School of Science

Dean: Gail M. Simmons

The School of Science at The College of New Jersey is dedicated to providing students with an outstanding education in biology, chemistry, computer science, mathematics and statistics, and physics that emphasizes the excitement of scientific exploration and the importance of science to society. Through coursework, independent study, faculty-sponsored laboratory or field research and internships, the School aims to foster a deep understanding of the concepts and processes of science. The School of Science is also dedicated to producing excellent teachers of science in cooperation with the School of Education through elementary education programs and its secondary education programs in biology, chemistry, physics and mathematics. Students in the School of Science can expect to go on to rewarding careers in a wide variety of fields, including graduate study, professional schools, teaching, high-technology industry, public service, media or any other area in which a strong science background is important.

The departments of the School of Science are located in adjacent buildings next to Lake Ceva: the Science Complex (chemistry, mathematics and statistics, and physics), The Biology Building (biology) and Holman Hall (computer science). The Science Complex and the Biology Building are newly constructed facilities, equipped with modern tools of science and science education—including a planetarium, astronomical observatory, optics laboratory, nuclear magnetic resonance laboratory, spectroscopy and chromatography suite, molecular modeling suite, electron microscopy suite, molecular biology laboratory, greenhouse, Sun workstation laboratory, Intel computing laboratory, mathematics education laboratory, and several computer classrooms. Individual faculty laboratories are designed to allow intensive interaction between students and faculty in an undergraduate-focused research environment.

The Office of the Dean of Science is in Holman Hall 304. The secretary to the dean is Monica Zrada. You may contact the dean at 609/771-2724.

Biology

Faculty: Fangboner, *Chair;* Bossart, Bricker, Kayne, Klug, Lipton, Lovett, Morrison, Norvell, O'Connell, Reinert, Rockel, Rose, Shevlin

The objectives of the department are to develop an understanding by students of biological principles that underlie all living things, to instill in students a sense of inquiry, and to sharpen the analytical-thinking skills of students. Whenever possible, laboratory experiences emphasize independent research.

At the completion of the program, all students receive a Bachelor of Science in Biology. The major is a liberal-arts-based program that prepares students for: 1) occupations in biologically related professions, 2) advanced graduate study in biology, 3) a variety of health career professions, and 4) teaching at the secondary level. Occupations include, for example, research-oriented positions with private industrial and pharmacological enterprises and state and federal agencies. Graduate study may lead to both Master of Science and Ph.D. degrees. Health careers include allopathic (MD) and osteopathic (DO) medicine, dentistry, pharmacy, physical therapy, occupational therapy, physician assistant, podiatry, optometry, and veterinary medicine.

Students interested in pursuing a career in pharmaceutical sales and marketing can combine a major in biology (BIOA) with a minor in marketing. See Professor Pelham, School of Business, or the biology chairperson for more information.

Requirements for the Major

There are six programs within the biology major: liberal arts (BIOA), secondary teaching (BIOT), seven-year BS/MD (BIOM), seven-year BS/OD (optometry; BIOP), early childhood education/biology (ECBI), and elementary education/biology (ELBI).

Liberal Arts (BIOA) and Secondary Education (BIOT)

Fifty-seven credits (BIOA) or 51 credits (BIOT) of major requirements including 23 credits of biology core courses (BIOL 100, 183, 184, 211, 261, 321, and 498), 18 credits (BIOA) or 12 credits (BIOT) of biology options, plus eight credits of organic chemistry (CHEM 321–322 or 331–332), and eight credits of physics (PHYS 201–202 or 191–192 if BIOA; or PHYS 201–202 if BIOT). Six credits of Calculus (MATH 127–128) and eight credits of General Chemistry (CHEM 201–202) are part of the general education requirements.

Seven-Year BS/MD Program (BIOM)

Is available only to an entering freshman. Forty-seven credits of major requirements including 23 credits of biology core courses (BIOL 100, 183, 184, 211, 261, 321, and 498), eight credits of General Physics (PHYS 201–202), eight credits of Organic Chemistry (CHEM 321–322 or 331–332), and a minimum of 28 credits at NJ Medical School. Six credits of Calculus (MATH 127–128) and eight credits of General Chemistry (CHEM 201–202) are part of the general educa-

tion requirements. The student needs to earn a 3.4 or better each semester overall and in the sciences, and earn a B or better in BIOL 183–184, CHEM 201–202 or HONR 201–202, CHEM 321–322 or CHEM 331–332, and PHYS 201–202.

Seven-Year BS/OD (Optometry) Program (BIOP)

Is available to an entering freshman and to enrolled biology freshmen and first-semester sophomores. Sixty credits of major requirements including 23 credits of biology core courses, (BIOL 100, 183, 184, 211, 261, 321, and 498), 18 credits of biology options including BIOL 331 or 332, eight credits of General Physics (PHYS 201–202), eight credits of Organic Chemistry (CHEM 321–322 or 331–332), three credits of Statistics (STAT 115), and a minimum of 13 credits at S.U.N.Y. State College of Optometry. Six credits of Calculus (MATH 127–128), eight credits of General Chemistry (CHEM 201–202), and three credits of Psychology (PSYC 101) are part of the general education requirements. Minimum overall GPA no lower than 3.2, minimum science and math prerequisite courses GPA no lower than 3.2 with no grade below a C.

Elementary Education/Biology (ELBI) and Early Childhood Education/Biology (ECBI)

Thirty-two credits of major requirements, eight credits of biology core (BIOL 261 and 321), eight (8) credits of biology options, eight credits of Organic Chemistry (CHEM 321–322), and eight credits of College Physics (PHYS 191–192), or General Physics (PHYS 201–202). Eight credits of General Biology (BIOL 183–184), eight credits of General Chemistry (CHEM 201–202) or HONR 201–202, six credits of mathematics (two courses from among IDSC 105, STAT 115, MATH 127–128), eight credits of biology core (BIOL 211, and 498) are included in the general education requirements.

Elementary Education M/S/T (ELST) and Early Childhood Education M/S/T (ECST) with a Biology Specialization

This interdisciplinary major integrates formal study in mathematics, biology, chemistry, physics, and technology. Students electing a biology specialization will complete 42 credits of "core" requirements including Calculus (MATH 127–128), General Biology (BIOL 183–184), Principles of Chemistry (CHEM 101–102), College Physics (PHYS 191–192), Introduction to Human Technological Behavior (TSNG 171), Principles of Structures and Mechanisms (TSNG 211), and an M/S/T-approved elective. The biology specialization consists of a minimum of 21 credits including two of the following core biology courses, BIOL 211/Cell and Molecular, BIOL 261/Ecology and Field, BIOL 321/Genetics, and two biology elective courses at the 300 level or higher.

Program Entrance, Retention, and Exit Standards

Every major program at The College has set standards for allowing students to remain in that program, to transfer within The College from one program to another, and to graduate from a program.

The following are the standards for BIOA and BIOT:

■ Retention in the program is based on the following performance standards in these "critical content courses": The student must have a minimum cumulative science GPA of 2.0 in three science courses required by the major by the end of the fourth semester in the major.

■ Transfer into the program from another program within The College is based upon the following performance standards in these "foundation courses": There must be at least three 100/200-level science courses and a GPA of 3.0 or better in all science courses. See department for application.

■ Graduation requires a GPA of 2.0 in courses for the program and in the required science and all science courses taken at TCNJ and earning a minimum grade of C– or better in the following courses: BIOL 183, 184 (or 181 and 182), BIOL 211, BIOL 261, BIOL 321, and BIOL 498. See control sheet for clarifications.

The following are the standards for BIOM:

■ Retention into the program is based on the following performance standards in these "critical content courses": overall 3.4 GPA each semester and a B or better in BIOL 183/184, CHEM 201/202, CHEM 331/332, and PHYS 201/202.

■ Transfer in the program from another program within The College is based upon the following performance standards in these "foundation courses." There is no internal transfer allowed by the articulation agreement.

■ Graduation includes credits earned at the Medical College of New Jersey; see control sheet for clarification.

The following are the standards for BIOP:

■ Retention in the program is based on having a 3.2 GPA in the biology curriculum and a 3.2 in the optometry science and math prerequisites with no grade below a C; see the articulation agreement for further details.

■ Transfer in the program can only be achieved from the BIOA major and is based on having a 3.2 or better GPA in the required optometry courses. For further details see the articulation agreement.

■ Graduation includes credits earned at S.U.N.Y. Optometry; see articulation agreement for further requirements and modifications.

Biology Minor

The minor consists of 21 credits:

BIOL	181–182 or 183–184	8
Two of the following:		8
BIOL	211/Cell and Molecular Biology	
BIOL	321/Genetics	
BIOL	261/Ecology and Field Biology	
Plus		
Biology Options (two courses)		5 cr. minimum

At least two of the courses making up this minor must be 300 level or higher. No more than three courses (up to a total of 12 credits) can be transferred into the minor.

Departmental Honors

The Departmental Honors Program provides advanced research experience and recognition of outstanding achievement. To be eligible, the biology major must have at least 32 credits earned at The College of New Jersey, including 12 credits of biology courses. The student should have an overall grade point average of 3.3 or better, and a science grade point average of 3.5 or better. The candidate must make application by written request to the biology department honors adviser (for further details see Professor Fangboner). The candidate must complete the biology major with an overall GPA of 3.3 and a science GPA of 3.5 or better, including at least 18 credits in biology courses completed at TCNJ and must complete the equivalent of nine credits of honors biology work. The research will culminate with a presentation and a written thesis presented in a form acceptable to a scientific journal. For completion of departmental honors, the student's Honors Review Committee must judge the initial proposal and the final thesis "Honors Quality." Students who have completed the program successfully will be certified by the Department of Biology to graduate "With Departmental Honors in Biology."

Graduation Requirement

The biology major (BIOA, T, M, and P) will need one biology course at the organismal level or higher from among the following: 331, 332, 341, 342, 343, 350, 370, 371, 375, 442, or 465.

Course Transfer and AP Standards

College science course transfer credits will need to be a C or better to be acceptable.

An Advanced Placement (AP) score of five in biology earns eight credits for BIOL 183 and 184; a score of four earns four credits (BIOL 184).

Marine Sciences Consortium

TCNJ is a member of the New Jersey Marine Sciences Consortium, a group of universities and colleges interested in education and research in the marine sciences. Extensive summer programs conducted at field stations along the New Jersey coastline are available to interested students. For details and course descriptions, please refer to TCNJ summer bulletin.

Biology Major: Teacher Preparation (BIOT)

Students planning to teach middle or high school biology should consult with Professor Lipton in planning their academic program. These plans should take into account requirements for: the major, general education, professional courses, and state certification. To be retained in the program, a student must earn at least a 2.5 cumulative grade point average (CGPA) before enrolling in SCED 303/Junior Professional Experience. The student must establish a minimum 2.75 CGPA in all science courses, and must have completed the biology core before he/she is allowed to student teach (BIOL 490).

Candidates for a teacher-education certificate must have a 2.75 CGPA and pass the appropriate Praxis examination before the New Jersey State Department of Education will issue the appropriate certificate. Teacher-education candidates will receive a "certificate of eligibility with advanced stand-ing" which requires a candidate to be provisionally certified for his/her first year of teaching. After one year of successful teaching, the candidate is eligible for a permanent certificate. The teacher candidate will also have to pay a fee during his/her first year of teaching.

Elementary Education/Biology Major and Early Childhood Education/Biology Major

A student who wants to major in biology and teach in an elementary school or who wants to major in biology and teach nursery school or young elementary school children must follow a modified teaching curriculum. For details see Professor Klug.

Four-Year Suggested Sequence BIOA

Freshman Year

BIOL	183, 184/General Biology I, II	8
CHEM	201, 202/General Chemistry I, II	8
RHET	101, 102/Rhetoric I, II	6
IDSC	151/Athens to New York	3
	Foreign Language	0–6*
	Electives	0–8
BIOL	100/Biology Freshman Seminar	1
	Total for year	**34**

Sophomore Year

BIOL	211/Cell and Molecular Biology	4
BIOL	261/Ecology and Field Biology	4
BIOL	Biology Option	4
CHEM	321, 322/Organic Chemistry I, II	8
IDSC	252/Society, Ethics, and Technology	3
	Foreign Language*	0–3
MATH	127, 128/Calculus I, II	6
	Electives*	0–3
	Total for year	**32**

Junior Year

BIOL	321/Genetics	4
BIOL	Biology Option	4
PHYS	191, 192/College Physics I, II	
or		
PHYS	201, 202/General Physics I, II	8
	Fine or Performing Arts (GE)	3
	History (GE)	3
	Literature (GE)	3
	Philosophy/Religion (GE)	3
	Social Sciences-Content (GE)	3
	Total for year	**31**

Senior Year

BIOL	498/Biology Seminar	2
BIOL	Biology Options	10
	Social Sciences-Process (GE)	3
	Electives	16
	Total for year	**31**

Students exempting three to nine credits of the foreign language requirement should substitute an equal number of elective credits.

Suggested Pre-Medical Curriculum (BIOA Major)

 A large number of students whose career goal is in medicine, dentistry, or other allied health fields pursue a premedical curriculum through enrollment as a biology major. Careful advisement within the department and through the Medical Careers Advisory Committee is provided. Using the following courses to fulfill requirements has been highly suc-

cessful in preparing students for such careers and facilitating their admission to appropriate medical or dental schools:

Mathematics:	MATH 127, 128
Physics:	PHYS 201, 202
Social Sciences:	PSYC 101 and any other social sciences course
Biology Options:	BIOL 413 and 332 and 10 credits of any other option courses
Chemistry:	CHEM 350

The above courses best prepare students for the Medical College Admissions Test (MCAT) and the course work during the first two years in medical school. Frequent advice should be sought from medical career advisers in the department (Shevlin, Fangboner, Kayne, Klug, Lipton, and O'Connell).

BIOL 100/Biology Freshman Seminar   1 cr.
(one meeting per week for 10 wks)
(annually—fall)
Required of all freshman biology majors, this course provides an orientation to higher education, to the The College of New Jersey community, and to the major program offered by the biology department, including, among other topics, its curriculum, advisement opportunities, career options, laboratory safety procedures, and facilities. An academic component involving a set of common readings may also be part of the course. Grading is pass/fail.

**BIOL 141, 142/Principles of Human Anatomy and   8 cr.
Physiology I, II**
(3 class hours, 3 lab hours)
(annually)
Prerequisites: Open only to nursing majors or by permission of instructor
Designed to meet the needs of students who wish to achieve an understanding of the structure and function of the human body. The concept of homeostasis will be emphasized. Includes a laboratory component that uses the cat as the dissection specimen. Opportunities for collecting and analyzing data are provided.

BIOL 181, 182/Principles of Biology I, II   8 cr.
(2 class hours, 1 recitation hour, 2 lab hours)
(annually)
Restriction: Not to be taken by biology majors without permission from the chair of the biology department
Prerequisite: Pass Basic Skills Reading (test or course)
Perspectives on the World: Science
Major principles of biology as they relate to humans are emphasized. Human evolution, bodily organization, physiology, and relatedness to other life forms are highlighted in the first semester. During the second semester, the human organism, populations, and ecosystems are stressed via focus on reproduction, genetics, behavior, interspecies relations, and environmental quality.

