DUAL DEGREE PROGRAM: BIOMEDICAL ENGINEERING COMBINED WITH CHEMICAL AND BIOLOGICAL ENGINEERING

Requirements
Effective Fall 2023

Freshman

		AUCC	Credits
BIOM 100	Overview of Biomedical Engineering		1
CBE 160	MATLAB for Chemical and Biological Eng		1
CHEM 111	General Chemistry I (GT-SC2)	3A	4
CHEM 112	General Chemistry Lab I (GT-SC1)	3A	1
CHEM 113	General Chemistry II		3
LIFE 102	Attributes of Living Systems (GT-SC1)	3A	4
MATH 160	Calculus for Physical Scientists I (GT-MA1)	1B	4
MATH 161	Calculus for Physical Scientists II (GT-MA1)	1B	4
PH 141	Physics for Scientists and Engineers I (GT-SC1)	3A	5
Select one group from the following:			3
Group A:			
CBE 101	Introduction to Chemical and Biological Engr		
Group B:			
CBE 101A	Introduction to Chemical and Biological Engr: Lecture		
CBE 101B	Introduction to Chemical and Biological Engr: Laboratory		
	Total Credits		**30**

Sophomore

CBE 201	Material and Energy Balances		3
CBE 205	Fundamentals of Biological Engineering		3
CBE 210	Thermodynamic Process Analysis		3
CHEM 114	General Chemistry Lab II		1
CHEM 341	Modern Organic Chemistry I		3
CHEM 343	Modern Organic Chemistry II		3
CHEM 344	Modern Organic Chemistry Laboratory		2
CO 150	College Composition (GT-CO2)	1A	3
MATH 261	Calculus for Physical Scientists III		4
MATH 340	Intro to Ordinary Differential Equations		4
MECH 262	Engineering Mechanics		4
	Total Credits		**33**

Junior

BC 351	Principles of Biochemistry		4
BIOM 300	Problem-Based Learning Biomedical Engr Lab		4
BMS 300	Principles of Human Physiology		4
CBE 310	Molecular Concepts and Applications		3

CBE 320	Chemical and Biological Reactor Design		3
CBE 330	Process Simulation		3
CBE 331	Momentum Transfer and Mechanical Separations		3
CBE 332	Heat and Mass Transfer Fundamentals		3
CBE 393	Professional Development Seminar		1
Social and Behavioral Sciences (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences)		3C	3
	Total Credits		**31**
Senior			
BIOM 421	Transport Phenomena in Biomedical Engineering		3
BIOM 422	Quantitative Systems and Synthetic Biology		3
CBE 333	Chemical and Biological Engineering Lab I		2
CBE 430	Process Control and Instrumentation		3
CBE 442	Separation Processes		4
CBE 443	Chemical and Biological Engineering Lab II		2
CBE 451	Chemical and Biological Engineering Design I		3
PH 142	Physics for Scientists and Engineers II (GT-SC1)	3A	5
STAT 315	Intro to Theory and Practice of Statistics		3
BME Broad Elective (see list below)			3
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)		3B	3
	Total Credits		**34**
Fifth Year			
BIOM 486A	Biomedical Design Practicum: Capstone Design I	4A,4B,4C	4
BIOM 486B	Biomedical Design Practicum: Capstone Design II	4A,4B,4C	4
BME Technical Elective[1]			5
CBE Technical Elective			5
Advanced Writing (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing)		2	3
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)		3B	3
Diversity, Equity, and Inclusion (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-equity-inclusion)		1C	3
Historical Perspectives (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives)		3D	3
	Total Credits		**30**
	Program Total Credits:		**158**

BME Technical Electives - Select 5 credits

Code	Title	Credits
BC 401	Comprehensive Biochemistry I	3
BC 403	Comprehensive Biochemistry II	3
BC 404	Comprehensive Biochemistry Laboratory	2
BC 411	Physical Biochemistry	4
BC 463	Molecular Genetics	3
BC 465	Molecular Regulation of Cell Function	3
BC 565	Molecular Regulation of Cell Function	4
BIOM 350A	Study Abroad--Ecuador: Prosthetics	1-2
BIOM 431/ECE 431	Biomedical Signal and Image Processing	3
BIOM 441	Biomechanics and Biomaterials	3

