BIOLOGY

Undergraduate Program Information

A student may earn the Bachelor of Arts in biology or the Bachelor of Science in biology, genetics, microbiology, or conservation ecology through major studies in the Department of Biology. The Bachelor of Science in biology or microbiology is recommended for premedical and predental students, for those preparing to teach biology and other sciences at the secondary and college levels, for those interested in the numerous fields of biological research and applied biology, and for those planning on obtaining an advanced degree in biology.

Freshmen should begin taking required biology and chemistry courses in their first year. Degree plans for specific areas of interest can be obtained from the Biology Success Center (https://bio.nmsu.edu/success2.html) in Foster Hall room 204. More information on the Department of Biology is available on our web site (http://bio.nmsu.edu).

A student must earn a grade of C- or better to receive credit for any nondepartmental or departmental requirement for any major or minor offered by the Department of Biology.

Students who wish to explore a minor or supplementary course work in a specific discipline to enhance their academic experience are encouraged to speak with an advisor. The Biology Department offers minors in biology, microbiology, human biology, conservation ecology, or genetics and biotechnology. A student may not earn a major and a minor in the same discipline.

A student must fulfill a second language requirement to receive a Bachelor of Arts or Bachelor of Science degree in the Biology and Microbiology majors. ***This requirement does not apply to the Conservation Ecology major, offered jointly with the Department of Fisheries, Wildlife and Conservation Ecology, or the Genetics and Biotechnology major, offered jointly with the Department of Plant and Environmental Science.*** To meet the second language requirement, the student must do one of the following:

- Complete two semesters of second language courses numbered 1110 and 1120 with a grade of C- or better. Spanish speakers should complete SPAN 1210 Elementary Spanish for Heritage Learners I, SPAN 1220 Spanish for Heritage Learners II or SPAN 2210 Spanish for Heritage Learners III with a C- or better to fulfill the requirement.
- Challenge the 1120 level of French, Chinese, German, Japanese, or Spanish; or the 1130 level for the Spanish-for Heritage Learners student or the 1130 level for Portuguese.
- Obtain college certification of completion of two years of a second language at the high school level with a grade of C- or higher in the second-year level. (i.e. equivalent to FREN 2120G French IV, GRMN 2120 German IV, SPAN 2120 Spanish IV, etc.)
- Complete two semesters of American Sign Language, courses SIGN 1110 American Sign Language I and SIGN 1120 American Sign Language II, with a grade of C- or better.
- Pass a three-credit, upper-division course (numbered 300 or above) taught in a second language by the department of Languages and Linguistics.
- Obtain certification of a working knowledge of a Native American language from the American Indian program director.
- Obtain certification of a working knowledge of a second language if such language is not taught at NMSU from the head of the Department of Languages and Linguistics.
- In the case of a foreign student who is required to take the TOEFL exam admission, the dean will automatically waive the second language requirement.

Graduate Program Information

The Department of Biology offers research and coursework that cover the natural world whether it is at the molecular, organismic, or ecosystem level. Our goal is to prepare students for careers in diverse areas such as ecology, microbiology, evolution, botany, health science, and biology education through formal coursework, research experiences, interactive seminars, and professional development activities. Biology graduate students conduct their own research in a productive environment using state-of-the-art facilities. The Biology Department offers the following degree emphasis:

- Thesis Masters research program in Biology (M.S.)
- Non-thesis Masters program in Biology (M.S.)
- Non-thesis Masters program in Biology (Biotechnology emphasis) (M.S.)
- Doctorate research program in Biology (Ph.D.)

For research toward the Master of Science or the Doctorate of Philosophy, students can choose among the Department's three areas of emphasis:

1. Behavioral, Ecological, and Evolutionary Biology
2. Cell and Organismal Biology
3. Microbiology

There are two formal course requirements for all Biology Graduate students, with the exception of students in the accelerated non-thesis MS Biotechnology option. These core courses are

Prefix	Title	Credits
BIOL 510	Current Topics in Biology	3
BIOL 540	Science and Ethics	1-3

All graduate students develop their curriculum plan in consultation with their faculty advisor and graduate committee. Graduate students may also take a minor in other graduate departments and programs. Sample course sequences within the Department's three different emphases are described in the Biology Graduate Handbook available for download from the Graduate Student section of the Biology website (https://bio.nmsu.edu/students/grads.html).

All prospective applicants must submit all required materials specified in the Department Graduate Application Packet available in the Graduate Student section of the Biology website (https://bio.nmsu.edu/students/grads.html).

Degrees for the Department

Bachelor Degree(s)

- Biology (Secondary Education) - Bachelor of Arts (https://catalogs.nmsu.edu/nmsu/arts-sciences/biology/biology-secondary-education-bachelor-arts/)
- Biology - Bachelor of Arts (https://catalogs.nmsu.edu/nmsu/arts-sciences/biology/biology-bachelor-arts/)
- Biology - Bachelor of Science (https://catalogs.nmsu.edu/nmsu/arts-sciences/biology/biology-bachelor-science/)

- Conservation Ecology - Bachelor in Conservation Ecology (https://catalogs.nmsu.edu/nmsu/arts-sciences/biology/conservation-ecology-bachelor-conservation-ecology/)
- Genetics and Biotechnology - Bachelor of Science in Genetics (https://catalogs.nmsu.edu/nmsu/arts-sciences/biology/genetics-biotechnology-bachelor-science-genetics/)
- Microbiology - Bachelor of Science (https://catalogs.nmsu.edu/nmsu/arts-sciences/biology/microbiology-bachelor-science/)

Master Degree(s)

- Biology - Master of Science (https://catalogs.nmsu.edu/nmsu/graduate-school/biology-master-science/)

Doctoral Degree(s)

- Biology - Doctor of Philosophy (https://catalogs.nmsu.edu/nmsu/graduate-school/biology-doctor-philosophy/)

Minors for the Department

- Biology - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/arts-sciences/biology/biology-undergraduate-minor/)
- Conservation Ecology - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/arts-sciences/biology/conservation-ecology-undergraduate-minor/)
- Genetics and Biotechnology - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/arts-sciences/biology/genetics-biotechnology-undergraduate-minor/)
- Human Biology - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/arts-sciences/biology/human-biology-undergraduate-minor/)
- Microbiology - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/arts-sciences/biology/microbiology-undergraduate-minor/)

C. Shuster, Professor, Department Head
Donovan Bailey, Professor, Associate Department Head

Professors Bailey, Boecklen, Curtiss, Hanley, Hansen, James, Mabry, Milligan, C. Shuster, M. Shuster, Serrano, Unquez, Wright, Xu; ***Associate Professors*** Castillo; ***Assistant Professors*** Corcoran, Heinrich, Jaszczak, Linscott, Orr

C. D. Bailey, Ph.D. (Cornell)– plant systematics; W. J. Boecklen, Ph.D. (Northern Arizona)– plant/ insect and community ecology; M. G. Castillo, Ph.D. (Wisconsin)– microbiology/immunology; A. Corcoran, Ph.D. (University of California-Los Angeles) – algal ecology; J. Curtiss, Ph.D. (University of Colorado at Boulder)– cell and development; K. A. Hanley, Ph.D. (California-San Diego)– evolution, ecology, and control of flaviviruses; I. A. Hansen, Ph.D. (University of Wurzburg)– molecular vector biology; K. K. Heinrich, D.A. (Idaho State)- biology education and ecology; *A. C. James, Ph.D. (University of Rochester)- science education; J.S. Jaszczak, Ph.D. (University of Virginia)- developmental and neurobiology; T. M. Linscott, Ph.D. (University of Idaho)*– ecophysiology and evolution; K. E. Mabry, Ph.D. (California-Davis)– behavioral ecology; B. G. Milligan, Ph.D. (California-Davis)– plant evolutionary biology; T. J. Orr, Ph.D. (University of California, Riverside)- reproductive physiology/ecology; E. E. Serrano, Ph.D. (Stanford)– biophysics, neuroscience; C. B. Shuster, Ph.D. (Tufts)– cell and developmental biology; M. Shuster, Ph.D. (Tufts)– biology education; G. A. Unguez, Ph.D. (California-Los Angeles)– developmental biology; T. F. Wright, Ph.D. (California-San Diego)– animal behavior and evolution; J. Xu, Ph.D. (Military Medical University, Shanghai)– mosquito-malaria interactions.

