### Computational Biology Course Descriptions 12-14

<table>
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<tr>
<th>Course Number and Title</th>
<th>Course Description and Prerequisites</th>
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<tr>
<td><strong>INTRODUCTORY COURSES</strong></td>
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| BIO 311C: Introductory Biology I | Introduction to biological energy transformation, cell structure and physiology, and gene expression.  
*Prerequisites:* Credit or registration for CH 301 or 301H. |
| BIO 311D: Introductory Biology II | Introduction to mechanisms of inheritance, evolution, physiology, and species interactions. Basic principles of Mendelism, molecular genetics, structure and function of genes and chromosomes, populations and evolution.  
*Prerequisites:* BIO 311C with a grade of at least C-. |
| BIO 325: Genetics | Basic principles of Mendelism, molecular genetics, structure and function of genes and chromosomes, populations and evolution.  
*Prerequisites:* BIO 311C and 311D with a grade of at least C- in each. |
| CH 301: Principles of Chemistry I | Three lecture hours a week for one semester. Some sections also require one enrichment/discussion hour a week; these are identified in the Course.  
*Prerequisite:* Credit with a grade of at least C- or registration for one of the following: Mathematics 305G, 408C, 408D, 408K, 408L, 408M, 408N, 408S, Statistics and Scientific Computation 302; and an appropriate score on the ALEKS chemistry placement examination. |
| CH 302: Principles of Chemistry II | Development and application of concepts, theories, and laws underlying chemistry.  
*Prerequisites:* Credit with a grade of at least C- in Chem 301 or 301H; and credit with a grade of at least C- or registration for one of the following: M408C, 408D, 408K, 408L, 408M, 408N, 408S, SSC 302 |
| CH 204: Introduction to Chemical Practices | Introduction to the techniques of modern experimental chemistry. Designed to provide basic laboratory and analytical skills. May include organic, analytical, and physical chemistry, as well as materials science.  
*Prerequisites:* Credit or registration for CH 302. |

### CALCULUS COURSE – CHOOSE ONE OF THE FOLLOWING SEQUENCES

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| M408C: Differential and Integral Calculus | Introduction to the theory and applications of differential and integral calculus of functions of one variable; topics include limits, continuity, differentiation, the mean value theorem and its applications, integration, the fundamental theorem of calculus, and transcendental functions.  
*Prerequisites:* A score of at least 80 on the ALEKS placement examination. |

**AND**

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| M408D: Sequences, Series, and Multivariable Calculus | Introduction to the theory and applications of sequences and infinite series, including those involving functions of one variable, and to the theory and applications of differential and integral calculus of functions of several variables; topics include parametric equations, sequences, infinite series, power series, vectors, vector calculus, functions of several variables, partial derivatives, gradients, and multiple integrals.  
*Prerequisites:* M 408C, 408L, or 408S with a grade of at least C-. |

**OR**

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<tr>
<td>M 408N: Differential Calculus for Science</td>
<td>Introduction to the theory of differential calculus of functions of one variable, and its application to the natural sciences. Subjects may include limits and</td>
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differentiation, with applications to rates of change, extremes, graphing, and exponential growth and decay.

**Prerequisites:** A score of at least 70 on the ALEKS placement examination.

**AND**

**M 408S: Integral Calculus for Science**

Restricted to students in the College of Natural Sciences. Introduction to the theory of integral calculus of functions of one variable, and its applications to the natural sciences. Subjects may include integration and its application to area and volume, and transcendental functions, sequences, and series and their application to numerical methods.

**Prerequisites:** M 408C, 408K, or 408N with a grade of at least C-.

**Required Math Course**

**M 362K: Probability I**

An introductory course in the mathematical theory of probability, fundamental to further work in probability and statistics, includes basic probability properties, conditional probability and independence, various discrete and continuous random variables, expectation and variance, central limit theorem, and joint probability distributions.

**Prerequisites:** M 408D, 408L, or 408S with a grade of at least C-.

**Additional Math Course - Choose at least 3 hours**

**M 340L: Matrices and Matrix Calculations**

Techniques of matrix calculations and applications of linear algebra.

**Prerequisites:** M 408C, 408K, or 408N with a grade of at least C-.

**M 341: Linear Algebra and Matrix Theory**

Vector spaces, linear transformations, matrices, linear equations, determinants. Some emphasis on rigor and proofs.

**Prerequisites:** M 408D or 408M with a grade of at least C-.

**SSC 329C: Practical Linear Algebra I**

Matrix representations and properties of matrices; linear equations, eigenvalue problems and their physical interpretation; and linear least squares and elementary numerical analysis. Emphasis on physical interpretation, practical numerical algorithms, and proofs of fundamental principles.

