

REQUIREMENTS FOR MAJORS

BIOLOGY

BIOCHEMISTRY

BIOPHYSICS

CHEMISTRY

ECONOMICS and ENGINEERING

ENVIRONMENTAL ANALYSIS

ENVIRONMENT, ECONOMICS, AND POLITICS

MOLECULAR BIOLOGY

NEUROSCIENCE

ORGANISMAL BIOLOGY

PHYSICS

SCIENCE MANAGEMENT

**KECK SCIENCE DEPARTMENT
CLAREMONT MCKENNA COLLEGE**

2020-2021

Claremont McKenna College

Keck Science Department

BIOLOGY MAJOR

Career opportunities for those who major in biology are numerous. Besides being one of the traditional preparatory fields for those pursuing careers as health care professionals, Biology is an excellent choice of major for those interested in secondary education, ecology, or the burgeoning genetic engineering industry. And, of course, the areas of academic and industrial research are open to those who pursue a Ph.D. in the discipline.

These course requirements should be considered a minimum program in biology. 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. **Suggested programs are available, and Keck Science faculty should be consulted for advice at the earliest possible opportunity.**

Required Courses:

1. Biology Foundation courses:

- Introductory Biology: BIOL043L KS and BIOL044L KS; or BIOL040L KS and BIOL044L KS; or BIOL042L KS and BIOL044L KS;
- Introductory Chemistry: CHEM014L KS and CHEM015L KS; or CHEM040L KS and CHEM015L KS; or CHEM014L KS and CHEM042L KS; or CHEM029L KS
- Calculus I: MATH030 or equivalent

2. Three STEM Breadth courses selected from the list below. Breadth courses may not be double-counted as Foundation or Elective courses. Courses should be selected in consultation with a Keck Science advisor. Note that some courses in this list may be required pre-requisites for some upper division biology courses.

- Up to two courses in Organic Chemistry (CHEM 116L, CHEM 117L KS)
- Up to two courses in General Physics (PHYS 30L KS, PHYS 31L KS, or PHYS 33L KS, PHYS 34L KS)
- One introductory course in computer programming (CS00, MATH 042 SC, CS 005G HM, or equivalent).
- One math course for which MATH 030 or higher is listed as a prerequisite
- One upper division Environmental Science course taught by the Keck Science Dept. (e.g., EA100KS, EA103KS, EA104KS)
- One course in the history, philosophy, or ethics of science (e.g. HIST 082 HM, PHIL 103 PZ, PHIL 038 P0)

3. Six^{††} Biology Elective courses, numbered 100 or higher, including at least three laboratory courses (indicated by the "L" subscript). Elective courses may not be double counted as foundation or breadth courses.

4. Senior Thesis in Biology, complete one of the following options. *Students must register their thesis plans with the Keck Science Department during the spring semester of their penultimate year.*

- BIOL 191 KS, one-semester thesis in biology
- BIOL 188L KS and BIOL 1190L KS, two-semester thesis in biology
- BIOL 189L KS and BIOL 190L KS, two-semester thesis in biology with a summer research component

‡Note: Dual majors (SC/CMC) in Biology need only 4 Biology Elective Courses (at least two with lab)

* Note: Students wishing to continue their education in biology-related graduate or professional school programs may need to supplement this basic curriculum with additional course work in science. Department faculty should be consulted for advice at the earliest possible opportunity.

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BIOCHEMISTRY MAJOR

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

MAJOR REQUIREMENTS:

Biology 43L, and either Biology 44L or Biology 143, or Biology 40L and either Biology 44L, or Biology 143, or Biology 42L and Biology 44L, or Biology 143	Introductory Biology Genetics Introduction to Biological Chemistry
Biology 157L Biology 170L Biology 177	Integrated Biology and Chemistry Cell Biology Molecular Biology Biochemistry
Chemistry 14L, 15L, or Chemistry 29L, or Chemistry 40L and 15L, or Chemistry 42L	Basic Principles of Chemistry Accelerated General Chemistry Introduction to Biological Chemistry Integrated Biology and Chemistry
Chemistry 116L, 117L Chemistry 121,122	Organic Chemistry Principles of Physical Chemistry
Any two of the following three Advanced Lab courses: Chemistry 125L Chemistry 126L Chemistry 127L	Advanced Laboratory in Biochemistry Advanced Laboratory in Chemistry Advanced Laboratory in Chemistry
Physics 30L, 31L, or Physics 33L and 34L	General Physics for the Life Sciences Principles of Physics
Mathematics 30, 31	Calculus I, II
Bio/Phys/Chem 191 or 188L/190L or 189L/190L*	One or two-semester Thesis in Science

* Biochemistry majors are encouraged to do a two-semester thesis.

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BIOPHYSICS MAJOR

The Biophysics major integrates the physical principles that are part of the core material found in a traditional physics major with areas of interest in the life sciences. Offering many possible avenues via molecular/cellular, biomechanical, organismal and/or physiological sequences, the major is appropriate for students interested in attending graduate school in physics or biophysics and provides a solid background for students planning a career in the health fields.