Biology Courses

BIOL 1120G. Human Biology
3 Credits (3)
This course is an introduction to modern biological concepts with an emphasis on the relevance to humans and their relationships with the environment.
Learning Outcomes

1. Explain that biology is a scientific discipline based on observations and experimentations.
2. Explain the process of scientific inquiry and explain how scientific knowledge is discovered and validated.
3. Describe the chemical basis of living organisms and how biomolecules contribute to the structure and function of cells.
4. Develop a basic familiarity with cells and cell organelles.
5. Describe the structure and function of DNA as well as how DNA is used in the production of proteins
6. Describe the basic principles of genetics and heredity leading to human diversity.
7. Identify the major features of the systems in the human body, and understand the anatomy and physiology of them
8. Describe the roles of the organ systems in maintaining homeostasis
9. Explain the principles of evolution by means of natural selection explaining the diversity of life. 1
10. Describe how science and technology have impacted life in particular to society and the environment (e.g. medicine, forensic science, agriculture, ecology, sustainability).

BIOL 1120L. Human Biology Laboratory
1 Credit (3P)
This course introduces exercises, experiences, and activities exploring biological concepts and theories relevant to humans and their relationship to the environment in a laboratory setting.
Prerequisite(s)/Corequisite(s): BIOL 1120G.
Learning Outcomes

1. Understand general principles of cell structure and function.
2. Understand general principles of genetics.
3. Understand basic human anatomy and physiology.
4. Communicate scientific information effectively.
5. Demonstrate an understanding of the scientific method.
6. Knowledge of appropriate laboratory skills
7. Apply quantitative reasoning and scientific thinking to real world problems.

BIOL 1130G. Introductory Anatomy & Physiology (non-majors)
4 Credits (3+3P)
This course introduces the anatomy (structure) and physiology (function) of the human body, which includes the study of basic chemistry, molecules, cells, tissues, organs, organ systems, and terminology related to these concepts. May be repeated up to 4 credits. Restricted to Community Colleges campuses
Learning Outcomes

1. (Lecture) Define and explain anatomy and physiology.
2. (Lecture) Use anatomic directional, regional, and sectional terminology related to the human body.
3. (Lecture) Explain and describe the basic chemical principles of the human body including the structure and function of carbohydrates, lipids, proteins and nucleic acids.

4. (Lecture) Develop a basic familiarity with cells and cell organelles that include cell division, DNA replication, and protein synthesis.
5. (Lecture) Describe the structure and function of the major tissues in the human body.
6. (Lecture) Identify and describe the basic anatomical features of the integumentary, skeletal, muscle, nervous, endocrine, cardiovascular, lymphatic, digestive, respiratory, urinary and reproductive systems.
7. (Lecture) Describe the basic physiological roles of the integumentary, skeletal, muscle, nervous, endocrine, cardiovascular, lymphatic, digestive, respiratory, urinary and reproductive systems.
8. (Lecture) Apply and describe the principles of homeostasis in the human body.
9. (Laboratory) Use and apply proper anatomic terms 1
10. (Laboratory) Develop skills using the microscope correctly. 1
11. (Laboratory) Identify basic tissue types. 1
12. (Laboratory) Discuss and describe the basic anatomical features of the integumentary, skeletal, muscle, nervous, endocrine, cardiovascular, lymphatic, digestive, respiratory, urinary and reproductive systems. 1
13. (Laboratory) Demonstrate and describe physiological roles of the integumentary, skeletal, muscle, nervous, endocrine, cardiovascular, lymphatic, digestive, respiratory, urinary and reproductive systems.

BIOL 1190G. Contemporary Problems in Biology
4 Credits (3+3P)
Fundamental concepts of biology will be presented using examples from relevant problems in ecology, medicine and genetics. For nonscience majors only. Community Colleges only.

Learning Outcomes

1. Identify the unity and diversity of living things
2. Identify the structure and function of cells an biological molecules
3. Recognize and demonstrate patterns of inheritance
4. Describe mechanisms of evolution
5. Describe the human body systems including immune response
6. Discuss population dynamics and ecological systems
7. Describe the process of scientific inquiry, solve problems scientifically, and communicate on a scientific level
8. Apply quantitative analysis and scientific thinking to scientific and real world problems

BIOL 1996. Topics in Biology
1-3 Credits (1-3)
Introductory level coverage of biological topics. May be repeated up to 9 credits.

Learning Outcomes

1. Varies

BIOL 2110G. Principles of Biology: Cellular and Molecular Biology
3 Credits (3)
This course introduces students to major topics in general biology. This courses focuses on the principles of structure and function of living things at the molecular, cellular and organismic levels of organization. Major topics included are introduction to the scientific process, chemistry of cells, organization of cells, cellular respiration, photosynthesis, cell division, DNA replication, transcription, and translation. Must be taken with BIOL 2110L to meet general education requirements. May be repeated up to 3 credits.
Prerequisite/Corequisite: a C- or better in MATH 1215 or higher and a C- or better in (CHEM 1120G or CHEM 1215G or CHEM 1216).

Learning Outcomes

1. Apply the scientific method to develop and evaluate hypotheses and propose an experiment to test a scientific hypothesis related to cell biology and molecular biology.
2. Describe the distinguishing characteristics of various biological molecules (water, carbohydrates, lipids, proteins, and nucleic acids).
3. Compare and contrast the basic features of cells and how prokaryotic cells differ from eukaryotic cells.
4. Understand how organisms maintain homeostasis in a dynamic environment.
5. Describe how biological molecules are acquired and how they are subsequently used to meet the metabolic needs of organisms.
6. Describe membrane structure and function.
7. Describe and analyze the nature of bioenergetic transformations and metabolism within the cell.
8. Describe the processes of cellular respiration and photosynthesis.
9. Analyze with specific detail the processes of DNA replication, transcription, and translation. 1
10. Analyze with specific detail the types, mechanisms, and regulation of cellular division. 1
11. Assess important applications of cell and molecular biology to energy use, medicine, and other day-to-day processes.

BIOL 2110L. Principles of Biology: Cellular and Molecular Biology Laboratory
1 Credit (3P)
This course introduces students to major topics in general biology. This courses focuses on the principles of structure and function of living things at the molecular, cellular and organismic levels of organization. Major topics included are introduction to the scientific process, chemistry of cells, organization of cells, cellular respiration, photosynthesis, cell division, genetics, DNA replication, transcription, and translation. May be repeated up to 1 credit.
Prerequisite: MATH 1215 or higher, and a C- or better in (CHEM 1120G or CHEM 1215G or CHEM 1216).
Prerequisite/Corequisite: BIOL 2110G.

Learning Outcomes

1. Describe and apply the scientific method to solve problems in biological context
2. Demonstrate knowledge of laboratory safety skills and procedures.
3. Practice principles of scientific method while conducting laboratory activities and experiments.
4. Perform laboratory activities using relevant laboratory equipment, chemical reagents, and supplies to observe biological specimens, to measure variables, and to design and conduct experiments.
5. Operate light microscopes, prepare wet mount slides, and use stains.
6. Exhibit ability to use pipettes and other volumetric measuring devices, chemical glassware, balances, pH meters or test papers, spectrophotometers, and separation techniques, such as chromatography and/or electrophoresis to perform activities relevant to other course competencies.
7. Analyze and report data generated during laboratory activities and experiments.

BIOL 2210. Human Anatomy and Physiology I for the Health Sciences
4 Credits (3+3P)
This course is the first of two that serve as an introduction to human anatomy and physiology for biology majors and allied health students. The course entails describing, explaining, and analyzing structure and

function from the submicroscopic to the organismal level with emphasis on anatomic, directional, and sectional terminology, basic cellular structure and metabolism, tissue differentiation and characteristics, and organ system structure and function; Specifically the integumentary, skeletal, muscular, and nervous systems. Restricted to: Community Colleges only.

Learning Outcomes

1. Describe and apply anatomical terminology.
2. Describe multi cellular organization.
3. Distinguish and describe major tissue types.
4. Describe the structure and function of the integumentary system.
5. Describe the structure and function of the skeletal system.
6. Describe the structure and function of the muscular system.
7. Describe the structure and function of the nervous system.
8. Describe the structure and function of the special senses.
9. Define homeostasis and describe specific examples for the integumentary, skeletal, muscular, and nervous systems.

