UC San Diego

JACOBS SCHOOL OF ENGINEERING
Shu Chien-Gene Lay Department of Bioengineering

Bioengineering: Bioinformatics (BE28)
Triton Day 2023 Information Packet

Packet Contents

The UCSD Department of Bioengineering

Mission Statement

To provide our students with an excellent education that enables successful, innovative, and lifelong careers in bioengineering industries and professions.

Student Learning Outcomes

Upon completion of the Bioengineering Program, graduates in Bioengineering; Bioengineering: Biotechnology; Bioengineering: BioSystems; and Bioengineering: Bioinformatics are expected to have the desired knowledge, skills, attitudes, and behaviors as indicated below.

- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- An ability to communicate effectively with a range of audiences.
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment , establish goals, plan tasks, and meet objectives.
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
- An ability to develop innovative thinking to solve bioengineering problems with creativity and entrepreneurship.

Academic Integrity and Research Ethics

The overall mission of the Dept. of Bioengineering is to provide students with an education that enables successful, innovative, and lifelong careers in bioengineering industries and professions, including a recognition of professional and social responsibilities, and sensitivity to ethical and health-related issues.
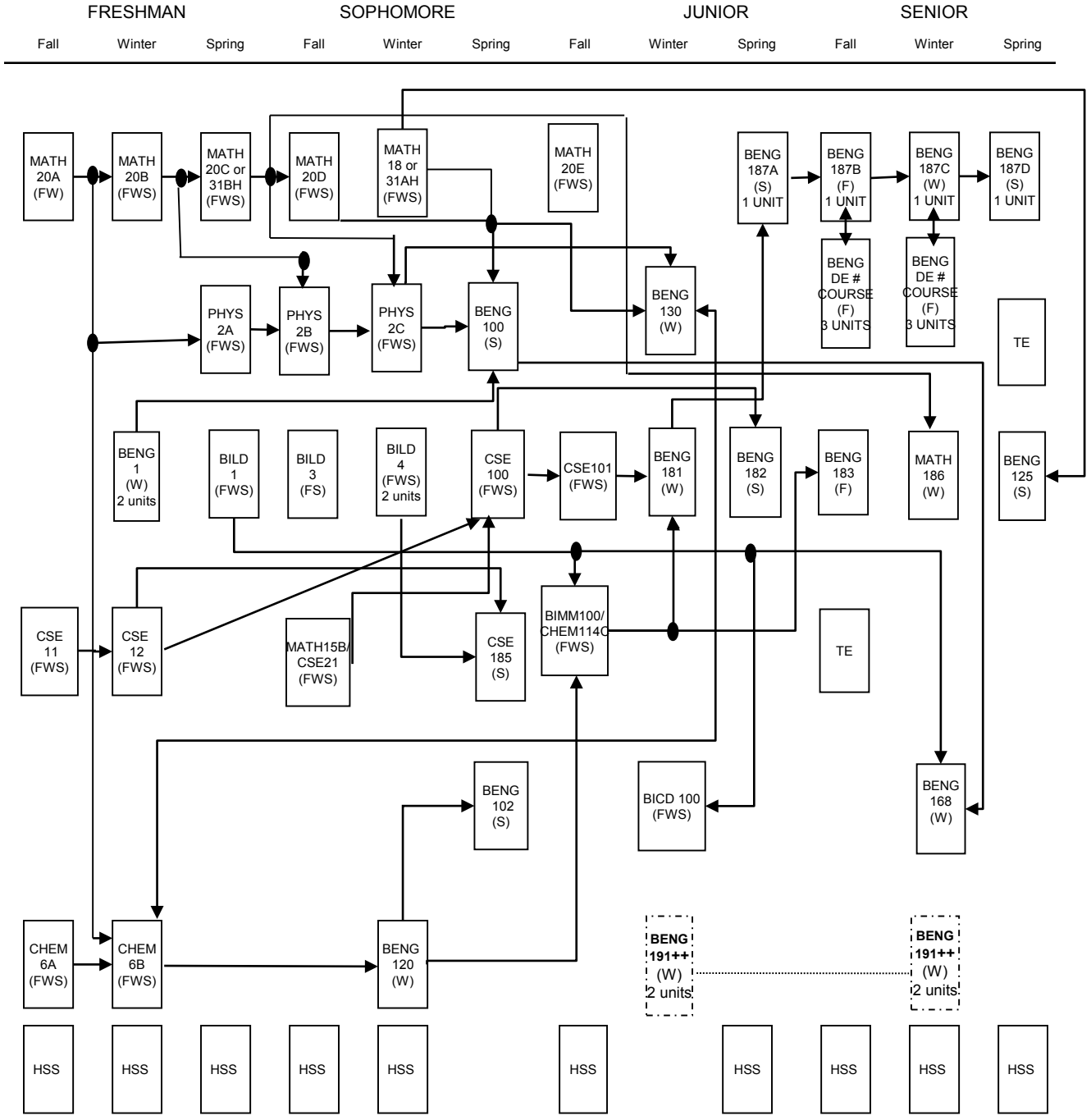
The UCSD Policy on Academic Integrity states the general rules for student integrity. It establishes the standards that apply to academic course work undertaken by all undergraduate and graduate students of this University. The policy is based on the fundamental tenet that the principle of honesty must be upheld if the integrity of scholarship is to be maintained by an academic community.

