

Biology

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Professors: Dennehy, Meléndez, Savage-Dunn, Waldman, Weinstein, Zakeri; *Associate Professors:* Baker, Holtzman, Lahti, Ma, Short, Sperling; *Assistant Professors:* Alvarado, Fath, Tajerian; *Lecturers:* Cheema, Muehlbauer, Vesanen; *Laboratory Technicians:* Birne, Castillo, David, Freilich, Hudson, Tessitore; *Department Secretary:* Capellan; *Professors Emeritus:* Chabora, Greller, Michels, Roze, Szalay; *Associate Professors Emeritus:* Alsop, Calhoun, Koepfer, Nathanson, Pierce, Rifkin

Majors Offered: Biology (State Education Code 26453) and Biology-Secondary Education (State Education Code 26453)

The Biology Department offers the biology major with two concentrations—Biology and Biology-Education—as well as the biology minor. Students who choose one of these options must consult with an appropriate faculty advisor early in their course of studies.

Faculty advisors are available for students interested in general biology, biology-education, evening studies, transfer and permit courses, second baccalaureate, interdisciplinary studies, and graduate (master's and doctoral) studies. Inquire at the office (SB D346) or call 718-997-3400 for appropriate advisor and office hours.

The biology major provides students with a foundation for a variety of professional options. Upon graduation, they may find employment as technicians in health-related, industrial, or university laboratories. Those desiring a research career in the governmental, private, or academic sector should plan to continue their education at the graduate level. Such a career may be focused toward work in the field and/or in the laboratory.

This concentration is valuable to those interested in consumer protection services, environmental law, forestry, conservation, and scientific and medical illustration or writing. Government opportunities exist in the Departments of Agriculture, State, Interior, Commerce, Health and Human Services, and Treasury. This concentration is also the traditional route to professional schools leading to careers in medicine, dentistry, optometry, and other health-related vocations.

The Biology-Education concentration, a program of study coordinated with the Division of Education, is for students who want to meet the requirements for teaching biology in middle, junior high, and senior high schools. Questions concerning this major should be referred to the Biology-Education Advisor. Students also should consult with an advisor in either the Elementary & Early Childhood Education Department (EECE) or the Secondary Education & Youth Services Department (SEYS) to determine the education requirements for New York State certification.

THE MAJORS AND THE MINOR

Students who choose the Biology major must consult with an appropriate program advisor (the programs are listed below) early in their course of studies. Majors interested in the health professions should consult with the college pre-professional career advisor. Students choosing the Biology-Education major must consult with the Biology-Education Advisor. Students who choose to minor in biology must consult with the Undergraduate Advisor.

All students must prepare a concentration plan with an advisor and file this with the department before registering for any advanced biology courses, typically by the beginning of the sophomore year. This plan is solely a description of a proposed course of study; it may be changed at any time in consultation with an advisor. All students also must be listed with the Registrar as a biology major, Biology-Education major, or a biology

minor. Both the concentration plan and notification of the Registrar are required before a student can take advantage of departmental preregistration for advanced courses in biology or be graduated with a major or minor in biology.

All courses credited toward the biology major must be completed with a grade of C– or better. Credits earned in Tutorial (Biology 387) and Research (Biology 390–396) may not be applied toward the major's requirements. CHEM 113.1, CHEM 113.4 114.1 and 114.4 (or CHEM 19 and 159) are prerequisite to all 300-level biology courses.

No course may be taken more than twice, and credit will be given only once for the same course except where otherwise noted in the course description.

A maximum of 3 credits in combination of tutorial (BIOL 386) plus research (BIOL 390, 391, 395, or 396) courses may be taken in one semester. A maximum of 12 credits in combination of tutorial (BIOL 386) plus research (BIOL 390, 391, 395, or 396) courses may be applied toward the degree.

The Biology Majors

See the box on page 112 for the specific requirements for the majors.

Note: Students wishing to attend health-profession schools or to undertake further graduate training must take some or all of the following cognate courses: CHEM 113.1, 113.4, 114.1, 114.4, 251, 252; PHYS 121.1, 122.4, 122.1, 122.4; MATH 151 and 152; or equivalents.

Biology Majors Who Want to Enter the Health Professions

Advisors: V. Cook, M. Vasanen

Office Staff: H. Wonahua-Adam

Office: Science Bldg. B338, 718-997-3470

It is recommended that pre-health profession students take several laboratory courses in biology and biochemistry. These courses should be completed before the beginning of the senior year.

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REQUIREMENTS FOR THE MAJOR: BIOLOGY (MAJOR CODE BIOL-BA)

All courses credited toward the major or minor must be completed with a minimum grade of C–.

Required

At least 36 credits in biology, including BIOL 105, 106, and two of BIOL 285, 286, or 287 with the remainder being in 200-level courses and above, of which at least three of the advanced courses, not including BIOL 344, 381, 390, 391, 395, or 396, must be at the 300 level, and at least four must be laboratory courses. One year of general chemistry (CHEM 113.1, CHEM 113.4, 114.1 and 114.4 or equivalent) plus one semester of organic chemistry (CHEM 251 or equivalent) plus one semester of calculus (MATH 142 or 151 or equivalent) or BIOL 230 or equivalent. At least 20 of the biology credits above BIOL 105 and 106 must be taken at Queens College. Course selection must be made in consultation with a departmental advisor.

Transfers

A maximum of 16 biology credits are accepted as transfer credits in the major.

