
Integrative Biology

Keith A. Crandall, Chair
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College of Biology and Agriculture Office of Academic
Advisement
379 WIDB, (801) 422-3042

Admission to Degree Program

All degrees within this department are open enrollment programs.

The Discipline

Programs in the Department of Integrative Biology focus on training students in the organismal and broader perspectives of the biological sciences. Fields include systematics of taxonomic groups, ecology, and evolution, which often rely on the application of molecular biology and genetics.

Career Opportunities

Integrative biology entails rigorous, broad training and synthetic reasoning, which prepare students for careers in a wide variety of professional fields ranging from technical work in research laboratories to field technicians for environmental research companies or government agencies. Majors may develop their interest in such diverse areas as environmental biology, evolutionary biology, aquatic biology, molecular biology, plant biology, or taxonomy. Students satisfy the requirements for graduate studies in the biological sciences or professional schools.

The bioinformatics major is for students with interests in both the computer and the biological sciences. The degree merges these interests in the areas of bioinformatics and computational biology, giving students the skills for graduate or professional (medical, dental, law) schools or immediate employment opportunities after completing the undergraduate program, especially with biotechnology companies.

The biology composite teaching program provides a solid foundation in courses that meet the National Science Teachers Association certification requirements for secondary education biology teaching. The program also prepares students for continuing their education in graduate school.

Graduation Requirements

To receive a BYU bachelor's degree a student must complete, in addition to all requirements for a specific major, the following university requirements:

- The university core, consisting of requirements in general and religious education (See the University Core section of this catalog for details. For a complete listing of courses that meet university core requirements, see the current class schedule.)
- A minimum of 30 credit hours in residence
- A minimum of 120 credit hours
- A cumulative GPA of at least 2.0

Undergraduate Programs and Degrees

BS	Bioinformatics
BS	Biology Composite Teaching
BS	Integrative Biology

Students should see their college advisement center for help or information concerning the undergraduate programs.

Graduate Programs and Degrees

This department offers MS and PhD degrees. See the graduate school Web site: <http://www.byu.edu/gradstudies>

BS Bioinformatics (64–65 hours*)

Program Objectives

Bioinformatics is an interdisciplinary program offering substantial training in both the biological sciences and the physical and mathematics sciences, with an emphasis on computer programming coupled with genetics and molecular biology. Students will acquire programming, databasing, and operating system skills plus a foundation in mathematics and statistics.

Major Requirements

1. Complete the following:
Biol 120, 240, 340, 420.
InBio 265, 365, 370, 465.
2. Complete the following:
Chem 105, 106.
C S 142, 235, 236, 240.
Math 112, 113, 214.
Stat 441, 442.
3. Complete one course from the following:
Chem 152, 351.
4. With approval of an advisor, complete 6 hours from upper-division electives in computer science, statistics, mathematics, or biology.

*Hours include courses that may fulfill university core requirements.

BS Biology Composite Teaching (88 hours*, including licensure hours)

Program Objectives

Students completing the bachelor's degree in biology composite teaching are prepared to:

1. Design lesson plans and laboratory experiences and give formal classroom instruction for middle-school and secondary school courses in biology and related topic areas. This includes leading field trips for outdoor nature exposure.
2. Teach (with specific-focus instruction in the program methods) courses in advanced placement biology and its related fields.
3. Help students appreciate the fragility of natural systems; teach principles for the preservation, management, and use of natural ecosystems; and teach how to critically evaluate competing demands on natural resources.
4. Help students discriminate between legitimate scientific knowledge and society's many quasi-scientific claims associated with earth's management, medical issues, etc.

Major Requirements

1. Complete the following biology core courses:
Biol 120, 220, 240, 340, 350, 420, 421.
Note: Biol 420, 421 must be taken at BYU.
2. Complete the following:
Chem 105, 152, 285.
Geol 101.
InBio 235, 331, 341, 344, 370, 380, 441, 470.
Phcs 105.
Stat 221.
3. Complete the Professional Education Component:
 - a. Complete the following:
CPSE 402.
InBio 276R, 377, 378, 379.
IP&T 286.
Sc Ed 350, 353.

Integrative Biology

Note: Fingerprinting and FBI clearance must be completed prior to enrollment in InBio 377, InBio 378, and 379 should be taken concurrently in the semester prior to taking Sc Ed 476R.