BIOL 2225. Human Anatomy and Physiology II
4 Credits (3+3P)

This course is the second of two that serve as an introduction to human anatomy and physiology for biology majors and allied health students. The course entails describing, explaining, and analyzing structure and function from the submicroscopic to the organismal level with emphasis on specific cellular, tissue, and organ structure and physiology, and organ system structure and function; specifically the endocrine, cardiovascular, respiratory, urinary, and reproductive systems. Additionally, an analysis of these concepts is included: fluid and electrolyte balance, pregnancy, growth and development from zygote to newborn, and heredity. Restricted to: Community Colleges only. May be repeated up to 4 credits.
Prerequisite: BIOL 2210.

Learning Outcomes

1. Identify and describe the major anatomical features of the endocrine, cardiovascular, lymphatic, respiratory, digestive, urinary, and reproductive systems.
2. Analyze the physiological roles of the endocrine, cardiovascular, lymphatic, respiratory, digestive, urinary, and reproductive systems in maintaining homeostasis in the human body.
3. Explain how fluid and electrolyte balance is maintained in the human body.
4. Compare and contrast the anatomy and physiology of male and female reproductive systems.
5. Describe pregnancy from conception to parturition including human growth and development from zygote to newborn.
6. Explain heredity and genetic control.

BIOL 2310. Microbiology
3 Credits (3P)

Introduction to the basic principles of microbiology, microbial pathogenesis, host defenses and infectious diseases. The course will emphasize concepts related to the structure and function of microorganisms, including their mechanisms of metabolism and growth. Host parasite interactions will also be emphasized, including mechanisms of microbial pathogenesis and mechanisms of host defenses against infectious diseases. Restricted to Community Colleges campuses only.
Prerequisite(s): CHEM 1120G or CHEM 1215G or CHEM 1225G.
Corequisite(s): BIOL 2310L.

Learning Outcomes

1. Describe and compare the structure and function of prokaryotic and eukaryotic cells.
2. Describe and compare the techniques used for staining of and microscopic observation of bacteria including morphology.
3. Describe the nutritional requirements for bacterial growth and the impact of environmental factors on bacterial growth (temperature, pH, oxygen, etc.).
4. Describe and compare the mechanisms of aerobic respiration, anaerobic respiration, and fermentative metabolism.
5. Describe the mechanism of bacterial growth by binary fission, and laboratory methods used for observing and measuring bacterial growth.
6. Describe the mechanisms of bacterial DNA replication, RNA transcription, and translation, and compare and contrast witheukaryotic cells.
7. Describe the structure and replication strategies of viruses.
8. Describe and contrast mechanisms of innate nonspecific immunity and adaptive specific immunity.
9. Describe immune hypersensitivity reactions, autoimmune diseases, and immunodeficiency diseases. 1
10. Differentiate between host microberelationships, mechanisms of microbial pathogenesis, differentiate between communicable and noncommunicable diseases and describe mechanisms of direct and indirect transmission of communicable diseases.

BIOL 2310L. Microbiology Lab
1 Credit (3P)

This course will emphasize both the theory and hands-on application of techniques used in a microbiology laboratory for the growth and identification of bacterial species. Students will learn microscopy skills and staining techniques for the observation of bacteria. Students will also learn aseptic techniques used for isolation of bacteria, inoculation of cultures, and interpretation of selective and differential growth media for the identification of bacterial species.
Prerequisite: BIOL 2310 or BIOL 2320 or concurrent enrollment.

Learning Outcomes

1. Demonstrate skills of microscopy.
2. Demonstrate skills of bacterial staining.
3. Demonstrate aseptic technique for inoculation of bacterial growth media.
4. Interpret results from selective and differential media.
5. Demonstrate appropriate use of diagnostic reagents.
6. Interpret results of diagnostic assays.
7. Identify unknown bacterial species through the use of a dichotomous key, inoculation and interpretation of laboratory assays, and application of the scientific method.

BIOL 2320. Public Health Microbiology
3 Credits (3)

This course introduces microbiology on the health profession level. It incorporates cell structure, metabolism, growth, controls of growth, infectious epidemiology, etiology, pathogenicity, and relative virulence of pathogens. It will lead to students assessing a clinical infection scenario from the microbiological perspective that includes making diagnoses based on data from appropriate diagnostic tests, investigating appropriate treatment options, and making recommendations for prevention.
Prerequisite: BIOL 2110G and BIOL 2110L.

Learning Outcomes

1. Identify key physical features of various infectious agents and describe their structure and function in the pathogen
2. Describe the microbiological, serological, biochemical and genetic tests that are used to identify infectious agents in a laboratory setting and be able to interpret test results in order to identify the pathogen
3. Explain how structural and metabolic differences between infectious agents and human host can be exploited for chemotherapy
4. Explain the observed effect of a particular environmental change on the growth of a given microorganism, and the relationship between bacterial growth patterns and selected foodborne illnesses
5. Describe several mechanisms by which pathogens generate genetic diversity and the role genetic diversity plays in resistance to therapy and treatment failure
6. Explain the role of innate, and adaptive immunity in host defense
7. Describe general virulence strategies used by variety of pathogens, and different types of vaccines along with recommendations for vaccinations of specific populations
8. Demonstrate understanding of signs and symptoms of selected diseases, and be able to relate disease agents with environmental reservoirs and transmission

BIOL 2505. Pathophysiology
3 Credits (3)

This course is designed to provide the conscientious student with a solid foundation for understanding the pathophysiological processes of the human organism. Successful completion of this course will promote the general student learning outcomes listed below. Corequisite/Prerequisites(s): AHS 154 or BIOL 2225. Restricted to: Community Colleges only.

Prerequisite(s): AHS 153 or BIOL 2210.

Learning Outcomes

1. To describe the general concepts of disease processes and factors associated with disease causation.
2. To identify the function of basic cellular structures, determining the process of cellular malfunctions.
3. To describe the response of the body to injury and immunologic challenge.
4. To discuss the etiology, pathogenesis, and treatment modalities of frequently occurring diseases.

BIOL 2511. Human Pathophysiology
3 Credits (3)

The first in a two-course sequence that covers changes in body physiology that result from disease or injury. Includes a general introduction to pathophysiology as well as an overview of altered cellular and tissue biology, injury, inflammation, and neoplasia. Students will also explore deviation from fluid, hemodynamic, and endocrinologic balance. Topics related to the science of pathophysiology, including pathology, pathogenesis, etiology, epidemiology, and clinical manifestations, are also discussed throughout the course where relevant. Grade of C- or higher in microbiology is recommended. Restricted to Community Colleges campuses only.

Prerequisite(s): Grade of C- or higher in BIOL 2210 and BIOL 2225.

Learning Outcomes

1. The cellular adaptations occurring in atrophy, hypertrophy, hyperplasia, dysplasia, and metaplasia; the types and causes of cellular injury; and the types of necrosis.
2. The different compartments for body fluids; the factors that affect water movement; the processes that drive and affect capillary exchange; the mechanisms causing edema; the electrolytes in body compartments; the various electrolyte imbalances; the body mechanisms that maintain acid-base balance; and the various acid-base imbalances and how they are compensated for .
3. The interrelationships of DNA, RNA, and proteins; the various types of mutations; the various types of mutagens, the various types of numerical and structural chromosomal aberrations; the various genetic terms; the single-gene disorders discussed in class; the multifactorial disorders discussed in class.
4. The relationships between genes, environment, and multifactorial diseases; the criteria used to define multifactorial disease; the characteristics of multifactorial traits; and the various features of the threshold model.
5. The terms related to tumor/cancer biology, classification, and nomenclature; the various features of cancer biology, including the characteristics of cancer and the genetic basis of cancer; features related to cancer invasion and metastasis; and the clinical manifestations and treatments of cancer.
6. Features related to Innate and adaptive immunity; features related to the first, second, and third lines of defense; the mechanisms and manifestations of inflammation; components/mechanisms related to the complement, clotting, and kinin systems; mechanisms of wound healing; and features of dysfunctional wound healing.
7. Aspects/mechanisms of specific (adaptive) immunity, features related to the structure, function, and classification of immunoglobulins; features related to haptens, antigens, immunogens, and epitopes; the different types of antigens; features related to immunological memory; and features related to the different types of active and passive immunity.
8. Aspects related to allergy, autoimmunity, and alloimmunity; aspects/mechanisms/examples related to the four basic types of hypersensitivity reactions; mechanisms and examples related to autoimmunity; and aspects/mechanisms related to immunodeficiency.
9. The risk factors for infection; the six components of the chain of infection; general concepts, terms, and processes/mechanisms related to basic microbiology; and the mechanisms of microbial pathogenicity. 1
10. General concepts, terms, and processes/mechanisms related to normal hormonal action; mechanisms of hormonal alterations; processes/mechanisms related to the pathophysiology of the various disorders discussed in class; and the clinical manifestations and treatment of the hormonal alterations discussed in class.