Select a maximum of 3 credits from the following:

BIOM 476	Biomedical Engineering Clinical Practicum	
BIOM 495	Independent Study	
BIOM 504/CBE 504	Fundamentals of Biochemical Engineering	3
BIOM 518/ECE 518	Biophotonics	3
BIOM 522/CBE 522	Bioseparation Processes	3
BIOM 525/MECH 525	Cell and Tissue Engineering	3
BIOM 526/ECE 526	Biological Physics	3
BIOM 527A/ ECE 527A	Biosensing: Cells as Circuits	1
BIOM 527B/ ECE 527B	Biosensing: Signal and Noise in Biosensors	1
BIOM 527C/ ECE 527C	Biosensing: Sensor Circuit Fundamentals	1

BIOM 527D/ ECE 527D	Biosensing: Electrochemical Sensors	1
BIOM 527E/ ECE 527E	Biosensing: Affinity Sensors	1
BIOM 527F/ ECE 527F	Biosensing: Biophotonic Sensors Using Refractive Index	1
BIOM 531/MECH 531	Materials Engineering	3
BIOM 533/CIVE 533	Biomolecular Tools for Engineers	3
BIOM 537/ECE 537	Biomedical Signal Processing	3
BIOM 570/MECH 570	Bioengineering	3
BIOM 573/MECH 573	Structure and Function of Biomaterials	3
BIOM 574/MECH 574	Bio-Inspired Surfaces	3
BIOM 576/MECH 576	Quantitative Systems Physiology	4
BIOM 578/MECH 578	Musculoskeletal Biosolid Mechanics	3
BIOM 579/MECH 579	Cardiovascular Biomechanics	3
BMS 301	Human Gross Anatomy	5
BMS 302	Laboratory in Principles of Physiology	2
BMS 310	Anatomy for the Health Professions	4
BMS 320	Virtual Laboratory in Physiology	2
BMS 325	Cellular Neurobiology	3
BMS 345	Functional Neuroanatomy	4
BMS 405	Nerve and Muscle-Toxins, Trauma and Disease	3
BMS 409	Human and Animal Reproductive Biology	3
BMS 420	Cardiopulmonary Physiology	3
BMS 430	Endocrinology	3
BMS 450	Pharmacology	3
BMS 500	Mammalian Physiology I	4
BMS 501	Mammalian Physiology II	4
BMS 503/NB 503	Developmental Neurobiology	3
BMS 505/NB 505	Neuronal Circuits, Systems and Behavior	3
BZ 310	Cell Biology	4
BZ 311	Developmental Biology	4
BZ 350	Molecular and General Genetics	4
BZ 476/BZ 576	Genetics of Model Organisms	3
CBE 505	Biochemical Engineering Laboratory	1
CBE 543	Membranes for Biotechnology and Biomedicine	3
CHEM 334	Quantitative Analysis Laboratory	1
CHEM 335	Introduction to Analytical Chemistry	3
CHEM 433	Clinical Chemistry	3
CHEM 539A	Principles of NMR and MRI: Basic NMR Principles	1
CHEM 539B	Principles of NMR and MRI: NMR Diffusion Measurements-2D NMR and MRI	1
CHEM 539C	Principles of NMR and MRI: Advanced NMR and MRI Techniques	1
CM 501	Advanced Cell Biology	4
CM 502/NB 502	Techniques in Molecular & Cellular Biology	2
ECE 569/MECH 569	Micro-Electro-Mechanical Devices	3
ERHS 332	Principles of Epidemiology	3
ERHS 450	Introduction to Radiation Biology	3
ERHS 502	Fundamentals of Toxicology	3
ERHS 510/VS 510	Cancer Biology	3
ERHS 540	Principles of Ergonomics	3
FSHN 470	Integrative Nutrition and Metabolism	3
HES 307	Biomechanical Principles of Human Movement	3
HES 319	Neuromuscular Aspects of Human Movement	4
HES 403	Physiology of Exercise	3
HES 420	Electrocardiography and Exercise Management	3
HES 476	Exercise and Chronic Disease	3
MATH 455	Mathematics in Biology and Medicine	3
MECH 543	Biofluid Mechanics	3
MIP 300	General Microbiology	3
MIP 302	General Microbiology Laboratory	2
MIP 342	Immunology	4
MIP 343	Immunology Laboratory	2
MIP 351	Medical Bacteriology	3
MIP 352	Medical Bacteriology Laboratory	3
MIP 420	Medical and Molecular Virology	4
MIP 443	Microbial Physiology	4
MIP 450	Microbial Genetics	3
NB 500/BMS 502	Readings in Cellular Neurobiology	1