REQUIREMENTS FOR THE MAJOR: BIOLOGY- EDUCATION (MAJOR CODE BIOLED-BA)

Required

At least 30 credits in biology, including BIOL 105, BIOL 106, and two of BIOL 285, 286 or 287; the remainder must be in 200- and 300-level courses, of which at least two must be 300-level courses and at least three must be laboratory courses. A minimum of a year of chemistry (normally CHEM 101.1, 101.3, 102.1 and 102.3, or equivalent); and one semester of calculus (MATH 142 or 151, or equivalent) or BIOL 230 or equivalent. At least 16 of the credits above BIOL 105 and 106 must be taken at Queens College. Course selection must be made in consultation with the biology-education advisor.

Also required are 16 credits in major-level courses in the following cognate departments: Chemistry & Biochemistry; Computer Science; Earth & Environmental Sciences;

Family, Nutrition & Exercise Sciences; Mathematics; Physics. These courses are to be chosen in consultation with the advisor.

Also required is a co-major in Elementary & Early Childhood Education or a major in Secondary Education & Youth Services, as prescribed by a subject matter advisor of the pertinent EECE or SEYS Department.

REQUIREMENTS FOR THE MINOR IN BIOLOGY (MINOR CODE BIOL-MIN)

Students who minor in biology must complete BIOL 105 and 106 and at least 9 credits of advanced biology courses, not including the research courses (BIOL 390, 391, 395, 396). All the advanced courses must be taken at Queens College.

REQUIREMENTS FOR THE MINOR IN HEALTH SCIENCES

A minimum of 20 credits from the following courses is required.

- BIOL 40, 41, 44, 45, 105, 106, 201, 230, 285, 286
- CHEM 101.1, 101.3, 102.1, 102.3, 103.1, 103.3, 113.1, 113.4, 114.1, 114.4, 251.1, 251.4, 252.1, 252.4, 371
- FNES 163
- PHYS 121.1, 121.4, 122.1, 122.4, 145.1, 145.4, 146.1, 146.4

1. Of the 20 required credits, at least 10 must be taken in residence at Queens College. All 20 credits must be completed with a grade of C or higher. In courses in which the lecture and laboratory components have separate registration numbers (e.g., CHEM 113.1 and 113.4 or PHYS 121.1 and 121.4), students must pass both components for the credits to be counted toward the minor. The minor requirements may overlap with a student's major's requirements. In such cases, a maximum of 10 credits may be applied toward both the major and the minor; the remaining credits required for the minor must be different from the student's major's requirements.
2. For transfer students who have taken courses relevant to the minor, a maximum of 10 transferred credits may be used to fulfill the minor's requirements.

Biology Majors Who Wish to Teach Biology in Secondary Schools

Advisor: Inquire at department office.

Students who want to meet requirements for a certificate to teach biology in middle, junior, or senior high schools should follow the major in Biology-Education and consult with the Secondary Education and Youth Services Department to determine the education requirements for New York State certification.

The Biology Minor

See the box on this page for the specific requirements for the minor.

All courses credited toward the biology minor must be completed with a grade of C– or better. Tutorial or research courses (BIOL 387, 390, 391, 395, 396) may not be credited toward the biology minor. CHEM 113.1, CHEM 113.4, 114.1, and 114.4 are prerequisite to all 300-level biology courses. No course may be taken more than twice, and credit will be given only once for the same course.

Note: All 200-level and above biology courses must be taken at Queens College.

MINOR IN HEALTH SCIENCES

Advisor: S. Cheema

Background

The minor in the health sciences is suitable for students planning to pursue a career in the health professions and needing to complete prerequisite courses required by professional schools that may not be required for their majors at Queens College.

Recruitment

Queens College students who have already declared a major will be eligible to opt for the minor.

BIOLOGY

POST-BACCALAUREATE CERTIFICATE IN MEDICAL CAREER PREPARATION

Advisor: M. Vasanen

The program for the Post-Baccalaureate Certificate in Medical Career Preparation is designed for individuals seeking to switch career paths and enter fields in the health professions, including allopathic or osteopathic medicine, dentistry, veterinary medicine, podiatric medicine, pharmacy, optometry, physician assistant, physical therapy, or occupational therapy. The program couples academics with individualized pre-health advising and tutoring services. It also offers assistance in obtaining essential research, clinical volunteering, and community service experience. After successful completion of the program, students are prepared to take the appropriate standardized tests and apply to competitive health professions schools.

Requirements for Matriculation

- A Bachelor of Arts (BA) or Bachelor of Science (BS) degree
- An official transcript from the college or university where the BA or BS was awarded
- Official transcripts from all previously attended colleges and universities
- A minimum overall undergraduate grade-point average (GPA) of 3.0
- Completion of fewer than or equal to 25 credits of required pre-health course work, with a grade of *B* or better
- Completed application and fee
- A short essay (400–500 words) describing why the candidate wants to pursue a career in the health professions
- Letters of recommendation (maximum of three)

Departmental Requirements

The core pre-health course work is generally completed within a two-year period. It includes the following courses, listed per semester.