BIOL 183, 184/General Biology I, II   8 cr.
(3 class hours, 3 lab hours)
(annually)
Prerequisite: Pass Basic Skills math and reading tests or courses
Perspectives on the World: Science
For biology majors. Fundamentals of cellular and subcellular structures, genetics, evolution, metabolism, and organismal biology: morphology and physiology function in plants and animals. Students who are not science majors or are not planning to enter a health profession should consider taking BIOL 181–182 to fulfill their general education requirement in science.

BIOL 211/Cell and Molecular Biology   4 cr.
(3 class hours, 1 recitation hour)
(every semester)
Prerequisites: BIOL 183, 184
Corequisite: CHEM 321
An introduction to the nomenclature, origin, and function of essential molecules and cellular components of living organisms. Structural and functional characteristics of various eukaryotic and prokaryotic cells demonstrating that the molecular and cellular levels of organization are intimately integrated.

BIOL 212/Principles of Microbiology   4 cr.
(3 class hours, 3 lab hours)
(annually—spring)
Restriction: To be taken only by nursing majors
Prerequisites: Two semesters of biology and two semesters of chemistry
Study of microorganisms and their relationship to health and disease, biomedical research, and the balance of nature.

**BIOL 213/Laboratory Techniques in Cell   3 cr.
and Molecular Biology**
(2 class hours, 3 lab hours)
(annually—fall)
Prerequisites: BIOL 183, 184; CHEM 201, 202
A theoretical and practical presentation of the experimental laboratory techniques and instrumentation used in cell and molecular biology.

**BIOL 241, 242/Human Anatomy and   8 cr.
Physiology I, II**
(3 class hours, 3 lab hours)
(annually)
Prerequisites: BIOL 183, 184; CHEM 201, 202
A detailed study of the structure and function of the human body. Homeostatic mechanisms are emphasized. Laboratory experiences include dissection of the cat, study of human anatomy, microscopic anatomy of both the cat and human, and opportunities for the student to make quantitative studies of the physiological processes taking place in the human body.

BIOL 261/Ecology and Field Biology*   4 cr.
(3 class hours, 3 lab hours)
(every semester)
Prerequisites: BIOL 183, 184
An introduction to modern ecology. The interactions that determine the distribution, abundance, and function of organisms, populations, and species are examined both theoretically and practically within an evolutionary context. Topics covered include physiological ecology, optimization theory, natural selection, population biology, species interactions, community relationships, and ecosystem dynamics. Laboratory and field activities emphasize quantitative and experimental approaches to the study of ecology.

*Field trips may be required at the student's expense.

BIOL 312/Microbiology   **4 cr.**
(3 class hours, 3 lab hours)
(annually)
Prerequisites: BIOL 183, 184; CHEM 322
Fundamental concepts in microbiology and the relationship of microorganisms to disease, and the balance of nature. Laboratory emphasis: the physiology of bacteria, preparation and use of selective and differential media, and related methodology.

BIOL 313/Applied and Industrial Microbiology*   **4 cr.**
(3 class hours, 3 lab hours)
(alternate years)
Prerequisite: BIOL 312
Topics research, development, and quality control in water testing, food preparation, pharmaceutical manufacture, and medical diagnosis. Laboratory emphasizes manipulative skills and field trips.

BIOL 321/Genetics   **4 cr.**
(3 class hours, 3 lab hours)
(every semester)
Prerequisites: BIOL 183, 184 or 181, 182; CHEM 201, 202 or permission of instructor
Introduction to the major concepts of genetics and inherited variations; the nature, distribution, and expression of heredity information in representative plants and animals. Laboratory will emphasize analytical approaches used in genetic studies.

BIOL 332/Comparative Vertebrate Anatomy   **4 cr.**
(3 class hours, 3 lab hours)
(annually—spring)
Prerequisites: BIOL 183, 184 or permission of the instructor
Descriptive and functional comparative anatomy of representative vertebrates is developed with strong emphasis on the themes of phylogeny and ontogeny of organs and organ systems. Structural-functional relationships are also elucidated.

BIOL 341/Biology of Seed Plants*   **4 cr.**
(3 class hours, 3 lab hours)
(alternate years)
Prerequisites: BIOL 183, 184
The integration of form and function in angiosperms and gymnosperms emphasizing evolutionary patterns of development in vegetative and reproductive organs. Topics include plant anatomy and physiology, growth and development, plant classification, and plant ecology. Laboratory includes macro- and microanatomy, physiological experiments, outdoor studies, and field trips to plant habitats and gardens.

BIOL 342/Biology of the Invertebrates   **4 cr.**
(3 class hours, 3 lab hours)
(alternate years)
Prerequisites: BIOL 183, 184
A detailed consideration of the functional morphology and evolution of the animal phyla from the protozoa through the echinoderms. Adaptive radiation within the major groups is discussed and the interrelationships of the various phyla are analyzed. The laboratory experience encourages individual investigations of representative animals.

BIOL 343/General Entomology   **4 cr.**
(3 class hours, 3 lab hours)
(occasionally)
Prerequisites: BIOL 183, 184
Emphasis will be placed on the biology, morphology, physiology, taxonomy, and economic importance of insects. Evolution within the class will be woven into various lectures,

particularly those pertaining to morphology. Laboratory investigations include preparation of an insect collection.

BIOL 350/Biology of Fungi*   **4 cr.**
(3 class hours, 3 lab hours)
(alternate years)
Prerequisites: BIOL 183, 184
An introduction to the structure, physiology, ecology, genetics, classification, and economic importance of representative taxa of fungi. Laboratory topics parallel those of lecture but also include the initiation and maintenance of axenic fungal cultures.

BIOL 351/Developmental Biology   **4 cr.**
(3 class hours, 3 lab hours)
(annually)
Prerequisites: BIOL 183, 184, 211; CHEM 322
Corequisite: BIOL 321
Introduction to morphogenetics, cellular, genetic and epigenetic aspects of an organism's development. The study will explore classical and molecular approaches. Emphasis will be on the molecular mechanisms of development. Model systems will range from *C. elegans* and *Drosophila* to vertebrates.

BIOL 352/Biometry   **4 cr.**
(3 lecture hours, 3 lab hours)
(alternate years)
Prerequisites: BIOL 183, 184 or permission of instructor
Introduction to the use of statistical methods in the biological sciences. Emphasis is placed upon the application and interpretation of statistical analyses as an aid to drawing meaningful conclusions from field and laboratory investigations. Topics include: sampling methods, descriptive statistics, hypothesis testing, analysis of variance, correlation, regression, frequency analysis, and the design of experiments.

BIOL 370/Oceanography*   **4 cr.**
(3 class hours, 3 lab hours)
(alternate years)
Prerequisites: BIOL 183, 184; CHEM 201, 202
Introduction to physical, chemical, geological, and biological oceanography. Lecture and discussion topics include plate tectonics, bathymetry, physical and chemical properties of seawater, currents, waves, tides, open ocean and benthic ecosystems, estuarine, intertidal and coral reef ecology, and marine mammals. The laboratory will focus on biological oceanography and will include two one-day weekend field trips.

BIOL 371 Evolution   **4 cr.**
(3 class hours; 1 recitation hour)
(alternate years)

Prerequisites: BIOL 181, 182 or BIOL 183, 184; CHEM 201, 202
Nothing in biology makes sense except in light of evolution.
This famous quote by a renowned evolutionary biologist emphasizes the centrality of evolution to all fields of biology. BIOL 371 takes a multidisciplinary approach to the study of genetic change and the origination of biological diversity. Students will gain expertise in historical and modern perspectives of evolutionary theory and concepts, and explore the dynamic nature of evolutionary processes in the contemporary world.

*Field trips may be required at the student's expense.

BIOL 375/Environmental Quality,   **4 cr.**
Protection, and Health*
(3 class hours, 3 lab hours)
(annually—fall)
Prerequisites: CHEM 201, 202; BIOL 261 or permission of instructor
A multidisciplinary, scientific consideration of environmental problems, management, engineering, and law. Epidemiology, toxicology, and pathophysiology of environmental diseases are emphasized. Modeling simulations and case histories are included. Laboratory consists of assay for and interpretation of biological parameters that characterize natural and altered environments.

BIOL 387/Faculty-Student Research   **3 cr.**
Prerequisite: Junior standing
The course provides the opportunity for a small group of students (usually four to six) to work together with a faculty member on a collaborative project, or a series of related projects, that are part of a faculty member's ongoing research or scholarly program.

BIOL 397/Biology Internship   **3 or 6 cr.**
Prerequisites: Sophomore status, completion of at least 16 credits of biology and eight credits of chemistry courses, minimum GPA of 2.5 (for transfer students at least 12 credits in science at TCNJ), and departmental permission
Application of biological principles through completion of an approved supervised project in a paid or non-paid work setting. The first six credits count toward biology options. A student may take a maximum of six additional credits that will apply toward free electives. All placements must be approved by Professor Klug, who coordinates internships.

BIOL 410/Advances in Molecular Biology   **4 cr.**
(3 class hours, 3 lab hours)
(alternate years)
Prerequisites: BIOL 211, 321; CHEM 322
An in-depth study of the molecular basis of important biological processes of both prokaryotes and eukaryotes.

BIOL 411/Cell Physiology   **4 cr.**
(3 class hours, 3 lab hours)
(annually)
Prerequisites: BIOL 183, 184, 211; CHEM 322
A detailed examination of animal cell function. Laboratory experience involves familiarization with modern techniques in cell investigation; individual laboratory research projects are required.

BIOL 413/Microscopic Anatomy and   **4 cr.**
Techniques
(3 class hours, 3 lab hours)
(annually—fall)
Prerequisite: BIOL 211
A study of cells and tissues with emphasis on the techniques available for microscopic analysis of vertebrate organs.

BIOL 442/Applied Botany*   **4 cr.**
(3 class hours, 3 lab hours)
(occasionally)
Prerequisites: BIOL 183, 184; CHEM 201, 202
Integrates the fundamentals of plant growth, reproduction, metabolism, and disease with the utilization of plants by people. Topics include the history of agriculture, modern methods of plant breeding, and genetic engineering, and crop-growing techniques ranging from the chemistry intensive to organic. Also considered are plants as medicines in traditional societies and in the modern search for drugs, plants as herbs and spices, and plant conservation. In addition to experiments in lab and field collections of useful plants, the laboratory includes field trips to places where botany is practiced, such as an agricultural research firm, a native plant nursery, and a botanical garden.

BIOL 445/Introduction to Virology   **4 cr.**
(3 class hours, 3 lab hours)
(occasionally)
Prerequisites: BIOL 211, 312
An introduction to the viruses of eukaryotic and prokaryotic hosts. Basic principles and phenomena of virology will be stressed. Tissue culture, serologic tests, and isolation techniques will be introduced in the laboratory.

BIOL 446/Introduction to Immunology   **4 cr.**
(3 class hours, 3 lab hours)
(occasionally)
Prerequisites: BIOL 211, 312
An introduction to the fundamentals of immunology. Provides a background for understanding the immune system and basic serological techniques.

BIOL 463/Topics in Biology   **3–4 cr.**
(2–3 class hours, 0–3 lab hours, 0–1 recitation hour)
Prerequisites: BIOL 183, 184; CHEM 201, 202; other prerequisites as determined by the department
Selected topics which may vary from year to year.

BIOL 465/Physiological and Behavioral Ecology*   **4 cr**
(3 class hours, 3 lab hours)
(alternate years)
Prerequisite: BIOL 261
A detailed investigation into the role of physiological function and behavior in shaping the interactions among organisms and between organisms and their environment. Emphasis is placed upon the study of physiological and behavioral adaptations of animals to adverse environmental conditions. Topics examined will include the physiological and behavioral aspects of feeding, digestion, excretion, reproduction, metabolism, temperature regulation, and water balance.

BIOL 476, 477/Honors Independent Study   **3 or 6 cr.**
Prerequisite: Approval of the departmental honors adviser; to be used by students enrolled in The College Honors Program, if independent study is to count among their honors courses
An original laboratory or field research project under the supervision of a faculty member. The experience culminates in both a written and oral/poster presentation of the work to the department.

BIOL 487/Faculty-Student Research   **3 cr.**
Prerequisite: Senior standing
The course provides the opportunity for a small group of students (usually four to six) to work together with a faculty member on a collaborative project, or a series of related projects, that are part of a faculty member's ongoing research or scholarly program.

*Field trips may be required at the student's expense.

BIOL 488/Current Themes in Biology   **2 cr.**
(2 recitation hours)
(occasionally)
Prerequisites: Advanced standing and completion or enroll-
ment in BIOL 211, 261 and 321; or permission of the instruc-
tor. May be taken for credit as a biology option only once
Student discussions of readings centered around a common
topic or theme relevant to the study of modern biology. Em-
phasis is on the analysis, synthesis, and integration of ideas
and issues presented in assigned readings. Topics and themes
vary each offering.

BIOL 489/Secondary Education Biology   **1 cr.**
Student-Teaching Seminar
(1 class hour)
Corequisites: BIOL 490 and SCED 489
Discussion of and help with practical problems faced by the
student teacher and beginning teachers. Study of important
issues in science education. Course to be taken during stu-
dent-teaching semester.

BIOL 490/Student Teaching   **10 cr.**
(every semester)
Prerequisite: Meeting all criteria for admission to student
teaching
Student teaching during the senior year. Teaching in ap-
proved public schools, supervised and observed by college
and public school teachers. Observation, participation, and
responsible teaching.

BIOL 491/Electron Microscopy for Biologists   **4 cr.**
(3 class hours, 4 lab hours)
(annually—spring)
Prerequisites: BIOL 211 and permission of instructor
Theory and operation of the transmission and scanning
electron microscopes with special emphasis on applications
to biological studies. Basic principles and procedures for
preparation of biological specimens for electron microscopy.
In the laboratory, students will gain experience in the opera-
tion of the ultramicrotome, electron microscope, and the
necessary darkroom equipment. Limited to 12 students.

BIOL 498/Biological Seminar   **2 cr.**
(2 class hours)
(every semester)
Prerequisite: Completion of the biology core curriculum
Oral and written presentations by students in current re-
search topics oriented around a unifying theme. Primary and
secondary literature sources are utilized. May be taken for
credit more than once. Topics vary each semester.

BIOL 499/Independent Study in Biology   **1–6 cr.**
Prerequisites: Advanced standing in biology and a 2.5 GPA
overall and in all science courses taken at TCNJ
Pursuit of an original research project under the direction of
a supervising professor. Results and conclusions serve as the
basis of an oral or poster presentation to faculty and stu-
dents as well as a written paper submitted to the faculty
mentor.

PHYS 390/Methods of Teaching Science   **3 cr.**
(3 class hours)
Modern trends in content, methods, techniques, organiza-
tion, and philosophy of science education. Preparation for
student teaching.

Chemistry

Faculty: Dumas, *Chair;* Arvanitis, Bradley, P. Cohen,
Fleischer, Huang, Keller, Smith

The Department of Chemistry offers courses for the entire
student population in addition to specialty programs. It pre-
pares students for careers in the chemical industry and re-
search as well as for entrance to graduate school. Careful
selection of courses, with advisement by the department, can
also prepare a student for the field of teaching or for further
study toward degrees in professional fields such as medicine
and dentistry. Students interested in pursuing a career in
pharmaceutical sales and marketing can combine a major in
chemistry (CHMA) with a minor in marketing. See your ad-
viser or the chemistry chairperson for more information.