CBE Technical Electives - Select 5 credits

Code	Title	Credits
Select 5 credits from the following:		
AB 410	Understanding Pesticides	3
ATS 555	Air Pollution	3
ATS 560	Air Pollution Measurement	2
BC 401	Comprehensive Biochemistry I	3
BC 403	Comprehensive Biochemistry II	3
BC 404	Comprehensive Biochemistry Laboratory	2
BC 411	Physical Biochemistry	4
BC 441	3D Molecular Models for Biochemistry	1
BC 463	Molecular Genetics	3
BC 464	Molecular Genetics Recitation	1
BC 517	Metabolism	2
BC 521/CHEM 521	Principles of Chemical Biology	3
BIOM 350A	Study Abroad--Ecuador: Prosthetics	1-2
BIOM 517/ECE 517	Advanced Optical Imaging	3
BIOM 525/MECH 525	Cell and Tissue Engineering	3
BIOM 526/ECE 526	Biological Physics	3
BIOM 531/MECH 531	Materials Engineering	3
BIOM 532/MECH 532	Materials Issues in Mechanical Design	3
BIOM 533/CIVE 533	Biomolecular Tools for Engineers	3
BIOM 537/ECE 537	Biomedical Signal Processing	3
BIOM 573/MECH 573	Structure and Function of Biomaterials	3
BIOM 574/MECH 574	Bio-Inspired Surfaces	3
BIOM 576/MECH 576	Quantitative Systems Physiology	4
BIOM 579/MECH 579	Cardiovascular Biomechanics	3
BMS 301	Human Gross Anatomy	5
BMS 302	Laboratory in Principles of Physiology	2