Fall Semester 1

■ BIOL 105, General Biology: Physiology and Cell Biology	4
■ CHEM 113.4, General Chemistry I	4
■ CHEM 113.1, Introduction to Chemical Techniques	1
■ MATH 141, Calculus/Differentiation	3

Spring Semester 1

■ BIOL 106, General Biology: Life-forms and Ecosystems	4
■ CHEM 114.4, General Chemistry II	4
■ CHEM 114.1, Quantitative and Qualitative Analysis	1
■ PSYCH 107.3 and 107.1 or SOC 205, Social Statistics	4

Summer Semester 1

■ CHEM 251.4, Organic Chemistry I	4
■ CHEM 251.1, Organic Chemistry Laboratory I	1

Fall Semester 2

■ CHEM 252.4, Organic Chemistry II	4
■ CHEM 252.1, Organic Chemistry Laboratory II	1
■ PHYS 121.4, General Physics I	4
■ PHYS 121.1, General Physics I Laboratory	1

Spring Semester 2

■ CHEM 371, Biochemistry I	4
■ PHYS 122.4, General Physics II	4
■ PHYS 122.1, General Physics II Laboratory	1

Total 49

During the glide year (Fall and Spring Semesters 3), students are strongly encouraged to continue their academic studies and take several additional science courses. They may choose from the following relevant science courses: BIOL 201, 285, 286, 325, 326, 350, 360, 365, 366, 368, 369, and 373; and CHEM 372 and 376.

credits

Requirements

NONMAJOR COURSES

The department offers survey and topic-oriented courses (designated as the 1–099 series) that have been designed for nonmajors. Most of these courses have recitation/demonstration sections rather than formal laboratories.

DEPARTMENT AWARDS

The department offers the following prizes and awards: the *Donald E. Lancefield Award*, for excellence in biology, to be awarded to the biology major with the highest grade-point average; the *Darwin Prize*, for the biology major with the second highest grade-point average who has demonstrated an interest in research; the *Laura H. and Arthur L. Colwin Prize*, for excellence in undergraduate research, to be awarded to a biology major who is not a pre-professional student; the *Muriel & Philip Feigelson Award*, to a graduating senior majoring in biology who has done the best undergraduate research and has also demonstrated significant academic achievement; the *Max K. Hecht Scholarship Fund*, to a junior or graduating senior who is considered to be an outstanding biology major, with accomplishments in academic research studies (preference will be given to students interested in organismic biology, Max's field); and the *Victor J. Jules Scholarship*, awarded to biology majors who: (1) have demonstrated financial need, (2) have filed a concentration plan as a major and completed or are in the process of completing at least 6 credits of electives in biology, and (3) have an overall GPA of at least 3.0 (first consideration will be given to eligible sophomores and then to juniors; this endowed scholarship is to be used for educational expenses).

*MAT charges possible.

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COURSES*

Course Numbering

Courses offered by the Biology Department are numbered according to the following system:

BIOL 1–099. Courses open to students in all disciplines, but not creditable to the major or minor in biology.

BIOL 100–199. Introductory courses for majors and minors (freshman level).

BIOL 200–299. Second-level courses for which the prerequisites are BIOL 108 and CHEM 114.1, CHEM 114.4 (sophomore or junior level).

BIOL 300–399. Third-level courses having either a 200-level biology or advanced-level chemistry prerequisite (upper-class level).

In addition, the middle digit of all 200- and 300-level course numbers is used to denote the area of study of the course, as follows:

- 0 Microbiology
- 1 Botany
- 2 Zoology
- 3 Mathematical Biology
- 4 Community and Ecosystem Biology
- 5 Genetics and Evolution
- 6 Cell and Developmental Biology
- 7 Physiology
- 8 Variable Content, Seminars, Colloquia
- 9 Undergraduate Research

NONMAJOR COURSES*

BIOL 8. Fundamentals of Biology. 2 lec., 2 lab. hr.; 3 cr. A survey course in biology designed for students in Adult Collegiate Education (ACE) and the LEAP project. The areas of cell biology, heredity, development, physiology, ecology, and evolution are covered. Emphasis will be placed on human-related topics such as health, the environment, and current developments in biology. No previous knowledge of biology or chemistry is assumed. Not open to students who have taken BIOL 11. Fall, Spring

BIOL 9. Introductory Biology. 3 lec. hr.; 3 cr.

A general introduction to biology in the areas of cell biology, genetics, development, vertebrate physiology, ecology, and evolution. No previous knowledge of biology or chemistry assumed. Not open to students who have taken BIOL 11 or the equivalent. This course is designed for non-science majors and may not be used to fulfill biology major or minor requirements.

BIOL 10. Laboratory in Introductory Biology.

3 lab hr.; 1 cr. Prereq.: BIOL 9. Laboratories in the topics of introductory biology as presented in BIOL 9. May not be used to fulfill biology major or minor requirements. Not open to students who have taken BIOL 11.

BIOL 11. Introduction to College Biology.

3 lec., 3 lab. hr.; 4 cr. A general introduction to biology in the areas of cell biology, genetics, development, vertebrate physiology, ecology, and evolution. No previous knowledge of biology or chemistry assumed. For students in all areas, including physical education majors and prospective biology majors who have not had previous high school biology or chemistry courses. Not open to students who have taken BIOL 8, 9, or the equivalent, except with permission of the chair. This course is designed for non-science majors and may not be used to fulfill biology major or minor requirements. (LPS, SW, SCI)

BIOL 13. Writing in the Sciences: Life Science

Themes. 3 hr.; 3 cr.; Prereq.: English 110. BIOL 13 fulfills the College Writing 2 requirement and builds on the work of English 110 (College Writing 1), in order to teach the conventions of writing in the discipline of science. It is a discipline-based writing seminar that provides students with the opportunity to hone their writing skills within a field of scientific inquiry. Because lucid writing is essential to communicating science, students will work on the clear expression of ideas within different genres of scientific literature, adapted for different audiences. In developing the

science writer's craft, students will also gain techniques applicable to other academic disciplines since writing skills have a universal application. (EC2)

BIOL 14. Introduction to Biology and Society.