BIOL 2512. Human Pathophysiology II
3 Credits (3)

The second in a two-course sequence that covers changes in body physiology that result from disease or injury. This course focuses on the pathophysiology of the nervous, cardiovascular, lymphatic, respiratory, digestive, urinary, and reproductive systems. Topics related to the science of pathophysiology, including pathology, pathogenesis, etiology, epidemiology, and clinical manifestations, are also discussed throughout the course where relevant. Grade of C- or higher in microbiology is recommended. Restricted to Community Colleges campuses only. May be repeated up to 3 credits.

Prerequisite: Grade of C- or higher in BIOL 2210, BIOL 2225, and BIOL 2511.

Learning Outcomes

1. The different types of sensory modalities; the different dysfunctions of the general and special senses; the different pain theories

discussed in class; the various aspects of the neuroanatomy and neuromodulation of pain; the various clinical descriptions of pain; the various aspects of temperature regulation; components of the pathogenesis of fever; the various disorders of temperature regulation; the various aspects of sleep disorders; the various components of visual dysfunction; and the various aspects of auditory, gustatory, and olfactory dysfunction.

2. The various alterations in cognitive systems; the various alterations in arousal; the outcomes of alterations in arousal; the various alterations in awareness; the various seizure disorders; the various data processing deficits; various alterations in cerebral hemodynamics; and alterations in neuromotor function.
3. The various disorders of the central and peripheral nervous systems; and the various disorders of the neuromuscular junction.
4. The components of normal blood; the process/stages of hematopoiesis; the various normal RBC laboratory values; the components and functions of the lymphatic system; the various types of imbalances of erythropoiesis; the various types of anemias and their causes; the various types of polycythemia and their causes; the processes related to hemostasis; the various alterations of white blood cells and their causes; and the various alterations of lymphoid and hemostatic function.
5. The various diseases of the veins; the various diseases of the arteries; the various aspects of atherosclerosis; features related to the pathogenesis and consequences of coronary artery disease; the disorders of the heart wall and their consequences; the various aspects of valvular dysfunction; aspects of the pathogenesis and manifestations of rheumatic disease; the causes, pathogenesis, and manifestations of infective endocarditis; the causes, manifestations, and pathophysiology of heart failure; and the various types of shock.
6. The various signs and symptoms of pulmonary disease; the various conditions caused by pulmonary disease/injury; the various disorders of the chest wall and pleura; and the causes, manifestations, and pathophysiology of selected pulmonary disorders.
7. The features and consequences of upper and lower urinary tract obstruction; the various types of urinary tract infection; the causes, pathogenesis, and clinical manifestations of glomerulonephritis; the various features of nephrotic and nephritic syndrome; and the various features (etiology, pathophysiology, and clinical manifestations) of both acute kidney injury and chronic kidney disease.
8. The various clinical manifestations of gastrointestinal dysfunction; the various aspects (etiology, pathophysiology, and clinical manifestations) of disorders of motility; the causes, manifestations, and pathophysiology of gastritis; features related to the causes, manifestations, and pathophysiology of peptic ulcer disease; features related to the etiology, pathogenesis and pathophysiology of selected malabsorption syndromes, inflammatory bowel diseases, diverticular disease of the colon, appendicitis, and irritable bowel syndrome; the various types of vascular insufficiency; the various disorders of nutrition and their causes and clinical manifestations; and the various disorders of the accessory organs of digestion.
9. The various features associated with alterations of sexual maturity (delayed puberty and precocious puberty); features related to the etiology, pathogenesis, and pathophysiology of the various disorders of the male reproductive system, including disorders of the urethra, disorders of the penis, disorders of the scrotum, disorders of the testes, disorders of the epididymis, disorders of the prostate gland, and disorders of the male breast; features related to the etiology, pathogenesis, and pathophysiology of male sexual dysfunction; features associated with abnormalities of reproductive tract development; the various hormonal and menstrual alterations and their causes and clinical manifestations; the various conditions related to infection, inflammation, and pelvic organ prolapse (uterine prolapse, cystocele, rectocele, and enterocele); conditions involving benign growths and cancer (endometriosis, cervical cancer, vaginal cancer, vulvar cancer, endometrial cancer, uterine sarcoma, and ovarian cancer); features related to the etiology, pathogenesis, and pathophysiology of female sexual dysfunction (disorders of desire, vaginismus, anorgasmia, and dyspareunia); features related to infertility; and features related to the etiology, pathogenesis, and pathophysiology of breast cancer.

BIOL 2610G. Principles of Biology: Biodiversity, Ecology, and Evolution
3 Credits (3)

This course is an introduction to the dynamic processes of living things. Major topics include the mechanisms of evolution, biological diversity, Mendelian genetics, and ecology.

Prerequisite/Corequisite: grade of C- or better in MATH 1215 or higher, or a Math Placement Exam score adequate to enroll in mathematics courses beyond MATH 1215.

Learning Outcomes

1. Understand the scientific method and apply it to biological topics of genetics, evolution, ecology, and biodiversity.
2. Apply quantitative reasoning and scientific thinking to real world problems.
3. Identify and describe the basic principles of evolution.
4. Analyze the relationships between the genetics of populations and evolution.
5. Analyze the processes of speciation.
6. Describe how the hierarchical classification scheme is used to categorize organisms.
7. Describe how DNA research has modernized bio systematics.
8. Compare and contrast the general characteristics of each of the living domains and kingdoms.
9. Relate the structure of organisms to the way they function. 1
10. Explain how the life histories of organisms are adapted for different environments. 1
11. Relate the complexity of behavior to the overall complexity of an organism. 1
12. Describe the ecological roles played by organisms in each kingdom. 1
13. Compare basic ecological principles at the population and community levels of organization. 1
14. Describe and compare energy relationships and the cycling of materials in ecosystems. 1
15. Identify and describe the basic principles of Mendelian genetics.

BIOL 2610L. Principles of Biology: Biodiversity, Ecology, and Evolution Laboratory
1 Credit (3P)

This laboratory course is an introduction to the dynamic processes of living things. This course introduces students to the methods used in the study of Mendelian genetics, evolution, ecology, and biological diversity. Designed for students continuing in life sciences.

Prerequisite/Corequisite: BIOL 2610G; grade of C- or better in MATH 1215 or higher, or a Math Placement Exam score adequate to enroll in mathematics courses beyond MATH 1215.

Learning Outcomes

1. Describe and apply the scientific method to generate testable hypotheses in evolution and ecology.

2. Design and conduct laboratory experiments using relevant laboratory equipment and methods.
3. Analyze and report data generated during laboratory activities and experiments.
4. Communicate scientific results from experiments in Mendelian genetics, evolution, ecology, and biodiversity.

BIOL 2996. Special Topics
1-3 Credits
Specific subjects to be announced in the Schedule of Classes. May be repeated for a maximum of 6 credits. Community Colleges only.
Learning Outcomes
1. Varies

BIOL 301. Principles of Ecology
3 Credits (3)
A survey of ecology including general theory, the adaptations of organisms, population dynamics, species interactions, and the structure and function of natural communities and ecosystems. MATH 1511G and A ST 311 recommended. Same as ENVS 301. Crosslisted with: ENVS 301.
Prerequisite(s): BIOL 2610G, MATH 1220G.

BIOL 302. Molecular Biology Techniques Laboratory
3 Credits (6P)
This combined lecture and laboratory course emphasizes molecular biology laboratory practices through the hands-on application of commonly applied techniques, protocols, and equipment. The topics covered include both the fundamental development of empirical data as well as data analysis using stand-alone and web-based resources. Consent of instructor required.
Prerequisite(s): BIOL 2110G or equivalent, and MATH 1220G.