- b. Complete 12 hours from the following:
Sc Ed 476R.

Recommended Courses

Geol 103, 111, 112.
InBio 230, 352, 431, 432, 433, 443, 445, 446, 447.
Math 119 (to fill the GE Advanced Languages requirement).
PAS 282, 283.

*Hours include courses that may fulfill university core requirements.

BS Integrative Biology (62–68 hours*)

The Discipline

The integrative biology degree provides students with current, practical knowledge of plants and animals, emphasizing whole organism biology in both ecological and evolutionary contexts. Broad, synthetic training, from molecular to community levels of organization, equips students to address critical issues and contemporary biological problems associated with the long-term preservation of earth's biodiversity. Elective flexibility allows students to emphasize the botanical or zoological fields, or create a combined program of study. Undergraduate research opportunities may include internships, museum collections curation, bioinventory and data-basing activities, applied molecular genetics, and field and laboratory research in ecology, conservation biology, or evolutionary biology.

Major Requirements

1. Complete the following:
Biol 120, 220, 240, 340, 350, 420, 421.
Chem 105, 106.
InBio 331, 341.
2. Complete one course from the following:
InBio 380.
PAS 440.
PDBio 305, 362.
3. Complete one course from the following:
Chem 285, 351.
4. Complete one of the following options:
Either Phscs 105, 106
Or Phscs 121, 220.
5. Complete one of the following options:
Either Math 119
Or Math 112, 113.
6. Complete 16 hours of electives from one of the following options:
 - a. Combined option: complete 8 hours from both lists below for a total of 16 hours:
 1. Taxonomy and systematics: complete 8 hours from the following:
InBio 430, 441, 442, 443, 445, 446, 447, 510, 511, 512, 541.
MMBio 417.
PAS 330, 515.
 2. Ecology and evolution: complete 8 hours from the following:
Biol 360.
Chem 481.
InBio 352, 370, 450, 452, 453, 470, 525, 550, 556, 557, 558, 560, 580, 581.
PAS 282, 283, 355, 357, 411, 416, 417, 419, 424, 551, 552, 553, 554.
Stat 221.

- b. Mentoring option: with written approval of assigned advisor, complete up to 8 hours of one of the following, plus electives evenly divided between items A.1 and A.2 above to total 16 hours.
Biol 494R.
InBio 494R.

7. Complete an exit interview.

Recommended Courses for Career Options

Botany

Students seeking career and graduate school opportunities in botanical fields should build their electives on a foundation of basic plant biology courses. Coupled with the broad integrative biology core, the following courses provide students with the greatest diversity of options for postgraduate work or training in plant biology:

InBio 430, 510, 511, 512.
PAS 282, 283, 355, 440, 515.

Students completing InBio 430 and PAS 330 and 355 often find summer employment opportunities with government land agencies.

Federal Register Requirements

The federal register requirements for botany, ecology, and zoology can be met by choosing appropriate electives. Botany requires 24 semester hours in plant-related courses. Ecology requires 30 semester hours in basic and applied biology, including at least 9 semester hours in ecology and 12 hours in the physical and mathematical sciences. Zoology requires 20 semester hours in zoology and related animal sciences.

GIS Applications

Students interested in GIS applications should consider a minor in geographic information systems (20–23 hours). See the Geography Department for details.

Natural Resource Policy

Students seeking careers in natural resource policy should complete InBio 370, 417, and 450 and consider a minor in political science (21 hours). See the Political Science Department for details.

*Hours include courses that may fulfill university core requirements.

Integrative Biology (InBio)

Undergraduate Courses

101. Principles of Biology Laboratory. (1:0:2) F, W Prerequisite: concurrent enrollment in Biol 100.

Required of all elementary education and early childhood education majors; enrollment limited to elementary education or early childhood education majors.

134. Appreciation of Nature. (3:2:2) F, W Prerequisite: basic biology course.

Identifying common plants and animals; techniques for teaching natural history. Field trips required.

235. Field Botany. (3:3:6) F

Recognition, characteristics, and uses of common trees and shrubs.

265. (InBio-PAS) Genomics. (3:2:1) F, W Prerequisite: bioinformatics major status or Biol 120.