BMS 305	Domestic Animal Gross Anatomy	4
BMS 325	Cellular Neurobiology	3
BMS 330	Microscopic Anatomy	4
BMS 345	Functional Neuroanatomy	4
BMS 409	Human and Animal Reproductive Biology	3
BMS 420	Cardiopulmonary Physiology	3
BMS 430	Endocrinology	3
BMS 450	Pharmacology	3
BMS 460	Essentials of Pathophysiology	3
BMS 500	Mammalian Physiology I	4
BMS 501	Mammalian Physiology II	4
BMS 503/NB 503	Developmental Neurobiology	3
BMS 505/NB 505	Neuronal Circuits, Systems and Behavior	3
BMS 545	Neuroanatomy	5
BMS 575	Human Anatomy Dissection	4
BSPM 302	Applied and General Entomology	2
BSPM 361	Elements of Plant Pathology	3
BZ 310	Cell Biology	4
BZ 311	Developmental Biology	4
BZ 348/MATH 348	Theory of Population and Evolutionary Ecology	4
BZ 350	Molecular and General Genetics	4
BZ 360	Bioinformatics and Genomics	4
CBE 406	Introduction to Transport Phenomena	3
CBE 501	Chemical Engineering Thermodynamics	3
CBE 502	Advanced Reactor Design	3
CBE 503	Transport Phenomena Fundamentals	3
CBE 504/BIOM 504	Fundamentals of Biochemical Engineering	3
CBE 505	Biochemical Engineering Laboratory	1
CBE 514	Polymer Science and Engineering	3
CBE 521	Mathematical Modeling for Chemical Engineers	3
CBE 522/BIOM 522	Bioseparation Processes	3
CBE 524	Bioremediation	1
CBE 540/CIVE 540	Advanced Biological Wastewater Processing	3
CBE 570	Biomolecular Engineering/Synthetic Biology	3
CHEM 261	Fundamentals of Inorganic Chemistry	3
CHEM 311	Introduction to Nanoscale Science	3
CHEM 334	Quantitative Analysis Laboratory	1
CHEM 335	Introduction to Analytical Chemistry	3
CHEM 338	Environmental Chemistry	3
CHEM 431	Instrumental Analysis	4
CHEM 433	Clinical Chemistry	3
CHEM 440	Advanced Organic Chemistry Laboratory	2
CHEM 461	Inorganic Chemistry	3
CHEM 522	Methods of Chemical Biology	2
CHEM 532	Advanced Chemical Analysis II	3
CHEM 537	Electrochemical Methods	3
CHEM 539A	Principles of NMR and MRI: Basic NMR Principles	1
CHEM 539B	Principles of NMR and MRI: NMR Diffusion Measurements-2D NMR and MRI	1
CHEM 539C	Principles of NMR and MRI: Advanced NMR and MRI Techniques	1
CHEM 541	Organic Molecular Structure Determination	2
CHEM 543	Structure/Mechanisms in Organic Chemistry	2
CHEM 545	Synthetic Organic Chemistry I	3
CHEM 547	Physical Organic Chemistry	3
CHEM 555	Chemistry of Sustainability	3
CHEM 569	Chemical Crystallography	3
CHEM 570	Chemical Bonding	3
CHEM 575	Fundamentals of Chemical Thermodynamics	1
CHEM 576	Statistical Mechanics	2
CHEM 577	Surface Chemistry	3
CHEM 579	Chemical Kinetics	3
CIVE 322	Basic Hydrology	3
CIVE 330	Ecological Engineering	3
CIVE 360	Mechanics of Solids	3
CIVE 401	Hydraulic Engineering	3
CIVE 413	Environmental River Mechanics	3
CIVE 423	Groundwater Engineering	3
CIVE 438	Fundamentals of Environmental Engr	3
CIVE 439	Applications of Environmental Engr Concepts	3
CIVE 440	Nonpoint Source Pollution	3
CIVE 442	Air Quality Engineering	3
CIVE 520	Physical Hydrology	3
CIVE 531	Groundwater Hydrology	3
CIVE 538	Aqueous Chemistry	3
CIVE 560	Advanced Mechanics of Materials	3
CM 501	Advanced Cell Biology	4
CM 502/NB 502	Techniques in Molecular & Cellular Biology	2
CS 165	CS2--Data Structures	4
CS 220	Discrete Structures and their Applications	4
CS 270	Computer Organization	4
ECE 204	Introduction to Electrical Engineering	3
ECE 430/MATH 430	Fourier and Wavelet Analysis with Apps	3
ENGR 510	Engineering Optimization: Method/ Application	3
ENGR 550/ MATH 550	Numerical Methods in Science and Engineering	3
ERHS 320	Environmental Health--Water Quality	3
ERHS 332	Principles of Epidemiology	3
ERHS 410	Environmental Health-Air and Waste Management	3
ERHS 446	Environmental Toxicology	3
ERHS 448	Environmental Contaminants	3
ERHS 450	Introduction to Radiation Biology	3
ERHS 502	Fundamentals of Toxicology	3
ERHS 503	Toxicology Principles	1
ERHS 510/VS 510	Cancer Biology	3