BIOL 305. Principles of Genetics
3 Credits (3)
Covers fundamental principles of reproduction, variation, and heredity in plants and animals. May be repeated up to 3 credits.
Prerequisite: (BIOL 2610G and BIOL 2110G, or BIOL 2110G and BCHE 140, and either CHEM 1215G or CHEM 1216).
Learning Outcomes
1. To provide an introduction to the basic concepts, methods, and terminology of genetics. Introduction to genomics and bioinformatics.
2. To develop a working understanding of genetics and heredity
3. To understand in some depth, the mechanism of DNA replication, transcription and protein synthesis. To understand the regulation of gene expression.
4. To examine the impact of genetics on both basic and applied aspects of the biological sciences, as well as its effects on our everyday lives.

BIOL 309. Guided Biological Research Lab
3 Credits (3)
This laboratory course provides a guided experience to hands-on research in biology. It is intended for early-career undergraduates who have finished the introductory sequence of Biology courses. Topics will vary with instructor.
Prerequisite(s): BIOL 2610G, BIOL 2110G, and MATH 1220G.

BIOL 311. General Microbiology
3 Credits (3)
Principles of physiology, molecular biology, ecology, and taxonomy of microorganisms.
Prerequisite(s): BIOL 2110G and MATH 1220G.

BIOL 311 L. General Microbiology Laboratory
2 Credits (4P)
Microbiology techniques and procedures, including isolation and identification of microorganisms and biotechnology procedures that employ microorganisms.
Prerequisite(s)/Corequisite(s): BIOL 2320 or BIOL 311. Prerequisite(s): BIOL 2110G and MATH 1220G.

BIOL 312. Plant Taxonomy
3 Credits (2+3P)
Classification and identification of representative plant families and local plants. Emphasis on ability to use technical sources. Saturday field trips may be recommended.
Prerequisite(s): BIOL 2610G and MATH 1220G.

BIOL 313. Structure and Function of Plants
3 Credits (2+3P)
Structure, function, and survey of plants. BIOL 2110G recommended.
Prerequisite(s): BIOL 2610G, MATH 1220G, and sophomore-level standing.

BIOL 314. Plant Physiology
3 Credits (3)
Photosynthesis, respiration, water relation of plants, minerals and organic nutrition, growth and development.
Prerequisite(s): BIOL 2110G and CHEM 1225G.

BIOL 322. Zoology
3 Credits (2+3P)
Structure, function, and survey of animals. BIOL 2110G recommended.
Prerequisite(s): BIOL 2610G, MATH 1220G, and at least sophomore-level standing.

BIOL 350. Special Topics
1-4 Credits
Specific subjects announced in Schedule of Classes and offered as scheduled courses. May be repeated for unlimited credit.

BIOL 351. Biology Internship
1-6 Credits
Substantial off-campus experience in biology selected by student in consultation with regular biology faculty member. Internship must be approved by faculty member. Student will supply mutually agreed upon documentation of internship activities after the internship is completed. May be repeated up to 6 credits. Restricted to: BIOL, MBIO, CEC, GEBT majors. Graded: S/U Grading (S/U, Audit).
Prerequisite(s): 45 college credits, 2.5 or better GPA, consent of instructor.

BIOL 353. Pre-Professional Human Anatomy
4 Credits (4)
Pre-professional clinincally-oriented survey of human anatomy. Designed primarily for pre-nursing majors. Provides comprehensive anatomical training for students planning careers in health and allied health sciences, such as medicine, dentistry, nursing, physical therapy, physicians aid, human nutrition, and food science. Suitable as a biology elective. Concurrent enrollment in BIOL 353 L is recommended but not required. May be repeated up to 4 credits.
Prerequisite(s): BIOL 2110G and either CHEM 1120G, CHEM 1215G, or CHEM 1216.

BIOL 353 L. Pre-Professional Human Anatomy Laboratory
1 Credit (3P)
Laboratory experience in human anatomy using anatomical models and cat dissections. Designed as a learning aid to support and augment BIOL 353 pre-professional Human Anatomy. For students planning careers in health and allied health sciences such as medicine, dentistry,

nursing, physical therapy, physicians aid, human nutrition, and food science. May be repeated up to 1 credits.
Prerequisite(s)/Corequisite(s): BIOL 353. Prerequisite(s): BIOL 2110G and either CHEM 1120G, CHEM 1215G, or CHEM 1216.

BIOL 354. Physiology of Humans
3 Credits (3)
Principles of integrative functions in humans. A systems approach emphasizing tissues, organs, and their regulation.
Prerequisite(s): BIOL 2110G and MATH 1220G.

BIOL 354 L. Laboratory of Human Physiology
1 Credit (3P)
Laboratory to accompany BIOL 354.
Prerequisite(s): MATH 1220G and either BIOL 2221, BIOL 381, BIOL 354, or concurrent enrollment in BIOL 354.

BIOL 377. Cell Biology
3 Credits (3)
Fundamentals of eukaryotic cell structure, organization, and function. Emphasis on membranes, subcellular organelle systems, cytoskeleton, and cell cycle. Includes basic aspects of molecular biology. May be repeated up to 3 credits. BIOL 2610G recommended.
Prerequisite(s): (BIOL 2110G, BIOL 305 or GENE 315) and MATH 1220G.

BIOL 381. Animal Physiology
3 Credits (3)
Principles of integrative function in animals, emphasizing tissues, organs, organ systems, and regulation. Includes adaptations of animals to their environments. BIOL 2610G and BIOL 377 recommended.
Prerequisite(s): BIOL 2110G and junior-level standing, MATH 1220G.

BIOL 382. Plant Signalling and Development
3 Credits (3)
This is a course that introduces plant signalling pathways and their role in development to students. The lectures are structured to facilitate in-class discussions on the current state and future directions in this field. Topics will cover a wide range of biological questions and the methods used to study them. May be repeated up to 3 credits.
Prerequisite(s): BIOL 305 or GENE 315, and MATH 1220G.

BIOL 385. An Introduction to Cancer
3 Credits (3)
This course will cover 3 areas of cancer research and their interdisciplinary connections: clinical cancer research, epidemiology and public health, and basic cancer research. May be repeated up to 3 credits.
Prerequisite(s): BIOL 305 or GENE 315 or equivalent and MATH 1220G.

BIOL 398. Biology Research Programs
1-3 Credits
Directed studies and research experiences, by arrangement with instructor. May be repeated for a maximum of 6 credits.

BIOL 402. Biology Honors Thesis
1-3 Credits (1-3)
Provides guidance in how to write a scientific paper in the sciences. Students will produce an honors thesis based on previous independent research. Consent of instructor required.
Prerequisite(s): MATH 1220G and consent of instructor.

BIOL 412. Seminar in Microbiology
1 Credit (1)
Seminar to aid students in assessment and presentation of current topics in microbiology.
Prerequisite(s): BIOL 311, BIOL 311 L, and MATH 1220G.

BIOL 417. Topics in Environmental Microbiology
3 Credits (3)
This is an advanced undergraduate course based on current literature in Environmental Microbiology, and is a seminar-style, discussion-based class. Topics typically include marine microbiology, ancient DNA, and the human microbiome. Crosslisted with: BIOL 577.
Prerequisite(s): MATH 1220G, BIOL 477 or consent of instructor.

BIOL 424. Human Osteology
3 Credits (3)
A survey of the functional, developmental, and evolutionary biology of the human skeleton. Identifying bones and teeth from hands-on experience with skeletal and dental material. Provides a foundation for human evolutionary studies, bioarchaeology and forensic anthropology. Students are recommended to take ANTH 355 or an equivalent before enrolling in this course. BIOL 424L should be taken concurrently when it is offered. Crosslisted with: ANTH 474.

BIOL 427. Symbiosis
3 Credits (3)
In-depth treatment of the ecology, evolution, and mechanisms that are found in symbiotic systems. May be repeated up to 3 credits. Crosslisted with: BIOL 527.
Prerequisite(s): BIOL 2610G, BIOL 2110G, and MATH 1220G.