Introduction to genomics and genome projects (human, plant, bacterial, yeast, parasites). Introduction to genes and genomes; computational and statistical approaches for analyzing genomic data, including genome sequencing and annotation, gene expression and the transcriptome, proteomics and functional genomics, and genetic variation and SNPs.

270. Animal Restraint. (1:0:2) F, W

Restraint and first aid techniques for pet, laboratory, domestic, and wild animals.

276R. Exploration of Teaching in Biological Sciences. (4:Arr.:Arr. ea.) F, W Prerequisite: minimum GPA of 2.85 in Chem 105, Biol 120, 220, and one major course.

Field-based initial teaching experience directed at helping prospective teachers experience demands and opportunities associated with teaching secondary students.

291R. Veterinary Medicine Seminar. (0.5:1:0 ea.) F

Preview into veterinary medicine as a profession. Application procedure and preparation for veterinary school.

331. Plant Diversity. (4:3:3) F, W Prerequisite: Biol 220 or instructor's consent.

Comparative organization and evolutionary significance of morphological, physiological, reproductive, and ecological differences in fungi, algae, and principal groups of land plants. Laboratory included.

341. Animal Diversity. (4:3:3) F, W Prerequisite: Biol 220 or instructor's consent.

Comparative organization and evolutionary significance of morphological, physiological, reproductive, and ecological differences in invertebrates and vertebrates. Laboratory included.

344. Natural History of the Vertebrates. (3:2:2) F Prerequisite: InBio 341.

Intensive study of selected vertebrate species stressing natural history and systematics. Designed to accommodate needs of biology teaching majors.

352. Introduction to Marine Biology. (3:3:0) W Prerequisite: InBio 341.

Marine life, the sea as an environment, and research methods.

353. Field Biology. (4:2:7) On dem. Prerequisite: InBio 341.

Field investigations into the natural history of living organisms. Extended field trips required.

365. Computational Biology. (3:2:1) F Prerequisite: InBio 265, C S 240.

Computational analysis of DNA data; introduction to bioinformatics databasing using Pearl and SQL; configuration of UNIX workstations for bioinformatics analyses.

370. Bioethics. (2:1:3) F, W Prerequisite: introductory biology course.

In-depth lecture and small-group discussion of varied bioethical issues. LDS Church positions emphasized when appropriate.

377. Teaching Methods and Instruction in Biology. (3:Arr.:Arr.) F, W Prerequisite: InBio 276R; fingerprinting and FBI clearance.

Developing meaningful and engaging instruction for secondary students in biological sciences; developing critical thinking, problem solving, literacy, and democratic character; assessing learner performance.

378. Practicum in Biology Teaching. (1:0:3) F, W Prerequisite: concurrent enrollment in InBio 377.

Implementing meaningful and engaging instruction for secondary students in biology; developing critical thinking, problem solving, literacy, and democratic character; assessing learner performance.

379. Classroom Management. (1:1:0) F, W Prerequisite: concurrent enrollment in InBio 377, 378.

Current theory, research, and application in classroom management; creating positive teacher-student and peer relationships; developing optimal learning environments.

380. Comparative Animal Physiology and Anatomy. (4:3:3) F Prerequisite: Biol 220 or instructor's consent. Recommended: InBio 341.

Structure and function of animal organ systems; structural and physiological responses to demands of and changes in environment; evolutionary constraints on anatomy and physiology.

392R. Preveterinary Preceptorship. (1–2:0:Arr. ea.) F, W, Sp

Supervised on-the-job exposure to veterinary medicine under a clinical setting, supplemented with academic assignments.

398R. Biology Teaching Seminar. (1–2:0:0 ea.) F, W, Sp, Su

Students in an academic team assist instructor in design and/or implementation of a class.

430. Plant Classification. (3:2:3) W, Sp Prerequisite: Biol 220 or instructor's consent.

General principles of taxonomy and classification, emphasizing family identification and use of keys to the temperate flora.

441. Entomology. (3:2:3) F Prerequisite: InBio 341 or equivalent.

External morphology, natural history, evolution, distribution, and phylogeny of insects. Insect collection required.

442. Advanced Invertebrate Zoology. (5:6:0) F even yr. Prerequisite: InBio 341.

Functional morphology, cladistics, ecology, behavior and interrelationships of invertebrates.