The chemistry department is accredited by the American
Chemical Society. Students completing the chemistry major
will receive a Bachelor of Science degree.

Transfer students are required to take a minimum of 15
credits of chemistry courses numbered CHEM 300 or above
(including a minimum of two laboratory electives) for grad-
uation as chemistry majors from The College of New Jersey.

Those students wishing honors in chemistry may earn
that diploma designation by successfully completing a series
of ACS examinations and a research project.

Chemistry Major (CHMA)

Freshman Year

CHEM	100/Freshman Chemistry Seminar	0
CHEM	201, 202/General Chemistry I, II	8
PHYS	201, 202/General Physics I, II	8
MATH	127, 128/Calculus I, II	6
RHET	101, 102/Rhetoric I, II	6
IDSC	151/Athens to New York	3
	Total for year	**31**

Sophomore Year

CHEM	331, 332/Organic Chemistry I, II	8
CHEM	303/Descriptive Inorganic Chemistry	3
CHEM	391/Physical Chemistry I	3
CHEM	316/Sophomore Chemistry Seminar	1
CMSC	215/Computer Science I	3
IDSC	252/Society, Ethics, and Technology	3
	Foreign Language*	0–6
	Perspectives on the World (GE)	3
	Electives	0–11
	Total for year	**32**

Junior Year

CHEM	310/Analytical Chemistry	3
CHEM	392/Physical Chemistry II	3
CHEM	403/Physical Chemistry Laboratory	3
CHEM	317/Junior Chemistry Seminar	1
CHEM	450/Inorganic Chemistry	3
	Foreign Language*	0–3
	Perspectives on the World (GE)	9
	Electives	9–12
	Total for year	**34**

Students exempting three to nine credits of the foreign language requirement should substitute the same number of electives.

Senior Year

CHEM	318/Senior Chemistry Seminar	1
CHEM	410/Advanced Analytical Chemistry	3
CHEM	Chemistry Laboratory Option	3
CHEM	430/Biochemistry	3
CHEM	455/Advanced Inorganic Chemistry	
or		
CHEM	457/Organometallics	3
	Perspectives on the World	6
	Electives	12
	Total for year	**31**

Program Entrance, Retention, and Exit Standards

Every major program at The College has set standards for allowing students to remain in that program, to transfer within The College from one program to another, and to graduate from a program. The following are the standards for chemistry programs. Minimum grades are noted in parentheses:

■ Retention in the program is based on the following performance standards in these "critical content courses": CHEM 201 and 202 General Chemistry I and II (C); CHEM 331 Organic Chemistry I (C).

■ Transfer into the program from another program within The College is based upon the following performance standards in these "foundation courses": CHEM 201/General Chemistry (C); MATH 127/Calculus I (C).

■ Graduation requires a GPA of 2.0 in courses for the program.

Pre-Health Profession Option for Chemistry Majors

Students interested in health-related careers such as medicine, dentistry, pharmacy, etc. may study for admission to these professional schools through chemistry major CHMA (above). Careful selection of courses within this major and within free electives will prepare the student to meet health professional school admission requirements. Those interested in such careers are urged to contact Professors Lynn M. Bradley, Jan Fleischer, or Paul Cohen who are the chemistry department advisers for health careers. (See also Medical Career Advisory Committee.)

Chemistry Major: Teacher Preparation (CHMT)

Candidates for a teacher-education certificate must have a 2.75 cumulative grade point average, meet the state hygiene/physiology requirement, and pass the appropriate Praxis examination before the New Jersey State Department of Education will issue the appropriate certificate.

Teacher-education candidates will receive a "certificate of eligibility with advanced standing" which allows a candidate to be provisionally certified for his or her first year of teach-

ing. After one year of successful teaching, the candidate is eligible for a permanent certificate. The teacher candidate will also have to pay a fee during his or her first year of teaching.

Freshman Year

CHEM	100/Freshman Chemistry Seminar	0
CHEM	201, 202/General Chemistry I, II	8
PHYS	201, 202/General Physics I, II	8
MATH	127, 128/Calculus I, II	6
RHET	101, 102/Rhetoric I, II	6
IDSC	151/Athens to New York	3
	Total for year	**31**

Sophomore Year

CHEM	331, 332/Organic Chemistry I, II	8
CHEM	303/Descriptive Inorganic Chemistry	3
CHEM	391/Physical Chemistry I	3
CHEM	316/Sophomore Chemistry Seminar	1
IDSC	252/Society, Ethics, and Technology (GE)	3
SCED	203/Sophomore Professional Experience	2
RDLA	328/Teaching Reading in Middle through Senior H.S.	2
	Foreign Language (GE)	0–6
	Perspectives on the World (PA) or (PL)	3
	Total for year	**31**

Junior Year

CHEM	310/Analytical Chemistry	3
CHEM	392/Physical Chemistry II	3
CHEM	403/Physical Chemistry Laboratory	3
CHEM	317/Junior Chemistry Seminar	1
CHEM	450/Inorganic Chemistry	3
SCED	303/Junior Professional Experience	6
PSYC	101/General Psychology (GE) (PSC)	3
SOCL	101/Introductory Sociology (GE) (PSP)	3
PHIL	230/Philosophical Issues in Science (PP)	3
PHYS	390/Methods of Teaching Science	3
	Foreign Language (GE)	3
	Total for year	**34**

Senior Year

CHEM	318/Senior Chemistry Seminar	1
CHEM	410/Advanced Analytical Chemistry	3
CHEM	340/History of Chemistry and Physics (PH)	3
CHEM	489/Chemistry Teaching Seminar	1
CHEM	490/Student Teaching and Seminar	10
SCED	489/Seminar Student Teaching	1
EDFN	403/School in American Culture	3
	Perspectives on the World (PA) or (PL)	3
	Advanced Physics Elective-300 level or higher	3
	Free Electives*	4
	Total for year	**32**

Teacher preparation majors seeking American Chemical Society certification must also complete two chemistry laboratory electives.

Elementary Education M/S/T (ELST) and Early Childhood Education M/S/T (ECST) with a Chemistry Specialization

This interdisciplinary major integrates formal study in mathematics, biology, chemistry, physics, and technology. Students electing a chemistry specialization will complete 42 credits of "core" requirements including Calculus (MATH 127–128), Principles of Biology (BIOL 181–182), General

Chemistry (CHEM 201–202), College Physics (PHYS 191–192), Introduction to Human Technological Behavior (TSNG 171), Principles of Structures and Mechanisms (TSNG 211), and an M/S/T-approved elective. The chemistry specialization consists of a minimum of 21 credits including the core chemistry courses, (CHEM 321–322 Organic I, II), and two chemistry elective courses (five-credit minimum) at the 300 level or higher.

Chemistry Minor

Twenty-one (21) credits in CHEM courses including CHEM 201, 202 and other CHEM courses numbered 300 or higher, but not including CHEM 316, 317, 318, 340, 490, 495, or 499.

CHEM 100/Freshman Chemistry Seminar   0 cr.
(1 class hour)
(annually)
Required of all freshman chemistry majors, this course provides an orientation to The College of New Jersey community; to chemistry faculty; and to the chemistry liberal arts and chemistry education programs offered by the Department of Chemistry including, among other topics, advisement opportunities, curriculum and scheduling, laboratory safety procedures, facilities, professional societies and student affiliates, career options, and the American Chemical Society Code of Ethics. The academic component, involving common readings and assignments, is part of the course requirements. Grade is P/U.

CHEM 101, 102/Principles of Chemistry I, II   8 cr.
(3 class hours, 3 lab hours each semester)
(annually)
Restriction: Science, nursing, health, or mathematics majors should take CHEM 201, 202; not CHEM 101, 102
Perspectives on the World: Science
Development of modern chemical concepts regarding the structure and behavior of matter on a macroscopic and atomic level. Emphasis upon understanding the vital role of chemistry in our culture. Selected relevant topics such as environmental pollution, atomic energy, food, macromolecules, and biochemical processes are included.

CHEM 201, 202/General Chemistry I, II   8 cr.
(3 class hours, 3 lab hours each semester)
(every semester)
Laws and theories of matter in its various states: atomic and molecular structure from quantum and orbital interpretations; kinetics and equilibrium; periodicity and properties. Quantitative experiments coordinated with lectures. A working knowledge of elementary algebra is required. A high school chemistry course is strongly recommended. Math basic skills must be satisfactorily completed before registering for this course.

CHEM 303/Descriptive Inorganic Chemistry   3 cr.
(2 class hours, 3 lab hours)
(annually)
Prerequisite: CHEM 202
The chemistry of families of elements with emphasis on the more important members. Occurrence, metallurgy, properties, compounds, uses, and analytical behavior are stressed.

**CHEM 304/Qualitative and Spectroscopic   3 cr.
Techniques in Inorganic Chemistry**
(2 class hours, 4 lab hours)
(alternate years)
Prerequisites: CHEM 201, 202
A descriptive study of the modern concepts of inorganic chemistry emphasizing structure determination by spectroscopic methods in inorganic chemistry including one-dimensional heteronuclear NMR, near and far IR, magnetic susceptibility, and optical rotary dispersion. Qualitative methods are employed to aid in the determination of elemental composition.

CHEM 310/Analytical Chemistry   3 cr.
(2 class hours, 4 lab hours)
(annually)
Prerequisite: CHEM 202
A study of quantitative analysis including analytical data treatment, equilibrium calculation, volumetric determination, and potentiometry.

CHEM 316/Sophomore Chemistry Seminar   1 cr.
(1 class hour)
(annually)
Prerequisite: Freshman seminar, CHEM 100
A seminar course designed for sophomore chemistry majors. Included in this course are: use of the chemistry computer center for scientific word processing, molecular-modeling programs, and other software computer programs needed by the chemist. Other topics include use of the chemical literature such as *Chemical Abstracts* and the library computer search program DIALOG. Professionalism and ethics will also be discussed.

CHEM 317/Junior Chemistry Seminar   1 cr.
(1 class hour)
(annually)
Prerequisite: CHEM 316
One-credit course designed to explore career options within the field of chemistry. Topics include graduate school applications and opportunities, internships, departmental research, and career presentations. A final oral and written research project is also required.

CHEM 318/Senior Chemistry Seminar   1 cr.
(1 class hour)
(annually)
Prerequisite: CHEM 317
A course designed for senior chemistry majors. Oral and written papers will be presented on current chemical literature and each student will be required to develop, present, and defend an original research proposal to the class.

CHEM 321, 322/Organic Chemistry I, II   8 cr.
(3 class hours, 3 lab hours)
(annually)
Restriction: Chemistry majors require CHEM 331, 332, not CHEM 321, 322
Prerequisite: CHEM 202
Coverage in lectures is similar to that in CHEM 331, 332 but laboratory meetings are designed in accordance with the needs of students majoring in biology.

CHEM 331, 332/Organic Chemistry I, II   **8 cr.**
(3 class hours, 4 lab hours)
(annually)
Restriction: Required for chemistry majors
Prerequisite: CHEM 202
The chemistry of organic compounds with emphasis on re-action mechanisms. Theory and descriptive material on aliphatic, alicyclic, aromatic, and heterocyclic compounds.

CHEM 340/History of Chemistry and Physics   **3 cr.**
(3 class hours)
(annually)
Prerequisite: One year of a college science
The principles of chemistry and physics and the interaction of chemistry, physics, and society from earliest times through modern times and on into the future are studied. The work of selected chemists, physicists, the evolution of energy, mechanics, atomic structure and other modern theo-ries, the development of various chemical industries, the im-portance of environmental concerns, and other currently important subjects will be examined. Admission without prerequisite by permission of instructor only.

CHEM 341/Organic Spectroscopy Laboratory   **3 cr.**
(2 class hours, 4 lab hours)
(annually)
Prerequisites: CHEM 321 or 331 and 322 or 332
A study of the modern concepts of structure determination in organic chemistry by spectroscopic methods, emphasizing one- and two-dimensional 1H and 13C NMR, IR and mass spectroscopies.

CHEM 345/Fundamentals of Chemical Instrumentation   **3 cr.**
(1 class hour, 4 lab hours)
(occasionally)
Restriction: Not applicable to chemistry major
Prerequisite: CHEM 332 or 322
A laboratory course emphasizing the use and application of specialized chemical instruments.

CHEM 350/Essentials of Biochemistry   **3 cr.**
(3 class hours)
(annually)
Restriction: Not open to chemistry majors
Prerequisites: BIOL 211; CHEM 332 or 322
A one-semester lecture course covering amino acids and pro-teins, intermediary metabolism, lipids, carbohydrates, and the biochemistry of nucleotides, DNA and RNA. Designed for science majors with no background in physical chemistry.

CHEM 365/Chemical Aspects of the Environment   **3 cr.**
(3 class hours)
(occasionally)
Prerequisite: Six credits of college science
Chemical processes involved in the environment with em-phasis on pollution and its control.

CHEM 391, 392/Physical Chemistry I, II   **6 cr.**
(3 class hours)
(annually)
Prerequisites: CHEM 202, MATH 228, PHYS 201
A study of thermodynamics, kinetics, quantum mechanics, statistical mechanics, and other areas fundamental to an un-derstanding of the physical behavior of matter.

CHEM 403/Physical Chemistry Laboratory   **3 cr.**
(6 lab hours)
(annually)
Prerequisite: CHEM 392
Laboratory experiments that apply physical principles to sys-tems of chemical interest. Use of modern instrumentation is emphasized, as is statistical treatment of data.

CHEM 410/Advanced Analytical Chemistry   **3 cr.**
(2 class hours, 4 lab hours)
(annually)
Prerequisites: CHEM 310, 392, 403
A study of principles, applications and operations of chemi-cal instrumentation.

CHEM 415/Separation Science   **3 cr.**
(2 class hours, 4 lab hours)
(alternate years)
Prerequisite: CHEM 410
A study of the principles and applications of a variety of chemical separation processes with an emphasis on modern chromatographic methods.

CHEM 420/Advanced Organic Chemistry   **3 cr.**
(2 class hours, 4 lab hours)
(alternate years)
Prerequisites: CHEM 322 or 332 and CHEM 392
A detailed study of the mechanisms and kinetics of organic reactions. Advanced synthetic techniques are also studied.

CHEM 430/Biochemistry   **3 cr.**
(2 class hours, 4 lab hours)
(occasionally)
Prerequisites: CHEM 332 or 322 and CHEM 392
The fundamental principles of chemistry as they apply to bi-ological and physiological processes.

CHEM 450/Inorganic Chemistry   **3 cr.**
(3 class hours)
(annually)
Prerequisites: CHEM 303 and CHEM 392
Modern structural concepts of inorganic chemistry coupled with recent interpretations of inorganic reaction mechanisms.

CHEM 455/Advanced Inorganic Laboratory Techniques   **3 cr.**
(2 class hours, 4 lab hours)
(alternate years)
Prerequisites: CHEM 391, 392, 410, 450
A study of advanced techniques in the synthesis, characteri-zation, and identification of inorganic compounds. These techniques will include nuclear magnetic resonance, infrared spectroscopy, chromatography, stereochemical methods, and magnetic measurements.