BIOL 436. Disease Vector Biology
3 Credits (3)
Fundamentals of disease vector biology with emphasis on molecular biology. Explores an overview of vector borne diseases, insect endocrinology, insect immunity, olfaction, vector genome projects and transgenic insect techniques. Includes student presentations and literature discussions. Crosslisted with: BIOL 536
Prerequisite(s): BIOL 2110G, BIOL 305, and MATH 1220G.

BIOL 442. Genomics Technology
3 Credits (3)
The course introduces current genomic techniques in genome sequencing, transcriptome analysis, detection of genetic variation, and metagenomics. May be repeated up to 3 credits. Crosslisted with: BIOL 562.
Prerequisite(s): BIOL 2110G, BIOL 305 or BIOL 478 or GENE 315, and MATH 1220G.

BIOL 446. Bioinformatics and NCBI Database
3 Credits (3)
The course discusses how to use NCBI database and bioinformatic tools for research with genomics approaches. The topics include nucleotide and protein sequence analysis, similarity search with blast algorithms, gene/genome annotation, protein structure analysis, gene expression analysis, and metagenomic study.
Prerequisite(s): BIOL 2110G, BIOL 305 or BIOL 478 or GENE 315, and MATH 1220G.

BIOL 450. Special Topics
1-3 Credits
Specific subjects announced in the Schedule of Classes and offered as scheduled courses. May be repeated for unlimited credit.

BIOL 451. Physiology of Microorganisms
3 Credits (3)
Aspects of cellular physiology unique to prokaryotes. BCHE 395 recommended.
Prerequisite(s): C- or better in BIOL 311, MATH 1220G.

BIOL 455. Biometry
3 Credits (3)
Biometry is the analysis of biological data using mathematical and statistical models. The course will cover basic theories of probability and statistics and will introduce principles of sampling, estimation,

experimental design, and hypothesis testing. Students will analyze biological data using computer programs and will perform tests for goodness-of-fit, independence, analysis of variance, correlation, and regression.
Prerequisite: BIOL 2610G or BIOL 2110G, and MATH 1220G.

Learning Outcomes

1. Cover basic theories of probability and statistics.
2. Understand principles of sampling, estimation, experimental design, and hypothesis testing.
3. Analyze biological data.
4. Perform tests for goodness-of-fit, independence, analysis of variance, correlation, and regression.

BIOL 459. Darwinism Versus Creationism
3 Credits (3)
This course examines the debate regarding Creationism versus Darwinism as explanations for the origin and diversification of life on Earth. Topics covered include the nature and philosophy of science, new-world creationism, old-world creationism, intelligent design, history of evolutionary thought, modern evolutionary theory, and the Creationism-Darwinism debate at the societal, political, and educational interfaces. The course structure will include formal lectures and in-class discussion of assigned readings.
Prerequisite(s): BIOL 2610G or BIOL 2110G, and MATH 1220G.

BIOL 459 H. Darwinism versus Creationism Honors
3 Credits (3)
This course will examine the history and philosophy surrounding the debate between Darwinism and Creationism. The course will also examine the consequences of the debate at the interface of sociology, economics, politics, and education. The Honors version of the course (BIOL 459H) will require a term paper in addition to the requirements of BIOL 459. Crosslisted with: BIOL 459.
Prerequisite(s): BIOL 2610G or BIOL 2110G, and MATH 1220G.

BIOL 462. Conservation Biology
3 Credits (3)
Examination of the value of biological diversity, the natural processes that control biological diversity, and the ways in which human activities have resulted in the loss of biological diversity, both regionally and globally.
Prerequisite(s): BIOL 301 and either MATH 1430G or MATH 1511G.

BIOL 467. Evolution
3 Credits (3)
Covers theory, historical background, population variation, natural selection, adaptation, speciation.
Prerequisite(s): BIOL 2610G, BIOL 305 or GENE 320, and MATH 1220G.

BIOL 469. Biology of Emerging Infectious Diseases
3 Credits (3)
This class will investigate the evolutionary and ecological drivers of disease emergence. The effect of emerging diseases on human health will be addressed throughout the class, but the class will also consider the consequences of disease emergence for the health of wildlife and plant populations. Additionally, the class will consider the mechanisms used to control disease emergence and why they succeed or fail.
Prerequisite(s): MATH 1220G, Introductory Genetics (BIOL 305 or equivalent) or consent of the instructor.

BIOL 470. Developmental Biology
3 Credits (3)
The purpose of this course is to introduces students to the principles that govern the development of a single fertilized egg cell into a complex multicellular organism. These principles, and often the molecular mechanisms by which they are accomplished, appear to be universal for all multicellular organisms including both plants and animals. We will explore issues such as: how cells become committed to particular cell fates and how this commitment is maintained; how organs acquire particular shapes, sizes and positions; the developmental causes of some human diseases; how the environment affects development; and, how changes in development provide the material basis for evolutionary change.
Prerequisite(s): BIOL 2110G, BIOL 305, and MATH 1220G.

BIOL 473. Ecology of Microorganisms
3 Credits (2+3P)
The metabolic interactions of microorganisms in the environment, with emphasis on their roles in ecological processes.
Prerequisite(s): MATH 1220G, BIOL 311 or consent of instructor.

BIOL 474. Immunology
3 Credits (3)
Basic concepts of the immune response.
Prerequisite(s): MATH 1220G, BIOL 305, and CHEM 2115 or CHEM 313.

BIOL 475. Virology
3 Credits (3)
Mechanisms of viral infections of animals and man. BCHE 395 or BIOL 305 are recommended.
Prerequisite(s): BIOL 311 and MATH 1220G.

BIOL 476. Soil Microbiology
3 Credits (3)
Nature and physiology of soil microorganisms, how they affect plant growth and recycle nutrients. Land framing, bioremediation, and other environmental problems as influenced by soil microorganisms. SOIL 2110 and BIOL 311 recommended. Same as SOIL 476.

BIOL 476 L. Soil Microbiology Laboratory
1 Credit (3P)
Enumeration of soil microorganisms, their activities, and transformations they mediate. Same as SOIL 476L.
Prerequisite(s)/Corequisite(s): BIOL 476.

BIOL 477. Applied and Environmental Microbiology
4 Credits (4)
A lecture-laboratory course on the microorganisms and the reactions they mediate which either impact the environment or have industrial applications. Reading of current literature will be emphasized. Topics include bioremediation, water quality, and aspects of industrial and food microbiology.
Prerequisite(s): MATH 1220G, BIOL 311, and 311 L, or consent of instructor.

BIOL 478. Molecular Biology of Microorganisms
3 Credits (3)
The biochemical basis for gene mutation, recombination, and expression with emphasis on prokaryotes. Includes fundamentals of recombinant DNA technology. BIOL 305 and BCHE 395 recommended.
Prerequisite(s): BIOL 311 and MATH 1220G.

BIOL 479. Medical Microbiology
3 Credits (3)
An in-depth overview of microbial pathogens associated with human infectious disease. Etiological agents, pathogenesis, and processes leading to the disease state and the therapies of infectious disease.
Prerequisite(s): MATH 1220G and BIOL 311 required, BIOL 474 recommended.

BIOL 479 L. Medical Microbiology Laboratory
1 Credit (1)

Overview of common procedures used by medical microbiologists to identify agents of disease or microbial pathogen traits. May be repeated up to 1 credits.
Prerequisite(s)/Corequisite(s): BIOL 479. Prerequisite(s): MATH 1220G, BIOL 311, BIOL 311 L.

BIOL 480. Animal Behavior
3 Credits (3)
A survey of the field of animal behavior. BIOL 322 recommended. May be repeated up to 3 credits.
Prerequisite: MATH 1220G or higher, BIOL 2610G, and junior-level standing.
Learning Outcomes
1. Distinguish between proximate mechanisms and ultimate causation.
2. Engage in the scientific process as applied to animal behavior.
3. Interpret and produce graphical representations of data.
4. Describe general patterns of animal behavior across a wide range of contexts.

BIOL 484. Animal Communication
3 Credits (3+3P)
An examination of how animals produce and perceive signals, what factors influence the form of signals in different sensory modalities, and how conflicts between senders and receivers affect signaling strategies. Weekly discussion from the primary literature and group research products. May be repeated up to 3 credits.
Prerequisite: BIOL 2610G or consent of instructor, and MATH 1220G or higher.
Learning Outcomes
1. Describe how animal signals are produced, transmitted, and received in various taxa,
2. Understand how evolutionary, ecological and economic principles help predict how animals will communicate,
3. Describe general patterns of animal communication across a range of social contexts.