2 lec.; 1 lab. hr.; 3 cr. A lecture and lab course focusing on the exploration of scientific principles, their applications, and critical analysis of the results of selected subjects that focus on their impact on society. Various current topics of interest will be explored in the context of their scientific basis and their ethical and economic impacts on social systems. Readings, written assignments, and discussions are designed to encourage students to develop interpretative and analytical skills as they explore biological advances and their impact on society. Laboratories will present opportunities for the observation of biological fundamentals, observation and data gathering, statistical analyses and hypothesis testing, computer simulations and explorations of various topics, such as population growth, ecological footprints, food consumption and production, genetic fundamentals and analysis, and evolutionary processes. (LPS, SCI)

BIOL 17. Science, Medicine and You. 3 lab. hr.;

3 cr. This laboratory course is designed to introduce students to the tools needed to critically evaluate the scientific and medical information presented in the media (both in print and on the Internet). This course will provide you insight into current scientific and medical discoveries with a focus on how they impact you. Each lab will explore a specific human disease/condition such as heart disease, flu pandemics, HIV, cancer, and aging. You will become comfortable with science in the news through weekly "newscasts" presented by fellow lab members. You will also carry out some of the important experimental techniques that lead to our current understanding.

BIOL 21. Introduction to Human Genetics.

3 lec. hr.; 3 cr. Heredity, with special emphasis on human genetics. For non-science majors. May not be used to fulfill biology major or minor requirements.

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BIOL 22. Introduction to Human Physiology.

3 lec. hr.; 3 cr. How the human body works: support and movement, coordination and communication, digestion, excretion, and reproduction. For non-science majors. May not be used to fulfill biology major or minor requirements. (SCI)

BIOL 23. Human Biological Origins. 3 lec. hr.; 3 cr. Biology in the fourth dimension. A tour through time to examine our successively more remote ancestors and their relationships to other important groups such as birds and dinosaurs. Includes some trips to museums. For non-science majors. May not be used to fulfill biology major requirements.

BIOL 24. Biology and Society. 3 lec. hr.; 3 cr. Prereq.: None, although BIOL 11 is recommended. A non-major lecture course (supplemented with video) focusing on selected biological principles in genetics, development, evolution, physiology, and ecology which are discussed in the context of their impact on the human population. The approach throughout is to initially provide a scientific background of principles and processes and then relate them to human society in the most global sense. The ethical considerations of many situations, such as genetic testing, pollution influences on developmental disabilities, and humanitarian aid in overpopulation crises, are considered. (SCI)

BIOL 25. Biological Evolution. 3 lec. hr.; 3 cr. Prereq.: BIOL 11 or high school biology. A survey of the evidences for biological evolution, including the origin and history of life, the forces driving change, and human evolution, past, present, and future. This course is designed for non-science majors and may not be used to fulfill biology major or minor requirements. (SW, SCI)

BIOL 28. Infectious Diseases. 3 lec. hr.; 3 cr. Prereq.: BIOL 9 or 11, or permission of the instructor. The life cycle, evolution, ecology, and infection processes of disease-causing organisms. Epidemiology and transmission mechanisms of pathogens. Immunol-

ogy, disease prevention, and drug discovery methods. Specific examples include diseases important to human history, newly emerging diseases, and bioterrorism. This course is designed for the non-science major and may not be used to fulfill biology major or minor requirements.

BIOL 34. Genomics Research Experience I. 3 cr. Open to freshmen only. The first part of a two-semester sequence (Biology 34 and 35) that will introduce students to the scientific method for designing procedures for investigating natural phenomena, collecting data, acquiring new knowledge, and correcting and integrating existing knowledge. Students with no background in biology will participate in an authentic research experience—integrated into a laboratory course designed for freshmen—that will result in a significant contribution to the understanding of microbial genomics. During the fall course, soil samples will be collected in the field. From these samples students will identify and purify bacteriophages (viruses that infect bacteria). The bacteriophages will be characterized structurally by electron microscopy, and their DNA will be purified and sequenced. (SCI) Fall

BIOL 35. Genomics Research Experience II. 3 cr. Prereq.: BIOL 34. The second part of a two-semester sequence (Biology 34 and 35). During the spring course, open only to those completing the fall course (BIOL 34). DNA sequences of phages obtained during the fall semester will be analyzed with bioinformatic tools and compared with those of phages isolated at other locations. The goal is to identify genes and their organization, examine their similarities and differences that may characterize different phage groups, and determine how these groups may have arisen during evolution. (SCI) Spring

BIOL 40. Anatomy and Physiology I. 2 lec., 1 rec., 3 lab. hr.; 4 cr. First semester of a two-semester combined lecture and laboratory course. Functional and descriptive anatomy and physiology with focus on human systems. May not be used to fulfill biology major or minor requirements.

BIOL 41. Anatomy and Physiology II. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: C– or better in BIOL 40. Second semester of a two-semester combined lecture and laboratory course. Functional and descriptive anatomy and physiology with focus on human systems. May not be used to fulfill biology major or minor requirements.

BIOL 43. Anatomy and Physiology. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: A grade of C– or better in BIOL 11 or 106; CHEM 101.1, 101.3 or 102.1, 102.3. Functional and descriptive anatomy and physiology of the human and other mammals, emphasizing practical aspects. May not be used to fulfill biology major or minor requirements.

BIOL 44. Food and Human Microbiology. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 11, BIOL 40 or BIOL 106. The student will be introduced to general microbiology. Emphasis will be placed on the microbiology of food and human disease and immunology. The laboratory will deal with the characteristics of microorganisms and their role in the preparation of food. May not be used to fulfill biology major or minor requirements.

