, field interviews, data collection, analysis, report production and presentation. Emphases include both oral and written communication methods. First and second semester. Morhardt

141. Vertebrate Anatomy.

Morphology, ontogeny, and evolution of vertebrate organ systems, with emphasis on the evolutionary aspects of vertebrate development. The laboratory includes dissection of major vertebrate types and examination of basic histologic and embryologic materials. Prerequisites: Biology 43, 44. Enrollment limited to 36. Laboratory fee $50. Second semester. Guthrie

143. Genetics.

A course giving an overview of the mechanisms of inheritance at the molecular, cellular, and population levels. Prerequisites: Biology 43, 44; Chemistry 14 and 15, or 29. Enrollment limited to 36. First semester. Armstrong. Second semester. Staff

145. Evolution.

A course focussing on the underpinnings of the modern synthetic theory of evolution. Topics will include historical development of evolutionary thinking; major events in the history of life; molecular

mechanisms of evolution; speciation; systematics; biogeography; evolutionary ecology and evolutionary aspects of behavior. Prerequisites: Biology 43, 44, or permission of instructor. Enrollment limited to 24. First semester. McFarlane

146. Ecology.

An exploration of the factors and interrelationships in influencing the distribution and abundance of organisms. Theoretical models and empirical data are applied to questions of biogeography, life histories, population regulation, community structure and resource management. Laboratory component will include an introduction to computer modeling in ecology, and the processing of quantitative data from field and laboratory investigations. Prerequisites: Biology 43, 44. Enrollment limited to 18. Laboratory fee $50. First semester. McFarlane

149. Neurobiology.

This course will examine the structure, function, and organization of nervous systems. Topics will include signal transduction, electrophysiology, the role of trophic factors, development of the nervous system, and neural networks. Consideration will also be given to neuropathologic conditions such as Parkinsons' and Alzheimer's diseases. Prerequisites: Biology 43, 44; and Chemistry 14 and 15, or 29. Enrollment limited to 24. First semester. Copp

150. Biomechanics.

This course considers the forces of nature that influence the way organisms survive, grow, and reproduce. Mechanical phenomena will be investigated in terms of their relevance to organismal design and ecology. Prerequisites: Biology 43, 44. (Not offered in 2003-2004.)

151. Developmental Biology.

Lectures, discussions, and laboratory exercises explore the current state of our understanding of how complex organisms arise from single cells. Topics will include reproduction, growth, differentiation and pattern formation at the organismal, cellular and molecular levels. Prerequisites: Biology 43, 44; and Chemistry 14 and 15, or 29. Enrollment limited to 18. Laboratory fee $50. Second semester. Justice

154. Animal Behavior.

Lectures, discussion and videos covering the biological approach to behavior. Topics include the physiological, neurological, genetic, evolutionary and ecological approaches to behavior, with an emphasis on behavioral ecology. Prerequisites: Biology 43, 44, or permission of instructor. Enrollment limited to 50. First semester. Karnovsky

157. Cell Biology.

This course is concerned with the molecular aspects of the cells of higher organisms; emphasis on, and reading of, current research. The laboratory includes autoradiography, histology, fractionation of cell organelles, and protein purification. Time will be available for individual projects. Discussion three hours, laboratory four hours. Prerequisites: Biology 43, 44; Chemistry 14 and 15, or 29, and permission of instructor. Enrollment limited to 18. Laboratory fee $50. First semester. Tang. Second semester. Armstrong

158. Cell Cycle, Diseases, and Aging.

Introduces properties of cell-division cycle. Explores mechanisms of aging and diseases, including caner, based on principles of cell cycle control. Elaborates on signaling pathways and molecular nature of the regulation fundamental to all eukaryotes. Emphasizes the advancements and current understanding of the field. Lectures, paper presentations, and discussions. Prerequisite: Biology 43. Enrollment limited to 18. First semester. Tang

159. Natural Resource Management.

A course designed to allow students to appreciate the role of science in understanding environmental systems. Lectures will consist of an intensive analysis of natural resource problems and the impacts of human activities on these resources. Appropriate for biology or environmental studies concentrators with upper division standing. Prerequisites: Biology 43, 44. Enrollment limited to 24. Second semester. Morhardt

160. Immunology.

A course dealing with topics of current research in immunology, such as antigen-antibody interactions, antibody synthesis, hypersensitivity, and autoimmunity. Students will prepare papers and participate in discussions based on the current literature. Outside speakers may supplement the material. Prerequisites: Biology 43, 44; Chemistry 14 and 15, or 29; some advanced work in Biology. Enrollment limited to 36. (Not offered in 2003-2004.)

