

Fourth Year

APh 78 abc	Senior Thesis, Experimental ³	9	9	9
or				
APh 77	Laboratory in Applied Physics ³	-	9	9
Ph 106 abc	Topics in Classical Physics	9	9	9
	Electives ²	9	9	9
	HSS Electives	9	9	9
	Other Electives	18	9	9
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		54	54	54

¹ See item 1, option requirements.

² See item 5, option requirements.

³ See item 4, option requirements.

Suggested Electives

The student may elect any course that is offered in any term provided he or she has the necessary prerequisites for that course. The following subjects are especially suitable for a well-rounded course of study. They need not be taken in the year suggested.

Second Year	Third Year	Fourth Year
APh 23, APh 24, Ma 5 abc, MS 115 ab	APh 77, Ph 77 abc, EE 114 ab, Ch 6 ab, Ge 101, APh 100, ME 19 ab	APh 77, APh 100, APh 101 abc, APh 105 abc, APh 114 abc, ACM 101 abc, ACM 104, Ch 125 abc, Ph 125 abc, Ph 129 abc, Ph 77 abc

More Specialized Courses

APh 156 abc, APh/BE 161, APh/EE 183 ab, APh 190 abc, APh/EE 130, APh/EE 131, APh/EE 132, ChE 103 abc, EE 91 ab, Ge 102, Ge 103.

Astrophysics Option

Modern astronomy—certainly as practiced at Caltech—is essentially astrophysics. With the goal of understanding the physical processes that govern the universe, its constituents, and their evolution, astronomy uses the apparatus and methodology of physics to gather and interpret data.

The astrophysics option is designed to give the student an understanding of the basic facts and concepts of astronomy today, to stimulate his or her interest in research, and to provide a basis for graduate work in astronomy/astrophysics. The sequence (Ay 20, 21) constitutes a solid introduction to modern astrophysics and may be taken either sophomore or junior year, with more advanced courses (Ay 101, 102, plus Ay electives) taken in the junior and senior years. It is desirable for a student to gain as broad a background as possible in related fields of science and engineering.

Attention is called to the fact that any student whose grade-point average is less than 1.9 at the end of an academic year in the subjects listed in the Division of Physics, Mathematics and Astronomy may, at the discretion of his or her department, be refused permission to continue the work in this option.

Option Requirements

1. Ay 20, 21, 101, 102, 30 or 141, 31, Ph 125 abc or APh 125 abc, and Ph 106 abc.
2. Ph 3 plus any two of Ph 5, Ph 6, Ph 7, or Ay 105. APh 23 and 24 taken as a pair may be substituted for one of these labs.
3. 54 additional units of Ay or Ph courses.
4. 27 additional units of science or engineering electives, of which 18 must be outside the Division of Physics, Mathematics and Astronomy. Core classes (e.g., Ay 1, Ge 1, Bi 1) do not count towards fulfillment of this requirement.
5. Passing grades must be earned in a total of 486 units, including the courses listed above.

Typical Course Schedule

		Units per term		
		1st	2nd	3rd
<i>Second Year</i>				
Ph 2 ab	Sophomore Physics	9	9	-
or				
Ph 12 abc				
Ma 2 ab	Sophomore Mathematics	9	9	-
Ay 20	Basic Astronomy and the Galaxy	10	-	-
Ay 21	Galaxies and Cosmology	-	9	-
Ay 30	Current Trends in Astronomy	-	3	-
	Physics Laboratory	6-9	6-9	6-9
	Core Menu Course	-	-	9
	HSS Electives	9	9	9
	Electives	0-6	0-3	15-21
		<hr/>	<hr/>	<hr/>
		43-52	45-51	39-48
<i>Third Year</i>				
Ph 125 abc	Quantum Mechanics	9	9	9
Ph 106 abc	Topics in Classical Physics	9	9	9
Ay 101	The Physics of Stars	11	-	-
Ay 105	Astronomy Instrumentation Lab	-	9	-
	HSS Electives	9	9	9
	Electives	9-12	9-15	18-24
		<hr/>	<hr/>	<hr/>
		47-50	45-51	45-51
<i>Fourth Year</i>				
Ay 31	Written Communication	-	-	3
Ay 102	Physics of the Interstellar Medium	-	9	-
	Astronomy or Physics Electives	18	18	18
	HSS Electives	9	9	9
	Electives	18-24	9-15	15-21
		<hr/>	<hr/>	<hr/>
		45-51	45-51	45-51

An ability to present one's work is vital to a successful career in research and teaching. Ay 30 satisfies the oral communications

requirement, but for further development, students are *also* urged to sign up for Ay 141 in their junior and senior years. Ay 31 satisfies the written communication requirement. Students are encouraged (but not required) to undertake research leading to a senior thesis; credit for this work is provided through Ay 78. Nonthesis research credits may be earned through Ay 142 with a maximum of 9 units per term. Computational skills may be acquired through Ph 20–21 and/or ACM 106.