BIOL 488. Principles of Conservation Genetics
3 Credits (3)
Fundamentals of the genetics of small populations. Genetic technologies used in studying small populations. Application of genetics and evolution to the conservation of biological populations.
Prerequisite(s): MATH 1220G and BIOL 305.

BIOL 490. Neurobiology
3 Credits (3)
Fundamentals of neurobiology with an emphasis on properties of neurons and glia, principles of synaptic transmission, development of nervous system and organization of motor and sensory systems.
Prerequisite(s): BIOL 2110G, MATH 1430G or equivalent.

BIOL 498. Biology Research Programs
1-3 Credits
Directed studies and research experiences, by arrangement with instructor. May be repeated for a maximum of 6 credits.

BIOL 509. Guided Biological Research Lab
3 Credits (3P)
This laboratory course provides a guided experience to hands-on research in biology. It is intended for early-career graduate students wishing an introduction to research practices. Topics will vary with instructor. Crosslisted with: BIOL 309.

BIOL 510. Current Topics in Biology
3 Credits (3)
Introduction to diverse topics in modern biology, including dynamic areas of current research.

BIOL 514. Plant Physiology
3 Credits (3)
Overview of photosynthesis, respiration, water relations of plants, minerals and organic nutrition, growth and development. May be repeated up to 2 credits.
Prerequisite: BIOL 2110G and CHEM 1225G.
Learning Outcomes
1. Describe how individual plants survive in variable environments. This means that students will be able to: a. Summarize the chemical and physical bases for major plant processes. b.Explain how major plant processes interact to support plant growth and development. c. Describe the adaptive forms of physiological processes and their underlying anatomical modifications.
2. Predict consequences of environmental change on physiological processes within individual plants.
3. Apply course concepts to real-world scenarios that involve plant function and plant development.
4. Describe experimental approaches used to understand physiological processes within individual plants.

BIOL 520. Molecular Cell Biology
3 Credits (3)
An in-depth look at cellular processes and structures at the molecular level. Emphasis is placed on formal student presentations and discussions of current literature.
Prerequisite: BIOL 377 or equivalent.

BIOL 527. Symbiosis
3 Credits (3)
In-depth treatment of the ecology, evolution, and mechanisms that are found in symbiotic systems. May be repeated up to 3 credits. Crosslisted with: BIOL 427.
Prerequisite(s): Graduate status.

BIOL 536. Advanced Disease Vector Biology
3 Credits (3)
Fundamentals of disease vector biology with emphasis on molecular biology. Explores an overview of vector borne diseases, insect endocrinology, insect immunity, olfaction, vector genome projects and transgenic insect techniques. Includes student presentations and literature discussions. Taught with: BIOL 436.
Prerequisite(s): BIOL 2110G and BIOL 305.

BIOL 540. Science and Ethics
1-3 Credits (1-3)
Ethical concerns facing researchers in the basic and applied biological sciences. Coverage of responsible conduct in research including scientific integrity and research misconduct, mentor/trainee responsibilities, data management, authorship, publication practices, human subjects, animal welfare, intellectual property, conflicts of interest and effort and collaborative science. Emphasis on ethical reasoning skills. Discussion of ethical and societal implications of issues selected from a broad range of contemporary research areas (genetics, reproductive biology, environmental sciences, nanoscience, drug discovery, bioengineering, neuroscience). Subtitled. May be repeated up to 4 credits. Crosslisted with: PHIL 540.

BIOL 541. Professional Development Seminar
1-3 Credits
Practical aspects of career enhancement including job seeking, professional presentations, grant proposals, etc.

Prerequisite: consent of instructor.

BIOL 550. Special Topics
1-3 Credits
Readings, discussions, and/or field and laboratory investigation of selected problems. Possible topics: human genetics, systematic entomology, or parasitism in animals. May be repeated for unlimited credit.
Prerequisite: consent of instructor, and designation of a specific topic before registration.

BIOL 562. Advanced Genomics Technology
3 Credits (3)
This course covers current genomics techniques in genome sequencing, transcriptome analysis, detection of genetic variation, and metagenomics. May be repeated up to 3 credits. Consent of Instructor required. Crosslisted with: BIOL 442.

BIOL 565. Biology In The K-6 Curriculum
3 Credits (3)
Linking important biological concepts to the K-6 curriculum and standards. Addressing known content area challenges with effective pedagogical approaches. Aligning content, standards, classroom activities and assessment. Does not fulfill requirements for degrees in biology. Consent of Instructor required. Restricted to: Master of Arts in Education: Elementary Mathematics and Science majors.
Learning Outcomes
1. Explain that biology is a scientific discipline based on observations and experimentations.
2. Explain the process of scientific inquiry and explain how scientific knowledge is discovered and validated.
3. Describe the chemical basis of living organisms and how biomolecules contribute to the structure and function of cells.
4. Develop a basic familiarity with cells and cell organelles.
5. Describe the structure and function of DNA as well as how DNA is used in the production of proteins
6. Describe the basic principles of genetics and heredity leading to human diversity.
7. Identify the major features of the systems in the human body, and understand the anatomy and physiology of them
8. Describe the roles of the organ systems in maintaining homeostasis
9. Explain the principles of evolution by means of natural selection explaining the diversity of life. 1
10. Describe how science and technology have impacted life in particular to society and the environment (e.g. medicine, forensic science, agriculture, ecology, sustainability) 1
11. Describe the benefits of a case study approach to teaching 1
12. Align biology content with specific K-6 (e.g. NGSS) science standards 1
13. Design an instructional case study (complete with teaching notes and assessment) to address specific K-6 science standards

BIOL 566. Advanced Bioinformatics and NCBI Database
3 Credits (3)
The course discusses how to use NCBI database and bioinformatic tools for research with genomics approaches. The topics include nucleotide and protein sequence analysis, similarity search with blast algorithms, gene/genome annotation, protein structure analysis, gene expression analysis, and metagenomic study. Consent of Instructor required.

BIOL 568. Communities and Ecosystems
3 Credits (3)
Community ecology is an interdisciplinary field that integrates numerous theories, concepts, and methods to study the patterns and dynamics of biotic assemblages. Because biotic groups affect the biogeophysical and biogeochemical processes that govern Earth system functioning, community ecology also plays an increasingly large role in the study of ecosystem ecology, a discipline which seeks to understand the processes governing nutrient and energy flow across the Earth system. This course will explore the theories and methods for study of biodiversity, biogeography, and community assembly, as well as the pathways through which communities exert influence on ecosystem functioning. Topics will also include evolutionary influences on communities, the integration of community ecology into conservation and land management, and community ecology in an era of rapid environmental change.

BIOL 577. Advanced Topics in Environmental Microbiology
3 Credits (3)
This course is based on current literature in Environmental Microbiology, and is a seminar-style, discussion-based class. Topics typically include marine microbiology, ancient DNA and the human microbiome.
Prerequisite(s): Consent of instructor.

BIOL 581. Physiology of Animals
3 Credits (3)
Comprehensive treatment of integrative physiology of animals, emphasizing tissues, organ systems, and regulatory control, including neuroendocrine function, circulation, respiration, and excretion. Term paper required. BIOL 2610G, BIOL 377 recommended.
Prerequisite: BIOL 2110G.

BIOL 582. Advanced Plant Signalling and Development
3 Credits (3)
This is a course that introduces plant signalling pathways and their role in development to students. The lectures are structured to facilitate in-class discussions on the current state and future directions in this field. Topics will cover a wide range of biological questions and the methods used to study them. May be repeated up to 3 credits.
Prerequisite(s): BIOL 305 or GENE 315, and MATH 1220G.

BIOL 587. Behavioral and Evolutionary Ecology
3 Credits (3)
This course will investigate the causes and consequences of phenotypic variation and the adaptive value of phenotypic traits.

BIOL 589. Speciation and Adaptation
1-3 Credits (1-3)
Examination of the two great themes of evolutionary biology. Begins with an historical overview of perspectives on these evolutionary processes, and then moves through the foundations of modern research to focus on recent advances driven by improvements in theory and technology. Emphasis on synthesis of the primary literature through lectures, discussion, and written assignments.
Learning Outcomes
1. Students will actively participate in discussions focused on both classic foundational texts as well as recent research in this field.
2. Students are expected to lead class discussions on relevant evolution topics.
3. Students will learn to write a literature review paper on a specific topic in the field of evolutionary biology.