**Prerequisites:** Credit or registration for M 408C, 408K, or 408N.

**Additional Math Course - Choose at least 3 hours**

**M358K: Applied Statistics**

Exploratory data analysis, correlation and regression, data collection, sampling distributions, confidence intervals, and hypothesis testing.

**Prerequisites:** M 362K with a grade of at least C-.

**M378K: Introduction to Mathematical Statistics**

Same as SSC 378. Sampling distributions of statistics, estimation of parameters (confidence intervals, method of moments, maximum likelihood, comparison of estimators using mean square error and efficiency, sufficient statistics), hypothesis tests (p-values, power, likelihood ratio tests), and other topics.

**Prerequisites:** M 362K with a grade of at least C-.

**SSC 321:**

**SSC 325H:**
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<th>Course Code</th>
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<tr>
<td>SSC 328M</td>
<td>Biostatistics</td>
<td>Introduction to methods of statistical analysis of biological data.</td>
<td>Four hours of coursework in BIO and either M 408D or 408L.</td>
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<td><strong>COMPUTER SCIENCE</strong></td>
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<td>CS 313E</td>
<td>Elements of Software Design</td>
<td>Object-oriented design of software in a modern high-level language, using software library packages. Introduction to elementary data structures and complexity of algorithms.</td>
<td>CS 303E or 305J with a grade of at least C-</td>
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<td>SSC 322:</td>
<td>Introduction to Scientific Computation</td>
<td>Introduction to programming using both the C and Fortran (95/2003) languages, with applications to basic scientific problems. Covers common data types and structures, control structures, algorithms, performance measurement, and interoperability.</td>
<td>Credit or registration for M 408C or 408K or 408N.</td>
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<tr>
<td><strong>ADDITIONAL COMPUTER SCIENCE COURSE</strong> - CHOOSE AT LEAST 3 HOURS</td>
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<td>CS 323E</td>
<td>Elements of Scientific Computing</td>
<td>Fundamentals of software issues related to scientific computing. Topics include floating-point computations, numerical computation errors, interpolation, integration, solution of linear systems of equations, optimization, and initial value problems of ordinary differential equations. Implementations of algorithms are investigated using MATLAB for matrix and vector computations. Examples are drawn from a variety of science and mathematics areas.</td>
<td>CS 303E or equivalent, M 408C, 408K, or 408N; M 408D, 408M, or 427L; and credit with a grade of at least C- or registration for M 341 or 340L.</td>
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<td>CS 323H</td>
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<td>CS 324E</td>
<td>Elements of Graphics and Visualization</td>
<td>Basics of two- and three-dimensional computer graphics systems, modeling and rendering, and selected graphics software APIs. Other topics may include interactive graphics, animation, graphical user interfaces, and the graphical presentation of information.</td>
<td>C S 307 or 313E or EE 422C with a grade of at least C-</td>
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<tr>
<td>CS 327E</td>
<td>Elements of Databases</td>
<td>A practical introduction to database management systems, with discussion of database administration and management. Survey of logical modeling, database design with a focus on relational databases, SQL query language, and current applications. Topics may include data integrity, performance, concurrency, transaction processing, recovery, security, and Web applications.</td>
<td>C S 307 or 313E or EE 422C with a grade of at least C-</td>
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<tr>
<td>CS 329E</td>
<td>Topics in Elements of Computing</td>
<td>Three lecture hours a week for one semester. May be repeated for credit when the topics vary.</td>
<td>C S 303E or the equivalent with a grade of at least C-</td>
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<tr>
<td>CS 337:</td>
<td>Theory in Programming</td>
<td>Application of program-analysis theory to program design. Methodologies for</td>
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Practice

large-scale program design. Designed to help students bring together theoretical and programming skills.

**Prerequisites:** C S 314, 314H, 315, or 315H; 336 or 336H; and M 408C, 408L, or 408S.

CS 367: Numerical Methods

Topics include systems of linear equations, numerical integration, ordinary differential equations, and nonlinear equations. Construction and use of large numerical systems. Influence of data representation and computer architecture on algorithm choice and development.

**Prerequisites:** C S 310, 310H, 429, or 429H; 336 or 336H; M 408D, 408M, or 427L; and 340L or 341.

SSC 329D: Practical Linear Algebra II

Iterative solutions to linear equations and eigenvalue problems; properties of symmetric and nonsymmetric matrices, exploitation of parsity and diagonal dominance; introduction to multivariate nonlinear equations; numerical analysis; and selected applications and topics in the physical sciences.