BIOL 45. Microbiology for Health Professions. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 11 or BIOL 40 and 41, or equivalent, with a grade of C+ or better, or permission of instructor. May not be used to fulfill biology major or minor requirements. Not open to students who have completed BIOL 201. Microbiology with emphases on characteristics, natural history, and handling of human pathogens. This course is designed for students planning to enter into a professional nursing program and other health professions.

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BIOL 51. Sociobiology. Prereq.: Open only to juniors and seniors. An evolutionary and ecological analysis of social behavior and communication in humans and animals. Nature and nurture from a modern scientific perspective. Examines the biological and social basis of behaviors such as altruism, male and female reproductive strategies, parenting, generation gaps, cultural patterns, and language. May not be used to fulfill biology major or minor requirements.

BIOL 52. The Biology of Cancer. 3 lec. hr.; 3 cr. Prereq.: BIOL 11 or permission of the instructor. How normal cell function and division is controlled as compared to the metabolism and growth of cancer cells. Includes consideration of the factors causing or contributing to cancer formation (chemicals, viruses, radiation, diet, genetics), the classification of cancers, the rationale for and description of the different types of cancer therapy, and future directions for cancer research. May not be used to fulfill biology major or minor requirements.

INTRODUCTORY COURSES FOR THE MAJOR

BIOL 105. General Biology: Physiology and Cell Biology. (formerly Biology 108) 3 lec., 3 lab. hr.; 4 cr. Prereq.: High School biology and chemistry. Not open to students who have taken BIOL 108. Principles of cell biology, heredity and information transfer, physiology, and development. (LPS, SW, SCI)

BIOL 106. General Biology: Life-forms and Ecosystems. (formerly Biology 107) 3 lec., 3 lab. hr.; 4 cr. Prereq.: BIOL 105 or BIOL 108 or permission of Chair. Not open to students who have taken BIOL 107. Principles of animal and plant diversity, evolution, behavior, and ecology. (LPS, SW, SCI)

200-LEVEL MAJOR COURSES

BIOL 200. Foundations of Research in Biology. 2 lec. hr.; 2 cr. Prereq.: BIOL 105 and a B– or greater average in biology courses. Introduction to the critical thinking tools required to conduct research in biology. Topics include the scientific method, experimental design, and hypothesis testing; introductory statistical methods for data analysis; communication of research findings via research papers, posters, and oral talks; and ethics in scientific research. BIOL 200 is a prerequisite for all students interested in registering in the research project courses BIOL 390, 391, 395, and 396 with faculty members in the Biology Department.

Microbiology

BIOL 201. General Microbiology. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 106; CHEM 102.1, 102.3 or 114.1 and 114.4 or equivalent. Significance, structure, metabolism, and functions of microorganisms; the basic bacteriological techniques of culture, isolation, and identification.

Botany

BIOL 213. Field Botany. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 106. Introduction to local flora and vegetation. Lectures will emphasize the structure and composition of local vegetation. Laboratories will consist mainly of field trips to parks, preserves, and botanical gardens. Students will submit a field trip report and a plant collection.

BIOL 310. Lower Plants. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 106 and 287. Introduction to the biology of the algae, fungi, and bryophytes of the northeastern United States. Laboratory includes several field trips.

BIOL 315. Higher Plants. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 107. Survey of the vascular plants with emphasis on the flowering plants and taxonomic characteristics useful in identification of major plant groups. Laboratories will be devoted to techniques of

identification. Students will submit a plant collection. Field trips comprise a large part of the laboratory component; they will occupy half or whole days.

Zoology

BIOL 220. Invertebrate Zoology. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 106. Evolution, classification, anatomy, and physiology of the invertebrates. Laboratory includes dissection of representative forms and a weekday or weekend field trip.

BIOL 226. Comparative Vertebrate Anatomy. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 106. Functional and phylogenetic morphology of the vertebrates. Laboratory includes dissection of representative forms.

Mathematical Biology

BIOL 230. Biostatistics. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 106 or the equivalent. Not open to students who have successfully completed any one of the following courses (or their equivalents): ECON 249; MATH 14, 241; PSYCH 107; SOC 205, 306. Probability models, statistical inference, design of experiments, and critical analysis of statistical applications in biology. (SQ)

Community and Ecosystem Biology

BIOL 241. Techniques of Field Biology. 1 lec., 4 lab. hr.; 3 cr. Prereq.: BIOL 107; CHEM 114.1, CHEM 114.4 or 159 or the equivalent. An introduction to collection and analyses of data in the field. Topics shall include design of experiments and controls, methodologies of different types of field collections, use of keys, and statistical analyses. One evening and several all-day weekend field trips to different study sites may be included. A collection may be required.

Genetics and Evolution

BIOL 245. Evolution and Culture. 3 lec. hr.; 3 cr. Prereq.: BIOL 106 or equivalent, or permission of the instructor. Assessment of recent evolutionary theories associated with culture: behavioral ecology, evolutionary psychology, memetics, and bio-cultural co-evolution.

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These theories are comparatively examined and compared by discussing current research, critiques, and their application to human and animal cultures.

BIOL 251. Genetics Laboratory. 1 rec., 3 lab. hr.; 2 cr. Prereq. or coreq.: BIOL 285. Laboratory exploration of the fundamental concepts of genetic analysis utilizing different model organisms.