165. Advanced Topics in Environmental Biology.

Readings and discussion of current technical journal articles in active areas of environmental biology.

Topics are chosen for their current relevance and technical interest. Students present papers for class discussion and conduct a formal literature review on a topic of their choice. Prerequisites: Biology 43, 44. Enrollment limited to 18. First semester. Morhardt

166. Animal Physiological Ecology.
This is an animal physiological ecology course that will emphasize physiological interactions of animals with their biotic and abiotic environments. Information about the physiology and ecology of animals will be integrated from the tissue, organ, and whole organism levels. We will cover a series of topics that illustrate both the diverse and conservative nature of physiological systems. Prerequisites: Biology 43, 44, and 131, or 132, or 146. Enrollment limited to 24. (Not offered in 2003-2004.)

169. Marine Ecology.
A course designed to expose students to the study of the ecology of marine organisms. Lectures will cover various aspects of marine environments. Laboratories and field trips will include ecological sampling procedures and a survey of local marine plants and animals. Prerequisite: Biology 43, 44. Enrollment limited to 24. Laboratory fee $50. First semester. Baduini

170. Molecular Biology.
An introduction to the molecular biology of viruses, prokaryotic cells and eukaryotic plant and animal cells. Lecture topics will include DNA structure, replication, mutation, recombination, transposition, recombinant DNA, protein synthesis from the viewpoints of transcription, translation and regulation, and virus structure and function. Laboratory experiments will include DNA isolation from prokaryotes and eukaryotes, restriction and ligation, cloning and isolation of recombinant DNA, and methods of protein analysis. Prerequisites: Biology 43, 44; Chemistry 14 and 15, or 29, and 116. Enrollment limited to 18. Laboratory fee $50. First semester. Edwalds-Gilbert. Second semester. Wiley

171. Biology of Cancer.
Examination of cellular and molecular phenomena, using the cancer cells as the focus. Topics discussed will include patterns of cancer in populations, the cell cycle, stages in cancer formation, mutagenesis and carcinogens, tumor viruses and oncogenes, heredity and cancer, immune system and cancer, and biological rationales for treatments. Prerequisites: Biology 43, 44; and Chemistry 15. Enrollment limited to 24. Second semester. Sadava

175. Applied Biostatistics.
A hands-on introduction to choosing, applying, and interpreting the results of statistical methods for life scientists. The course will include traditional parametric statistics, such as t-tests, analysis of variance, correlation and regression analysis, together with powerful non-parametric randomization tests. Data presentation and experimental design will be addressed, together with a miscellanae of less-common statistical techniques that find use outside of the laboratory setting. Enrollment limited to 16. First semester. Baduini

176. Tropical Ecology.
Examination of the many facets of tropical biodiversity and community structure, with an emphasis on tropical rainforests and conservation issues. Prerequisites: Biology 43, 44. Enrollment limited to 24. (Not offered in 2003-2004.)

177. Biochemistry. (See "Chemistry.")

178. Biophysics. (See "Physics.")

179. Introduction to Modeling for the Biological Sciences. (See "Physics.")

188. Senior Research in Biology.
Seniors may apply to do laboratory or field investigation with a faculty member. The topic should be chosen by the end of the junior year. In this course, library and lab materials are developed, research begun, and seminar discussion held with faculty members and students in the field of concentration. (This is the first course for students doing a two-semester senior project.) Laboratory fee $50. First and second semester. Staff

190. Senior Experimental Thesis in Biology.
Senior laboratory or field investigation research is culminated and results are summarized in a written thesis and formal presentation. This is the second-semester course for those doing a two-semester research thesis. Laboratory fee $50. First and second semester. Staff

191. Senior Library Thesis in Biology.
An extensive library research thesis required of all majors in science who are not completing 188L/190L. Students are required to complete both a substantive written thesis and make a formal presentation. There is no laboratory or fieldwork component. Students doing a one-semester library thesis register for this course during the semester in which the thesis is written and due. First and second semester. Staff