BIOENGINEERING: BIOINFORMATICS (BINF) COURSE FLOWCHART

Not *Accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering & Technology [EAC/ABET]*   ~REV. 6-4-18~

(ALL COURSES REQUIRED FOR THE MAJOR MUST BE TAKEN FOR LETTER GRADES.)

	FRESHMAN			SOPHOMORE				JUNIOR			SENIOR	

| Fall | Winter | Spring | Fall | Winter | Spring | Fall | Winter | Spring | Fall | Winter | Spring |

MATH 20A (FW) → MATH 20B (FWS) → MATH 20C or 31BH (FWS) → MATH 20D (FWS) → MATH 18 or 31AH (FWS) → MATH 20E (FWS)

BENG 187A (S) 1 UNIT → BENG 187B (F) 1 UNIT → BENG 187C (W) 1 UNIT → BENG 187D (S) 1 UNIT

BENG DE # COURSE (F) 3 UNITS

BENG DE # COURSE (F) 3 UNITS

PHYS 2A (FWS) → PHYS 2B (FWS) → PHYS 2C (FWS) → BENG 100 (S)

BENG 130 (W)

TE

BENG 1 (W) 2 units

BILD 1 (FWS)

BILD 3 (FS)

BILD 4 (FWS) 2 units

CSE 100 (FWS) → CSE101 (FWS) → BENG 181 (W)

BENG 182 (S)

BENG 183 (F)

MATH 186 (W)

BENG 125 (S)

CSE 11 (FWS) → CSE 12 (FWS)

MATH15B/ CSE21 (FWS)

CSE 185 (S)

BIMM100/ CHEM114C (FWS)

TE

BENG 102 (S)

BICD 100 (FWS)

BENG 168 (W)

CHEM 6A (FWS) → CHEM 6B (FWS) → BENG 120 (W)

BENG 191++ (W) 2 units .... **BENG 191++** (W) 2 units

| HSS | HSS | HSS | HSS | HSS | | HSS | | HSS | HSS | HSS | HSS |

++BENG 191 may be taken <u>once</u> and is <u>recommended</u> for Juniors and Seniors, but <u>not</u> required.

<u>Electives:</u>

BENG 199

Bioinformatics Major Requirements

(Note: All course descriptions and prerequisites are from the 2022-23 Catalog).

Freshman Year Courses

Fall Quarter

MATH 20A. Calculus for Science and Engineering (4) Foundations of differential and integral calculus of one variable. Functions, graphs, continuity, limits, derivative, tangent line. Applications with algebraic, exponential, logarithmic, and trigonometric functions. Introduction to the integral. (Two credits given if taken after MATH 1A/10A and no credit given if taken after MATH 1B/10B or MATH 1C/10C. Formerly numbered MATH 2A.) ***Prerequisites:*** Math Placement Exam qualifying score, or AP Calculus AB score of 3 (or equivalent AB subscore on BC exam), or SAT II MATH 2C score of 650 or higher, or MATH 4C or MATH 10A.

CSE 11. Introduction to Computer Science and Object-Oriented Programming: Java (4) Accelerated introductory programming including an object-oriented approach. Covers basic programming topics from CSE 8A including variables, conditionals, loops, functions/methods, structured data storage, and mutation. Also covers topics from CSE 8B including the Java programming language, class design, interfaces, basic class hierarchies, recursion, event-based programming, and file I/O. Basics of command-line navigation for file management and running programs. Zero units of credit offered for CSE 11 if CSE 8B taken previously or concurrently. Recommended preparation: Significant prior programming experience (for example, high school AP CSA). Students should consult the "CSE Course Placement Advice" web page for assistance in choosing a first CSE course. ***Prerequisites:*** restricted to undergraduates. Graduate students will be allowed as space permits.

CHEM 6A. General Chemistry I (4)
First quarter of a three-quarter sequence intended for science and engineering majors. Topics include atomic theory, bonding, molecular geometry, stoichiometry, types of reactions, and thermochemistry. May not be taken for credit after CHEM 6AH. Recommended: proficiency in high school chemistry and/or physics. ***Corequisite:*** MATH 10A or 20A or prior enrollment.

Winter Quarter

MATH 20B. Calculus for Science and Engineering (4) Integral calculus of one variable and its applications, with exponential, logarithmic, hyperbolic, and trigonometric functions. Methods of integration. Infinite series. Polar coordinates in the plane and complex exponentials. (Two units of credits given if taken after MATH 1B/10B or MATH 1C/10C.) ***Prerequisites:*** AP Calculus AB score of 4 or 5, or AP Calculus BC score of 3, or MATH 20A with a grade of C– or better, or MATH 10B with a grade of C– or better, or MATH 10C with a grade of C– or better.

CSE 12. Basic Data Structures and Object-Oriented Design (4) Use and implementation of basic data structures including linked lists, stacks, and queues. Use of advanced structures such as binary trees and hash tables. Object-oriented design including interfaces, polymorphism, encapsulation, abstract data types, pre-/post-conditions. Recursion. Uses Java and Java Collections. ***Prerequisites:*** CSE 8B or CSE 11; restricted to undergraduates. Graduate students will be allowed as space permits.

CHEM 6B. General Chemistry II (4) Second quarter of a three-quarter sequence intended for science and engineering majors. Topics include covalent bonding, gases, liquids, and solids, colligative properties, physical and chemical equilibria, acids and bases, solubility. May not be taken for credit after CHEM 6BH. ***Prerequisites:*** CHEM 6A or 6AH and MATH 10A or 20A. Recommended: concurrent or prior enrollment in MATH 10B or 20B.