Variable Content

BIOL 280. Topics in Biology. 1–3 hr.; 1–3 cr. Prereq.: BIOL 106 and permission of instructor. Particular topic of current interest in biology. May be repeated for credit if topic changes but credited only once for the major.

Principles Courses

BIOL 285. Principles of Genetics. 3 lec., 1 rec. hr.; 4 cr. Prereq.: BIOL 105 and 106; Pre- or coreq.: CHEM 102.1, 102.3 or 114.1 and 114.4 or the equivalent. The inheritance, structure, and function of genetic material.

BIOL 286. Principles of Cell Biology. 3 lec. hr.; 3 cr. Prereq.: BIOL 105 and 106; Pre- or coreq.: CHEM 102.1, 102.3 or 114.1 and 114.4 or equivalent. Structure, function, and regulation of cells, including cell cycle, subcellular compartmentalization, signal transduction, and cell-cell interactions.

BIOL 287. Principles of Evolutionary Biology. 3 lec., 1 rec. hr.; 4 cr. Prereq.: BIOL 106. The mechanisms and processes of biological evolution.

BIOL 288. General Ecology. 2 hr. lec., 1 hr. rec.; 3 cr. Prereq.: BIOL 105 and 106. The relationships between organisms and their environment and between organisms and other organisms. Lab sessions will be a mix of indoor and field activities.

300-LEVEL MAJOR COURSES

Botany

BIOL 312. Morphology and Evolution of Plants. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 106 and one of 210, or 212, or 213; CHEM 114.1, CHEM 114.4 or 102.1, 102.3 or equivalent. Comparisons of plant form and function. Lectures will emphasize the structure and origin of plant organs, and the use of this information in classifying major plant groups. Information from paleobotany will be integrated with comparative morphology of living plants. Laboratory includes several field trips.

also see BIOL 371 (Plant Physiology) and BIOL 380 (Field Biology)

Zoology

BIOL 320. Parasitology. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 106 and 220; CHEM 114.1, CHEM 114.4 or 102.1, 102.3 or equivalent, or permission of the chair. Ecology, distribution, pathology, and control of the parasites of humans and other selected animals. Particular emphasis on the evolution of host-parasite relationships, and on the approaches to solving the basic problems of animal parasitism.

BIOL 321. Entomology. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 220; CHEM 102.1, 102.3 or 114.1 and 114.4 or equivalent, or permission of the chair. Anatomy, physiology, classification, and ecology of the terrestrial mandibulate arthropods, with special emphasis on the insects. Laboratory includes field trips and may require an insect collection. Students should expect to reside at a field study site in the greater metropolitan New York area for at least one week of the course (dormitory fees will be announced and collected at time of registration). Summer Session only.

BIOL 325. Anatomy and Physiology I. 3 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 286, CHEM 114.1, CHEM 114.4, or equivalents, or permission of the instructor. The structure, function, and integration of the nervous, musculoskeletal, and circulatory systems. Laboratory will focus on human systems.

BIOL 326. Anatomy and Physiology II. 3 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 286, CHEM 114.1, CHEM 114.4, or equivalents, or permission of the instructor. The structure, function, and integration of the respiratory, osmoregulatory, digestive, and endocrine systems. Laboratory will focus on human systems.

also see BIOL 345W (Animal Behavior), BIOL 360 (Vertebrate Histology), BIOL 365 (Developmental Biology), BIOL 372 (Vertebrate Physiology), and BIOL 380 (Field Biology)

Mathematical Biology

BIOL 330. Design of Experiments. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 230 or an equivalent introductory course in statistics (ECON 249; MATH 241; PSYCH 107; SOC 205, 306), or permission of the instructor. The design and analysis of biological experiments. Formulation of biological problems in terms of statistical analysis, planning experiments, and anticipating appropriate analyses. Use of computer statistical packages.

Community and Ecosystem Biology

BIOL 340. General Ecology. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 287 or permission of the chair. Theory and analysis of structure, growth, regulation, and dynamic interactions within and between populations. Composition of biological communities in terms of their structure, species abundance and diversity, interspecific interactions, and integration with the physical environment.

BIOL 344. Contemporary Issues in Biology. 3 hr.; 3 cr. Prereq.: BIOL 285, 286, and two of the three 300-level courses required for the major. A lecture and discussion course for senior biology majors focusing on a critical analysis of selected subjects encompassing current biological developments in the context of their ethical, scientific, and economic impact on human social systems. This course is designed to permit students to develop interpretative and analytical skills and to explore their own intellectual and practical responses

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to the impact of biological advances on society. Using primary literature, students are expected to write and discuss a number of their papers; one of these will be a long paper in conjunction with an oral presentation.

BIOL 345W. Animal Behavior. 3 lec., 1 rec.; 4 cr. Prereq.: ENGL 110; BIOL 285 or 287. Study of animal behavior. Topics include the description, evolution, development, physiological basis, and ecological significance of behavior. Includes one field trip to a natural area such as Jamaica Bay Wildlife Refuge to witness wild animal behavior and a second field trip to a place such as the Bronx Zoo to observe behaviors in captive organisms that illustrate concepts presented in the course.

BIOL 346. Limnology. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 287 or permission of the chair. Survey of the physical, chemical, and biological properties and features of streams, rivers, and lakes.

BIOL 347. Marine Biology. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 287 or permission of the chair. Study of marine organisms and biological oceanography. Short trips scheduled on oceanographic research vessels. Usually offered in Summer.

BIOL 348. Chemical Ecology. 2 lec. hr.; 2 cr. Prereq.: BIOL 107 and 108; CHEM 251 or equivalent. The chemical mediation of ecological interactions, including chemical basis of food selection, plant antiherbivore and antifungal defenses, chemistry of mutualistic associations, animal pheromones and defense substances, allelopathy, and chemicals in the environment.