443. Ichthyology. (3:2:3) F odd yr. Prerequisite: InBio 341.

Fish systematics, evolution, morphology, distribution, and natural history.

445. Herpetology. (4:3:2) W even yr. Prerequisite: InBio 341.

Reptile and amphibian evolution, systematics, morphology, distribution, and natural history. Lab emphasizes taxonomy, classification, and distribution of western U.S. species.

446. (InBio–PAS) Ornithology. (3:2:3) W Prerequisite: InBio 341.

Avian systematics, evolution, distribution, and natural history. Two three-day field trips required.

447. Mammalogy. (3:2:3) F Prerequisite: InBio 341.

Mammalian diversity, evolution, distribution, and natural history. Two three-day field trips required.

450. Conservation Biology. (3:3:0) F Prerequisite: Biol 220, 350.

Scientific principles of conservation: applying population genetics and phylogenetic and ecological theory to preservation of biological diversity; developing sustainable ecological systems compatible with human resource use.

452. Marine Ecology. (3:2:3) Sp Prerequisite: InBio 352 and instructor's consent.

Marine ecology of planktonic, sublittoral, rocky shore, sandy shore, and mudflat communities. Extensive field trips.

453. Development of Marine Animals. (3:0:6) Sp Prerequisite: InBio 352 and instructor's consent.

Culturing, studying, and reporting on the development of eggs, embryos, and larvae of marine animals.

465. Bioinformatics. (3:2:1) W Prerequisite: InBio 365.

3-D protein structural comparisons, hidden Markov models for database comparisons, homology detection, multiple sequence analyses, and protein family comparisons. Exercises in computer programming in genomics.

470. History and Philosophy of Biology. (3:3:0) F Prerequisite: biology core courses through Biol 420.

Development of fundamental generalizations of biology; nature of science; applications to major philosophical issues of current science.

485R. Case Studies in Animal Biology. (2:1:3 ea.) Sp, Su Prerequisite: instructor's consent.

Topics vary.

494R. Mentored Research. (1–6:0:Arr. ea.) F, W, Sp, Su Prerequisite: supervisor's consent.

Independent student research under faculty supervision.

500-Level Graduate Courses (available to advanced undergraduates)

510. Advanced Plant Taxonomy. (3:2:3) F even yr. Prerequisite: InBio 230 or equivalent.

Review of taxonomic literature and research methods. One three-day field trip required.

Integrative Biology

511. Lichenology. (3:2:3) On dem.

Classification, morphology, and ecology of lichens. Field trip required.

512. Angiosperm Phylogeny. (3:2:4) F odd yr. Prerequisite: InBio 230 or equivalent.

Description, classification, phylogeny, and geographic distribution of flowering plant families.

525. Animal Disease, Biosecurity, and Zoonoses. (3:3:0) W Prerequisite: InBio 380 or instructor's consent.

Animal disease, emphasizing prevention, organ systems affected, biosecurity, and zoonotic potential.

541. Aquatic Entomology. (4:2:4) F even yr. Recommended: InBio 441 or equivalent.

Morphology, classification, biology, and functional ecology of aquatic insects. Field trips required.

550. Physiological and Chemical Ecology. (3:3:0) W odd yr. Prerequisite: Biol 350 or equivalent.

Ecophysiological response of plants to their environment.

555. Evolutionary and Ecological Modeling. (2:2:0) W even yr. Prerequisite: senior status in bioinformatics program or graduate status; Stat 511, 512, or equivalent quantitative experience; instructor's consent.

Using models in ecology. Practical experience in analytical, simulation, and agent-based models.

556. Limnology. (2:2:0) F even yr. Prerequisite: Biol 350, Chem 106; or equivalents.

Lakes and reservoirs; their biota and physical/chemical properties.

557. Stream and Wetland Ecology. (3:3:0) F odd yr. Prerequisite: Biol 350, Chem 106.

Stream and wetland ecology; their biota and their physical/chemical properties.

558. Aquatic Ecology Laboratory. (1:0:3) F even yr. Prerequisite: InBio 556 or 557 or concurrent registration.

Field experience in aquatic ecology, including shoreline processes, fluvial mechanics, and quantitative and qualitative assessment of lotic and lentic systems. Overnight field trips required.