BENG 1. Introduction to Bioengineering (2) An introduction to bioengineering that includes lectures and hands-on laboratory for design projects. The principles of problem definition, engineering inventiveness, team design, prototyping, and testing, as well as information access, engineering standards, communication, ethics, and social responsibility will be emphasized. P/NP grades only. ***Prerequisites:*** none. (W)

Spring Quarter

MATH 20C. Calculus and Analytic Geometry for Science and Engineering (4) Vector geometry, vector functions and their derivatives. Partial differentiation. Maxima and minima. Double integration. (Two units of credit

given if taken after MATH 10C. Credit not offered for both MATH 20C and 31BH. Formerly numbered MATH 21C.) *Prerequisites:* AP Calculus BC score of 4 or 5, or MATH 20B with a grade of C– or better.

PHYS 2A. Physics—Mechanics (4) A calculus-based science-engineering general physics course covering vectors, motion in one and two dimensions, Newton's first and second laws, work and energy, conservation of energy, linear momentum, collisions, rotational kinematics, rotational dynamics, equilibrium of rigid bodies, oscillations, gravitation. Students continuing to PHYS 2B/4B will also need MATH 20B. *Prerequisites:* MATH 10A-B or 20A or 20B or 20C or 31BH. Recommended preparation: prior or concurrent enrollment in MATH 20B.

BILD 1. The Cell (4) An introduction to cellular structure and function, to biological molecules, bioenergetics, to the genetics of both prokaryotic and eukaryotic organisms, and to the elements of molecular biology. ***Recommended preparation***: prior completion of high school- or college-level chemistry course.

Sophomore Year Courses

Fall Quarter
MATH 20D. Introduction to Differential Equations (4) Ordinary differential equations: exact, separable, and linear; constant coefficients, undetermined coefficients, variations of parameters. Systems. Series solutions. Laplace transforms. Techniques for engineering sciences. Computing symbolic and graphical solutions using Matlab. (Formerly numbered MATH 21D.) May be taken as repeat credit for MATH 21D. *Prerequisites:* MATH 20C (or MATH 21C) or MATH 31BH with a grade of C– or better.

PHYS 2B. Physics—Electricity and Magnetism (4) Continuation of PHYS 2A covering charge and matter, the electric field, Gauss's law, electric potential, capacitors and dielectrics, current and resistance, electromotive force and circuits, the magnetic field, Ampere's law, Faraday's law, inductance, electromagnetic oscillations, alternating currents and Maxwell's equations. Students continuing to PHYS 2C will also need MATH 20C or 31BH. *Prerequisites:* PHYS 2A or 4A and MATH 20B or 20C or 31BH. Recommended preparation: prior or concurrent enrollment in MATH 20C or 31BH.

BILD 3. Organismic and Evolutionary Biology (4) The first principles of evolutionary theory, classification, ecology, and behavior; a phylogenetic synopsis of the major groups of organisms from viruses to primates.

CSE 21. Mathematics for Algorithms and Systems (4) This course will provide an introduction to the discrete mathematical tools needed to analyze algorithms and systems. Enumerative combinatorics: basic counting principles, inclusion-exclusion, and generating functions. Matrix notation. Applied discrete probability. Finite automata. *Prerequisites:* CSE 20 or MATH 15A or MATH 31CH; students who have completed MATH 154 or MATH 184 or MATH 188 previously or concurrently may not receive credit for CSE 21; restricted to undergraduates. Graduate students will be allowed as space permits.

Winter Quarter
MATH 18. Linear Algebra (4) Matrix algebra, Gaussian elimination, determinants. Linear and affine subspaces, bases of Euclidean spaces. Eigenvalues and eigenvectors, quadratic forms, orthogonal matrices, diagonalization of symmetric matrices. Applications. Computing symbolic and graphical solutions using Matlab. Students may not receive credit for both MATH 18 and 31AH. *Prerequisites:* Math Placement Exam qualifying score, or AP Calculus AB score of 3 (or equivalent AB subscore on BC exam), or SAT II Math Level 2 score of 650 or higher, or MATH 4C, or MATH 10A, or MATH 20A. Students who have not completed listed prerequisites may enroll with consent of instructor.

PHYS 2C. Physics—Fluids, Waves, Thermodynamics, and Optics (4) Continuation of PHYS 2B covering fluid mechanics, waves in elastic media, sound waves, temperature, heat and the first law of thermodynamics, kinetic theory of gases, entropy and the second law of thermodynamics, Maxwell's equations, electromagnetic waves, geometric optics, interference and diffraction. Students continuing to PHYS 2D will need MATH 20D. *Prerequisites:* PHYS 2A or 4A, and MATH 20C or 31BH. Recommended preparation: prior or concurrent enrollment in MATH 20D. Prior completion of PHYS 2B is strongly recommended.

BILD 4. Introductory Biology Lab (2) Students gain hands-on experience and learn the theoretical basis of lab techniques common to a variety of biological disciplines such as biochemistry, molecular biology, cell biology, and

bioinformatics. Students will work in groups, learning how to collect, analyze, and present data while using the scientific method to conduct inquiry-based laboratory experiments. Material lab fees will apply.