Requirements for the Major in Biophysics

1. Foundation courses:

- a. Introductory Biology (two semesters: Biology 43L–44L, or Biology 40L, Introduction to Biological Chemistry and 44L, or Biology 42L, Integrated Biology and Chemistry and 44L, or equivalent);
- b. Basic Principles of Chemistry (two semesters: Chemistry 14L–15L, or Chemistry 40L, Introduction to Biological Chemistry and Chemistry 15L, or Chemistry 29L, Accelerated General Chemistry, or Chemistry 42L, Integrated Biology and Chemistry, or equivalent);
- c. General Physics for the Life Sciences (two semesters: Physics 30L–31L, or Physics 33L–34L, Principles of Physics (two semesters), or equivalent);
- d. Modern Physics with Computational Applications (Physics 35);
- e. Biophysics (Physics 178 or equivalent);
- f. Calculus III (Mathematics 32); Differential Equations (Mathematics 111 or equivalent);
- g. One computer programming course (CS 5 HMC, CS 51 CMC or Physics 108 KS).

2. Five Additional Advanced Courses:

- a. Three (3) upper-division courses from Biology. Organic Chemistry (Chemistry 116L) may be substituted for one of the three upper-division Biology courses, but one of the remaining two upper-division Biology courses must still include a laboratory component.
- b. At least two (2) of the following four (4) courses: Physics 101, Physics 102, Physics, 114, Physics 115.

3. Senior Thesis (one- or two-semester).

A study abroad experience is strongly encouraged but not required.

NOTE: For Biophysics majors, PHYS 30L–31L may substitute for PHYS 33L–34L as a prerequisite.

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CHEMISTRY MAJOR

The student of chemistry examines, describes, and explores the composition, structure, and properties of substances and the changes they undergo. This curriculum provides a firm foundation in the principles of chemistry as well as sufficient experience to prepare the student for basic research, secondary school teaching, the pursuit of a career in medicine, or graduate study in the field. The Keck Science chemistry major is accredited by the American Chemical Society (ACS).

MAJOR REQUIREMENTS

1. Chemistry 14L-15L. Basic Principles of Chemistry, or Chemistry 29L. Accelerated General Chemistry, or Chemistry 40L-15L. Introduction to Biological Chemistry, or Chemistry 42L, Integrated Biology and Chemistry
2. Chemistry 116L-117L. Organic Chemistry
3. Chemistry 121-122. Principles of Physical Chemistry
4. Physics 33L-34L. Principles of Physics, or Physics 30L-31L. General Physics for the Life Sciences, with permission of adviser
5. Chemistry 126L-127L. Advanced Laboratory in Chemistry
6. Chemistry 128. Inorganic Chemistry
7. Chemistry 177. Biochemistry
8. Electives: one advanced elective (or two halves) in chemistry, molecular biology, or interdisciplinary electives involving chemical concepts of techniques, chosen in consultation with the chemistry faculty.
9. Senior Thesis in Chemistry; chemistry majors must complete a one- or two-semester thesis in chemistry. Students must do a two-semester research thesis (Chem 188L-Chem 190L or Chem 189L-Chem 190L) to complete the ACS accredited major in chemistry.

NOTES: Mathematics 31, Calculus II is co-required of Chemistry 121, Mathematics 32, Calculus III is co-required for Chemistry 122 and Biology 43L, Introductory Biology, or Biology 40L, Introduction to Biological Chemistry, or Biology 42L, Integrated Biology and Chemistry, is co-required for Chemistry 177. Additional electives in chemistry, mathematics, physics and computer science are strongly recommended for all chemistry majors.

Requirements for a Dual Major in Chemistry

A dual major in chemistry requires seven upper-division chemistry courses, in addition to senior thesis. This reduces the load of a regular chemistry major by two courses. The seven courses must include: Organic Chemistry 116L and 117L, Physical Chemistry 121 and 122, at least one semester of Advanced Laboratory (either 126L or 127L), and either Inorganic Chemistry 128 or Biochemistry 177. The remaining elective can consist of either a single upper-division course or two halves. All lower-division courses and prerequisites in other disciplines (math, physics) must still be met. Students doing a dual major in chemistry are not eligible for the ACS accredited major.

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ECONOMICS AND ENGINEERING

The Economics and Engineering program allows students interested in a liberal arts education, together with a demanding curriculum in both economics and engineering, to earn two undergraduate degrees within five years. This is commonly called a “3+2 program.” Students in the Economics and Engineering (E&E) program study at CMC for the first three years, completing general education and E&E major requirements toward the Bachelor of Arts degree, then transfer to a regionally accredited school of engineering to complete a Bachelor of Science degree.

Primary Contact: Professor Scot Gould, Program Coordinator

MAJOR REQUIREMENTS:

The major in Economics and Engineering requires 17-18 courses while enrolled at CMC, distributed as follows:

1. Economics (7 courses)

- ECON050CM – Principles of Economic Analysis
- ECON086 CM – Accounting for Decision Making
- ECON101 CM – Intermediate Microeconomics
- ECON125 CM – Econometrics
- 3 Elective Courses: 1 Level 1 and 2 Level II

2. Physics (4 courses)

- PHYS033L KS – Principles of Physics
- PHYS034L KS – Principles of Physics
- PHYS035 KS – Modern Physics with Computational Applications
- 1 upper level physics course or HMC engineering course (excluding PHYS108 KS)