559R. Advanced Topics in Ecology and Evolution. (1–6:Arr.:Arr. ea.) On dem. Prerequisite: instructor's consent.

Current topics in ecology, evolution, and systematics.

560. Population Genetics. (4:4:0) W odd yr. Prerequisite: Biol 420 or equivalent.

Basic principles of population genetics applied to natural populations; drift, selection, and nonrandom mating; inferring population subdivision, migration, and gene flow.

580. Scanning Electron Microscopy. (3:2:4) F, W Prerequisite: instructor's consent.

Theoretical and practical scanning electron microscopy of biological, physical science, and engineering samples, emphasizing practical applications.

581. Transmission Electron Microscopy. (3:2:4) F Prerequisite: instructor's consent.

Theoretical and practical transmission electron microscopy of biological, physical science, and engineering samples, emphasizing practical applications.

590R. Advanced Science In-Service. (1–5:Arr.:Arr. ea.) Su In-service course for science teachers. Subjects may include:

- Ecology Science In-Service
- Genetics Science In-Service
- Evolution Science In-Service
- Botany Science In-Service
- Meteorology Science In-Service

Graduate Courses

For 600- and 700-level courses, see the BYU 2007–2008 Graduate Catalog.

Integrative Biology Faculty

Professors

- Belk, Mark C. (1992) BS, MS, Brigham Young U., 1985, 1987; PhD, U. of Georgia, 1992.
- Cates, Rex G. (1985) BS, MS, Utah State U., 1965, 1968; PhD, U. of Washington, 1971.
- Crandall, Keith A. (1995) BA, Kalamazoo Coll., 1987; AM, PhD, Washington U., 1993.
- Jeffery, Duane E. (1969) BS, MS, Utah State U., 1962, 1963; MA, PhD, U. of California, Berkeley, 1966, 1972.
- Nelson, C. Riley (1999) BS, MS, Utah State U., 1980, 1984; PhD, Brigham Young U., 1986.
- Roeder, Beverly L. (1990) BA, Whittenberg U., 1978; DVM, Ohio State U., 1982; MS, Kansas State U., 1986; PhD, Pennsylvania State U., 1990.
- Rogers, Duke S. (1989) BS, MS, Texas A&M U., 1976, 1979; PhD, U. of California, Berkeley, 1986.
- Shiozawa, Dennis K. (1978) BA, Weber State Coll., 1972; MS, Brigham Young U., 1975; PhD, U. of Minnesota, St. Paul, 1978.
- Sites, Jack W., Jr. (1982) BS, MS, Austin Peay State U., 1973, 1975; PhD, Texas A&M U., 1980.
- St. Clair, Larry Lee (1976) BS, MS, Brigham Young U., 1974, 1975; PhD, U. of Colorado, 1984.

Associate Professors

- Braithwaite, Lee F. (1964) BS, MS, PhD, Brigham Young U., 1959, 1962, 1970.
- Johnson, Leigh A. (1999) BS, Brigham Young U., 1991; PhD, Washington State U., 1996.
- ~~McClellan, David A. (2001) BS, MS, Brigham Young U., 1991, 1994; PhD, Louisiana State U., 1999.~~
- Peck, Steven L. (2000) BS, Brigham Young U., 1986; MS, U. of North Carolina, 1988; PhD, North Carolina State U., 1997.
- Rader, Russell B. (2000) BS, MS, Brigham Young U., 1977, 1982; PhD, Colorado State U., 1987.
- Whiting, Michael (1997) BS, Brigham Young U., 1990; PhD, Cornell U., 1994.

Assistant Professors

- Hanegan, Nikki L. (2004) BS, U. of Houston, Central, 1978; MS, PhD, U. of Texas, Austin, 1990, 2001.
- Hatch, Kent A. (2001) BS, Brigham Young U., 1990; MS, PhD, U. of Wisconsin, 1995, 1996.
- Johnson, Jerald B. (2004) BS, U. of Utah, 1993; MS, Brigham Young U., 1999; PhD, U. of Vermont, 2000.