BENG 120. Organic Chemistry Structural and Design Principles (4) Structural and design principles of carbon compounds. Structure and stereochemistry. Functional groups and chemical transformations. Structure and design principles of biomolecules. Molecules of life and their organization. *Prerequisites:* CHEM 6A and 6B; majors only or consent of department. (W)

Spring Quarter

BENG 100. Statistical Reasoning for Bioengineering Applications (4) General introduction to probability and statistical analysis, applied to bioengineering design. Topics include preliminary data analysis, probabilistic models, experiment design, model fitting, goodness-of-fit analysis, and statistical inference/estimation. Written and software problems are provided for modeling and visualization. *Prerequisites:* BENG 1, MATH 18 or MATH 31AH or MATH 20F, MATH 20C or MATH 31BH, and MATH 20D, and PHYS 2A-B-C, or consent of department. (S)

CSE 100. Advanced Data Structures (4) High-performance data structures and supporting algorithms. Use and implementation of data structures like (un)balanced trees, graphs, priority queues, and hash tables. Also, memory management, pointers, recursion. Theoretical and practical performance analysis, both average case and amortized. Uses C++ and STL. Credit not offered for both MATH 176 and CSE 100. Equivalent to MATH 176. Recommended preparation: background in C or C++ programming. *Prerequisites:* CSE 12 and CSE 15L and CSE 21 or MATH 154 or MATH 184A and CSE 5A or CSE 30 or ECE 15 or MAE 9; restricted to undergraduates. Graduate students will be allowed as space permits.

CSE 185. Advanced Bioinformatics Laboratory (4) This course emphasizes the hands-on application of bioinformatics to biological problems. Students will gain experience in the application of existing software, as well as in combining approaches to answer specific biological questions. Topics include sequence alignment, fast database search, comparative genomics, expression analysis, computational proteomics, genome-wide association studies, next-generation sequencing, genomics, and big data. Students may not receive credit for CSE 185 and BIMM 185. Restricted to CS27, BI34, BE28, and CH37 majors. *Prerequisites:* CSE 11 or CSE 8B and CSE 12 and MATH 20C or MATH 31BH and BILD 1 and BIEB 123 or BILD 4 or BIMM 101 or CHEM 109.

BENG 102. Molecular Components of Living Systems (4) Introduction to molecular structures. Macromolecules and assemblies-proteins, nucleic acids, and metabolites. Principles of design of simple and complex components of organelles, cells, and tissues. **Prerequisites:** BENG 120 or consent of department. (S)

Junior Year Courses

Fall Quarter

MATH 20E. Vector Calculus (4) Change of variable in multiple integrals, Jacobian, Line integrals, Green's theorem. Vector fields, gradient fields, divergence, curl. Spherical/cylindrical coordinates. Taylor series in several variables. Surface integrals, Stoke's theorem. Gauss' theorem. Conservative fields. *Prerequisites:* MATH 18 or MATH 20F or MATH 31AH and MATH 20C (or MATH 21C) or MATH 31BH with a grade of C– or better.

CSE 101. Design and Analysis of Algorithms (4) Design and analysis of efficient algorithms with emphasis of nonnumerical algorithms such as sorting, searching, pattern matching, and graph and network algorithms. Measuring complexity of algorithms, time and storage. NP-complete problems. *Prerequisites:* CSE 21 or MATH 154 or MATH 158 or MATH 184 or MATH 188 and CSE 12 or DSC 30; restricted to undergraduates. Graduate students will be allowed as space permits.

BIMM 100/CHEM 114C. Molecular Biology: Molecular mechanisms and applications of the central dogma. Genome structure and function. Transcription and translation. Regulation of gene expression. Use of DNA technology in basic and applied biology. Note: Students will not receive credit for both BIMM 100 and CHEM 114C. *Prerequisites:* BILD 1 and BIBC 103 or BILD 4 or BILD 70 or BIMM 101 and BENG 120 or CHEM 40A or CHEM 40AH and BENG 120 or CHEM 40B or CHEM 40BH.

BENG 130. Biotechnology Thermodynamics and Kinetics (4) An introduction to physical principles that govern biological matter and processes, with engineering examples. Thermodynamic principles, structural basis of life, molecular reactions and kinetics, and models to illustrate biological phenomena. *Prerequisites:* CHEM 6B, MATH 20A, 20B, 20D, PHYS 2A, 2B, 2C; majors only or consent of department. (W)

BENG 181. Molecular Sequence Analysis (4) (Cross-listed as BIMM 181 and CSE 181.) This course covers the analysis of nucleic acid and protein sequences, with an emphasis on the application of algorithms to biological problems. Topics include sequence alignments, database searching, comparative genomics, and phylogenetic and clustering analyses. Pairwise alignment, multiple alignment, DNA sequencing, scoring functions, fast database search, comparative genomics, clustering, phylogenetic trees, gene finding/DNA statistics. This course open to bioinformatics majors only. *Prerequisites:* CSE 100 or MATH 176 and CSE 101 and BIMM 100 or CHEM 114C. Students may receive credit for one of the following: CSE 181, BIMM 181, or BENG 181.

BICD 100. Genetics (4) An introduction to the principles of heredity emphasizing diploid organisms. Topics include Mendelian inheritance and deviations from classical Mendelian ratios, pedigree analysis, gene interactions, gene mutation, linkage and gene mapping, reverse genetics, population genetics, and quantitative genetics. *Prerequisites:* BILD 1 and BILD 3.