3. Mathematics (4 or 5 courses)

- MATH031 CM – Calculus II
- MATH032 CM – Calculus III
- MATH060 CM – Linear Algebra

AND 1 of the following:

- CSCI055 CM – Discrete Structures
- MATH111 CM – Differential Equations
- MATH152 CM – Statistical Inference *

NOTE:

*MATH151 CM – Probability is a prerequisite for MATH152 CM

4. Chemistry (1 course)

1 course selected from:

- CHEM014L KS – Basic Principles of Chemistry
- CHEM029L KS – Accelerated General Chemistry

5. Computer Science (1 course)

1 course selected from:

- CSCI005 HM – Introduction to Computer Science
- PHYS108 KS – Programming for Science and Engineering
- Approved equivalent introductory programming course

NOTES:

- PHYS108 KS may not be applied toward the upper level physics requirement.
- At least 1 engineering course is strongly recommended.
- Students considering chemical engineering should complete CHEM 014L KS/CHEM 015L KS (or CHEM 029L KS) and CHEM 166L KS/CHEM 117L KS. This option increases the total number of courses for the major to 20-21.
- Interested majors may take engineering courses at Harvey Mudd College; check the requirements at other

- engineering institutions for transferability.
- Some engineering programs require additional requirements to those listed above. Students are strongly encouraged to regularly consult with the Program Coordinator to ensure proper preparation for transfer to their chosen engineering program.

Special Options for Majors

Dual Major

Dual or double majors including Economics and Engineering are not permitted.

General Education Requirement Information for Economics and Engineering Majors:

General Education Requirement in Science

Every CMC student must complete one (1) laboratory science course offered by the Keck Science Department or elsewhere within the Claremont Consortium. This requirement must be satisfied by the end of the 2nd year at CMC.

General Education Requirements in the Social Science and Humanities

For the general education requirement in the social sciences and the humanities, Economics and Engineering majors must complete courses in 3 of the 4 fields of the social sciences, including ECON 050 CM, together with courses in 2 of the 4 fields of the humanities (literature, philosophy, religious studies, and literature in a foreign language).

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Environmental Analysis Major Program

Claremont McKenna, Harvey Mudd, Pitzer, Pomona and Scripps Colleges participate in a Five-College collaboration that allows students to take advantage of a broad range of courses, facilities, and opportunities in the study of environmental issues.

The Environmental Analysis (EA) Program at CMC is designed to prepare students for careers in many environmental problem-solving fields, including law, policy, medicine, chemistry, conservation, global climate change, urban planning, and resource management. It also provides a solid background for careers in environmental education and community environmental action. Students considering an EA major or minor should discuss the eligibility of specific courses with their academic advisor and with the Environmental Science faculty.

Below are the requirements for the *EA: Environmental Science* track. Students interested in the *Environmental Policy or Environment: Society and the Environment* track should see the Claremont McKenna Catalog for the major requirements. Students who are particularly interested in the *Environmental Analysis: Environment and Society* track may pursue this through Pitzer College.

MAJOR REQUIREMENTS:

The major consists of three sets of requirements:

1) *Introductory Core*

2) *One Specialized Field* in which to develop a course plan:

- *Environmental Science*
- *Environmental Policy*
- *Society and the Environment*
- *Sustainability and the Built Environment*

3) *A senior thesis capstone of two courses for the Environmental Science Track*

Environmental Science Specialized Field:

A major in Environmental Analysis (Science track) requires a minimum of 14 courses and a senior thesis. Students interested in this major/track should discuss the eligibility of specific courses with their faculty advisor and with EA science faculty.

- *Introductory Core:* EA 010 PO, and either EA 020 PO or EA 086 PZ or POLI 136 PO and EA 030L KS

- Introductory Biology: BIOL 044L
- Introductory Chemistry: CHEM 014L or CHEM 040L or CHEM 029L or CHEM 042L
- One introductory Earth science course (e.g., EA 55L KS or PO GEOL 020, or approved alternate)
- Six upper-division EA-approved science courses (or comparable courses approved by Keck Science EA faculty): at least three of these courses must include a laboratory component.
- One statistics/quantitative course (can be double-counted)
- One course in economics, government, or environmental policy approved by an EA adviser
- Senior Capstone (two courses) to include ONE of the following TWO options:
A one-semester thesis in Environmental Analysis (EA 191 KS), or
A two-semester thesis in Environmental Analysis (EA 188L KS/ EA 190L KS, or EA 189L KS/ EA 190L KS)

Keck Science Common Learning Outcomes

Students completing a major in the Keck Science Department should demonstrate the ability to:

1. Use foundational principles to analyze problems in nature.
2. Develop hypotheses and test them using quantitative techniques.
3. Articulate applications of science in the modern world.
4. Effectively communicate scientific concepts both verbally and in writing.

Student Learning Outcomes

An Environmental Analysis Major should be able to:

- Understand and describe the complex social, scientific and humanistic aspects of environmental issues.
- Understand and apply both disciplinary and interdisciplinary analysis to environmental issues.
- Critically analyze, evaluate, and interpret scholarly arguments and popular discourse and be able to communicate this analysis to a variety of communities.
- Develop well-reasoned solutions to environmental predicaments, testing them against relevant criteria and standards.
- Be able to craft well-researched, informative and effective scholarly presentations.
- Contribute knowledge and action regarding environmental issues to the public through service learning, internships, community-based-research, and other activities.