ERHS 530	Radiological Physics and Dosimetry I	3
ERHS 542	Biostatistical Methods for Qualitative Data	3
ERHS 547	Equipment and Instrumentation	3
F 311	Forest Ecology	3
FTEC 447	Food Chemistry	2
GEOL 150	Physical Geology for Scientists and Engineers	4
GEOL 452	Hydrogeology	4
GEOL 454	Geomorphology	4
GES 441	Analysis of Sustainable Energy Solutions	3
GES 542	Biobased Fuels, Energy, and Chemicals	3
HES 307	Biomechanical Principles of Human Movement	3
HES 319	Neuromuscular Aspects of Human Movement	4
HES 403	Physiology of Exercise	3
HES 420	Electrocardiography and Exercise Management	3
HORT 579	Mass Spectrometry Omics-Methods and Analysis	3
LIFE 201B	Introductory Genetics: Molecular/ Immunological/Developmental (GT-SC2)	3
LIFE 202B	Introductory Genetics Recitation: Molecular	1
LIFE 203	Introductory Genetics Laboratory	2
LIFE 210	Introductory Eukaryotic Cell Biology	3
LIFE 211	Introductory Cell Biology Honors Recitation	1
LIFE 212	Introductory Cell Biology Laboratory	2
LIFE 320	Ecology	3
MATH 301	Introduction to Combinatorial Theory	3
MATH 331	Introduction to Mathematical Modeling	3
MATH 332	Partial Differential Equations	3
MATH 360	Mathematics of Information Security	3
MATH 366	Introduction to Abstract Algebra	3
MATH 369	Linear Algebra I	3
MATH 405	Introduction to Number Theory	3
MATH 419	Introduction to Complex Variables	3
MATH 450	Introduction to Numerical Analysis I	3
MATH 451	Introduction to Numerical Analysis II	3
MATH 455	Mathematics in Biology and Medicine	3
MATH 460	Information and Coding Theory	3
MATH 466	Abstract Algebra I	3
MATH 467	Abstract Algebra II	3
MATH 469	Linear Algebra II	3
MATH 525	Optimal Control	3
MATH 530	Mathematics for Scientists and Engineers	3
MATH 532	Mathematical Modeling of Large Data Sets	3
MATH 535	Foundations of Applied Mathematics	3
MATH 546	Partial Differential Equations II	3
MATH 560	Linear Algebra	3
MECH 307	Mechatronics and Measurement Systems	4
MECH 324	Dynamics of Machines	4
MECH 325	Machine Design	3
MECH 331	Introduction to Engineering Materials	4
MECH 403	Energy Engineering	3
MECH 407	Laser Applications in Mechanical Engineering	3
MECH 424	Advanced Dynamics	3
MECH 425	Mechanical Engineering Vibrations	4
MECH 431	Metals and Alloys	3
MECH 432	Engineering of Nanomaterials	3
MECH 502	Advanced/Additive Manufacturing Engineering	3
MECH 507	Laser Diagnostics for Thermosciences	3
MECH 509	Design and Analysis in Engineering Research	3
MECH 513	Simulation Modeling and Experimentation	3
MECH 524	Principles of Dynamics	3
MECH 527	Hybrid Electric Vehicle Powertrains	3
MECH 529	Advanced Mechanical Systems	3
MECH 530	Advanced Composite Materials	3
MECH 543	Biofluid Mechanics	3
MECH 552	Applied Computational Fluid Dynamics	3
MIP 300	General Microbiology	3
MIP 302	General Microbiology Laboratory	2
MIP 315	Pathology of Human and Animal Disease	3
MIP 334	Food Microbiology	3
MIP 335	Food Microbiology Laboratory	2
MIP 342	Immunology	4
MIP 343	Immunology Laboratory	2
MIP 351	Medical Bacteriology	3
MIP 352	Medical Bacteriology Laboratory	3
MIP 420	Medical and Molecular Virology	4
MIP 425	Virology and Cell Culture Laboratory	2
MIP 432/ESS 432	Microbial Ecology	3
MIP 433/ESS 433	Microbial Ecology Laboratory	1
MIP 443	Microbial Physiology	4
MIP 450	Microbial Genetics	3
MIP 530	Advanced Molecular Virology	4
MIP 543	RNA Biology	3
MIP 550	Microbial and Molecular Genetics Laboratory	4
MIP 555	Principles and Mechanisms of Disease	3
MSE 501	Materials Technology Transfer	1
MSE 502A	Materials Science & Engineering Methods: Materials Structure and Scattering	1
MSE 502B	Materials Science & Engineering Methods: Computational Materials Methods	1
MSE 502C	Materials Science & Engineering Methods: Materials Microscopy	1
MSE 502D	Materials Science & Engineering Methods: Materials Spectroscopy	1
MSE 502E	Materials Science & Engineering Methods: Bulk Properties and Performance	1
MSE 502F	Materials Science & Engineering Methods: Experimental Methods for Materials Research	1
MSE 503	Mechanical Behavior of Materials	3