Spring Quarter
BENG 187A. Bioengineering Design Project: Planning (1) General engineering design topics including project planning and design objectives, background research, engineering needs assessment, technical design specifications, engineering standards, and design requirements and constraints. Introduction to biomedical and biotechnology design projects. Career and professional advising. Majors must enroll in the course for a letter grade in order to count the sequence toward the major. No exceptions will be approved. *Prerequisites:* BENG 112A or BENG 152 or BENG 168; bioengineering, bioengineering: biotechnology, or bioengineering: biosystems majors only or consent of department. (S)

BENG 182. Biological Databases (4) (Cross-listed as BIMM 182, CSE 182, and Chem 182.) This course provides an introduction to the features of biological data, how that data is organized efficiently in databases, and how existing data resources can be utilized to solve a variety of biological problems. Object-oriented databases, data modeling and description, survey of current biological database with respect to above, implementation of database focused on a biological topic. This course open to bioinformatics majors only. *Prerequisites:* CSE 100 or MATH 176. Students may receive credit for one of the following: CSE 182, BENG 182, or BIMM 182.

Senior Year Courses
Fall Quarter
BENG 187B. Bioengineering Design Project: Development (1) Development of an original bioengineering design for solution of a problem in biology or medicine. Analysis of economic issues, manufacturing and quality assurance, ethics, safety, design constraints, government regulations, and patent requirements. Oral presentation and formal engineering reports. Career and professional advising. Majors must enroll in the course for a letter grade in order to count the sequence toward the major. No exceptions will be approved. *Prerequisites:* BENG 187A; concurrent enrollment in one of BENG 119A, BENG 126A, BENG 127A, BENG 128A, BENG 129A, BENG 139A, BENG 147A, BENG 148A, BENG 149A, BENG 169A, or BENG 179A; bioengineering, bioengineering: biotechnology, or bioengineering: biosystems majors only or consent of instructor. (F)

BENG 183. Applied Genomic Technologies (4) Principles and technologies for using genomic information for biomedical applications. Technologies will be introduced progressively, from DNA to RNA to protein to whole cell systems. The integration of biology, chemistry, engineering, and computation will be stressed. Topics include technology for the genome, DNA chips, RNA technologies, proteomic technologies, aphysiomic and phenomic technologies, and analysis of cell function. *Prerequisites:* BIMM 100 or CHEM 114C, or consent of department. (F)

Winter Quarter
BENG 187C. Bioengineering Design Project: Implementation (1) Approaches to implementation of senior design project, including final report. Teams will report on construction of prototypes, conduct of testing, collection of data, and assessment of reliability and failure. Majors must enroll in the course for a letter grade in order to count the

sequence toward the major. No exceptions will be approved. ***Prerequisites:*** BENG 187B; concurrent enrollment in one of the following lab sections: BENG 119B, BENG 126B, BENG 127B, BENG 128B, BENG 129B, BENG 139B, BENG 147B, BENG 148B, BENG 149B, BENG 169B, or BENG 179B; bioengineering, bioengineering: biotechnology, or bioengineering: biosystems majors only or consent of instructor. (W)

MATH 186. Probability and Statistics for Bioinformatics (4) This course will cover discrete and random variables, data analysis and inferential statistics, likelihood estimators and scoring matrices with applications to biological problems. Introduction to Binomial, Poisson, and Gaussian distributions, central limit theorem, applications to sequence and functional analysis of genomes and genetic epidemiology. (Credit not offered for MATH 186 if ECON 120A, ECE 109, MAE 108, MATH 181A, or MATH 183 previously or concurrently. Two units of credit offered for MATH 186 if MATH 180A taken previously or concurrently.) ***Prerequisites****:* MATH 20C or MATH 31BH, or consent of instructor.

BENG 168. Biomolecular Engineering (4) Basic molecular biology and recombinant DNA technologies. Structure and function of biomolecules that decode genomes and perform energy conversion, enzymatic catalysis, and active transport. Metabolism of macromolecules. Molecular diagnostics. Design, engineering, and manufacture of proteins, genomes, cells, and biomolecular therapies. ***Prerequisites:*** BILD 1 and BENG 100, or consent of department. (W)

Spring Quarter

BENG 187D. Bioengineering Design Project: Presentation (1) Oral presentations of design projects, including design, development, and implementation strategies and results of prototype testing. Majors must enroll in the course for a letter grade in order to count the sequence toward the major. No exceptions will be approved. ***Prerequisites:*** BENG 187C; bioengineering, bioengineering: biotechnology, or bioengineering: biosystems majors only or consent of instructor. (S)

BENG 125. Modeling and Computation in Bioengineering (4) Computational modeling of molecular bioengineering phenomena: excitable cells, regulatory networks, and transport. Application of ordinary, stochastic, and partial differential equations. Introduction to data analysis techniques: power spectra, wavelets, and nonlinear time series analysis. ***Prerequisites:*** BENG 122A or BENG 123 or consent of department. (S)

*BENG 191/291. Senior Seminar I: Professional Issues in Bioengineering (2) (Conjoined with BENG 291.) Instills skills for personal and organizational development during lifelong learning. Student prepares portfolio of personal attributes and experiences, prepares for career interviews plus oral report of interviewing organizational CEO. Graduate students will prepare a NIH small business research grant. ***Prerequisites:*** consent of instructor. (F)

Two ("A" & "B") Design Elective Courses (6 units total) - Seniors work in teams on a project to design a solution to a multidisciplinary bioengineering problem suggested by professionals in bioengineering industry, academia, or medicine.

**Two 4-unit Technical Elective courses
Required for all students

*Recommended but not required; may be taken once.
**See departmental Student Affairs Office for additional information.