CHEM 457/Organometallic Chemistry Laboratory   **3 cr.**
(2 class hours, 4 lab hours)
(alternate years)
Prerequisites: CHEM 391, 392, 450
A study of modern concepts of structure and bonding in organotransition metal chemistry emphasizing synthetic methods, catalysis, and reaction mechanisms.

CHEM 480/Selected Topics in Chemistry   **3 cr.**
(3 class hours, or 2 class hours and 4 lab hours)
(occasionally)
Prerequisite: Approval of department chair
Selected topics of current relevance and interest in chemistry
will be presented by faculty and guest lecturers with special
areas of competency. Topics will be announced in advance.

CHEM 489/Chemistry Teaching Seminar   **1 cr.**
(every semester)
Analysis of student-teaching experience, which must be
taken concurrently with CHEM 490.

CHEM 490/Student Teaching   **10 cr.**
(half time for one semester)
Prerequisite: Meeting all criteria for admission to student
teaching
Student teaching during the senior year. Teaching in ap-
proved public schools, supervised and observed by college
and public school teachers. Observation, participation, and
responsible teaching.

CHEM 495/Internship in Chemistry   **1–6 cr.**
See department chairperson for further information.

CHEM 499/Independent Study in Chemistry   **3–6 cr.**
(hours to be arranged)
(every semester)
Prerequisites: CHEM 322, 332, 392
Designed for upper-level students who are majoring in
chemistry. Individual research projects are pursued under
the guidance of faculty. Chemistry minors may take three
credits of this course with approval of the chemistry depart-
ment chair. (May be repeated for credit with approval of de-
partment chair.)

Computer Science

Faculty: Wolz, *Chair;* Knox, Martinovic, Neff, Sampath
*Faculty from mathematics with joint teaching appointments in
computer science:* Conjura, Greenbaun, Iannone

The computer science curriculum is designed to prepare stu-
dents for employment as computer science specialists, and
provide a strong background for advanced study. The degree
offered is a BS in Computer Science. All students take
courses in programming fundamentals, software engineer-
ing, data structures, operating systems, compilers, and com-
puter organization and algorithm analysis. Upper-level
options provide exposure to a range of subdisciplines in-
cluding, but not limited to artificial intelligence, databases,
graphics, networks and programming languages. Students
are also required to participate in a "practicum" experience
in research or industry. All students also take extensive
course work in mathematics and science, as well as a broad
base in arts, humanities, history, and the social sciences.

Requirements for the Major

I. Required Core Courses
EITHER:
CMSC   220/CS I: Computational Problem Solving
   and
CMSC   230/CS II: Data Structures

or
CMSC   250/Accelerated CS 1, 2

REMAINING REQUIRED COURSES
CMSC   210/Discrete Structures of Computer Science
CMSC   325/Computer Architecture
CMSC   330/Operating Systems
CMSC   340/CS III: Programming in the Large
CMSC   410/Advanced Analysis of Algorithms
CMSC   434/Compilers and Interpreters

II. Computer Science Options
Select 18 credits from the following list. Students who take
CMSC 250 must select 21 credits. Students may take addi-
tional options courses for free elective credit.

PART A: Choose nine credits from the following:
CMSC   350/Digital Computer Graphics
CMSC   360/Networks
CMSC   370/Stack Machines
CMSC   380/Artificial Intelligence
CMSC   390/Programming Languages
CMSC   446/Database Management Systems
CMSC   485/Topics in Computer Science

PART B: Choose six credits from the following:
CMSC   493/Internship II in Computer Science
CMSC   497/Research/Presentation Seminar in Computer
        Science

PART C: Choose three (3) credits from either Part A or B or:
CMSC   499/Independent Study in Computer Science

III. Required Mathematics Courses
MATH   127/Calculus I
MATH   128/Calculus II
MATH   205/Linear Algebra I
MATH   215/Statistical Inference

IV. Computer Science Natural Science Options
One laboratory course beyond the general education science
requirement either in the same science or in another science.
Consult the department for details.

Program Entrance, Retention, and Exit Standards

Every major program at The College has set standards for al-
lowing students to remain in that program, to transfer within
The College from one program to another, and to graduate
from a program. The following are the standards for computer
science programs. Minimum grades are noted in parentheses:

- Retention in the program is based on the following
  performance standards in these "critical content
  courses": CMSC 210/Discrete Structures of Computer
  Science (C); CMSC 220/Computer Science I: Compu-
  tational Problem Solving (C); CMSC 230/Computer
  Science II: Data Structures (C).

- Transfer in the program from another program
  within The College is based upon the following per-
  formance standards in these "foundation courses":
  MATH 127/Calculus (C); CMSC Computational
  Problem Solving (C–).

■ Graduation requires a GPA of 2.0 in computer science overall and a grade of C in the following courses: CMSC 210/Discrete Structures of Computer Science; CMSC 220/Computer Science I: Computational Problem Solving; CMSC 230/Computer Science II: Data Structures; CMSC 340/Computer Science III: Programming in the Large.

Computer Science Minor

I. Required Courses
CMSC	210/Discrete Structures of Computer Science	
CMSC	220/CS I: Computational Problem Solving	
CMSC	230/CS II: Data Structures	
CMSC	340/CS III: Programming in the Large	

II. Options for Computer Science Minor
An additional six credits chosen from the following: CMSC 325, CMSC 330, CMSC 350, CMSC 360, CMSC 370, CMSC 380, CMSC 390, CMSC 410, CMSC 434, CMSC 446, CMSC 497, CMSC 499.

Minimum grade point average for the minor is the same as for the major.

Department Academic Regulations

A minimum of 21 credits in the major must be earned in the department. A minimum of 15 of the final 21 credits in the major must be earned in the department.

Advanced Placement—If a student has a strong background in a particular major course, then he/she may achieve advanced placement in one of three ways: 1) credit by examination; 2) waiver of the course; or 3) Advanced Placement Credit. Students given permission to waive a course are required to replace it with an upper-level (300 or 400) course.

Four-Year Suggested Sequence

CMSC 215, IDSC 105, and HONR 280 may not be taken by computer science majors except with special permission of the department and then only as free electives.

Students who take CMSC 250 accelerate requirements through their junior year.

Freshman Year
CMSC	099/Department Orientation Seminar	0
CMSC	220/CS I: Computational Problem Solving	4
CMSC	230/CS II: Data Structures	4
MATH	127/Calculus I	3
MATH	128/Calculus II	3
IDSC	151/Athens to New York	3
RHET	101/Rhetoric I	3
RHET	102/Rhetoric II	3
	Foreign Language	6
	Humanistic and Artistic Perspectives	3
	Total for year	**32**

Sophomore Year
CMSC	210/Discrete Structures of Computer Science	3
CMSC	340/CS III: Programming in the Large	4
CMSC	325/Computer Architecture	4
	Computer Science Option	3
MATH	215/Statistics and Probability	3

IDSC	252/Society, Ethics and Technology	3
	Foreign Language	3
	Social Sciences	3
	Free Electives	6
	Total for year	**32**

Junior Year
CMSC	330/Operating Systems	3
CMSC	434/Compilers and Interpreters	3
MATH	205/Linear Algebra	3
	Computer Science Options	9
	Natural Sciences	8
	Humanistic and Artistic Perspectives	6
	Total for year	**32**

Senior Year
CMSC	410/Advanced Data Structures and Algorithms	3
	CS Options	6
	CS Science Options	4
	General Education Requirements	6
	Free Electives	13
	Total for year	**32**

All computer science courses require prior completion of the College Basic Skills Requirements in mathematics, reading, and writing.

CMSC 210/Discrete Structures of Computer Science   3 cr.
(3 class hours)
(every semester)
Prerequisite: MATH 127
Concepts and structures fundamental to computer science. Declarative programming techniques will be used to explore discrete structures. Topics will include logic, relations, functions, word algebras, induction, and recursion.

CMSC 215/Computer Science I for Science and   3 cr.
Engineering
(3 class hours)
(every semester)
A first course in computer science for science, mathematics, and engineering science majors. Emphasis is on using computational methods to solve scientific problems. The programming languages C/C++ or Fortran will be used to teach structured programming and algorithm development. Topics include control structures, data typing, including structures and arrays, parameterized procedures, and recursion as well as simple I/O control. **This course may not be taken by computer science majors without permission of the department, and then only for free elective credit.**

CMSC 220/Computer Science I: Computational   4 cr.
Problem Solving
(4 class hours)
(every semester)
A first course in computer science for computer science majors in which students learn to express algorithmic ideas in an abstract manner. An object-oriented language such as Java will be introduced; however, the emphasis is on algorithmic design and implementation rather than language mechanics. Students will become intimately familiar with expressing mathematical ideas as programs.

CMSC 230/Computer Science II: Data Structures   **4 cr.**
(4 class hours)
(every semester)
Prerequisite: CMSC 220 with a grade of C or higher
A second course in computer science in which students learn
how the algorithms and structures studied in CMSC 220 are
implemented on a sequential machine. Classic data struc-
tures (lists, queues, stacks, trees, and tables) and algorithms
(searching and sorting) are considered, but the emphasis is
on analysis. First analysis of implementation techniques is
addressed by studying the trade-offs between static and dy-
namic structures. Second analysis of efficiency is studied first
informally and then using formal proof techniques. The im-
plementation of the object-oriented paradigm is also shown
via Java.

CMSC 250/Accelerated CS I, II   **4 cr.**
(4 class hours)
(annually)
Prerequisite: Permission of the department
A first course in computer science for students with exten-
sive experience programming, or those who have placed
above a standard set by the department on the CS AP exam.
It is also for those with some computer science background
who have gaps in their knowledge of the standard CS 1/CS 2
curriculum or took these courses elsewhere but have no ex-
perience programming in the programming language or
paradigm that supports our CS 1 and 2 sequence. The course
covers the material of CMSC 220 (CS 1) and CMSC 230 (CS 2)
in one semester. The basic introduction to programming of
CMSC 220 is considered a review, while the emphasis on
problem solving and solution design is presented within the
context of a thorough grounding in the classic data struc-
tures using the modern object-oriented framework. **NOTE:**
Students who take this course must complete a single addi-
tional free elective credit as well as an additional three credits
of CS options course or receive Advanced Placement credit.

CMSC 325/Computer Architecture   **4 cr.**
(4 class hours)
(annually)
Prerequisites: CMSC 210 and CMSC 230, both with a grade
of C or higher
The levels of abstraction in computer hardware are exam-
ined in theory and practice. The classic components of a
computer system including CPU control and datapath, ALU,
memory, and input/output are covered, with supporting case
studies in design and simulation. The use of a register trans-
fer language is examined. Hardwired control and micro-
programming control are examined in support of the
implementation of a machine language. A design project ties
together machine organization, assembly language program-
ming, and logic and design fundamentals. In addition to tra-
ditional architectures, high-performance computing is
considered, including CISC/RISC studies, pipelined architec-
tures, and parallel processors.

CMSC 330/Operating Systems   **3 cr.**
(3 class hours)
(annually)
Prerequisites: CMSC 325, CMSC 340, the latter with a grade
of C or higher
Study of resource management implemented by an operat-
ing system in multiprogramming environment with respect
to CPU, memory, file, and device. Emphasis on program-

ming techniques leading to system software design, develop-
ment, and implementation.

CMSC 340/Computer Science III: Programming   **4 cr.**
in the Large
(4 class hours)
(annually)
Prerequisite: CMSC 230 with a grade of C or higher
This course introduces the principles of the design and de-
velopment of large software systems. Students are expected
to apply those principles to the solution and implementation
of real-world problems. Students will learn C++, focusing on
object-oriented programming techniques. Algorithm com-
plexity will continue to be studied informally. Documenta-
tion and product presentation will be expected.

CMSC 350/Digital Computer Graphics   **3 cr.**
(3 class hours)
(annually)
Prerequisites: CMSC 340, CMSC 210, both with a grade of C
or higher
A thorough grounding in the fundamental principles of digi-
tal computer graphics methods for students with both com-
puter science and mathematical sophistication. Emphasis is
on algorithms and methods, not on using canned graphics
packages. Digital display devices, scan conversion algorithms,
windows and viewports, coordinate transformations in two
and three dimensions, projections, perspective transforma-
tions, clipping, systems of graphics procedures, interactive
graphic input, hard copy devices, half-toning, splines and
Bezier curves, hidden line and surface removal, and fractals.

CMSC 360/Networks   **3 cr.**
(3 class hours)
(annually)
Prerequisites: CMSC 210, CMSC 340, both with a grade of C
or higher
This course will introduce concepts of network program-
ming. The emphasis will be on protocols used to communi-
cate between various implementations of UNIX, as well as
PCs, Macs, and other systems. Topics include: ethernet, to-
ken ring, fiber-optic topologies; IP, ICMP, UDP, TCP proto-
cols; applications such as telnet, ftp, ping; ATM networks.
Laboratory experiences will include the use of network view-
ing tools such as traceroute, tcpdump, and dig. Network
applications will be written in such languages as C, Perl,
and TCL.

CMSC 370/Stack Machines   **3 cr.**
(3 class hours)
(occasionally)
Prerequisite: CMSC 325
The application and implementation of virtual stack ma-
chines and other intermediate-level models of computation.

CMSC 380/Artificial Intelligence   **3 cr.**
(3 class hours)
(annually)
Prerequisites: CMSC 210, CMSC 230, both with a grade of C
or higher
The study of how to make the computer behave intelligently.
Topics: state-space methods of problem solving, heuristic
search techniques, representation and use of knowledge, ap-
plications and design of expert systems, natural language
processing, vision and image understanding, and program-
ming in LISP, Prolog, or any of the latest AI languages.

CMSC 390/Programming Languages **3 cr.**
(3 class hours)
(annually)
Prerequisites: CMSC 210 and CMSC 340, both with a grade
of C or higher
This course covers alternatives to the imperative procedural
programming paradigm. Included are object-oriented, func-
tional, and logic programming. The emphasis is on language
design, use, and implementation.

CMSC 393/Internship I in Computer Science **3–6 cr.**
(every semester)
Prerequisite: Permission of internship coordinator
Counts as a general elective course. A supervised computer-
related field experience in industrial, governmental, or pri-
vate sector. Faculty supervisor advises the student where to
focus the learning objective for the given internship. Grading
is pass/unsatisfactory. Courses graded in a P/U basis are not
counted as part of the 64 semester hours of letter-graded
courses required for graduation with honors.

CMSC 410/Advanced Analysis of Algorithms **3 cr.**
(3 class hours)
(annually)
Prerequisites: CMSC 210 and CMSC 340, both with a grade
of C or higher
This course presents the major principles of algorithm de-
sign and analysis, and applies those principles to classical
problems in computer science. Topics include complexity,
advanced ADTs, searching and sorting, graph search and
traversal, dynamic programming, theoretical computer sci-
ence, operations on polynomials and matrices, and pattern
matching.

CMSC 434/Compilers and Interpreters **3 cr.**
(3 class hours)
(annually)
Prerequisites: CMSC 210 and CMSC 340, both with a grade
of C or higher
Theory and practice of designing and implementing lexical
analyzers, compilers, interpreters, and macro assemblers.
Formal language theory, regular expressions, Backus-Naur
form, formal and informal specification of semantics. Deter-
ministic and nondeterministic finite state automata, recur-
sive descent and predictive parsing, and code generation.
Issues of programming language design.