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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 junior or senior year, students participate in a clinic course directed toward a specific environmental project.

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 (7-8 courses):

- Biology 43L-44L. Introductory Biology, or Biology 40L-44L. Introduction to Biological Chemistry, or Biology 042L. Integrated Biology and Chemistry and Biology 044L
- Chemistry 14L-15L. Basic Principles of Chemistry, or Chemistry 29L. Accelerated General Chemistry, or Chemistry 40L-15L. Introduction to Biological Chemistry, or Chemistry 42L. Integrated Biology and Chemistry
- Biology 137. EEP Clinic
- Economics 86. Accounting for Decision Making (see "substitutions" below)
- Economics 101. Intermediate Microeconomics
- Economics 171. Environmental 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 Economics 167. Law and Economics
- Biology 146L. Ecology, or Biology 159. Natural Resource Management, or Biology 169L. Marine Ecology; or permission of the Committee Chair of EEP.
- Government 50. Introduction to Public Administration, or Government 121. Organization and Management
- Government 111. Politics and Population, or Government 118. The Processes of

Environmental Policymaking, or Government 144. Political and Social Movements

- Government 120. Environmental Law

3. Senior Thesis:

EEP majors must complete either a one- or two-semester senior thesis in Biology or X 190 CM Senior Thesis. For further information, see “General Education Requirements” and “Senior Thesis in Science.”

Substitutions for EEP Major Requirements

1. Students not planning advanced work in science may substitute environmental science and/or policy courses for Chemistry 14L-15L. 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.

Prerequisites for EEP Majors

The following courses are prerequisites for major requirements (and may be counted for general education requirements):

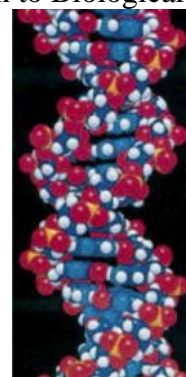
- Mathematics 30. Calculus I
- Economics 50. Principles of Economic Analysis, and
- Government 20. Introduction to American Politics

MOLECULAR BIOLOGY

Molecular Biology: This interdisciplinary major is focused on biology and the physical sciences, and incorporates a significant amount of mathematics. The major is research oriented and is designed to prepare students for graduate studies or medical school, as well as careers in biotechnology and the pharmaceutical industry. For further information, consult with the molecular biology faculty, Professors Armstrong, Edwalds-Gilbert, Tang, or Wiley.

MAJOR REQUIREMENTS:

Biology 43L or Biology 40L, or or Biology 42L	Introductory Biology or Introduction to Biological Chemistry
Chemistry 14L, 15L, or	Integrated Biology & Chemistry
Chemistry 29L or	Basic Principles of Chemistry
Chemistry 40L and 15L, or	Accelerated General Chemistry
Chemistry 42L	Introduction to Biological Chem
Mathematics 30, 31	Integrated Biology & Chemistry
Biology 143	Calculus I, II
Chemistry 116L, 117L	Genetics
Biology 173L	Organic Chemistry
Physics 33L, 34L, or	Mol. Biol. Seminar/Lab
Biology 157L	Principles of Physics
Biology 170L	Cell Biology
Biology 177	Molecular Biology
Chemistry 121	Biochemistry
Biology 188L, 190L or	Physical Chemistry I
189L, 190L; or	Two-semester thesis (preferred);
Biology 191	One-semester thesis



One additional Biology course with lab to be selected in consultation with the faculty advisor.

NOTES:

Biology 173L is a ½ credit sophomore level course, but juniors may take the course.

It is recommended that students take Genetics before Cell Biology and Molecular Biology.

Physics 33L, 34L are recommended, but Physics 30L, 31L may substitute.

For dual majors in Molecular Biology, students can only drop one upper-division elective.

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NEUROSCIENCE MAJOR

The major in Neuroscience is an interdisciplinary program of 16 courses (maximum) designed to provide students with an appreciation of diverse approaches to understanding the function of nervous systems, as well as the ability to conduct investigations within a particular subfield of interest. Students majoring in Neuroscience complete:

1. A common core program,
2. A sequence of four electives determined in consultation with an adviser in Neuroscience, and
3. A one- or two-semester thesis on a topic related to the four-course sequence.

The major provides good preparation for graduate work in biology, neuroscience, and a variety of other programs including medical school or other graduate health professions programs. Admission to particular advanced degree programs may require additional course work.

1. Common Core (5 courses)

- Introductory Biology (two semesters: Biology 43L-44L KS, or Biology 40L-44L KS, or Biology 42L-44L, or equivalent).
- Basic Principles of Chemistry (two semesters: Chemistry 14L-15L KS, or Chemistry 40L-15L KS, or CHEM 42L, or equivalent).
- Foundations of Neuroscience (Neuro 95 JT or an approved substitute).
- Neuroscience 1: Cell, Molecular: Biology/Neuroscience 148L KS.
- Neuroscience 2: Systems: Biology/Neuroscience 149 KS.