Additional Courses for Medical School

Bioinformatics students planning to apply to med school take the following courses in addition major requirements:

1. CHEM 6C
2. CHEM 7L
3. CHEM 41A
4. CHEM 41B
5. CHEM 41C
6. CHEM 43A
7. PHYS 2BL
8. PHYS 2CL
9. One of the following: BIBC 100, BIBC 102, CHEM 114A, or CHEM 114B
10. One year of English composition or writing (general education courses dependent on written material for grading should suffice)
11. One course in psychology and sociology (PSYC 1 and SOCI 70) helpful for the MCAT but not a prerequisite
12. Recommended additional coursework
    a. Human Physiology (BIPN 100 and/or BIPN 102)
    b. Cell biology (BICD 110)
    c. Microbiology (BIMM 120)

Most medical schools accept some AP and IB credit for prerequisites. Some medical schools do NOT accept AP/IB credit for prerequisites, and additional upper division coursework may be required. Please consult with a pre-med advisor if you have concerns.

For more information, please visit:
https://career.ucsd.edu/plan/explore/pre-health-med/medicine/prepare.html and consider meeting with a pre-med advisor. This information is meant to guide students in planning for a pre-med track, but may not fully encompass all requirements.

Frequently Asked Questions

1. **I was not directly admitted into the Bioengineering department. Is there a way that I can change into any of the "capped" majors later on?**

Possibly. Freshman students admitted in **FALL 2023** will be able to apply **"one time only"** to a "capped" major in **FALL 2024.** A certain number (*determined on an annual basis*) of "continuing" sophomore students who apply will be selected to enter the "capped" *Bioengineering*, *Bioengineering: Biotechnology*, *Bioengineering: Bioinformatics,* or the *Bioengineering: BioSystems* major. Interested continuing students must not be past sophomore standing, as time to graduation would be delayed. You are required to complete the following courses (depending on which major you wish to apply for) **prior** to applying in **FALL 2024**:
Bioengineering and *Bioengineering: Biotechnology*: BILD 1 (biology); CHEM 6AB; MAE 8 (MatLab); Math 20ABC; Physics 2AB.
Bioengineering: Bioinformatics: BILD 1; CHEM 6AB; CSE 11 (or CSE 8A and 8B); MATH 20ABC; PHYS 2AB.
Bioengineering: BioSystems: CHEM 6AB; MATH 20ABC; PHYS 2AB.

If you have met some of the courses by Advanced Placement ("AP") work, please be advised of the following: A minimum of 3 courses listed must have been completed at UC San Diego. If students can not meet this 3-course minimum due to prior credit, students may offer grades for **MATH 20D** (Differential Equations), **MATH 18** (Linear Algebra) or **MATH 20E** (Vector Calculus) until the 3 course minimum has been met.
Applications will be available **September 23, 2024**, and must be submitted by Friday of the second week of instruction- **Oct. 4, 2024**. Applications will be ranked according to the GPA obtained in the required courses and will be approved, starting with the student having the highest GPA in those courses, until the "open" slots are filled in each of the "capped" majors. Bioengineering Student Affairs staff will notify all applicants re: their status on **Wednesday ,Oct 9th, 2024**.

2. **What are the differences among the four majors within the Bioengineering Dept?**

  Bioengineering (BENG): This major prepares students for careers in the biomedical device industry and for further education in graduate school. Students completing the B.S. degree in Bioengineering have a broad preparation in traditional topics in engineering, allowing for a variety of career pathways. This program addresses the bioengineering topics of biomechanics, biotransport, bioinstrumentation, bioelectricity, biosystems, and biomaterials, and the complementary fields of systems and integrative physiology. Education in these areas allows application of bioengineering and other scientific principles to benefit human health by advancing methods for effective diagnosis and treatment of disease, e.g., through development of medical devices and technologies. The *BENG* major is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering & Technology [EAC/ABET].
  Bioengineering: Biotechnology (BTEC): This major prepares students for careers in the biotechnology industry and for further education in graduate school. The curriculum has a strong engineering foundation with emphasis on biochemical process applications. This program addresses the bioengineering topics of biochemistry, metabolism, kinetics, biotransport, biosystems, bioreactors, bioseparations, tissue engineering, and the complementary fields of cellular physiology. Education in these areas allows application of bioengineering and physicochemical principles to cellular and molecular biology, with the applications that benefit human health. The *BTEC* major is accredited by [EAC/ABET].
  Bioengineering: Bioinformatics (BINF): Bioinformatics is the study of the flow of information (genetic, metabolic, and regulatory) in living systems to provide an understanding of the properties of

cells and organisms. This major has been developed by the Departments of Bioengineering, Chemistry and Biochemistry, Computer Science and Engineering, and Division of Biology. The bioinformatics major in bioengineering emphasizes systems engineering and model-based approaches to interpreting and integrating bioinformatics data. The bioinformatics major prepares students for careers in the pharmaceutical, biotechnology, and biomedical software industries, and for further studies in graduate school. The *BINF* major is not accredited by a Commission of [EAC/ABET].

   Bioengineering: BioSystems (BSYS)*:* This major focuses on the interaction and integration of components in complex biological and engineering assemblages, and how the function and interactions of these components affect overall performance. The major draws on foundations of classical electrical and systems engineering, with biological applications at levels of the molecular and cellular to the physiological and whole organism, and provides an alternative to other bioengineering majors that emphasize mechanical, chemical, and computational approaches. The major prepares students for careers in the bioengineering industry, in research and development, and for further education in graduate, medical, and business schools. The *BSYS* major is accredited to a [EAC/ABET].