Suggested Electives

The student may elect any course offered in any division in a given term, provided that he or she has the necessary prerequisites for that course. The following courses are useful to work in various fields of astronomy and astrophysics: ACM 95, ACM 106, APh 23/24, Ay 105, Ay 121–127, EE 20, EE 91, EE/Ge 157, Ge/Ay 11 c, Ge 103, Ge/Ch 128, Ge 131, Ge/Ay 132, 133, 137, Ma 4, Ma 12, Ma 112, Ph 20–22, Ph 77, 101, 127, 129, 136, 199.

Biology Option

The undergraduate option in biology is designed to build on a solid foundation in mathematics and physical science by providing an introduction to the basic facts, concepts, problems, and methodologies of biological science. The option serves as a basis for graduate study in any field of biology or for admission to the study of medicine. Instruction is offered in the form of participation in the ongoing research programs of the division, as well as in formal course work. Course work emphasizes the more general and fundamental properties of living organisms, and areas of current research interest, rather than the traditional distinct fields within the life sciences.

The division encourages undergraduate participation in its research program and believes that research participation should be a part of each student's program of study. Students may elect to prepare an undergraduate thesis (Bi 90). Research opportunities may be arranged with individual faculty members, or guidance may be obtained from a student's individual faculty adviser in the division or from the biology undergraduate student adviser.

The requirements listed below for the biology option are minimal requirements. An adequate preparation for graduate work in biology will normally include additional elective research or course work in biology and/or advanced course work in other sciences or in mathematics. Flexibility to accommodate varied individual scientific interests, within the broad scope of biology, is achieved through the provision of elective courses, arrangements for individual research (Bi 22), and tutorial instruction (Bi 23). In addition, arrangements may be made to take courses at neighboring institutions in fields of biology that are not represented in our curriculum.

Premedical Program

The undergraduate course for premedical students is essentially the same as that for biology students and is intended as a basis for later careers in research as well as in the practice of medicine. It differs in some respects from premedical curricula of other schools; however, it has been quite generally accepted as satisfying admission requirements of medical schools.

It is recommended that all students contemplating application to medical school consult with the premed adviser, Angela Wood, at the Career Development Center, or David Chan, in the Division of Biology.

Option Requirements

1. Bi 8, Bi 9, Bi 117, Bi 122, Bi/CNS 150, and Ch 41 abc.
2. One advanced laboratory course chosen from Bi 123, Bi/CNS 162, Bi 180, Bi 227, or at least 12 units of independent research such as Bi 22.
3. Two courses chosen from Bi/Ch 110, 111, 113, and/or Bi/Ch 132.
4. Scientific writing requirement met by taking Bi 24 (six units), or by taking any other writing course such as En 84 or Ge 13 (three units) plus oral presentation at SURF Seminar Day or equivalent, with option representative approval.
5. None of the courses satisfying requirements 1–4 may be taken pass/fail, except Bi 8.
6. At least six additional biology courses to a total of 146 units in biology must be taken and passed. Bi 1, Bi 2, Bi 5, and Bi 10 cannot be counted toward this total. Distribution requirement: these additional courses must be drawn from at least two of the following course “tracks” defined below: biochemistry, genetics, developmental biology, neurobiology, computational and systems biology, organismal and biomedical biology, cell biology, and interdisciplinary technology. At least four of these additional courses (including courses drawn from at least two tracks) must be taken for letter grades. At least two of these additional graded courses (from different tracks) must be for at least nine units.
7. Passing grades must be earned in a total of 486 units, including the courses listed above.

Biology Tracks

Individual classes may be relevant to more than one track, but classes cannot be double counted toward the distribution requirement. Courses included in the general option requirements that provide logical background for these tracks are indicated in parentheses; however, these cannot be counted toward the distribution requirement.