CMSC 446/Database Management Systems **3 cr.**
(3 class hours)
(annually)
Prerequisites: CMSC 210 and CMSC 340, both with a grade
of C or higher
This course introduces the student to abstracts of well-
known database systems and the design and implementation
of a database system using a relational database package.

CMSC 485/Topics in Computer Science **3 cr.**
(3 class hours)
(every semester)
Prerequisites: CMSC 210 and CMSC 340, both with a grade
of C or higher
Study of an advanced topic in computer science chosen by
the instructor. Normally taken by junior or senior computer
science majors, this course may be elected several times, as
long as the topics differ.

CMSC 493/Internship II in Computer Science **3–6 cr.**
(every semester)
Prerequisite: Permission of instructor
A supervised computer-related field experience in indus-
trial, governmental, or private sector. Faculty supervisor ad-
vises the student where to focus the learning objective for the
given internship. A project at the internship is to be the level
of research in junior/senior independent study topics in
computer science. Grading is a letter grade. Paper and public
lecture required.

CMSC 497/Mentored Research in Computer Science **3 cr.**
(3 class hours)
(every semester)
Prerequisite: Permission of instructor
Intensive study of an advanced topic in computer science
under the supervision of a faculty mentor. Emphasizes stu-
dent activity, use of journals and monographs, discussions,
solution and presentations of problems. This course culmi-
nates in the writing of a journal-style paper and the presen-
tation of a public lecture.

CMSC 499/Independent Study in Computer Science **3 cr.**
(every semester)
Prerequisite: By invitation only
Student will study independently an appropriate area. A fac-
ulty adviser and a project description must be agreed upon
before registering for this course.

Mathematics and Statistics

Faculty: Conjura, *Chair;* Alves, Clark, Clifford, Cunningham,
Curtis, Greenbaun, Hagedorn, Hingston, Holmes, Iannone,
Kardos, Lee, Liebars, Navard, Papantonopoulou, Reimer,
Solano, Wang, Zheng

The Department of Mathematics and Statistics offers pro-
grams in three areas: statistics, mathematics, and mathemat-
ics teaching. In each of these programs, students are
provided with a basic mathematical background which will
be utilized in advanced study in one of these areas:

Mathematics (MATA)—This program is built on a strong ba-
sis of mathematics, including analysis and abstract algebra.
Each student will develop a program, through advisement, of
18 credits of upper-level mathematics courses according to
his or her own interests, which reflect the student's goal: ei-
ther graduate study or preparation for employment.

Mathematics Education (MATT)—In this program students
take mathematics and professional courses which qualify for
a mathematics degree and prepare them to meet the educa-
tional requirements for the New Jersey certificate to teach
mathematics K–12. Students participate in student-teaching
experiences in both their junior and senior years.

Statistics (MATC)—This program builds upon mathematical
skills acquired in the freshman and sophomore years so that
students become equipped with the knowledge necessary to
enable them to apply advanced statistical techniques to a wide
variety of real-life problems arising in application areas such
as business, government, and research. Students are prepared
to enter either graduate study or employment as a statistician.

Requirements for the Major

Mathematics (MATA)—Forty-eight credits in mathematics courses including: MATH 127, 128, 200, 205, 229, 230, 305, 306, 402, 420 and eighteen credits of upper-level mathematics options.

Mathematics Education (MATT)—Forty-eight credits in mathematics, statistics, and computer science courses including: MATH 127, 128, 200, 205, 229, 230, 305, 306, 316, 351, 355, STAT 215, CMSC 215, nine credits of mathematics options, and twenty-eight credits of professional courses.

Statistics (MATC)—Forty-eight credits in mathematics, statistics, and computer science courses including: MATH 127, 128, 200, 205, 229, 230, 316, CMSC 215, STAT 215, 410, twelve credits of upper-level statistics options and six credits of upper-level mathematics options.

Academic Regulations

Departmental Grade Prerequisite Requirement—Majors must earn a minimum grade of C– in a course which is prerequisite to another course in order to register for the subsequent course.

Departmental Transfer Credit Policy—Only grades of C– or better are accepted in transfer to meet the requirements of a major or minor within the department.

Graduation Requirements—A minimum of 21 credits in the major must be earned in the department. A minimum of 15 of the final 21 credits in the major must be earned in the department.

Advanced Placement—If a student has a strong background in a particular mathematics course, then he/she may achieve advanced placement in one of two ways: 1) credit by examination; or 2) waiver of the course. Students given permission to waive a course are required to replace it with an upper-level (300 or 400) major course.

Basic Skills Testing Requirement—Any student who has not satisfied The College basic skills requirement in mathematics is not permitted to register for any course in the Department of Mathematics and Statistics numbered 095 or above.

Calculus Readiness Test—All students enrolled in majors requiring calculus are tested for calculus readiness with the higher-level mathematics placement test. This test will determine placement in the course sequence which includes the calculus.

Prerequisites—If a student has not met the exact prerequisites of a course as stated in this bulletin, but believes that the requirements have been satisfied through equivalent experiences, the student may gain admission to the course with the approval of the department chair.

Graduate Studies—Students who plan to continue their math studies in graduate school should take MATH 305/306/Abstract Algebra, MATH 315/Linear Algebra II, MATH 402/Real Analysis, MATH 403/Advanced Calculus, MATH 405/Topology, and MATH 420/Complex Variables.

Program Entrance, Retention, and Exit Standards

Every major program at The College has set standards for allowing students to remain in that program, to transfer within The College from one program to another, and to graduate from a program. The following are the standards for programs in mathematics and statistics programs Minimum grades are noted in parentheses:

For students with major codes MATA, MATT, ELMA, ECMA, or DHMA

- Retention in the program is based on the following performance standards in these "critical content courses": MATH 127 *or* MATH 128 (B-) *and* MATH 200 *or* MATH 205 (C).

- Transfer into the program from another program within The College is based upon the following performance standards in these "foundation courses": MATH 125 *or* MATH 127 *or* MATH 128 (B-) *and* MATH 200 *or* MATH 205 (C).

- Graduation requirements: In courses offered by the Departments of Mathematics and Statistics and Computer Science a grade of C– or better must be earned for the course to satisfy a graduation requirement of the major. For 300 or 400 level courses, at most two grades of D or D+ may be counted. Only one of these grades can be earned in required courses; but, a grade of at least C– must be earned in any required course that is a prerequisite for another course that is subsequently taken. Students with codes MATT, ELMA, ECMA, and DMHA need a GPA of 2.75 overall.

For students with the major code MATC:

- Retention in the program is based on the following performance standards in these "critical content courses": MATH 316 (C) *and* STAT 116 *or* STAT 215 (C).

- Transfer in the program from another program within The College is based upon the following performance standards in these "foundation courses": MATH 125 *or* MATH 127 *or* MATH 128 (B–) *and* STAT 116 *or* STAT 215 (C).

- Graduation requirements: In courses offered by the Departments of Mathematics and Statistics and Computer Science a grade of C- or better must be earned for the course to satisfy a graduation requirement of the major. For 300 or 400 level courses, at most two grades of D or D+ may be counted. Only one of these grades can be earned in required courses. But, a grade of at least C– must be earned in any required course that is a prerequisite for another course that is subsequently taken.

Mathematics Major: (MATA)

Freshman Year
Fall

MATH	099/Department Seminar	0
MATH	127/Calculus I (GE)	3
MATH	200/Principles of Mathematics	3
IDSC	151/Athens to New York (GE)	3

RHET	101/Rhetoric I (GE)	3
	Foreign Language (GE)	3

Spring

MATH	128/Calculus II (GE)	3
MATH	205/Linear Algebra I	3
RHET	102/Rhetoric II (GE)	3
	Foreign Language (GE)	3
	General Education (GE)	3
	Total for year	**30**

Sophomore Year
Fall

MATH	229/Calculus III	3
MATH	Mathematics Option	3
PHYS	201/General Physics I (GE)	4
IDSC	252/Society, Ethics, and Technology (GE)	3
	Foreign Language (GE)	3

Spring

MATH	230/Calculus IV	3
MATH	Mathematics Option	3
PHYS	202/General Physics II (GE)	4
	General Education (GE)	6
	Total for year	**32**

Junior Year
Fall

MATH	305/Abstract Algebra I*	3
MATH	402/Real Analysis	3
	General Education (GE)	6
	Elective	1

Spring

MATH	306/Abstract Algebra II	3
MATH	420/Complex Variables	3
	General Education (GE)	3
	Electives	6
	Total for year	**28**

Senior Year
Fall

MATH	Mathematics Options 2	6
	Electives	9

Spring

MATH	Mathematics Options 2	6
	Electives	9
	Total for year	**30**
	Total required for graduation	**120**

*It is recommended to take MATH 301/Number Theory in preparation for MATH 305/Abstract Algebra.

*Consult chairperson for a list of approved courses.

Mathematics Major: Teacher Preparation (MATT)

Candidates for a teacher-education certificate must have a 2.75 cumulative grade point average, meet the state hygiene/physiology requirement, and pass the required Praxis assessment tests before the New Jersey State Department of Education will issue the appropriate certificate. Teacher-education candidates will receive a "certificate of eligibility with advanced standing" which requires a candidate to be provisionally certified for his or her first year of teaching. After one year of successful teaching, the candidate is eligible for a permanent certificate. The teacher candidate may also have to pay a fee during his or her first year of teaching.

Freshman Year
Fall

MATH	099/Department Seminar	0
MATH	127/Calculus I (GE)	3
MATH	200/Principles of Mathematics	3
IDSC	151/Athens to New York (GE)	3
RHET	101/Rhetoric I (GE)	3
	Foreign Language (GE)	3

Spring

MATH	128/Calculus II (GE)	3
MATH	205/Linear Algebra I	3
RHET	102/Rhetoric II (GE)	3
	Foreign Language (GE)	3
	Humanistic and Artistic Perspective (GE)	3
	Social Sciences Perspective (GE)	3
	Total for year	**33**

Sophomore Year
Fall

MATH	229/Calculus III	3
STAT	215/Statistical Inference	3
	Social Sciences Perspective (GE)	3
PHYS	201/General Physics I (GE)	4
	Foreign Language (GE)	3

Spring

MATH	230/Calculus IV	3
	Mathematics/Stats/Option*	3
PHYS	202/General Physics II (GE)	4
IDSC	252/Society, Ethics, and Technology (GE)	3
HLED	160/Current Health and Wellness Issues	3
SCED	203/Sophomore Professional Experience	2
	Total for year	**34**

Junior Year
Fall

MATH	305/Abstract Algebra I	3
MATH	316/Intro. to Probability	3
MATH	348/Teaching Mathematics in Elem. and Middle School	3
RDLA	328/Teaching Reading in Junior and Senior H.S.	2
	Humanistic and Artistic Perspectives (GE)	3
CMSC	215/Computer Science I for Science and Engineering	3

Spring

MATH	306/Abstract Algebra II	3
SCED	303/Junior Professional Field Experience	6
MATH	390/Teaching Mathematics in High School	3
MATH	355/History of Mathematics	3
	Total for year	**32**

Senior
Fall

MATH	351/Geometry	3
	Math/Stats/Option*	6
	Humanistic and Artistic Perspectives (GE)	3
	Electives	5

*Consult chairperson for a list of approved courses.

Spring

MATH	490/Senior Student Teaching in Mathematics	10
MATH	489/Seminar in Mathematics Education	1
SCED	489/Secondary Ed. Student-Teaching Seminar	1
	Total for year	**29**
	Total	**128**

Mathematics Major: Statistics (MATC)

Freshman Year
Fall

MATH	099/Department Seminar	0
MATH	127/Calculus I (GE)	3
MATH	200/Principles of Mathematics	3
IDSC	151/Athens to New York (GE)	3
RHET	101/Rhetoric I (GE)	3
	Foreign Language (GE)	3

Spring

MATH	128/Calculus II (GE)	3
MATH	205/Linear Algebra I	3
RHET	102/Rhetoric II (GE)	3
	Foreign Language (GE)	3
	General Education (GE)	3
	Total for year	**30**

Sophomore Year
Fall

STAT	215/Statistical Inference	3
MATH	229/Calculus III	3
CMSC	215/Computer Science I	3
IDSC	252/Society, Ethics, and Technology (GE)	3
	Foreign Language (GE)	3

Spring

MATH	230/Calculus IV	3
MATH	316/Introduction to Probability	3
	General Education (GE)	6
	Electives	3
	Total for year	**30**

Junior Year
Fall

STAT	410/Mathematical Statistics	3
STAT	Option*	3
	Science (GE)*	4
	General Education (GE)	6

Spring

MATH	Mathematics Option*	3
STAT	Statistics Option*	3
	Science	4
	General Education (GE)	3
	Electives	3
	Total for year	**32**

Senior Year
Fall

MATH	Mathematics Option*	3
STAT	Statistics Option*	3
	Electives	9

Spring

STAT	Statistics Option*	3
	Electives	10
	Total for year	**28**
	Total	**120**

*Consult chairperson for a list of approved courses.
**Statistics majors must take one of the following sequences: BIOL 183–184, CHEM 201–202, or PHYS 201–202.*

Elementary Education/Mathematics (ELMA), Early Childhood Education/Mathematics (ECMA), Deaf and Hard of Hearing/Mathematics (DHMA)

Forty-eight credits of major requirements, including MATH 127, 128, 200, 205, 229, 230, 305, 306, 316, 351, 355, STAT 215, CMSC 215, and nine credits of mathematics options.

Elementary Education M/S/T (ELST) and Early Childhood Education M/S/T (ECST) with a Mathematics Specialization

This interdisciplinary major integrates formal study in mathematics, biology, chemistry, physics, and technology. Students electing a mathematics specialization will complete 42 credits of "core" requirements including Calculus (MATH 127–128), Principles of Biology (BIOL 181–182), Principles of Chemistry (CHEM 101–102), College Physics (PHYS 191–192), Introduction to Human Technological Behavior (TSNG 171), Principles of Structures and Mechanisms (TSNG 211), and an M/S/T-approved elective. The mathematics specialization consists of a minimum of 21 credits including the core mathematics courses, (MATH 200/Principles), (MATH 229/Calculus III), (MATH 301 or 305 Abstract Algebra), and two mathematics elective courses at the 300 level or higher.

Mathematics and Statistics Minors

Students planning to minor should apply to the department as soon as possible. The minor requirements will be defined by the bulletin description at the time of application. Students must maintain the same mathematics and statistics cumulative average as required for graduation in the major.

A minimum of nine credits for the statistics minor and 12 credits for the mathematics minor must be earned at The College of New Jersey. For other requirements, see the academic rules and procedures section of this bulletin.

Mathematics Minor

A total of 21 semester hours are required for the mathematics minor.

Required Courses:		15
MATH	127,128/Calculus I, II	6
MATH	200/Principles of Mathematics*	3
MATH	205 or 301, Linear Algebra I, Number Theory	3
MATH	305/Abstract Algebra I	3
MATH	Mathematics Options	6
	Any MATH prefix course at the 200 level or above (excluding MATH 286, MATH 342, MATH 348, MATH 386, and MATH 390). At least one course must be at the 300 level or above.	
	Total	**21**

With the approval of the chair, a 300- or 400-level math course may substitute for MATH 200.