Professional Professors

- Adair, Marta (2001) BS, MS, Brigham Young U., 1981, 1990.
- Furniss, H. Blaine (1971) BS, MS, Brigham Young U., 1968, 1975.
- Gardner, John S. (1989) BS, Oregon State U., 1968; MS, PhD, Brigham Young U., 1976, 1978.
- Wilcox, Edward R. (2005) BA, PhD, U. of California, Davis, 1977, 1982.

Emeriti

- Allen, James Vincent (1969) BS, MS, Brigham Young U., 1967, 1968.
- Allman, Verl Phillips (1950) BS, MS, Brigham Young U., 1948, 1952.
- Barnes, James R. (1969) BS, Brigham Young U., 1963; MS, PhD, Oregon State U., 1967, 1972.
- Baumann, Richard W. (1975) BA, MS, PhD, U. of Utah 1965, 1967, 1970.
- Farmer, James L. (1969) BS, California Inst. of Technology, 1960; PhD, Brown U. 1966.
- Heckmann, Richard A. (1972) BS, MS, Utah State U., 1954, 1958; PhD, Montana State U., 1970.
- Heninger, Richard W. (1966) BS, Brigham Young U., 1957; MS, PhD, Oklahoma State U., 1959, 1961.

Jorgensen, Clive D. (1960) BS, MS, Brigham Young U., 1954, 1957; PhD, Oregon State U., 1964.
 Pritchett, Clyde L. (1967) BS, MS, Brigham Young U., 1960, 1962; PhD, U. of Wyoming, 1977.
 Smith, Lamont W. (1970) BS, Brigham Young U., 1960; MS, U. of Wisconsin, Madison, 1962; PhD, West Virginia U., 1970.
 Tanner, Wilmer W. (1949) BA, MA, Brigham Young U., 1936, 1937; PhD, U. of Kansas, 1949.
 Tolman, Richard R. (1982) BS, MS, U. of Utah, 1963, 1964; PhD, Oregon State U., 1969.
 Welsh, Stanley L. (1960) BS, MS, Brigham Young U., 1951, 1957; PhD, Iowa State U. of Science and Technology, 1960.
 Whitehead, Armand T. (1969) BS, Brigham Young U., 1965; PhD, U. of California, Berkeley, 1969.
 Wood, Stephen L. (1956) BS, MS, Utah State U., 1946, 1948; PhD, U. of Kansas, 1953.

International and Area Studies

International and Area Studies Advisement Center
 Noelani Sanchez, Supervisor
 273 HRCB, (801) 422-3548

International and Area Studies Program

Coordinators

Ancient Near Eastern Studies, Dana M. Pike
 Asian Studies, James A. Davis
 European Studies, Scott Sprenger
 International Relations, Darren G. Hawkins
 Latin American Studies, Ted E. Lyon
 Middle East Studies/ Arabic, Donna Lee Bowen

Admission to Degree Programs

All undergraduate international and area studies degree programs are open enrollment.

Graduation Requirements

To receive a BYU bachelor's degree a student must complete, in addition to all requirements for a specific major, the following university requirements:

- The university core, consisting of requirements in general and religious education (See the University Core section of this catalog for details. For a complete listing of courses that meet university core requirements, see the current class schedule.)
- A minimum of 30 credit hours in residence
- A minimum of 120 credit hours
- A cumulative GPA of at least 2.0

Undergraduate Programs and Degrees

BA Ancient Near Eastern Studies
 BA Asian Studies
 BA European Studies
 BA International Relations
 BA Latin American Studies
 BA Middle East Studies/ Arabic
 Minors Ancient Near Eastern Studies
 Asian Studies
 International Development
 Latin American Studies
 Middle East Studies

Students should see the International and Area Studies Advisement Center for help or information concerning the undergraduate programs.

General Information

International Career Center

The International Career Center, located in 273 HRCB (international_career@byu.edu), guides students of any major with their preparation for an international career. The ICC hosts international career-oriented lectures and offers advisement, employment and graduate school information, and networking assistance.

International Study Programs.

International Study Programs (ISP) are open to students from all university majors. Students need not be formally admitted to BYU to participate in International Study and BYU credit may be transferred to their home institution.

Study Abroad: BYU's traditional off-campus study programs. In these programs students are able to further their general education; pursue specialized courses in languages, the social sciences, humanities, fine arts, and other fields; gain valuable insights into their own country; and further international understanding.