BIOL 349. Chemical Ecology Laboratory. 4 lab. hr.; 2 cr. Prereq. or coreq.: BIOL 348. The use of modern instrumental techniques in chemical ecology: analysis of foods, measurement of nutrient and electrolyte levels of biological materials, isolation and quantification of plant and animal defense compounds. **also see** BIOL 380, Field Biology

Genetics and Evolution

BIOL 350. Molecular Genetics. 3 lec., 1 rec. hr.; 4 cr. Prereq.: BIOL 285 and 286; CHEM 251 or the equivalent. Chemistry majors may substitute CHEM 375 in lieu of BIOL 286. Molecular basis of heredity. Topics include the structure of DNA and RNA, transcription, translation, mechanisms of recombination and mutation, regulation, and transmission genetics of viruses, prokaryotes, and eukaryotes.

BIOL 352/ANTH 364. Anthropological Genomics. 3 lec. hr., 1 rec. hr.; 4 cr. Prereq.: ANTH 260 or BIOL 287 or BIOL 285 or instructor's permission. Exploration of how genes can be used to understand human history, ancestry, and evolution while also allowing students to participate in this growing area of knowledge by optionally collecting genetic data from their own genome. (SYN)

BIOL 355. Evolution Laboratory. 1 rec., 3 lab. hr.; 2 cr. Prereq.: BIOL 285 and 287. The use of bioinformatics and molecular biology techniques in evolutionary biobiology: analysis of genetic polymorphism in populations, molecular inference of phylogenies, phylogenetic, and population genetics methods. Use of pertinent computer analysis.

Cell and Developmental Biology

BIOL 360. Vertebrate Histology. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 105 and 286. Microscopic structure and ultrastructure of vertebrate tissue and organ systems. Laboratory emphasizes identification and analysis of commercially prepared slides of vertebrate tissue.

BIOL 362. Laboratory Techniques in Molecular Biology. 2 rec., 3 lab. hr.; 3 cr. Prereq.: BIOL 285 or permission of the instructor. Introduction to the basic laboratory techniques of molecular biology.

BIOL 363. Laboratory Techniques in Cellular Biology. 2 rec., 3 lab. hr.; 3 cr. Prereq.: BIOL 286 or permission of the instructor. Introduction to the basic laboratory techniques of cellular biology.

BIOL 364. Theory and Biological Application of Electron Microscopy. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 263 and 360. Principles and practice of electron microscope operation and preparation of tissues for fine structure studies.

BIOL 365. Developmental Biology. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 106 and 286. Gametogenesis, fertilization, and embryonic development through organogenesis. Mechanisms of cell differentiation and morphogenesis as revealed by techniques of experimental embryology.

BIOL 366. Immunology. 3 lec. hr.; 3 cr. Prereq.: BIOL 106 and 286. The components and mechanisms of action of the immune system. Topics include requirements for antigenicity, types of antibodies, humoral and cell-mediated responses including allergy, graft rejection, and autoimmune diseases.

BIOL 367. Molecular Biology. 3 lec. hr.; 3 cr. Prereq.: Two of the three Principles courses BIOL 285, BIOL 286 or BIOL 287, or equivalent, with a grade of C- or better, or permission of instructor. Molecular biology with emphasis on experimental evidence that demonstrates mechanisms of transcription and translation, and their regulation. This course is designed for advanced students majoring in Biology with an interest in cell and molecular biology.

BIOL 367. The Biology of Cancer. 3 lec. hr.; 3 cr. Prereq.: BIOL 285 and BIOL 286 completed with a C+ or better, or BIOL 366 completed with a C+ or better. The underlying mechanisms of tumorigenesis. Topics cover the genetic basis of cancer, cancer stem cells, tumor microenvironment, metabolism, angiogenesis, metastasis, and treatments, including cancer immunotherapies.

BIOL 369. Virology. 3 lec.; 3 cr. Prereq.: BIOL 286 with a grade of C+ or better, or permission of instructor. Selected viruses belonging to all virus families infecting

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humans. Students will gain comprehensive knowledge of the structure of given virus (both structural and genomic), replication cycle, pathogenesis, epidemiology, disease manifestations, treatments, and vaccines (current and under development).

Physiology

BIOL 371. Plant Physiology. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 106 and 286; and CHEM 252 or the equivalent. Anatomy, physiology, molecular biology, and development of plants.

BIOL 372. Vertebrate Physiology. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: BIOL 107 and 286; and CHEM 252 or the equivalent. Functioning of the major organ systems of animals, with special emphasis on the vertebrates.

BIOL 373. Neurobiology. 3 lec., 1 rec. hr.; 4 cr. Prereq.: BIOL 106 and 286, or permission of the instructor. Examination of the structure and function of the nervous system of both invertebrates and vertebrates. Emphases will be placed on cellular and molecular mechanisms underlying neural activity.

BIOL 374. Plant Physiology and Development. 4 lec.; 4 cr. Prereq.: Grade of C or better in BIOL 286, CHEM 114, or permission of instructor. Major aspects of plant anatomy, physiology, biochemistry, cellular and molecular biology, and influences of the biotic and abiotic environment on growth and development at the intercellular, intracellular, organismal, and community levels.