A minor in mathematics must achieve at least a 2.25 grade point average for all courses taken to fulfill the requirements for the minor.

Only courses with an earned grade of C– or higher can be used to fulfill the requirements for the minor with the following exception: Minors may count at most one D or D+ in a course at the 300 level or above from the mathematics options.

A minimum of 12 semester hours in the minor must be earned in the department.

Statistics Minor

Required Courses:		(6 cr.)
STAT	116/Statistics II	3
or		
STAT	215/Statistical Inference	3
MATH	125/Calculus for Business and the Social Sciences	3
or		
MATH	128/Calculus II	3

Options:		(12 cr.)
STAT	303/Design of Experiments	3
STAT	304/Sampling and Non-Parametric Statistics	3
STAT	305/Regression Analysis	3
STAT	314/Statistical Quality Control	3
MATH	316/Intro. to Probability	3
MATH	317/Linear Programming	3
MATH	318/Intro. to Operations Research and Decision Theory	3
STAT	410/Mathematical Statistics	3
STAT	414/Time Series Analysis	3
STAT	493/Internship in Statistics II	3–6
STAT	494/Seminar in Statistics	3
STAT	495/Independent Study in Statistics	3

A minor in statistics must achieve at least a 2.25 grade point average for all courses taken to fulfill the requirements for the minor. A total of at least 18 credits are required for the statistics minor. At least nine credits for the statistics minor must be completed at TCNJ. The minor program includes many courses specifically recommended for students interested in becoming Actuaries.

MATH 091/Basic Math Skills   **1 cr. (additive)**
(3 class hours—five-week course)
(every semester)
Academic development course. A requirement of all students scoring below criterion on a placement test. Study of fractions, decimals, ratio, proportion, and percent. Credit for this course does not count within the 120-credit requirement for graduation.

MATH 092/Basic Math Skills   **2 cr. (additive)**
(3 class hours—10-week course)
(every semester)
Academic development course. A requirement of all students scoring below criterion on a placement test. Study of elementary algebra and elementary geometry. Credit for this course does not count within the 120-credit requirement for graduation.

MATH 095/Intermediate Algebra   **3 cr. (additive)**
(3 class hours)
(every semester)
Prerequisites: Satisfactory completion of the academic development required in mathematics; demonstrated inadequate level of preparation for the courses MATH 120
This course is designed for students majoring in a field where at least one of the courses, Pre-Calculus (MATH 120), Calculus I (MATH 127), or Calculus for Business and the Social Sciences (MATH 125) is required. Conceptual understanding and skill development of traditional algebraic topics such as: linear equations and inequalities, exponents and polynomials, rational expressions, quadratic equations, and systems of linear equations are included.

MATH 101/Foundations of Mathematics I   **3 cr.**
(3 class hours)
(every semester)
Provides intuitive and formal experience in development and appreciation of structural bases characteristic of mathematics. Topics from: logic, sets, geometry, graph theory, and algorithms.

MATH 102/Foundations of Mathematics II   **3 cr.**
(3 class hours)
(every semester)
A liberal studies course providing intuitive and formal experience in development and appreciation of structural bases characteristic of mathematics. Topics from: combinatorial probability, abstract mathematical systems, and number theory.

MATH 105/Mathematical Structures   **3 cr.**
and Algorithms for Educators I
(3 class hours)
(every semester)
This course concerns the development of number systems, algebraic structures, and algorithms. The student will be required to reason mathematically, solve problems, and communicate mathematics effectively at different levels of formality, using a variety of representations of mathematical concepts and procedures. Physical materials and models will be used to explore fundamental properties of number systems, to model algorithms, and to explore selected algebraic structures. This course is especially appropriate for those students preparing to be elementary, early childhood, or special education teachers.

MATH 106/Mathematical Structures   **3 cr.**
and Algorithms for Educators II
(3 class hours)
(annually—spring)
Physical materials and models will be used to explore fundamental concepts of geometry, measurement, data analysis, statistics, and probability. The student will be required to reason mathematically, solve problems, and communicate mathematics effectively at different levels of formality, using a variety of representations of mathematical concepts and procedures. This course is especially appropriate for those students preparing to be elementary, early childhood, or special education teachers.

MATH 120/Pre-Calculus **3 cr.**
(3 class hours)
(every semester)
Prerequisite: MATH 095 or placement test into MATH 120
This course is only for students going on to calculus. Fundamentals of algebra, trigonometry, and analytic geometry. Stress is on computational and problem-solving techniques.

MATH 125/Calculus for **3 cr.**
Business and the Social Sciences
Prerequisite: MATH 120 or placement test into MATH 125 or MATH 127
A course intended for majors in business and the social sciences, and/or minors in statistics. Topics include differential calculus, integral calculus, and some linear algebra, with applications to areas of business and social science. Not for mathematics majors.

MATH 127/Calculus I **3 cr.**
(3 class hours)
(every semester)
Prerequisite: MATH 120 or placement test into MATH 127. Contact department for details.
This is the first semester of a four-semester sequence in Calculus for students in the mathematical and physical sciences. Some topics are presented rigorously. Topics include functions and limits, derivatives of algebraic functions, derivatives of transcendental functions, and applications of the derivative.

MATH 128/Calculus II **3 cr.**
(3 class hours)
(every semester)
Prerequisite: MATH 125 or 127
Topics include: Indefinite and definite integrals, volumes of revolution, arc length, techniques of integration, improper integrals**.**

MATH 200/Principles of Mathematics **3 cr.**
(3 class hours)
(every semester)
An introduction to the methods of mathematics and mathematical thinking. Typical topics: logic, sets, methods of proof, mappings (surjective, injective, bijective), commutative diagrams, and elementary functions. For mathematics majors or minors or by permission of the department chair.

MATH 205/Linear Algebra I **3 cr.**
(3 class hours)
(every semester)
An introduction to vector spaces and systems of linear equations essential for the understanding of both pure and applied mathematics. Selected topics include: vector spaces, linear independence, linear transformations, and matrices.

MATH 229/Calculus III **3 cr.**
(3 class hours each semester)
(every semester)
Prerequisite: MATH 128
Topics include: sequences, series, partial differentiation, multiple integrals, and parametric equations.

MATH 230/Calculus IV **3 cr.**
(3 class hours each semester)
(every semester)
Prerequisite: MATH 229
Topics include: Polar, cylindrical, and spherical coordinates,

multiple integrals; vector calculus, line and surface integrals, Green's Theorem, Stoke's Theorem, introduction to differential equations.

MATH 301/Number Theory **3 cr.**
(3 class hours)
(annually—spring)
Prerequisite: MATH 200
Divisibility, primes, unique factorization, diophantine equations, congruences, quadratic reciprocity, and such optional topics as sums of squares, number-theoretic functions, continued fractions, prime number theory, public-key encryption, and elliptic curves.

MATH 305/Abstract Algebra I **3 cr.**
(3 class hours each semester)
(every semester)
Prerequisites: MATH 200 and MATH 205 or MATH 301
This first course in abstract algebra introduces the student to selected topics in theory of groups. Material will be presented in a rigorous manner. Topics will include groups of permutations, cyclic groups, Lagrange's theorem, group homomorphisms, factor groups and isomorphism theorems.

MATH 306/Abstract Algebra II **3 cr.**
(3 class hours each semester)
(every semester)
Prerequisite: MATH 305
This second course in abstract algebra delves deeply into rings and fields. Topics include: polynomial rings, factorization of polynomials, field extensions, splitting fields, and constructible numbers.

MATH 315/Linear Algebra II **3 cr.**
(3 class hours)
(periodically)
Prerequisite: MATH 205
Studies vector spaces, linear transformations, matrix representations, determinants, eigenvalues and eigenvectors, inner product spaces, spectral theorem, Jordan normal form, bilinear forms, and applications.

MATH 316/Introduction to Probability **3 cr.**
(3 class hours)
(every semester)
Prerequisite: MATH 229
Mathematical models, sample spaces, permutations and combinations, conditional probability, discrete and continuous distributions, moment-generating functions, multivariate and marginal distributions.

MATH 317/Linear Programming **3 cr.**
(3 class hours)
(periodically)
Prerequisite: Any linear algebra course
Optimization using LP techniques: single/dual simplex methods, duality, degeneracy, applications to problems of transportation, trans-shipment, games.

MATH 318/Introduction to Operations Research **3 cr.**
and Decision Theory
(3 class hours)
(periodically)
Prerequisite: MATH 316
An introductory study into the mathematical theory and techniques of operations research. Students will become

familiar with such ideas as queuing theory, inventory control, search theory, reliability, stochastic models, Monte Carlo techniques, and methods of optimization.

MATH 320/Combinatorics **3 cr.**
(3 class hours)
(every fall)
Prerequisite: MATH 200
Topics such as predicate calculus, counting techniques, graphs, trees, enumeration, and binomial theorem.

MATH 326/Differential Equations **3 cr.**
(3 class hours)
(every spring)
Prerequisite: MATH 229
Presentation of subject through logical and orderly approach with emphasis on general concepts rather than isolated details. Topics: first-order ordinary differential equations, linear differential equations with constant coefficients, simultaneous differential equations, hyperbolic functions, and Laplace Transforms.

MATH 331/Numerical Mathematics I **3 cr.**
(3 class hours)
(periodically)
Prerequisites: MATH 229, CMSC 215
An introduction to numerical methods suitable for use on a digital computer. Topics include computer representation of numbers, round-off error in function evaluations, series approximations to functions, finding roots of functions, finding roots of polynomials, numerical integrations, and approximate numerical solutions to systems of simultaneous linear equations.

MATH 332/Numerical Mathematics II **3 cr.**
(3 class hours)
(periodically)
Prerequisites: MATH 326, MATH 331
A continuation of Numerical Mathematics I. Topics include numerical solutions of ordinary differential equations, least squares, Fourier approximations, Chebyshev economization.

MATH 342/Teaching Mathematics in **1 cr.**
Elementary School
(2 class hours)
(every semester)
Prerequisite: MATH 105 or 200
Examines the elementary school mathematics curricula, how children learn mathematics, and methods and strategies appropriate for teaching the many topics in mathematics. Emphasizes the organization of materials and activities for effective teaching, diagnostic work, and evaluation.

MATH 348/Teaching Mathematics in **3 cr.**
Elementary and Middle School
(annually—fall)
Prerequisite: MATH 200 or permission of instructor
A professional course for students majoring or specializing in mathematics. Examines the content in the elementary and middle school mathematics curricula, how children learn mathematics and the rationales for developing the methods and strategies for teaching the many topics in these mathematics curricula to children of diverse cultures. Emphasizes the organization of materials for effective teaching, problem solving, diagnostic work, and evaluation.

MATH 351/Geometry **3 cr.**
(3 class hours)
(annually—fall)
Prerequisite: MATH 200 or permission of the instructor
Geometry as a branch of contemporary mathematics. Topics include Axiomatic Systems, Euclid's Fifth Postulate, Euclidean, Neutral and non-Euclidean geometry.

MATH 355/History of Mathematics **3 cr.**
(3 class hours)
(annually—spring)
Prerequisites: One year of calculus and one semester of abstract algebra
Origin and development of geometry, algebra, and calculus, and their interaction with science and the humanities.

MATH 386/Differential Equations with Numerical **3 cr.**
Techniques
(3 class hours)
(every semester)
Prerequisite: MATH 128
Integrated introduction to standard topics in differential equations and basic linear algebra for engineering applications.

MATH 390/Teaching Mathematics in High School **3 cr.**
(3 class hours)
(annually—spring)
Prerequisite: MATH 200 or permission of instructor
Professionalized subject matter. Teaching techniques and lesson planning including a variety of classroom formats. Cooperative group work, writing in the mathematics classroom, technology, and manipulatives. Curriculum trends, professional obligations and responsibilities, student assessment. Content will include discrete mathematics, problem solving, concept of proof, and mathematical modeling.

MATH 402/Real Analysis **3 cr.**
(3 class hours per semester)
(annually)
Prerequisite: MATH 229
A logical development of mathematical analysis for functions of a single real variable. Topics include order, completeness, sequences, series, limits of functions, basic topology of the reals, differentiation, integration, sequences and series of functions and transcendental functions.

MATH 403/Advanced Calculus **3 cr.**
(3 class hours per semester)
(periodically)
Prerequisite: MATH 229
In this course, we explore the calculus of several variables from the point of view of the geometry of surfaces in Euclidean space. The emphasis will be on examples rather than proofs.

MATH 405/Topology **3 cr.**
(periodically)
Prerequisite: MATH 305 or permission of instructor
A first course in general topology. Typical topics: sets, Cartesian products, mappings, infinite sets, Cauchy sequences, connected sets, continuous functions, metric spaces, and topological spaces.

MATH 407/Projective Geometry   **3 cr.**
(3 class hours)
(occasionally)
An introduction to projective geometry. Topics include affine and projective plane, real projective plane, principle of duality, groups of automorphisms, and projective planes over division rings.

MATH 420/Complex Variables   **3 cr.**
(3 class hours)
(annually—spring)
Prerequisite: MATH 229
A logical development of the classical theory of functions of a complex variable, with emphasis on those parts of the theory which are most used in modern applications of the subject. Topics include: complex numbers; analytic functions; the exponential, trigonometric, hyperbolic, and logarithmic functions and their inverses; mapping by elementary functions; integrals; the Cauchy-Goursat theorem, the Cauchy integral formula, derivatives of analytic functions; the fundamental theorem of algebra; power series; residues and poles; and isolated, essential, and removable singularities.

MATH 440/Mathematical Logic   **3 cr.**
(3 class hours)
(periodically)
Prerequisite: Not open to freshmen or sophomores. Recommended only for those with some interest in and aptitude for pure mathematics
This course is principally concerned with Propositional Calculus and First Order Logic, two mathematical languages that abstract many of the patterns of logical thought. The two languages will be carefully defined and applied to actual reasoning problems. For each language, we will discuss metatheorems dealing with the properties of soundness, completeness, decidability, and consistency.

MATH 450/Honors Course in Mathematics   **3–6 cr.**
(occasionally)
Prerequisite: By invitation only
More sophisticated treatment of standard or advanced topics for carefully selected students. Exemptions from the regular courses whose syllabi are covered.

MATH 451/Topics in Algebra   **3 cr.**
(3 class hours)
(occasionally)
Prerequisites: MATH 229 and MATH 305
A flexible course in which the content is selected from topics in algebra. This is an elective course designed to enrich the background of the student as well as to bridge the gap between undergraduate math and graduate math.

MATH 452/Topics in Geometry and Topology   **3 cr.**
(3 class hours)
(occasionally)
Prerequisites: MATH 229 and MATH 305
A flexible course in which the content is selected from topics in geometry and topology. This is an elective course designed to enrich the background of the student as well as to bridge the gap between undergraduate math and graduate math.

MATH 453/Topics in Analysis   **3 cr.**
(3 class hours)
(occasionally)
Prerequisites: MATH 229 and MATH 305
A flexible course in which the content is selected from topics

in analysis. This is an elective course designed to enrich the background of the student as well as to bridge the gap between undergraduate math and graduate math.

MATH 454/Topics in Applied Mathematics   **3 cr.**
(3 class hours)
(occasionally)
Prerequisites: MATH 229 and MATH 305
A flexible course in which the content is selected from topics in applied mathematics. This is an elective course designed to enrich the background of the student as well as to bridge the gap between undergraduate math and graduate math.