199. Independent Study in Biology.
Students who have the necessary qualifications, and who wish to investigate in depth an area of study not covered in regularly scheduled courses, may arrange with a faculty member for independent study under his or her direction. A limited opportunity open to all students with permission of instructor. Full or one-half credit course. First and second semester. Staff

CHEMISTRY

14-15. Basic Principles of Chemistry.
A study of the structure of matter and the principles of chemical reactions. Topics covered include atomic and molecular structure, chemical bonding, thermodynamics, equilibria, electrochemistry, kinetics, descriptive inorganic and organic chemistry, and spectroscopy. Three lectures and one four-hour laboratory per week. (Chemistry 14 is a prerequisite for 15.) Laboratory fee $50 per semester. First semester. Elmore, Hatcher-Skeers, Purvis, Zanella. Second semester. Black, Elmore, Fucaloro

29. Accelerated General Chemistry.
A one-semester accelerated general chemistry course as an alternative to the year-long Basic Principles of Chemistry sequence (14-15) for students with a strong chemistry background. This course will cover atomic and molecular structure, spectroscopy, chemical bonding, thermodynamics, electrochemistry, kinetics, equilibria, transition materials, nuclear chemistry, and descriptive inorganic chemistry. Three lectures and one four-hour laboratory per week. Prerequisites: 4 or 5 on the Chemistry Advanced Placement test (or a score of 6 or 7 on the Higher Level Baccalaureate Exam, or completion of a comparable honors chemistry course in high school); Mathematics 30 (or concurrent enrollment), and permission of instructor. Laboratory fee $50 per semester. Second semester. Zanella

51. Topics in Forensic Science.
This course will explore chemical and physical methods used in modern crime detection. Topics as diverse as microscopy, toxicology, serology, fingerprinting. Document examination, DNA analysis, and arson investigation will be examined. Students will use case studies, collaborative work, and online resources extensively throughout the course. Enrollment limited to 45. Laboratory fee $30. (Not offered in 2003-2004.)

70. Land, Air, and Ocean Science.
This course is an introduction to basic principles of environmental science with application to air and water pollution. Topics including global warming, the ozone hole, acid rain, energy production, sustainable development, etc. will be discussed. We will concentrate on both the scientific explorations and the political implications of such issues. Enrollment limited to 45. Laboratory fee $30. Second semester. Purvis

116-117. Organic Chemistry.
The chemistry of organic compounds developed from considerations of bonding, structure, synthesis, and mechanisms of reaction. Selected applications of those principles to biological systems. Prerequisite: Chemistry 15, or equivalent. (Chemistry 116 is prerequisite for 117). Enrollment limited to 64. Laboratory fee $50. First and second semester. Bastin, Black, Williams

121-122. Principles of Physical Chemistry.
Courses designed to investigate physico-chemical systems through classical thermodynamics, statistical thermodynamics, kinetics, quantum mechanics and spectroscopy. Prerequisites: Chemistry 15; Physics 31 (or 34); and Mathematics 31. (Chemistry 121 is a prerequisite for 122.) Enrollment limited to 20. First and second semester. Fucaloro, Staff

126-127. Advanced Laboratory in Chemistry.
A survey of advanced laboratory techniques including physical chemistry methods, analytical chemistry (especially instrumental methods), and synthesis and characterization of compounds. Prerequisites: Chemistry 15, 117; Physics 34 (or 31); and Mathematics 31. (Chemistry 126 is prerequisite for 127.) Chemistry 121, and 122 recommended as co-requisites. Enrollment limited to 18. Laboratory fee $50. First and second semester. Fucaloro, Purvis, Williams, Zanella

130. Inorganic Synthesis.
This laboratory course will include a variety of synthetic techniques for inorganic compounds. Emphasis will be on transition metal complexes, including organometallic compounds, and some main group compounds will also be prepared. Students will use appropriate spectroscopic methods and chromatography to characterize products. Use of original journal references will be stressed. Prerequisites:

Chemistry 117 and 121 (or concurrent). One-half course credit. Enrollment limited to 12. Laboratory fee $50. Second semester. Williams, Zanella

134. Introduction to Molecular Modeling.

This course provides an introduction to both the theory and practice of current molecular modeling methods. Students use molecular mechanics, molecular orbital theory and molecular dynamics to study chemical systems ranging from small organic structures to large biomolecules. The computational work is carried out using Spartan, MacroModel and Gaussian software. One-half course credit. Prerequisites: Chemistry 117, 121. Enrollment limited to 12. First semester. Black

136. Modern Molecular Photochemistry.

This course will explore the interaction of light with molecules, and the chemical and physical changes that result. Emphasis will be placed on modern applications of photochemistry in the areas of synthesis, mechanistic studies, medicine, and materials science. One-half course credit. Prerequisite: Chemistry 117. Enrollment limited to 20. (Not offered in 2003-2004.)