2. Common Core Electives (3 courses): Choose any 3 courses from the following:

- General Physics for the Life Sciences: Physics 30L-31L KS, or Principles of Physics, Physics 33L-34L KS. (Only one semester of physics may count.)
- Mathematics: Math 31 SC (Calculus II or calculus IIS PO), statistics (Biology 175 KS or Psychology 91 PZ, or PSYC 103 SC or PSYC 109 CM), or an approved equivalent course.
- Computer science: Biology 133L KS, Physics 100 KS, NEUR 182 SC, NEUR 123 SC/NEUR 123L SC, CS 005, MATH 42 SC, or an approved equivalent course.
- Research Methods: Psychology 104 SC/PSYC 104L SC, or PSYC 092 PZ or PSYC 110 CM/PSYC 111L CM, or an approved equivalent course.

3. Course elective specializations:

A coherent grouping of four elective courses to be determined in consultation with an adviser in Neuroscience and approved by the Coordinator of the Intercollegiate Neuroscience Program.

Areas in which a student may elect to specialize include, but are not limited to,

- Behavioral Neuroscience,
- Cellular and Molecular Neuroscience,
- Clinical Neuroscience,

- Cognitive Neuroscience,
- Computational Neuroscience,
- Motor Control, or
- Neuropharmacology
- Philosophy of Neuroscience,
- Developmental Neuroscience

4. Senior Thesis (one or two courses)

A one- or two-semester Senior Thesis on a topic related to the student's selected Neuroscience Sequence. Students who choose the one-semester thesis option are required to take an additional course towards their neuroscience sequence.

- Neuroscience (NEUR) 188L and 190L, or 189L and 190L, two-semester thesis; or
- Neuroscience (NEUR) 191, one-semester thesis or equivalent for dual majors.

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ORGANISMAL BIOLOGY

This major provides a research-and-field-oriented background for students interested in research careers in either physiology or ecology/evolution and their allied fields. For further information, consult with the organismal biology/ecology faculty, Professors McFarlane, Preest, or Thomson.

MAJOR REQUIREMENTS

Biology 43L, 44L, or

Biology 40L and 44L, or

Biology 42L and 44L

Chemistry 14L, 15L or

Chemistry 29L, or

Chemistry 40L and 15L, or

Chemistry 42L

Mathematics 30, or a new Biomath course

Biology 175

Physics 30L, 31L

Biology 120

Introductory Biology

Introduction to Biological Chemistry

Integrated Biology and Chemistry

Basic Principles of Chemistry

Accelerated General Chemistry

Introduction to Biological Chemistry

Integrated Biology and Chemistry

Calculus I

Biostatistics, or equivalent

General Physics for the Life Sciences

Research Tools for Organismal Bio

Seven upper division biology courses, including 3 with lab. At least 6 courses must be taken from the 4 groups listed below, with at least one course from each group AND at least three from Group 1 or 3. No more than one course from Group 4 may be counted. Other biology courses may also be appropriate to fulfill the group requirements, if approved in advance by the biology faculty. One upper-division Environmental Analysis course offered by Keck Science may count as a non-lab elective, but will not count towards any of the Group requirements.

Group 1:

- Biology 129. Neuromuscular Physiology in Health and Disease
- Biology 131L. Vertebrate Physiology
- Biology 132L. Comparative Physiology
- Biology 133L. Mathematical Physiology
- Biology 140. Selected Topics in Neuroscience
- Biology 141L. Vertebrate Anatomy
- Biology 149. Neuroscience II: Systems
- Biology 150La. Human Anatomy: Limbs and Movement
- Biology 150Lb. Human Anatomy: Back and Core
- Biology 163L. Plant Physiology and Biotechnology
- Biology 166. Animal Physiological Ecology
- Biology 167. Sensory Evolution
- Biology 185. Biochemical Physiology
- Biology 187c. Topics in Biology: Neural Organization of Behavior

Group 2:

- Biology 143. Genetics
- Biology 144. Drugs and Molecular Medicine
- Biology 148L. Neuroscience 1: Cell, Molecular

- Biology 151L. Developmental Biology
- Biology 156L. Genomics and Bioinformatics
- Biology 157L. Cell Biology
- Biology 158. Cell Cycle and Diseases
- Biology 164. Virology
- Biology 168L. Microbiology
- Biology 170L. Molecular Biology
- Biology 171. Biology of Cancer
- Biology 177. Biochemistry
- Biology 181. Molecular Basis of Neurological Disorders
- Biology 187a. Topics in Biology: Epigenetics
- Biology 187b. Topics in Biology: Molecular Ecology
- Biology 187f. Topics in Biology: Advanced Genetics

Group 3:

- Biology 135L. Field Biology
- Biology 138L. Applied Ecology Lab
- Biology 138. Applied Ecology
- Biology 145. Evolution
- Biology 146L. Ecology
- Biology 147. Biogeography
- Biology 154. Animal Behavior
- Biology 165. Advanced Topics in Environmental Biology
- Biology 169L. Marine Ecology
- Biology 176. Tropical Ecology
- Biology 187. Special Topics in Biology

Group 4:

- Biology 174L. Introduction to Biological Research Statistics
- Biology 175. Applied Biostatistics

Students are strongly encouraged to pursue an in-depth research experience through either a study abroad program with a field biology component or an on-or off-campus summer research project. With prior departmental approval, students may count off-campus courses towards electives and/or research experiences towards thesis.

- A one- or two-semester thesis in Biology.