MATH 489/Seminar in Mathematics Education   **1 cr.**
(every semester)
Prerequisite: MATH 390
Corequisites: MATH 490 and SCED 489
A seminar fulfilling a complementary role in the mathematics student-teaching experience. Through group discussion and investigation of supporting professional literature, the student will be guided to a deeper appreciation of problems and practices in secondary mathematics education.

MATH 490/Student Teaching: Mathematics   **10 cr.**
(every semester)
Prerequisites: MATH 390 and meeting all the criteria for admission to student teaching including completion of all major requirements, a minimum overall GPA of 2.75
Corequisites: MATH 489 and SCED 489
Student teaching during the senior year under supervision of approved public school teachers and general supervision of college supervisors. Observation, participation, and responsible teaching.

MATH 493/Internship in Mathematics   **3 cr.**
(every semester)
Prerequisites: Junior standing and permission of the department
Applied experience in major field of study. Consult department for details.

MATH 496/Seminar in Mathematics   **3 cr.**
(3 class hours)
(occasionally)
Prerequisite: Permission of instructor
Intensive study of advanced topics in mathematics. Emphasizes student activity; use of journals and monographs; and discussion, solution and presentation of problems.

MATH 498/Independent Study in Mathematics   **1–3 cr.**
(every semester)
Prerequisite: By invitation only
Student will study independently an appropriate area. A department member will be assigned to advise the student.

STAT 115/Statistics I   **3 cr.**
(3 class hours)
(every semester)
General education course. Introduction to descriptive statistics and statistical inference. Topics include: averages, variability, histograms, probability, normal distribution, estimation, and hypothesis testing. A student may not receive credit for both STAT 115 and STAT 215.

STAT 116/Statistics II   3 cr.
(3 class hours)
(every semester)
Prerequisite: STAT 115
The second course in descriptive statistics. Designed to enable the student to better interpret statistical data. Topics include: hypothesis testing, linear regression, correlation, analysis of variance, design of experiments, and non-parametric tests.

STAT 215/Statistical Inference   3 cr.
(3 class hours)
(every semester)
Prerequisite: MATH 128 or MATH 125 or permission of instructor
General education course. This course provides a comprehensive introduction to descriptive statistics and the essential ideas of probability. Students will study foundations of classical parametric inference: point estimation; confidence intervals; hypothesis testing; and common statistical techniques, including simple regression and correlation. Examples will be drawn from a variety of social and natural sciences.

STAT 220/Introduction to Statistical   3 cr.
Computation
(3 class hours)
(annually—fall)
Prerequisite: STAT 115 or STAT 215
An introduction to statistical computation using modern computer programs and packages such as SAS and Excel. This is a problem-oriented course using the case-study approach.

STAT 303/Design of Experiments   3 cr.
(3 class hours)
(fall—even years)
Prerequisites: STAT 116 or STAT 215; and MATH 125 or MATH 128
This is an introductory course on the design of experiments and its broad applications in numerous scientific disciplines. Topics include the analysis of variance, factorial design, and fractional factorial experiments. A statistical package will be used throughout the course. (SAS, SPSS, or MINITAB)

STAT 304/Sampling and Non-Parametric Statistics   3 cr.
(spring—even years)
prerequisites: STAT 116 or STAT 215; and MATH 125 or MATH 128
This is an introductory course to the use of sampling theory and non-parametric statistics for problems that arise in scientific investigations. Topics include the design and analysis of sample surveys, as well as robust statistical tests and estimation techniques that are useful in a wide range of real-world applications.

STAT 305/Regression Analysis   3 cr.
(3 class hours)
(fall—odd years)
Prerequisites: STAT 116 or STAT 215, and MATH 125 or 128 and MATH 205; or MATH 205, MATH 316 and permission of instructor
An intermediate course on the theory and application of linear statistical models. Topics include matrix algebra, multiple regression, transformation, and weighted least squares. A statistical package will be used throughout the course (SAS, SPSS, or MINITAB).

STAT306 /Applied Multivariate Analysis   3 cr.
(3 class hours)
(spring—odd years)
Prerequisites: STAT 215 or STAT 116, and MATH 125 or MATH 128
The course will introduce students to a variety of multivariate statistical methods as aids to analyzing and interpreting large data sets. These methods will have general applications across a wide range of client disciplines. Statistical computer packages will be used throughout the course.

STAT 314/Statistical Quality Control   3 cr.
(3 class hours)
(spring—odd years)
Prerequisites: STAT 116 or STAT 215, and MATH 125 or MATH 128; or MATH 316 and permission of instructor
An introduction to modern techniques of quality control and reliability practice. Acceptance sampling, sampling plans, control charts, combinatorial reliability, failure models, and system reliability.

STAT 393/Internship I in Statistics   variable
(every semester)
Prerequisites: Junior standing and permission of department
A supervised statistics-related experience working for government or for the private sector. Based on input from the client, the student and faculty coordinator agree on the overall scope of the project, including learning objectives, work plan, and expected outputs. The content of the internship should require the student to do some research and/or creative work. Students will periodically inform the coordinator of status and, on completion of the internship will document the experience and make an oral presentation. The course counts as a general elective for the student with either a major or a minor in statistics. Grading is Pass/Unsatisfactory. Courses graded on a P/U basis are not counted as part of the 64 semester hours of letter-graded courses for graduation with honors.

STAT 410/Mathematical Statistics   3 cr.
(3 class hours)
(every fall)
Prerequisites: STAT 215 and MATH 316
Typical topics: Theory of sampling, law of large numbers, central limit theorem, normal approximation to binomial and poisson distributions, estimation of population parameters, hypothesis testing, confidence methods, regression analysis, change of variable and order statistics.

STAT 414/Time Series Analysis   3 cr.
(3 class hours)
(occasionally)
Prerequisites: STAT 116 or STAT 215 and MATH 229; or MATH 316
This is an introductory course to the theory and application of statistical time-series analysis. Techniques developed in the course will be used to analyze data that arise in engineering, economics, and many branches of empirical sciences.

STAT 415/Markov Chains and Random Processes   3 cr.
(3 class hours)
(occasionally)
Prerequisites: MATH 316 and MATH 205
An introductory course to random walks, Markov chains, and a variety of random processes. Techniques developed in the course will be used to illustrate the applications of these processes to science.

STAT 493/Internship II in Statistics   **variable**
(every semester)
Prerequisites: Junior standing and permission of department
A supervised statistics-related experience working for the government or the private sector, in which the student will be expected to include research as part of the project. Based on a general description of the project from the client, the student, working with the TCNJ faculty coordinator, will structure the project. The structure will include the learning objectives, the research issues, the projected work plan and the possible results. Students will periodically inform the faculty coordinator of status and progress. On completion, the student will formally document the project for the client and TCNJ. The student will also make an oral presentation that is open to the public. The course can count as an option in the statistics major or minor or as a general elective. A letter grade will be assigned by the faculty coordinator based on input from the client, as well as from the written and oral presentation.

STAT 494/Seminar in Statistics   **3 cr.**
(3 class hours)
(occasionally)
Prerequisite: Permission of instructor
An investigation of selected areas of the field through the use of journal articles and monographs, and the solution of problems which may be outside the scope of other course requirements.

STAT 495/Independent Study in Statistics   **1–3 cr.**
(every semester)
Prerequisite: Permission of instructor
The student will study independently a selected area of this discipline through the use of course books and journal articles coordinating this study under supervision of advisers.

IDSC 105/Applying Computing to Mathematical   **3 cr.**
Problem Solving
(See Interdisciplinary Studies.)

Physics

Faculty: Hiack, *Chair;* Becker, Dalafave, Gleeson, Goldstein, Kolp, Ochoa, Pfeiffer, Wickramasinghe

The objectives of the department are to develop the student's comprehension of the basic principles of physics, to instill a sense of inquiry in the student, to develop an appreciation of the role of physics in our attempt to understand the universe, and to develop an understanding of its power to deal with problems related to technology and the environment.

The physics major can, by proper choice of electives, prepare for graduate work in physics, astronomy, environmental science, or graduate school in professions such as medicine or law. The student may also choose to work in industry, public service, or teaching. The program for prospective teachers will prepare graduates to teach various courses ranging from high school physics to science in the junior and middle schools, depending on the courses elected. Therefore, it is strongly recommended that the student elect those courses which will satisfy the demands of his or her chosen profession.

The computational physics track combines physics, computer science, and mathematics. A graduate of this program

will have an understanding of physics and, in addition, will be able to apply computer knowledge to the solution of various technical problems.

Program Entrance, Retention, and Exit Standards

Every major program at The College has set standards for allowing students to remain in that program, to transfer within The College from one program to another, and to graduate from a program. The following are the standards for physics programs. Minimum grades are noted in parentheses.

■ Retention in the program is based on the following performance standards in these "critical content courses": PHYS 201 (C–), PHYS 202 (C–), PHYS 321 (C–).

■ Transfer in the program from another program within The College is based upon the following performance standards in these "foundation course": PHYS 201 (C–).

■ Graduation requires a GPA of 2.0 in courses for the program and earning a minimum grade of C– in the following courses: PHYS 201 (C–), PHYS 202 (C–), PHYS 321 (C–).

Physics Major (PHYA)
PHYA—Physics Liberal Arts Track

Forty-three (43) credits in required physics courses with an option for an additional six to 15 credits of required math and computer science courses with an option for an additional six.

Freshman Year

PHYS	099/Physics Introductory Seminar	0
PHYS	201, 202/General Physics I, II	8
CMSC	215/Computer Science I	3
MATH	127, 128/Calculus I, II	6
RHET	101, 102/Rhetoric I, II	6
IDSC	151/Athens to New York	3
	General Education	3
	Electives	3
	Total for year	**32**

Sophomore Year

PHYS	306/Math Physics	3
PHYS	321/Modern Physics	4
MATH	229/Calculus III	3
CHEM	201, 202/General Chemistry I, II	8
IDSC	252/Society, Ethics, and Technology	3
	Foreign Language*	6
	General Education	6
	Total for year	**33**

Junior Year

MATH	326 or 386/Differential Equations	3
PHYS	421/Electromagnetic Theory I	3
PHYS	Physics Major Required Courses	13–14
	General Education	3
	Foreign Language*	3
	Physics Major Option Courses	3
	Electives	3–6
	Total for year	**31–35**

*Students exempted from language requirements may take electives.

Senior Year

PHYS	Physics Major Required Courses	11–12
	General Education	6
	Physics Major Option Courses	3
	Electives	9–12
	Total for year	**29–33**

Physics major required courses		**28 cr.**
PHYS	311/Electric Circuits and Electronics	4
PHYS	401/Mechanics	3
PHYS	411/Optics and Wave Motion	4
PHYS	422/Electromagnetic Theory II	3
PHYS	416/Heat and Thermodynamics	3
PHYS	426/Particle and Nuclear Physics	3
PHYS	431/Introduction to Quantum Mechanics	3
PHYS	436/Solid State Physics	3
PHYS	451/Advanced Physics Laboratory	2

Physics Major Option Courses		**6 cr.**
PHYS	313/An Introduction to General Relativity	3
PHYS	316/Intermediate Physics for Medicine and Biology	3
PHYS	466/ Introductory Astrophysics	3
PHYS	499/Independent Study	variable

Physics Major: (PHYC)
(Computational Physics Track)
PHYC—Computational Physics Track

Thirty-six credits in required physics courses—24 credits in required math and computer science courses.

Freshman Year

PHYS	099/Physics Introductory Seminar	0
PHYS	201, 202/General Physics I, II	8
CMSC	215/Computer Science I	3
MATH	127, 128/Calculus I, II	6
RHET	101, 102/Rhetoric I, II	6
ISDC	151/Athens to New York	3
	General Education	3
	Electives	3
	Total for year	**32**

Sophomore Year

PHYS	306/Math Physics	3
PHYS	321/Modern Physics	4
MATH	229/Calculus III	3
ISDC	252/Society, Ethics, and Technology	3
CHEM	201, 202/General Chemistry I, II	8
	General Education	3
CMSC	220/Computational Problem Solving	4
CMSC	230/ Data Structures	4
	Total for year	**32**

Junior Year

MATH	326 or 386/Differential Equations	3
MATH	316/Introduction to Probability	3
PHYS	311/Electric Circuits and Electronics	4
PHYS	Physics Options	6–7
	Foreign Language*	6
	General Education	3
	Math and Computer Science Options	6
	Total for year	**31–32**

Students exempted from language requirements may take electives.

Senior Year

PHYS	Physics Options	10–11
	General Education	9
	Math and Computer Science Options	6
	Electives	4
	Foreign Language	3
	Total for year	**32–33**

Physics Options		**17 cr.**
PHYS	313/An Introduction to General Relativity	3
PHYS	316/Intermediate Physics for Medicine and Biology	3
PHYS	401/Mechanics	3
PHYS	411/Optics and Wave Motion	4
PHYS	466/Introduction to Astrophysics	3
PHYS	421/Electromagnetic Theory I	3
PHYS	422/Electromagnetic Theory II	3
PHYS	416/Heat and Thermodynamics	3
PHYS	426/Particle and Nuclear Physics	3
PHYS	431/Introduction to Quantum Mechanics	3
PHYS	436/Solid State Physics	3
PHYS	451/Advanced Physics Laboratory	2
PHYS	499/Independent Study in Physics	variable

Math and Computer Science Options		**12 cr.**
(at least 6 hrs. CMSC)		
CMSC	210 Discrete Structures	3
CMSC	325/Computer Architecture	4
CMSC	340/Programming in the Large	4
CMSC	350/Computer Graphics	3
CMSC	360/Networks	3
CMSC	370/Stack Machines	3
CMSC	380/Artificial Intelligence	3
CMSC	390/Programming Languages	3
STAT	115/Statistics I	3
MATH	315/Linear Algebra	3

PHYT—Physics Teacher Preparation Track

Sixteen (16) credits in required courses—nine credits of required math and computer science courses—11 credits of earth science courses, with options for an additional 23 credits in physics.

Physics Major: Teacher Preparation Track

Candidates for a teacher-education certificate must have a 2.75 cumulative grade point average, meet the state hygiene/physiology requirement, and pass the appropriate Praxis examination before the New Jersey State Department of Education will issue the appropriate certificate. Teacher-education candidates will receive a "certificate of eligibility with advanced standing" which requires a candidate to be provisionally certified for his or her first year of teaching. After one year of successful teaching, the candidate is eligible for a permanent certificate. The teacher-education candidate also will have to pay a fee during his or her first year of teaching.