137. EEP Clinic. (See "Biology.")

139. Environmental Chemistry.

This course is designed to apply the fundamental ideas of chemistry to environmental concepts. Major topics include water, air, and land pollution, industrial ecology, and chemical techniques for environmental analysis and remediation. One-half course credit. Prerequisite: Chemistry 116. Enrollment limited to 20. (Not offered in 2003-2004.)

172. NMR Spectroscopy.

Examines fundamental concepts in nuclear magnetic resonance spectroscopy with a focus on techniques used for organic structure elucidation as well as "in vivo" spectroscopy and magnetic resonance imaging. Hands on experience with data collection and analysis. Lecture. One-half course credit. Prerequisites: Chemistry 117 and 122. (Not offered in 2003-2004.)

175. Introduction to Medicinal Chemistry.

This course will emphasize the chemistry and biochemistry vital to drug design and drug action. Clinically important compounds will be used as examples throughout the course. Structure/activity and rational drug design concepts will also be discussed. One-half course credit. Prerequisite: Chemistry 117. (Not offered in 2003-2004.)

177. Biochemistry.

A study of structure and function in living systems at the molecular level. Discussion centers on intermediary metabolism, cellular control mechanisms, and energy flow, with particular emphasis on how this information is developed. Prerequisites: Biology 43, 44; Chemistry 116, 117, or permission of instructor. Enrollment limited to 50. First semester. Hatcher-Skeers, Wiley

188. Senior Research in Chemistry.

Seniors may apply to do laboratory or field investigation with a faculty member. The topic should be chosen by the end of the junior year. In this course library and lab materials are developed, research begun, and seminar discussion held with faculty members and students in the field of concentration. (This is the first course for students doing a two-semester senior project.) Laboratory fee $50. First and second semester. Staff

190. Senior Experimental Thesis in Chemistry.

Senior laboratory or field investigation research is culminated and results are summarized in a written thesis and formal presentation. This is the second-semester course for those doing a two-semester research thesis. Laboratory fee $50. First and second semester. Staff

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199. Independent Study in Chemistry.

Students who have the necessary qualifications, and who wish to investigate in depth an area not covered in regularly scheduled courses may arrange with a faculty member for independent study under his or her direction. A limited opportunity open to all students with permission of instructor. Full or one-half credit course. First and second semester. Staff

PHYSICS

30-31. General Physics.
A first-year general physics course introducing mechanics, sound, fluids, wave motion, heat, electricity, magnetism, atomic physics, relativity, and nuclear physics. This course is designed for majors in fields other than physics, chemistry, or engineering. Prerequisite or co-requisite: Mathematics 30, Calculus I, or permission of instructor. (Physics 30 is a prerequisite for Physics 31.) Laboratory fee $50. First and second semester. Coleman, Landsberg

33-34. Principles of Physics.
A first-year general physics course designed for physics, chemistry, and engineering majors. Topics include Newtonian mechanics, gravitation, fluids, wave motion, electrical measurements, DC and AC circuits, Maxwell's equations, and light. Prerequisites: Previous calculus experience or Mathematics 30 and 31 taken concurrently, or permission of instructor. Physics 33 is a prerequisite for 34. Laboratory fee $50. First and second semester. Coleman, Higdon

35. Modern Physics.
An introductory modern physics course designed as a continuation for Physics 33, 34. Topics include thermodynamics, relativity, atomic physics, elementary quantum mechanics, chemical bonding, solid state physics, band theory and appropriate applications. Prerequisites: Physics 34; and Mathematics 32. Mathematics 32 may be taken concurrently. First semester. Coleman

74. Distinguishing Sense from Nonsense: Innumeracy and Pseudoscience in Society.
This course will provide students with a critical framework for identifying both the proper uses and abuses of the "scientific method" and statistical analyses. The distinction between science and pseudoscience, common statistical paradoxes, and the fallibility of human thought processes will be discussed, along with some of their related social and legal ramifications. Applications will include such topics as astrology, the nature of coincidence, medical testing issues, psychic phenomena, near-death experiences, statistical issues relating to race and gender, etc. Enrollment limited to 45. Laboratory fee $30. (Not offered in 2003-2004.)