NOTES:

Students planning careers in biology should seriously consider taking additional upper division biology courses beyond the minimum required for graduation.

Pre-med and pre-vet students should plan to take two semesters of organic chemistry (Chem 116L and 117L) in their junior or senior year.

Students with a strong background in Chemistry (AP 4 or 5) should take the placement exam for the one-semester accelerated introductory chemistry course (Chem 29L) in place of the two- semester Chem 14L and Chem 15L sequence.

A Recommended **Minimum** Schedule:

	<u>FALL</u>	<u>SPRING</u>
Freshman	Chem 14L Bio 43L <u>or</u> Math 30	Chem 15L Bio 44L
Sophomore	Bio 120 Bio 43L <u>or</u> Math 30 Physics 30L	Physics 31L UD Bio Elective
Junior	UD Bio elective	Off-campus study (2 UD Bio electives recommended)
Senior	UD Bio elective Senior Thesis	UD Bio elective Senior Thesis

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PHYSICS MAJOR

Physics explores the fundamental principles governing the behavior of our universe, from the subatomic scale to the cosmological scale. These principles underlie most modern technologies, and have direct applications to biology, chemistry, neuroscience, engineering, environmental analysis, etc., making physics a highly versatile undergraduate major. Physics majors work closely with faculty as they develop a broad range of highly flexible analytical and quantitative model-building and problem-solving skills. Our program places particular curricular emphasis on computational/numerical modeling techniques, so that our majors are well versed in tackling complex problems which are not readily solved by traditional methods. Physics alumni go on to a variety of positions, including industrial and academic research, biophysics, engineering, finance, law, medicine, mathematics. Course requirements for the physics major are kept relatively modest, allowing students with multiple interests to pursue double and dual majors and minors.

MAJOR REQUIREMENTS:

Math 30, 31, 32	Calculus I, II, III
Math 111	Differential Equations
Physics 33L, 34L	Principles of Physics
Physics 35	Modern Physics with Computational Applications
Physics 100	Computational Physics & Engineering
Physics 101	Classical Mechanics with Computational Applications
Physics 102	Electromagnetism
Physics 108*	Programming for Science and Engineering
Physics 106L	Electronics Laboratory
Physics 114	Quantum Mechanics with Computational Applications
Physics 115	Statistical Physics with Computational Applications
Physics 191, 188L-190L, 189L-190L	One- or Two-Semester Senior Thesis in Physics

RECOMMENDED:

Chemistry 14L, or Chemistry 40L	Basic Principles of Chemistry
Math 110	Introduction to Biological Chemistry
	Introduction to Engineering Mathematics

* or Computer Science 51, Introduction to Computer Science, or other computer science course chosen in consultation with a faculty advisor.

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SCIENCE MANAGEMENT MAJOR

This program is designed to provide students with a solid background in science, economics, and fundamental managerial skills. The major requires a minimum of 18 courses in addition to the College's general education requirements. Majors complete a core program of a minimum of 13 courses in addition to a 5-course area of concentration. Students may also construct their own track in science with consultation with the Science Management advisor. Some major requirements may be waived due to placement. New students who plan to major in Science Management may enroll in five courses.

Primary Contact: Professor Anna Wenzel, Program Coordinator

General Education Requirement Information for Science Management Majors:

For the general education requirements in the Social Sciences, Science Management majors must complete three social-science courses, as follows:

- ECON050 CM - Principles of Economic Analysis
- GOV020 CM - Introduction to American Politics (or any CMC History course under 170)
- PSYC037 CM - Organizational Psychology

For the general education requirements in the Humanities, Science Management majors must complete appropriate courses in two of the four areas. A general education course in philosophy or a FHS course taught by a philosophy faculty member may serve as the prerequisite to the philosophy options in the Science Management major ethics requirement.

Major Requirements

The major in Science Management requires a minimum of 18 courses, distributed as follows:

1. Core Program (minimum of 13 courses)

Chemistry (1 or 2 courses)

- CHEM014L KS - Basic Principles of Chemistry
or CHEM040L KS - Introduction to Biological Chemistry
and
- CHEM015L KS - Basic Principles of Chemistry
- or
- CHEM029L KS - Accelerated General Chemistry

Biology (2 courses)

- BIOL043L KS - Introductory Biology
or BIOL040L KS - Introduction to Biological Chemistry
and
- BIOL044L KS - Introductory Biology

Note:

Students who wish to specialize in the Physics track have the option of taking PHYS 030L KS/PHYS 031L KS or PHYS 033L KS/PHYS 034L KS in lieu of Biology for their Core Program.