Freshman Year

PHYS	099/Physics Introductory Seminar	0
PHYS	201, 202/General Physics I, II	8
CMSC	215/Computer Science I	3
MATH	127, 128/Calculus I, II	6
RHET	101, 102/Rhetoric I, II	6

IDSC	151/Athens to New York	3
	General Education	3
	Electives	3
	Total for year	**32**

Sophomore Year

PHYS	321/Modern Physics	4
PHYS	Major Required Courses and Options	8
CHEM	201, 202/General Chemistry I, II	8
IDSC	252/Society, Ethics, and Technology	3
SCED	203/Sophomore Field Experience	2
	Foreign Language*	3–6
	General Education	3
	Total for year	**31–34**

Junior Year

EDFN	403/School in American Culture	3
SCED	303/Junior Professional Experience	6
PHYS	390/Methods of Teaching Science	3
RDLA	328/Teaching Reading	2
	Foreign Language	3–6
	Major Required Courses and Options	13–16
	Total for year	**32–35**

Senior Year

PHYS	490/Student Teaching**	10
PHYS	489/Seminar in Student Teaching	1
SCED	489/Seminar in Student Teaching	1
	Major Required Courses and Options	13–17
	General Education	6
	Elective	1
	Total for year	**31–35**

Required Courses		**31 cr.**
PHYS	201/202/General Physics I, II	8
CMSC	215/Computer Science I	3
MTRL	171/Intro. Meteorology	4
ASTR	161/Descriptive Astronomy	4
PHYS	311/Electric Circuits and Electronics	4
PHYS	321/Modern Physics	4
GOLG	120/Intro. to Geology	4

Options		**23 cr.**
CHEM	340/History of Chemistry and Physics	3
PHIL	230/Philosophical Issues in Science	3
ASTR	261/Astronomy II	4
GOLG	220/Geology II	4
PHYS	306/Math Physics	3
PHYS	313/An Introduction to General Relativity	3
PHYS	316/Intermediate Physics for Medicine and Biology	3
PHYS	401/Mechanics	3
PHYS	411/Optics and Waves	4
PHYS	421/Electromagnetic Theory I	3
PHYS	422/Electromagnetic Theory II	3
PHYS	416/Heat and Thermodynamics	3
PHYS	426/Particle and Nuclear	3
PHYS	431/Intro. to Quantum Mechanics	3
PHYS	451/Advanced Physics Laboratory	2
PHYS	466/Introductory Astrophysics	3
PHYS	499/Independent Study	variable
or		
MATH	326/Differential Equations	3
or		

CHEM	353/354/Organic Chemistry I, II	8
MATH	386/Diff. Eq. and Num. Tech.	3
BIOL	183, 184/General Biology I, II	8
MATH	229/Calculus III	3

PHYG—Earth Science Track

Sixteen (16) credits in required physics courses—nine credits of required math and computer science courses—11 credits of earth science courses, with options for an additional 23 credits in physics.

Physics Major: Earth Science Track

Freshman Year

PHYS	099/Physics Introductory Seminar	0
PHYS	201, 202/General Physics I and II	8
CMSC	215/Computer Science I	3
MATH	127, 128/Calculus I, II	6
RHET	101, 102/Rhetoric I, II	6
IDSC	151/Athens to New York	3
	General Education	3
	Electives	3
	Total for year	**32**

Sophomore Year

PHYS	Major Required Courses and Options	8
CHEM	201, 202/General Chemistry I, II	8
IDSC	252/Society, Ethics, and Technology	3
	Foreign Language*	6
	General Education	3
	Electives	4
	Total for year	**32**

Junior Year

	Foreign Language*	3
PHYS	Major Required Courses and Options	17–20
	Electives	12
	Total for year	**32–35**

Senior Year

PHYS	Major Required Courses and Options	11–14
	General Education	6
	Electives	14
	Total for year	**31–33**

Required Courses		**27 cr.**
PHYS	201, 202/General Physics I, II	8
PHYS	321/Modern Physics	4
CMSC	215/Computer Science I	3
MTRL	171/Intro. to Meteorology	4
PHYS	311/Electric Circuits and Electronics	4
ASTR	161/Descriptive Astronomy	4
GOLG	120/Intro. to Geology	4

Options		**22 cr.**
CHEM	340/History of Chemistry and Physics	3
PHIL	230/Philosophical Issues in Science	3
ASTR	261/Astronomy II	4
GOLG	220/Geology II	4
PHYS	306/Math Physics	3
PHYS	313/An Introduction to General Relativity	3
PHYS	316/Intermediate Physics for Medicine and Biology	3

Students exempted from language requirements may take electives.

PHYS	401/Mechanics	3
PHYS	411/Optics and Waves	4
PHYS	421/Electromagnetic Theory I	3
PHYS	422/Electromagnetic Theory II	3
PHYS	416/Heat and Thermodynamics	3
PHYS	426/ Particle and Nuclear	3
PHYS	431/Intro. to Quantum Mechanics	3
PHYS	451/Advanced Physics Laboratory	2
PHYS	466/Introductory Astrophysics	3
PHYS	499/Independent Study	variable
or		
MATH	326/Differential Equations	3
or		
CHEM	353/354/Organic Chemistry I, II	8
MATH	386/Diff. Eq. and Num. Tech.	3
BIOL	183, 184/General Biology I, II	8
MATH	229/Calculus III	3
BIOL	261/Ecology and Field Biology	4
BIOL	321/Genetics	4

Elementary Education-M/S/T (ELST) and Early Childhood Education-M/S/T (ECST) with a Physics Specialization

This interdisciplinary major integrates formal study in mathematics, biology, chemistry, physics, and technology. Students electing a physics specialization will complete 42 credits of "core" requirements including Calculus (MATH 127–128), Principles of Biology (BIOL 181–182), Principles of Chemistry (CHEM 101–102), General Physics (PHYS 201–202), Introduction to Human Technological Behavior (TSNG 171), Principles of Structures and Mechanisms (TSNG 211), and an M/S/T-approved elective. The physics specialization consists of a minimum of 21 credits including the core physics courses, (PHYS 311/Electrical Circuits and Electronics), (PHYS 306/Math Physics), (PHYS 321/Modern), one advanced physics elective course at the 300 level or higher.

Physics Minor

A minor in physics requires a total of 20 to 21 credits in physics courses. The required courses are PHYS 201/202 (General Physics I and II), PHYS 321 (Modern Physics), and PHYS 306 (Mathematical Physics). Two advanced physics courses (300 level or higher) must be added with the approval of the department chair.

PHYS	201, 202/General Physics I, II	8
PHYS	306/Math Physics	3
PHYS	321/Modern Physics	4
	Two advanced courses elected with the prior approval of the physics department chair	5–6
	Total required	**20–21**

PHYS 121, 122/ Principles of Physics I, II   **4, 4 cr.**
(3 class hours, 2 lab hours)
(annually)
Not for science or mathematics majors
Physical laws and concepts which clarify understanding of the physical environment. Stress on unity of physical ideas. Topics in PHYS 121: force, motion, momentum, energy, and gravitation. PHYS 122: wave motion, electric charges and fields, magnetism, the atom, light, and evolution of physics.

PHYS 191, 192/College Physics I, II   **4, 4 cr.**
(3 class hours, 2 lab hours)
(annually)
A course emphasizing the important principles and concepts of physics. PHYS 191 includes mechanics, wave motion, and sound; PHYS 192 includes heat, electricity, light, and modern physics.

PHYS 201, 202/General Physics I, II   **4, 4 cr.**
(3 class hours, 2 lab hours)
(every semester)
Corequisite for PHYS 201: MATH 127
Corequisite for PHYS 202: MATH 128
Perspectives on the World: Science
PHYS 201: Mechanics and wave motion. PHYS 202: Heat, light, electricity, and magnetism. Emphasizes understanding basic principles and concepts of physics. Use of problem solving is an integral part of course.

PHYS 306/Mathematical Physics   **3 cr.**
(3 class hours)
(annually—spring)
Prerequisites: PHYS 202, CMSC 215, or permission of instructor
Study of the methods used by theoretical physicists in solving problems, such as matrix algebra, vector calculus, and orthogonal functions. Emphasizes the major areas of classical physics such as mechanics, thermodynamics, and electromagnetism.

PHYS 311/Electrical Circuits and Electronics   **4 cr.**
(3 class hours, 2 lab hours)
(alternate years)
Prerequisite: PHYS 202
Fundamentals of AC and DC electric circuits. Design and use of filter, diode, transistor, and op-amp circuits. Introduction to digital electronics, microcomputers, and interfacing.

PHYS 313/An Introduction to General Relativity and Cosmology   **3 cr.**
(3 class hours)
(alternate years)
Prerequisite: PHYS 306
Study of the modern concepts of space and time. Systematic formulation of Einstein's Theory of Gravitation–The General Theory of Relativity. Emphasizes the applications of the theory to astrophysical problems including the dynamics of the observed universe. Also emphasizes the origin of the universe from the big bang and its subsequent evolution.

PHYS 316/Intermediate Physics for Medicine and Biology   **3 cr.**
(3 class hours)
(alternate years)
Prerequisite: PHYS 202
Study of physics that has medical and biological applications. The course will include topics such as: bioelectromagnetism (including nerve and muscle cell impulses, and EKG and EEG theory); emission and absorption of radiation; thermodynamics of living systems; fundamentals of imaging; ultrasound; x-rays, CAT scans, magnetic resonance imaging (MRI), and PET scans; the physics involved in nuclear medicine, such as gamma and positron emission. The course will provide a background needed by undergraduates as they prepare for biophysics, medicine and medical physics professions.

PHYS 321/Modern Physics   **4 cr.**
(3 class hours, 2 lab hours)
(annually—fall)
Prerequisites: PHYS 202, MATH 128
Fundamental concepts of 20th-century physics to include topics in special relativity, quantum theory, and atomic physics.

PHYS 390/Methods of Teaching Science   **3 cr.**
(3 class hours)
(annually—spring)
Modern trends in content, methods, techniques, organization, and philosophy of science education. Preparation for student teaching.

PHYS 401/Mechanics   **3 cr.**
(3 class hours)
(alternate years)
Prerequisites: MATH 326 or 386, PHYS 202, PHYS 306, CMSC 215
Classical mechanics including kinematics, dynamics, work and energy, gravitation, harmonic oscillations, translational and rotational motion of rigid bodies, properties of solid and liquids, and wave motion.

PHYS 411/Optics and Wave Motion   **4 cr.**
(3 class hours, 2 lab hours)
(alternate years)
Prerequisites: PHYS 202, PHYS 306, MATH 128, CMSC 215, or permission of instructor
A study of the properties of light and its interaction with matter. The areas of geometric, wave, and quantum optics are treated at an intermediate level.

PHYS 416/Heat and Thermodynamics   **3 cr.**
(3 class hours)
(alternate years)
Prerequisites: PHYS 202, PHYS 306, CMSC 215
Concepts of heat and temperature and interrelationship between energy and the physical properties of matter.

PHYS 421/Electromagnetic Theory I   **3 cr.**
(3 class hours)
(annually—fall)
Prerequisites: PHYS 202, PHYS 306, CMSC 215
A study of the electric and magnetic properties of matter with emphasis on fields, energy exchanges, and practical applications in electromagnetic fields.

PHYS 422/Electromagnetic Theory II   **3 cr.**
(3 class hours)
(alternate years)
Prerequisites: PHYS 421, PHYS 306, CMSC 215, or permission of instructor
A study of the theory and laws of classical electromagnetism on an intermediate level. Emphasis will be given to electrostatic charge distributions, potential theory, Maxwell's equations, and electromagnetic waves.

PHYS 426/Particle and Nuclear Physics   **3 cr.**
(3 class hours)
(alternate years)
Prerequisites: PHYS 321, CMSC 215
Quantum mechanical treatment of alpha decay, electron and positron emission, gamma radiation, nuclear models, nuclear reactions, parity, isospin, fission, fusion, fundamental particles, and antimatter.

PHYS 431/Introduction to Quantum Mechanics   **3 cr.**
(3 class hours)
(alternate years)
Prerequisites: PHYS 306, PHYS 321, CMSC 215
Fundamental concepts of quantum mechanics and applications to problems in modern physics. Wave mechanics and wave mechanical properties of matter studied using the Schroedinger approach.

PHYS 436/Solid State Physics   **3 cr.**
(3 class hours)
(alternate years)
Prerequisites: PHYS 321, PHYS 306
Corequisite: PHYS 421
Topics: crystal structure, diffraction of X-ray by crystals, lattice vibrations, thermal properties, free electron theory of metals, band theory, semiconductors, superconductors, and magnetism.

PHYS 451/Advanced Physics Laboratory   **2 cr.**
(4 lab hours)
(alternate years)
Prerequisites: PHYS 202, PHYS 306, PHYS 321, CMSC 215
Performance of physics experiments at an advanced level. Statistical treatment of data approaching that of research caliber applied to experiments of classical and modern format. Involvement in research.

PHYS 466/Introductory Astrophysics   **3 cr.**
(3 class hours)
(occasionally)
Prerequisites: PHYS 321, CMSC 215, or permission of instructor
Observational data and physics of stars and stellar systems, including: atomic structure and radiative processes; thermostatistics of excitation and ionization equilibria; photometry and spectroscopy; radiation transport, absorption, and scattering theory; thermodynamics of stellar structure and evolution; thermonuclear fusion reactions and nucleosynthesis; galactic structure and evolution; and cosmology.

PHYS 489/Physics Teaching Seminar   **1 cr.**
(every semester)
Analysis of student-teaching experience which must be taken concurrently with PHYS 490.

PHYS 490/Student Teaching in Physics   **10 cr.**
(every semester)
Prerequisites: Meeting all criteria for admission to student teaching
Student teaching during one semester of the senior year with an approved teacher in a public school under supervision of the cooperating teacher and college supervisors.

PHYS 499/Independent Study in Physics   **variable cr.**
(class hours individually arranged)
(every semester)
Prerequisite: Permission of instructor
Independent study in a selected area of physics, geology, meteorology, or astronomy through the use of scientific journals, source books, and experimentation.
This course may be repeated for credit if the topic is different.

ASTR 161/Descriptive Astronomy   **4 cr.**
(3 class hours, 2 lab hours)
(every semester)
Study of celestial bodies. Topics: earth and its motions, celestial sphere, properties of the solar system, stars, stellar evolution, galaxies, cosmology, time, and calendar. Evening observations with telescopes and planetarium demonstrations included. Laboratory exercises involve use of computer software, star charts, the planetarium, and telescopes.

ASTR 261/Astronomy II   **4 cr.**
(3 class hours, 2 lab hours)
(occasionally)
Prerequisite: ASTR 161
Study of the stellar universe. Topics: stellar properties, multiple stars, star clusters, variable stars, interstellar medium, stellar evolution, galaxies, and cosmology. Laboratory exercises involve use of computer software, telescopes, photometers, and spectroscopes.

GOLG 120/Introduction to Geology   **4 cr.**
(3 class hours, 2 lab hours)
(every semester)
Perspectives on the World: Science
An introductory course in the principles of geology. Topics will include earthquakes, glaciers, volcanoes, natural resources, and the evolution of the earth and life.

GOLG 220/Geology II   **4 cr.**
(3 class hours, 2 lab hours)
(every spring)
Prerequisite: GOLG 120
An in-depth study of geology, focusing on earth history and geologic time. Topics: sedimentology, stratigraphy, marine and non-marine depositional environments, relative and absolute time, and basic paleontology. Several required field trips and individual case studies are included in the course.

MTRL 171/Introduction to Meteorology   **4 cr.**
(3 class hours, 2 lab hours)
(alternate years—spring)
A study of basic weather processes. Topics: Earth-atmosphere system, heat balance, moisture and precipitation, air masses, fronts, storm systems, ocean circulation, climate, atmospheric optics, air pollution, satellite imagery, and interpretation. Laboratory exercises involve use of computer software, weather maps, and meteorological instruments. Field trips are a required part of the course.