MSE 504	Thermodynamics of Materials	3
MSE 505	Kinetics of Materials	3
NR 319	Introduction to Geospatial Science	4
NR 323/GR 323	Remote Sensing and Image Interpretation	3
NR 505	Concepts in GIS	4
PH 314	Introduction to Modern Physics	4
PH 315	Modern Physics Laboratory	2
PH 341	Mechanics	4
PH 351	Electricity and Magnetism	4
PH 353	Optics and Waves	4
PH 361	Physical Thermodynamics	3
PH 451	Introductory Quantum Mechanics I	3
PH 452	Introductory Quantum Mechanics II	3
PH 517	Chaos, Fractals, and Nonlinear Dynamics	3
PH 521	Introduction to Lasers	3
PH 522	Introductory Laser Laboratory	1
PH 531	Introductory Condensed Matter Physics	3
PH 561	Elementary Particle Physics	3
PH 571	Mathematical Methods for Physics I	3
PHIL 410	Gödel's Incompleteness Theorems	3
SOCR 330	Principles of Genetics	3
SOCR 400	Soils and Global Change-Impacts and Solutions	3
SOCR 455	Microbiomes of Soil Systems	3
SOCR 456	Soil Microbiology Laboratory	1
SOCR 467	Soil and Environmental Chemistry	3
SOCR 470	Soil Physics	3
SOCR 471	Soil Physics Laboratory	1
SOCR 567	Environmental Soil Chemistry	4
STAR 512	Design and Data Analysis for Researchers II	4
STAT 305	Sampling Techniques	3
STAT 341	Statistical Data Analysis I	3
STAT 342	Statistical Data Analysis II	3
STAT 400	Statistical Computing	3
STAT 420	Probability and Mathematical Statistics I	3
STAT 421	Introduction to Stochastic Processes	3
STAT 430	Probability and Mathematical Statistics II	3
STAT 460	Applied Multivariate Analysis	3

A maximum of 3 credits may be selected from the following courses:

ENGR 422	Technology Entrepreneurship
ENGR 502	Engineering Project and Program Management
ENGR 525	Intellectual Property and Invention Systems
FIN 305	Fundamentals of Finance
IDEA 310B	Design Thinking Toolbox: 3D Modeling
IDEA 310D	Design Thinking Toolbox: Digital Imaging
MGT 305	Fundamentals of Management
MGT 340	Fundamentals of Entrepreneurship
MKT 305	Fundamentals of Marketing