3. **I have received Advanced Placement credit from high school in one or more subjects. Does AP work exempt me from taking specific courses?**

 Yes. Depending upon the score you receive on an AP exam, you may be exempt from taking one or more courses required for your major. Please refer to section I below and/or the online UCSD General Catalog.

4. **Is it possible to do research as an undergraduate?**

Yes. As a student with lower-division standing, upon completion of 30 UCSD units with a 3.0 GPA, you may request to work with a faculty member and enroll in a BENG 99 (Independent Study for Undergraduates) course. Additionally, when you achieve upper-division standing and have completed a total of 90 units with a 2.5 GPA, you are encouraged to participate in research with a faculty member by enrolling in a BENG 199 course. Please refer to the Research Labs listing to see an up to date list of our faculty who you may have the option of doing research with.

5. **Can I graduate in four years with a major in the Bioengineering Department?**

Yes. Our department's major flowcharts are designed to be completed in four years.

6. **Is it possible to complete a minor or double major with a major in Bioengineering?**

Completion of a minor or a double major is not encouraged among the engineering departments. Engineering majors are very rigorous and require a large number of units to be completed. Often a student's graduation will be delayed if a minor or double major is planned. Students may not complete a minor or double major with another engineering department, per University policy.

7. **How many students are in the Bioengineering Dept?**

Approximately 535 undergraduate students across 4 majors.

8. **Does Bioengineering have a 5-Year BS/MS Program?**

Yes. Please reference section III below.

I. Advanced Placement Course Information

Exam and Units for University Credit	UCSD Course Exemptions for Use in Satisfying Bioengineering Major Requirements
Biology ~ 8 units	Score of 3 = BILD 10; may take BILD 1, 2, 3 for credit Score of 4 or 5 = exempts from BILD 1, 2, 3
Chemistry ~ 8 units	Score of 3 = exempts Chem. 4 Score of 4 = exempts Chem. 4 or 11; may take Chem. 6A, 6B, 6C for credit Score of 5 = exempt from Chem. 6A-B-C; may take Chem. 6AH, 6BH, 6CH for credit. **MUST TAKE CHEM 7L.**
Math: Calculus AB ~ 4 units	AB: Score of 3 on AB exam = exempts Math 10A AB: Score of 4 or 5 = exempts Math 20A
Math: Calculus BC ~ 8 units (8-unit max for both tests)	BC: Score of 3 on BC exam = exempts Math 20A BC: Score of 4 or 5 on BC exam = exempts Math 20A and 20B
Physics: Physics 1 or 2 Physics C: Mechanics ~ 4 units Physics C: Electricity and Magnetism ~ 4 units (8-unit max for all 3 tests)	1 or 2 exam = elective credit and exempt Phys. 10 C exam (Mech.) score of 3= exempt Phys. 1A C exam (Mech.) score of 4 or 5= exempt Phys 1A or 2A C exam (E&M) score of 3= exempt Phys. 1B C exam (E&M) score of 4 or 5= exempt Phys 1B or 2B

II. Technical Elective (TE) Course Policy

All Bioengineering majors must complete 8 units of technical elective credit to satisfy their major requirements. The number of units that must have "engineering" as the primary component depends on the major, as listed below.

MAJOR	Total # of TE Units Required	Minimum # of TE Units with Engineering Content Required
BENG	8	4 units
BTEC	8	6 units
BINF	8	8 units
BSYS	8	8 units

Courses that have "engineering" as its primary component, and are normally approved, include most 4-unit, upper-division (100 series) courses taken for a letter grade, not required for the major and taught in one of the departments of the Jacobs School of Engineering. ALL proposed technical electives must be approved by the Bioengineering Student Affairs office ***prior to*** enrollment in the course to verify technical elective credit.

Any portion of the TE requirement not fulfilled by "engineering" courses must be fulfilled by "science" courses. Courses that have "science" as its primary component and are normally approved are 4-unit, upper-division (100 series) courses taken for a letter grade, not required for the major and taught in the departments of Biological Sciences, Chemistry/Biochemistry, or Physics. Courses having a lab component are acceptable.

BENG 199, *Independent Study Research* courses may also be used toward satisfaction of the TE requirement. Students interested in doing research via BENG 199 courses must enroll with the same faculty member in two quarters of BENG 199. Doing so will satisfy both the TE course requirement and the required engineering component.

 "Teams in Engineering Sciences" (TIES) courses may also be used to satisfy the TE requirement for all departmental majors. The ENG 100D and ENG 100L courses are considered as "engineering"-type TE courses. Students will receive 8 units of TE credit after passing 1 quarter of ENG 100D (4 units) taken concurrently with ENG 100L (2 units), and passing 1 additional quarter of ENG 100L (2 units each), thus satisfying the TE course requirements for the major.

BENG 196 may be used to fulfill 4 units of technical elective requirements for all majors. Please see the Student Affairs office for instructions on enrolling in this course. **BENG 197 or BENG 198** courses may not be used to satisfy TE requirements in any majors in the Department of Bioengineering.

Additional Technical Elective Information:
https://bioengineering.ucsd.edu/undergrad/programs/technical-electives

III. 5 Year Bachelors/Masters Degree

The Department of Bioengineering (BENG) offers a five-year process leading to Bachelor of Science and Master of Science degrees in Bioengineering. It is available to undergraduate students who are enrolled in any of the major programs offered by BENG. The purpose of the BS/MS is to allow interested students to obtain the MS degree within one year following completion of the BS degree. **The program is open only to UCSD undergraduates and is only for the MS degree, not the M.Eng degree.**   Application to this program is a two-step process.