BIOL 590. Neuroscience
1-3 Credits
Detailed examination of the principles underlying nervous system organization and function. Emphasis on recent advances in

multidisciplinary, integrated approaches to study the nervous system. May be repeated up to 9 credits.

BIOL 598. Special Research Programs
1-9 Credits
Individual investigations either analytical or experimental.

BIOL 599. Master's Thesis
15 Credits
Thesis.

BIOL 600. Doctoral Research
1-15 Credits
Research.

BIOL 610. Seminar
1-3 Credits (1-3)
Oral presentation and discussion of journal articles and ongoing research projects. May be repeated up to 6 credits. Graded: S/U Grading (S/U, Audit).

BIOL 612. Microbiology Seminar
1 Credit (1)
Seminar to aid graduate students in assessment and presentation of classical and current topics in microbiology.

BIOL 697. University Teaching Experience
1-3 Credits
Certain graduate students will be permitted to teach up to one-third of one of the biology courses. The student will prepare and deliver lectures and will prepare, administer, and grade at least one examination. The professor in charge of the course will attend and evaluate the student's lectures. May be repeated up to 3 credits.
Learning Outcomes
1. Varies.

BIOL 698. Selected Topics
1-3 Credits
Selected topics for doctoral students.

BIOL 700. Doctoral Dissertation
15 Credits
Dissertation.

Genetics Courses

GENE 1110. Experimental Systems in Genetics
1 Credit (1)
Survey of molecular, biochemical, organismal, and computer science based approaches to investigate how genes determine important traits. Historical development and topics of current interest will be discussed.
Learning Outcomes
1. To give the students a historical perspective on the field of genetics.
2. To familiarize the students to introductory concepts and vocabulary to the field of genetics.
3. Introduce experimental systems within the field of genetics and to give perspective to current genetic research.
4. As this course is designed for beginning students as an overview of faculty and research labs on campus. The students majoring in genetics are encouraged to meet with faculty and to explore opportunities available to them on campus

GENE 303V. Genetics and Society
3 Credits (3)
Relates the science of genetics with social ramifications. Ways in which genetics and evolution interact with social, political, and economic issues. Includes genetic engineering, gene therapy, DNA finger-printing, ancient DNA, plant and animal improvement, and future prospects. Students required to formulate value judgments on contemporary biological issues that will impact society. Crosslisted with: AGRO 303V.
Learning Outcomes
1. Explain foundational genetic concepts and modern biotechnological techniques, including whole genome sequencing and genetic variation.
2. Analyze the implications of genetic technologies, such as cloning, gene therapy, genetic testing, and DNA forensics, to society.
3. Evaluate ethical issues surrounding genetic applications, including genetic discrimination, eugenics, and ownership of genetic information.
4. Develop and defend informed arguments about controversial topics in genetics (cloning and stem cells), using scientific evidence and ethical reasoning.
5. Collaborate on a group project (a term paper) to research and present real-world genetics-related issues and their impact on society.

GENE 305. Principles of Genetics
3 Credits (3)
Covers fundamental principles of reproduction, variation, and heredity in plants and animals. May be repeated up to 3 credits.
Prerequisite: (BIOL 2610G and BIOL 2110G, or BIOL 2110G and BCHE 140, and either CHEM 1215G or CHEM 1216).
Learning Outcomes
1. To provide an introduction to the basic concepts, methods, and terminology of genetics. Introduction to genomics and bioinformatics.
2. To develop a working understanding of genetics and heredity
3. To understand in some depth, the mechanism of DNA replication, transcription and protein synthesis. To understand the regulation of gene expression.
4. To examine the impact of genetics on both basic and applied aspects of the biological sciences, as well as its effects on our everyday lives.

GENE 305 L. Genetic Techniques
1 Credit (3P)
Experimental procedures used in genetic research including: sexual transmission genetics, eukaryotic DNA isolation, DNA marker development and genotyping, polymerase chain reaction, and cytogenetics.
Prerequisite(s)/Corequisite(s): GENE 315, or AGRO/ANSC/BIOL/HORT 305.

GENE 315. Molecular Genetics
3 Credits (3)
Covers fundamental principles of DNA structure and replication, transcription, translation, gene regulation, recombinant DNA technology, and a survey of genomics and bioinformatics. Recommend CHEM 313.
Prerequisite(s): CHEM 1225G and BIOL 2110G.

GENE 320. Hereditary and Population Genetics
3 Credits (3)
Covers fundamental principles of reproduction, variation, and heredity in plants and animals including: Mendelian inheritance, mitosis, meiosis, genetic linkage, random mating, genetic drift, natural selection, inbreeding, migration, mutation, interrelationships between individuals, populations and communities and the environment.
Prerequisite: CHEM 1215G & BIOL 2110G.

Learning Outcomes

1. Deduce correctly how a trait is being inherited from one generation to another in any species.
2. Explain correctly concepts associated with Mendelian, quantitative, and population genetics.
3. Solve numerical problems correctly associated with Mendelian inheritance of traits, gene linkage and recombination, quantitative inheritance of traits, and population genetics.

GENE 391. Genetics Internship
1-6 Credits (1-6)
Professional work experience in genetics under the joint supervision of an employer and a faculty member. Documentation of proposed internship activities must be submitted prior to the start of the internship. A written report is required after the internship is completed. No more than 6 credits toward a degree. May be repeated up to 6 credits. Graded: S/U Grading (S/U, Audit).

GENE 440. Genetics Seminar
1 Credit (1)
Organization, preparation, and presentation of genetic studies in model microorganism, plant, or animal systems that have been used to solve problems in molecular, cellular, and developmental biology.
Prerequisite: Seniors only; GENE 315 & GENE 320.

Learning Outcomes

1. Evaluate and discuss scientific literature associated with the use of a genetic model (microorganism, plant, or animal).
2. Identify several types of peer-reviewed journal articles.
3. Lead a discussion of a peer-reviewed journal article in genetics.
4. Develop and present a three-minute “lightning talk”.
5. Organize, develop, and deliver a presentation on a topic in genetics.

GENE 449. Special Problems
1-3 Credits (1-3)
Research problem, experience training, or other special study approved by a faculty adviser. Maximum of 3 credits per semester and a grand total of 3 credits toward a degree. Consent of instructor required.

GENE 450. Special Topics
1-3 Credits (1-3)
Specific subjects to be announced in the schedule of classes. Maximum of 3 credits per semester and a total of 3 credits toward a degree. Consent of instructor required.

GENE 452. Applied Bioinformatics
3 Credits (3)
Survey and application of publicly available bioinformatic tools that treat genomic DNA, cDNA, and protein sequences, RNA abundance, as well as tools that allow inference based on phylogenetic relationships.
Prerequisite: AGRO/ANSC/BIOL/HORT 305 or GENE 315 and GENE 320, and BCHE 341, or BCHE 395.

Learning Outcomes

1. Define bioinformatics and its relevance in different fields or disciplines.
2. Interpret gene sequence and expression information derived from genomic and transcriptomic databases.
3. Identify the importance of sequencing the genomes of organisms and determine the relationships of sequence to the structure, function, and diversity of DNA, RNA, and proteins.
4. Implement information derived from bioinformatics to solve specific biological problems (disease resistance in animals and plants).
5. Organize a round-table discussion of a peer-reviewed journal demonstrating the application of bioinformatics software/program(s) or databases to study (a) gene expression, (b) multiple sequence alignments, or (c) genomics and develop a presentation and research project proposal related to bioinformatics.

GENE 486. Genes and Genomes
3 Credits (3)
Extensive coverage of nuclear and organelle genome structure in plants and animals, genome restructuring including duplication, anueploidy, chromosome translocations and inversions, comparative genomics, and molecular systematics.
Prerequisites: AGRO/ANSC/BIOL/HORT 305 or GENE 315, and GENE 320.

Name: Biology Department

Office Location: Foster Hall room 275

Phone: (575) 646-3611

Website: http://bio.nmsu.edu/ (http://bio.nmsu.edu)