76. Sport Science.
A study of the scientific principles behind the dramatic improvements in athletic performance. The class will examine the kinematics, dynamics, physiology and engineering required of, or available to, today's athlete. Examples include projectile motion, rotational motion, aerodynamics, properties of materials, and human physiology. Enrollment limited to 45. Laboratory fee $30. (Not offered in 2003-2004.)

79. Energy and the Environment.
Examination of the options available for meeting projected U.S. and global energy requirements. Consideration of resources and conversion and consumption patterns, thermodynamic limitations; immediate and long-range engineering options; environmental consequences. Topics include conservation, fossil fuel, nuclear, geothermal, and solar energy systems. Enrollment limited to 45. Laboratory fee $30. (Not offered in 2003-2004.)

100. Computational Physics and Engineering.
This course is a comprehensive introduction to the application of computational techniques to physics and engineering. It provides direct experience in using computers to model physical systems and it develops a minimum set of algorithms needed to create physics and engineering simulations on a computer. Such algorithms are employed to solve nontrivial, real world problems through the investigation of seven major projects. Students will use MatLab computer mathematical software. No prior computer course is assumed. Prerequisites: Physics 33, 34; Mathematics 30, 31. Enrollment limited to 12. Second semester. Higdon

101. Intermediate Mechanics.
The applications of classical mechanics to statics and dynamics of rigid bodies, central force motions, and oscillators. Numerical analysis, Lagrangian methods, and nonlinear approximation techniques will be used. Prerequisites: Physics 33; Mathematics 111. Enrollment limited to 20. (Not offered in 2003-2004.)

102. Intermediate Electricity and Magnetism.
An upper division course in electrodynamics using analytical, but emphasizing numerical techniques to solve problems. Topics include electrostatic solutions using Laplace's and Poisson's equations, polarization, magnetostatics, magnetization, Maxwell's equations, electromagnetic waves, and electromagnetic radiation. Prerequisites: Physics 34, 100 or equivalent; Mathematics 32, or permission of instructor. Second semester. Landsberg

106. Introduction to Circuits and Applications.
An introduction to modern electronic circuit theory and practice for the engineering or science student. Topics include electrical measurement devices, semiconductor properties, and circuits using diodes and transistors. Both analog and digital circuits will be covered. Operational and differential amplifiers will be built. Prerequisites: Physics 33, 34. Enrollment limited to 20. (Not offered in 2003-2004.)

107. Materials Science.
An introductory examination of materials and their properties. Topics covered include: atomic packing and crystal structure, elastic and plastic deformation of metals, strengths of materials, ceramics, polymers, electric properties of semiconductors, piezoelectricity, paramagnetism and ferromagnetism. Prerequisites: Physics 33, 34. Enrollment limited to 20. (Not offered in 2003-2004.)

108. Programming for Science and Engineering.
This course is a comprehensive introduction to programming using MatLab, the primary language of engineering computations. It covers control constructs, internal and external procedures, array manipulations, user-defined data structures, and recursion. These elements are used to develop some computational techniques in engineering. No prior computer experience is required. Enrollment limited to 24. First semester. Higdon

114. Quantum Mechanics: A Numerical Methods Approach.
Introductory upper-level quantum mechanics using analytical, but emphasizing numerical methods to solve problems. Both Shrodinger's wave mechanics and Heisenberg's matrix formulation of quantum mechanics are used. Topics include: eigenvectors and eigenvalues tunneling, Koenig-Penney model, harmonic oscillator, WKB approximation, spin and Pauli matrices, hydrogen atom and Hatree-Falk approximation, Dirac notation, eigenvalue perturbation method: non-degenerate, degenerate, and time-dependent, Fermi's Golden rule and variational approximation. Prerequisites: Mathematics 110; Physics 100 or equivalent, or permission of instructor. (Not offered in 2003-2004.)

115. Statistical Mechanics with Numerical Approach and Application.
This course covers, at the junior-senior level, statistical mechanics and thermodynamics. Standard topics include the laws of thermodynamics, kinetic theory, classical statistical mechanics and its connection to thermodynamics, quantum statistical mechanics and its applications. In addition, numerical techniques are implemented and used to solve realistic thermodynamics problems in the computer lab. Prerequisites: Physics, 33, 34, 100 or equivalent; Mathematics 110. Enrollment limited to 20. (Not offered in 2003-2004.)