Program Information

Twelve units of Bioengineering graduate level courses must be completed during the student's senior undergraduate year, *in addition* to the requirements for the bachelor's degree.
- These twelve units will count toward the requirements for the master's degree **only** and must be taken for a letter grade. The student *may* take up to six graduate level courses during their senior year; six is the maximum that can be transferred per OGS requirements.

The student will arrange a schedule of courses for the senior year that will fulfill the requirements for the BS degree while also serving the program planned for the MS degree. Students are expected to meet the requirements for the MS degree in one year (three consecutive academic quarters) from the date of the receipt of the BS degree.
- Students are encouraged to meet with the Undergraduate and Graduate Coordinators to plan the undergraduate and graduate courses to be taken during the senior year. *Enrollment in graduate level courses is done manually and requires authorization from the Graduate Coordinator.*

Admission Requirements

To be eligible, students must have completed the first two quarters of their junior year in residence at UCSD and have an upper-division GPA of 3.5 or better. However, it should be noted that meeting and even exceeding minimum requirements does not *guarantee* admission. **Students taking a fifth year of undergraduate study are not eligible.**

More information: [Five-Year BS/MS Program | Shu Chien - Gene Lay Department of Bioengineering](#)

IV. Research Labs

[Biodynamics](#)	Jeff Hasty
[Bioinformatics and Systems Biology](#)	Shankar Subramaniam
[Biomaterials](#)	Brian Aguado
[Biomaterials and Regenerative Medicine](#)	Karen Christman
[Cardiac Mechanics](#)	Andrew McCulloch
[Cardiovascular Disease](#)	Francisco Contijoch
[Cardiovascular Imaging](#)	Elliot McVeigh
[Cartilage Tissue Engineering](#)	Robert Sah
[Composition of Biomolecules](#)	Rob Knight
[Computational Genomics and Stem Cell Biology](#)	Sheng Zhong
[Computational Genomics](#)	Ludmil Alexandrov
[Functional Cardiovascular Engineering](#)	Pedro Cabrales
[Genomics and Systems Biotechnology](#)	Xiaohua Huang
[Gene Regulation and Imaging](#)	Bogdan Bintu
[Health and Performance Indicators](#)	Benjamin Smarr
[Integrated Systems Neuroengineering](#)	Gert Cauwenberghs
[Microcirculation](#)	Geert Schmid-Schoenbein
[Multiscale Modeling of Pulmonary Arterial Hypertension](#)	Daniela Valdez-Jasso
[Nanoscale Bioengineering](#)	Ester Kwon
[Nanosensors and Devices for Biomedical Systems](#)	Ratnesh Lal
[Neural Engineering](#)	Gabriel Silva
[Optical Bioimaging and Spectroscopy](#)	Lingyan Shi
[Stem Cell Biology and Bioengineering Laboratory](#)	Adam Engler
[Systems Biology and Genetic Circuits](#)	Bernhard Palsson
[Systems Biology and Disease](#)	Stephanie Fraley
[Synthetic Biology and Stem Cell Engineering](#)	Prashant Mali

See the full list of Bioengineering faculty here: [Faculty | Shu Chien - Gene Lay Department of Bioengineering](#)

Undergraduate Student Resources

Academic	Well-Being	Cultural/Community
Bioengineering Student Affairs Office https://bioengineering.ucsd.edu/undergrad/advising **IDEA Engineering Student Center** (Inclusion, Diversity, Excellence, Achievement) https://jacobsschool.ucsd.edu/idea/ **Academic Internship Program** (AIP) https://aip.ucsd.edu/ **Study Abroad Office** https://studyabroad.ucsd.edu/ **Career Center** https://career.ucsd.edu/ Pre-Med Advising: https://career.ucsd.edu/advising/pre-health-med/index.html **Office of Academic Support and Instructional Studies** (OASIS) https://oasis.ucsd.edu/ **Office of Financial Aid and Scholarships** (OFAS) https://fas.ucsd.edu/	**Office for Students with Disabilities** (OSD) https://osd.ucsd.edu/ **Counseling and Psychological Services** (CAPS) https://caps.ucsd.edu/ **CARE at the Sexual Assault Resource Center** (CARE at SARC) https://care.ucsd.edu/ **The Hub Basic Needs Center** https://basicneeds.ucsd.edu/ **Student Health Services** https://studenthealth.ucsd.edu/	**Asian, Pacific Islander, Middle Eastern, Desi American Programs and Services** (APIMEDA) https://apimeda.ucsd.edu/ **Veterans Resource Center** https://svrc.ucsd.edu/ **Intertribal Resource Center** https://itrc.ucsd.edu/ **LGBT Resource Center** https://lgbt.ucsd.edu/ **Cross Cultural Center** https://ccc.ucsd.edu/ **Women's Center** https://women.ucsd.edu/ **Undocumented Student Center** https://uss.ucsd.edu/ **Black Resource Center** https://brc.ucsd.edu/ **Raza Resource Centro** https://raza.ucsd.edu/

Bioengineering Student Organizations

- Biomedical Engineering Society - https://bmes.ucsd.edu/
- Engineering World Health - https://ewh.ucsd.edu/
- International Society for Pharmaceutical Engineering - http://ispeucsd.weebly.com/
- Gender Minorities in Bioengineering - https://gmbe.ucsd.edu/
- Undergraduate Bioinformatics Club - https://ubicucsd.github.io/