Mathematics (1 course)

- MATH030 CM - Calculus I or demonstrated competency (e.g., score of 4 or 5 on Calculus BC AP)

Computer Science (1 course)One course selected from:

- CSCI040 CM - Computing for the Web
- CSCI005 HM – Introduction to Computer Science
- CSCI051G PO - Introduction to Computer Science in Grace with Lab
- CSCI051J PO - Introduction to Computer Science in Java with Lab
- CSCI051P PO - Introduction to Computer Science in Python with Lab

Economics (5 courses)

- ECON086 CM - Accounting for Decision Making
- ECON101 CM - Intermediate Microeconomics
- ECON120 CM - Statistics
- ECON134 CM - Corporate Finance (SVP students can take ECON165 for this requirement)
- ECON151 CM - Strategic Cost Management

Ethics (1 course)One course selected from:

- PHIL186 CM – Bioethics
- PHIL187 CM – Environmental Ethics
- PHIL190 CM - Science, Values, and Democracy
- PHIL180 CM - Health, Measurement, and Justice
- PSYC145 CM - Psychology of Morality

Project Management Fundamentals (1 course)One course selected from:

- ALS 400 (KGI) - Team Master's Project (course component)
- ENGR183 HM - Management of Technical EnterpriseECON150 PO - Industrial Organization
- ECON165 CM - Industrial Organization (offered annually; cannot be double-counted for the corporate finance requirement)

Senior Thesis (1 or 2 courses)

Majors must complete a thesis as the capstone requirement of the major.

Options include either a 2-semester Team Master's Project (TMP) or a 1- or 2-semester thesis in biology, chemistry, or physics. All students, including those participating in TMP, must enroll in the appropriate Keck Science thesis course. For further information, see Senior Thesis in Science, below.

2. Areas of Concentration (minimum of 5 courses)

All majors must complete an area of concentration track with a minimum of five courses.

Representative examples are listed below, although students may also construct their own sequence in consultation with the Science Management advisor.

A. Chemistry Track

- CHEM116L KS - Organic Chemistry
- CHEM117L KS - Organic Chemistry

- CHEM126L KS - Advanced Laboratory in Chemistry
or CHEM127L KS - Advanced Laboratory in Chemistry
- 2 additional upper-division chemistry courses

B. Physics Track

- MATH032 CM - Calculus III
- PHYS035 KS - Modern Physics with Computational Applications
- At least 3 additional upper-division physics courses from the following:
 - PHYS101 KS - Classical Mechanics with Computational Applications
 - PHYS102 KS - Electromagnetism
 - PHYS114 KS - Quantum Mechanics with Computational Applications
 - PHYS115 KS - Statistical Physics with Computational Applications

C. Biophysics Track

- PHYS030L KS - General Physics for the Life Sciences
- PHYS031L KS - General Physics for the Life Sciences
or
- PHYS033L KS - Principles of Physics
- PHYS034L KS - Principles of Physics

- MATH032 CM - Calculus III
- PHYS035 KS - Modern Physics with Computational Applications
- PHYS115 KS - Statistical Physics with Computational Applications
- PHYS178 KS - Biophysics

D. Biotechnology Track

- CHEM116L KS - Organic Chemistry
- CHEM117L KS - Organic Chemistry

Three (3) additional upper-division biology classes (at least one with lab). Recommendations include:

- BIOL131L KS - Vertebrate Physiology
- BIOL132L KS - Comparative Physiology
- BIOL133L KS - Introduction to Computational Neuroscience
- BIOL141L KS - Vertebrate Anatomy
- BIOL143 KS - Genetics
- BIOL150ALKS - Functional Human Anatomy and Biomechanics: Limbs and Movement
or BIOL150BLKS - Functional Human Anatomy and Biomechanics: Back and Core Stabilization
- BIOL156L KS - Genomics and Bioinformatics
- BIOL157L KS - Cell Biology
- BIOL158 KS - Cell Cycle, Diseases, and Aging
- BIOL164 KS - Virology
- BIOL170L KS - Molecular Biology
- BIOL177 KS - Biochemistry

E. Neuroscience Track

- NEUR095L JT - Foundations of Neuroscience
- BIOL148L KS - Neuroscience I: Cell, Molecular
- BIOL149 KS - Neuroscience II: Systems
- 2 additional neuroscience-related courses

F. Environmental Management Track

At least 2 courses in this sequence must have an associated laboratory component.

- BIOL138L KS - Applied Ecology and Conservation Lab

- BIOL165 KS - Advanced Topics in Environmental Biology
- EA100 KS - Global Climate Change
or EA100L KS - Global Climate Change
- CHEM139 KS - Environmental Chemistry

One (1) additional course in environmental analysis. Recommendations include:

- BIOL135L KS - Field Biology
- BIOL146L KS - Ecology with Lab
- BIOL147 KS - Biogeography
- BIOL169L KS - Marine Ecology
- BIOL176 KS - Tropical Ecology
- EA103 KS - Soils and Society
- EA104 KS - Oceanography

G. Public Health Track

Courses must be selected from 3 of the 5 fields listed below. Please note that some of these courses have prerequisites outside of the GE/Core program of this major.

Science

- CHEM116L KS - Organic Chemistry
- CHEM117L KS - Organic Chemistry
- PHYS030L KS - General Physics for the Life Sciences
- PHYS031L KS - General Physics for the Life Sciences

Economics

- ECON109 CM - Ethics, Economics, and Public Policy
- ECON129 PO - Health Economics
- ECON187 CM - The Economics of Poverty, Inequality, and Discrimination
- PHIL180 CM - Health, Measurement, and Justice

Psychology

- PSYC081 CM - Developmental Psychology
- PSYC103 PZ - Social Psychology
- PSYC107 CM - Neuroeconomics
- PSYC111 PZ - Physiological Psychology
- PSYC152 SC - Cultural Psychology
- PSYC155 CM - Seminar in Ethnic Minority Psychology and Mental Health
- PSYC176 PO - The Psychology of Health and Medicine
- PSYC185 CM - Health Psychology
- PSYC188 PZ - Seminar in Body Weight Regulation and Obesity
- PSYC193 PZ - Health Disparities Seminar