Variable Content, Seminars, Colloquia

BIOL 380. Field Biology Studies. BIOL 380.4, 12 hr.; 4 cr., BIOL 380.5, 15 hr.; 5 cr., BIOL 380.6, 18 hr.; 6 cr. Prereq.: CHEM 114.1, CHEM 114.4 or equivalent. Variable prerequisites and requires permission of the instructor(s). A variable content course encompassing field studies in the areas of botany, ecology, entomology,

invertebrate and vertebrate zoology, and limnology. Usually offered summers only, with the 3–6 credits depending on the subjects included and the time involved. The focus of the course is the comparative study of habitats and their components. Format and destinations are variable and costs reflect the modes of travel, destination, and type of accommodations. Courses in the 380 series may be repeated for a maximum of 6 credits.

BIOL 381. Colloquium in Biology. 1 hr.; 1 cr. Prereq.: BIOL 106; CHEM 102.1, 102.3 or 114.1 and 114.4 or equivalent; senior standing and permission of the instructor. Course may be repeated once for credit.

BIOL 385. Special Topics I. BIOL 385.1–385.4, 1–4 hr.; 1–4 cr. Prereq.: Two of BIOL 285, 286, and 287; additional prerequisites as appropriate for topic; permission of the instructor. One area of current interest will be studied in depth each semester. Course may be repeated for credit when the subject changes.

BIOL 386. Special Topics II. 2 lec., 1 rec., 3 lab. hr.; 4 cr. Prereq.: Two of BIOL 285, 286, and 287; additional prerequisites as appropriate for topic; permission of the instructor. One area of current interest will be studied in depth each semester. Course may be repeated for credit when subject changes.

BIOL 387. Tutorial in Biology. BIOL 387.1, 1 hr.; 1 cr., BIOL 387.2, 2 hr.; 2 cr., BIOL 387.3, 3 hr.; 3 cr. Prereq.: CHEM 114.1, CHEM 114.4 or equivalent; upper junior or senior standing and permission of a biology faculty mentor. Biology majors of exceptional ability will undertake an individual inquiry using literature sources into an area of mutual interest with a biology faculty mentor. This course may be repeated for up to a total of 6 credits. Each semester, a report of the inquiry undertaken must be submitted and approved by the faculty sponsor. This, together with the sponsor's written evaluation, must be submitted to the department.

Undergraduate Research

BIOL 390. Research in Biology I. BIOL 390.1, 3 hr.; 1 cr., BIOL 390.2, 6 hr.; 2 cr., BIOL 390.3, 9 hr.; 3 cr. Prereq.: BIOL 200; written permission of the faculty mentor and a description of the proposed research project, both submitted to the biology department research coordinator by the first week of the semester. Students arrange to work under the supervision of a member of the Biology faculty. A report of the project undertaken must be submitted to and approved by the faculty sponsor by the last week of the semester. This, together with the sponsor's written evaluation (grade), must be submitted to the Biology Department Research Coordinator. BIOL 390 may not be repeated for credit.

BIOL 391. Research in Biology II. BIOL 391.1, 3 hr., 1 cr.; BIOL 391.2, 6 hr., 2 cr.; BIOL 391.3, 9 hr., 3 cr. Prereq.: BIOL 390; written permission of the faculty mentor and a description of the proposed research project, both submitted to the Biology Department Research Coordinator by the first week of the semester. Students arrange to do research under the supervision of a member of the Biology faculty. A report of the research undertaken must be submitted to and approved by the faculty sponsor by the last week of the semester. This, together with the sponsor's written evaluation (grade), must be submitted to the Biology Department Research Coordinator. BIOL 391 may not be repeated for credit.

BIOL 395. Honors Research in Biology I. BIOL 395.1, 3 hr., 1 cr.; BIOL 395.2, 6 hr., 2 cr.; BIOL 395.3, 9 hr., 3 cr. Prereq.: BIOL 105 and 106; BIOL 200; BIOL 390 or 391; senior standing; written permission of the faculty mentor and a description of the proposed research project, both submitted to the Biology Department Research Coordinator by the first week of the semester. Students arrange to do honors research under the supervision of a member of the faculty. The student will develop a thesis proposal describing the plan for completion of the research project by the last week of the semester. This, together with the sponsor's written

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evaluation (grade), must be submitted to the Biology Department Research Coordinator. BIOL 395 may not be repeated for credit.

BIOL 396. Honors Research in Biology II. BIOL 396.1, 3 hr., 1 cr.; BIOL 396.2, 6 hr., 2 cr.; BIOL 396.3, 9 hr., 3 cr. Prereq.: BIOL 395; senior standing; thesis proposal from BIOL 395 must be on file with the Biology Department Research Coordinator. Students arrange to do honors research under the supervision of a member of the faculty. By the end of the semester, the student will write, submit, and defend their thesis before a 3-member committee composed of Biology faculty members in the field of the thesis. BIOL 396 may not be repeated for credit.

The following graduate courses are open to qualified undergraduate students with written permission of the department chair. Consult the *Graduate Bulletin* for course descriptions and limitations.

BIOL 585. Genetics.

BIOL 586. Cell Biology.

BIOL 610. Lower Plants.

BIOL 611. Mycology.^{††}

BIOL 612. Morphology and Evolution of Plants.^{††}

BIOL 613. Field Botany.^{††}

BIOL 614. Plant Systematics.^{††}

BIOL 621. Entomology.^{††}

BIOL 626. Vertebrate Phylogeny.

BIOL 630. Biometrics.^{††}

BIOL 640. General Ecology.

BIOL 644. Biology and Society.

BIOL 646. Limnology.

BIOL 666. Immunology.

BIOL 680. Field Biology Studies.

BIOL 685. Special Topics.