178. Biophysics.
A study of the action of various living systems such as the eye, ear, muscle, nerve, etc., from the point of view of mechanics, thermodynamics, and electrical theory. Prerequisites: Biology 43, 44; Chemistry 14; and Physics 30, 31, or permission of instructor. Mathematics 30 recommended. Enrollment limited to 24. (Not offered in 2003-2004.)

179. Introduction to Modeling for the Biological Sciences.
This course will provide a broad, hands-on introduction to mathematical and computer modeling for the biological sciences. Students will learn how to create computer models in order to analyze the behavior of a variety of biological systems. Topics will include population biology, genetics, ecological systems, biological disposition of drugs and toxins, cell physiology, and the spread of diseases and epidemics. No prior experience with computer programming is assumed. Prerequisites: one semester of calculus, one semester of introductory biology. This course may be taken for upper-division credit towards the biology or physics major. Enrollment limited to 15. (Not offered in 2003-2004.)

188. Senior Research in Physics.
Seniors may apply to do laboratory or field investigation with a faculty member. The topic should be chosen by the end of the junior year. In this course library and lab materials are developed, research begun, and seminar discussion held with faculty members and students in the field of concentration. (This is the first course for students doing a two-semester senior project.) Laboratory fee $50. First and second semester. Staff

190. Senior Experimental Thesis in Physics.
Senior laboratory or field investigation research is culminated and results are summarized in a written thesis and formal presentation. This is the second-semester course for those doing a two-semester research thesis. Laboratory fee $50. First and second semester. Staff

191. Senior Library Thesis in Physics.
An extensive library research thesis required of all majors in science who are not completing 188L/190L. Students are required to complete both a substantive written thesis and make a formal presentation. There is no laboratory or fieldwork component. Students doing a one-semester library thesis register for this course during the semester in which the thesis is written and due. First and second semester. Staff

199. Independent Study in Physics.
Students who have the necessary qualifications, and who wish to investigate in depth an area not covered in regularly scheduled courses may arrange with a faculty member for independent study under his or her direction. A limited opportunity open to all students with permission of instructor. Full or one-half credit course. First and second semester. Staff

Areas of Interest of Science Faculty:

Armstrong: Genetics, cell and molecular biology; chromatin dynamics and gene regulation in the fruit fly
Baduini: Marine community ecology; foraging ecology and population genetics of seabirds
Black: Organic chemistry; reaction mechanisms studied by computational techniques
Copp: Animal behavior, vertebrate and invertebrate physiology, neurobiology
Edwalds-Gilbert: Cell and molecular biology; pre-mRNA splicing in yeast
Fucaloro: Physical chemistry, especially emission and absorption; molecular spectroscopy; electron impact
Gould: Scanning probe microscopy; physics of sports
Guthrie: Evolutionary studies, field ecology, ornithology, zooarcheology
Hatcher-Skeers: Applications of nuclear resonance spectroscopy in determining the structure of DNA and other biological macromolecules
Higdon: Astrophysics, fluid dynamics, biophysics
Justice: Developmental, molecular, and cell biology; molecular genetics of fruit fly tumor suppressor genes
Landsberg: Non-linear systems: pattern formation, bifurcation theory, chaos, Josephson Junctions
McFarlane: Evolutionary ecology; biogeography; late Quaternary paleoecology and extinctions
Morhardt: Vertebrate ecology and physiology, environmental management
Naftilan: Binary stars, stellar atmospheres, cool stars
Poon: Synthesis and characterization of natural products
Preest: Physiology and ecology of animal energetics; thermal biology of terrestrial ectotherms; osmoregulatory physiology; herpetology; muscle physiology
Purvis: Chemistry of urban air pollution, primarily aerosol; public policy aspects of air pollution
Sadava: Cell biology, cancer mechanisms
Tang: Cell and molecular biology, biochemistry; cell cycle control in yeast
Wiley: Molecular biology, genetics, chromatin structure in the ciliate Tetrahymena
Williams: Fundamental late-metal organometallic chemistry, mechanisms of basic organometallic reactions
Zanella: Metal ion-promoted reactions, electron-transfer, heavy metal pollutants, and environmental chemistry