Sociology

- ANTH002 PZ - Introduction to Sociocultural Anthropology
- CHLT110 CH - Latinx Community Health
- CHLT153 PZ - Rural and Urban Social Movements
- ONT 101 PZ - Critical Community Studies
- PHIL155 SC - Ethics of the Beginning and End of Life
- SOC 086 PZ - Social Inequality
- SOC 120 PZ - Sex Politics
- SOC 170 PZ - Internship: Sociology of Health and Medicine

Government

- GOVT105 CM - Organization of Health Care and Public Policy

- GOVT106 CM - Politics of Interest Groups
- GOVT114 CM - Philanthropy, Voluntarism, and Nonprofits: Law, Public Policy and Leadership
- POLI151 SC - Women and Public Policy

Senior Thesis in Science

The senior thesis is a general education requirement and the capstone experience of a student's undergraduate education. Students must complete a senior thesis in at least one of their majors under supervision of a faculty reader who teaches within that major, unless granted a special exception.

Science majors have the following senior thesis options. Refer to the major requirements above for major-specific senior thesis requirements.

2-Semester Thesis with Lab (2 courses, 2 credits)

Students interested in a 2-semester thesis with lab take one of the following pairs of courses in the 1st and 2nd semester of the senior year:

- BIOL188L KS - Senior Thesis Research Project in Biology
- BIOL190L KS - Senior Thesis Research Project in Biology, Second Semester

- CHEM188L KS - Senior Thesis Research Project in Chemistry
- CHEM190L KS - Senior Thesis Research Project in Chemistry, Second Semester

- EA188L KS - Senior Thesis Research Project in EA Science
- EA190L KS - Senior Thesis Research Project in EA Science, Second Semester

- NEUR188L KS - Senior Thesis Research Project in Neuroscience
- NEUR190L KS - Senior Thesis Research Project in Neuroscience, Second Semester

- PHYS188L KS - Senior Thesis Research Project in Physics
- PHYS190L KS - Senior Thesis Research Project in Physics, Second Semester

2-Semester Thesis with Summer Research (2 courses, 1 credit)

Students interested in completing a 2-semester thesis by conducting a substantial research project during the summer after their junior year should register for one of the following pairs of courses in the 1st semester of the senior year. There is no credit or lab fee for 189L.

- BIOL189L KS - Senior Thesis Summer Research Project in Biology
- BIOL190L KS - Senior Thesis Research Project in Biology, Second Semester

- CHEM189L KS - Senior Thesis Summer Research Project in Chemistry
- CHEM190L KS - Senior Thesis Research Project in Chemistry, Second Semester

- EA189L KS - Senior Thesis Summer Research Project in EA Science
- EA190L KS - Senior Thesis Research Project in EA Science, Second Semester

- NEUR189L KS - Senior Thesis Summer Research Project in Neuroscience
- NEUR190L KS - Senior Thesis Research Project in Neuroscience, Second Semester

- PHYS189L KS - Senior Thesis Summer Research Project in Physics
- PHYS190L KS - Senior Thesis Research Project in Physics, Second Semester

1-Semester Experimental Thesis with Lab (1 course, 1 credit)

Students interested in a 1-semester experimental thesis with lab take one of the following in the 1st or 2nd semester of the senior year:

- BIOL190L KS - Senior Thesis Research Project in Biology, Second Semester
- CHEM190L KS - Senior Thesis Research Project in Chemistry, Second Semester
- EA190L KS - Senior Thesis Research Project in EA Science, Second Semester
- NEUR190L KS - Senior Thesis Research Project in Neuroscience, Second Semester
- PHYS190L KS - Senior Thesis Research Project in Physics, Second Semester
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1-Semester Library Thesis without Lab (1 course, 1 credit)

Students interested in a 1-semester library thesis without lab complete an extensive library research thesis in the 1st or 2nd semester of the senior year, chosen from:

- BIOL191 KS - One-Semester Thesis in Biology
- CHEM191 KS - One-Semester Thesis in Chemistry
- EA191 KS - One-Semester Thesis in EA Science
- NEUR191 KS - One-Semester Thesis in Neuroscience
- PHYS191 KS - One-Semester Thesis in Physics

Note:

The Senior Thesis Research Project course (188L) or the Summer Research Project course (189L) may not be counted as elective courses in the major.

Special Options for Majors in Science

Dual Major in Science

Students selecting a dual major including science should discuss their program requirements with the conveners of the appropriate programs. Usually up to 2 electives in science may be waived for dual majors including science. Unless otherwise specified above or exempted by the appropriate convener of the Keck Science Department, science students with dual majors are required to complete a 1- or 2-semester thesis in science.

Honors in Science

To be eligible for departmental honors in a science major, students must:

- Achieve a minimum GPA of 10.5 in courses in the major;
- Complete a 1- or 2-semester thesis project in which the student has demonstrated excellence by making a significant contribution to the progress of the research, by producing a thesis document judged to be of honors quality by the department, by presenting the work in a cogent fashion, and by engaging in the departmental seminar program.