**Prerequisites:** M 340L, 341, or S SC 329C.

SSC 335: Scientific and Technical Computing

A comprehensive introduction to computing techniques and methods applicable to many scientific disciplines and technical applications. Covers computer hardware and operating systems, systems software and tools, code development, numerical methods and math libraries, and basic visualization and data analysis tools.

**Prerequisites:** M 408D or 408M, and prior programming experience.

SSC 374D: Distributed and Grid Computing for Scientists and Engineers


**Prerequisites:** M 408D or 408M; M 340L; and prior programming experience using C or Fortran on Linux or Unix systems.

SSC 374E: Visualization and Data Analysis

Scientific visualization principles, practices, and technologies, including remote and collaborative visualization. Introduces statistical analysis, data mining, and feature detection.

**Prerequisites:** M 408D or 408M; Mathematics 340L; and prior programming experience using C or Fortran on Linux or Unix systems.

M 348: Scientific Computation in Numerical Analysis

Introduction to mathematical properties of numerical methods and their applications in computational science and engineering. Introduction to object-oriented programming in an advanced language. Study and use of numerical methods for solutions of linear systems of equations; nonlinear least-squares data fitting; numerical integration; and solutions of multidimensional nonlinear equations and systems of initial value ordinary differential equations.

**Prerequisites:** C S 303E or 307, and M 341 or 340L with a grade of at least C-

M 372K: Partial Differential Equations and Applications

Partial differential equations as basic models of flows, diffusion, dispersion, and vibrations. Topics include first- and second-order partial differential equations and classification (particularly the wave, diffusion, and potential equations), and their origins in applications and properties of solutions. Includes the study of characteristics, maximum principles, Green's functions, eigenvalue problems, and Fourier expansion methods.

**Prerequisites:** M 427K with a grade of at least C-

M 376C: Methods of Applied

Variational methods and related concepts from classical and modern applied
PHYSIOLOGY  

BIO 328: Introductory Plant Physiology  
General principles of the mineral nutrition, water relations, metabolic activities, growth and development of green plants  
**Prerequisites:** BIO 325 or 325H with a grade of at least C-, and CH 302 or 302H.

BIO 361T: Comparative Animal Physiology  
Physiology of organ systems in animal phyla, with special emphasis on physiological adaptations of organisms to their environment.  
**Prerequisites:** BIO 325 or 325H with a grade of at least C-.
BIO 365R: Vertebrate Physiology  Introduction to the nervous system and other excitable tissues. Subjects may include membrane potentials, ion channels, synaptic transmission, learning and memory, skeletal and cardiac muscle, and how systems of neurons lead to sensation and motor output. Human diseases are used to illustrate perturbation of normal function.  **Prerequisites:** BIO 325 or 325H with a grade of at least C-.

BIO 365S: Vertebrate Systems Physiology  Overview of body fluids, the cardiovascular system, respiration, digestion, metabolism, and endocrinology.  **Prerequisites:** BIO 311C; 325 or 325H; Chem 301 and one of the following: M408C, 408K, 408N, 408R, SSC 302 with a grade of at least C- in each.

### ADDITIONAL UPPER DIVISION BIOLOGY COURSEWORK – CHOOSE AT LEAST 3 HOURS

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<tr>
<td>BIO 320: Cell Biology</td>
<td>Principles of eukaryotic cell structure and function; macromolecules, energetics, membranes, organelles, cytoskeleton, gene expression, signaling, division, differentiation, motility, and experimental methodologies. <strong>Prerequisites:</strong> BIO 325 or 325H with a grade of at least C-.</td>
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<td>BIO 326R: General Microbiology</td>
<td>Overview of the major areas of micro-biological study, including cell structure and function, genetics, host-microbe interactions, physiology, ecology, diversity, and virology. <strong>Prerequisites:</strong> BIO 325 or 325H and CH 302 or 302H with grades of at least C-.</td>
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<td>BIO 344: Molecular Biology</td>
<td>Molecular basis of cellular processes: gene structure and function; DNA replication; RNA and protein synthesis; viruses; molecular aspects of immunology and cancer, and recombinant DNA. <strong>Prerequisites:</strong> BIO 325 or 325H with a grade of at least C-.</td>
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<td>BIO 349: Developmental Biology</td>
<td>Principles of animal development, with emphasis on developmental mechanisms. <strong>Prerequisites:</strong> BIO 325 or 325H with a grade of at least C-.</td>
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Choose 12 additional hours of upper division biology coursework; at least four laboratory coursework.