BME Broad Electives – Select 3 credits

Code	Title	Credits
AB 410	Understanding Pesticides	3
ATS 555	Air Pollution	3
ATS 560	Air Pollution Measurement	2
BC 401	Comprehensive Biochemistry I	3
BC 403	Comprehensive Biochemistry II	3
BC 404	Comprehensive Biochemistry Laboratory	2
BC 411	Physical Biochemistry	4
BC 441	3D Molecular Models for Biochemistry	1
BC 463	Molecular Genetics	3
BC 464	Molecular Genetics Recitation	1
BC 465	Molecular Regulation of Cell Function	3
BC 517	Metabolism	2
BC 521/CHEM 521	Principles of Chemical Biology	3
BC 563	Molecular Genetics	4
BIOM 350A	Study Abroad--Ecuador: Prosthetics	1-2
BIOM 431/ECE 431	Biomedical Signal and Image Processing	3
BIOM 441	Biomechanics and Biomaterials	3
BIOM 504/CBE 504	Fundamentals of Biochemical Engineering	3
BIOM 517/ECE 517	Advanced Optical Imaging	3
BIOM 518/ECE 518	Biophotonics	3
BIOM 522/CBE 522	Bioseparation Processes	3
BIOM 525/MECH 525	Cell and Tissue Engineering	3
BIOM 526/ECE 526	Biological Physics	3
BIOM 527A/ ECE 527A	Biosensing: Cells as Circuits	1
BIOM 527B/ ECE 527B	Biosensing: Signal and Noise in Biosensors	1
BIOM 527C/ ECE 527C	Biosensing: Sensor Circuit Fundamentals	1
BIOM 527D/ ECE 527D	Biosensing: Electrochemical Sensors	1
BIOM 527E/ ECE 527E	Biosensing: Affinity Sensors	1
BIOM 527F/ ECE 527F	Biosensing: Biophotonic Sensors Using Refractive Index	1
BIOM 531/MECH 531	Materials Engineering	3
BIOM 532/MECH 532	Materials Issues in Mechanical Design	3
BIOM 533/CIVE 533	Biomolecular Tools for Engineers	3
BIOM 537/ECE 537	Biomedical Signal Processing	3
BIOM 570/MECH 570	Bioengineering	3
BIOM 573/MECH 573	Structure and Function of Biomaterials	3
BIOM 574/MECH 574	Bio-Inspired Surfaces	3
BIOM 576/MECH 576	Quantitative Systems Physiology	4
BIOM 578/MECH 578	Musculoskeletal Biosolid Mechanics	3
BIOM 579/MECH 579	Cardiovascular Biomechanics	3
BMS 301	Human Gross Anatomy	5
BMS 302	Laboratory in Principles of Physiology	2
BMS 305	Domestic Animal Gross Anatomy	4
BMS 310	Anatomy for the Health Professions	4
BMS 320	Virtual Laboratory in Physiology	2
BMS 325	Cellular Neurobiology	3

BMS 330	Microscopic Anatomy	4
BMS 345	Functional Neuroanatomy	4
BMS 405	Nerve and Muscle-Toxins, Trauma and Disease	3
BMS 409	Human and Animal Reproductive Biology	3
BMS 420	Cardiopulmonary Physiology	3
BMS 430	Endocrinology	3
BMS 450	Pharmacology	3
BMS 460	Essentials of Pathophysiology	3
BMS 500	Mammalian Physiology I	4
BMS 501	Mammalian Physiology II	4
BMS 503/NB 503	Developmental Neurobiology	3
BMS 505/NB 505	Neuronal Circuits, Systems and Behavior	3
BMS 545	Neuroanatomy	5
BMS 575	Human Anatomy Dissection	4
BSPM 302	Applied and General Entomology	2
BSPM 361	Elements of Plant Pathology	3
BZ 310	Cell Biology	4
BZ 311	Developmental Biology	4
BZ 348/MATH 348	Theory of Population and Evolutionary Ecology	4
BZ 350	Molecular and General Genetics	4
BZ 360	Bioinformatics and Genomics	4
BZ 420	Evolutionary Medicine	3
BZ 476/BZ 576	Genetics of Model Organisms	3
CBE 406	Introduction to Transport Phenomena	3
CBE 501	Chemical Engineering Thermodynamics	3
CBE 502	Advanced Reactor Design	3
CBE 503	Transport Phenomena Fundamentals	3
CBE 505	Biochemical Engineering Laboratory	1
CBE 514	Polymer Science and Engineering	3
CBE 521	Mathematical Modeling for Chemical Engineers	3
CBE 524	Bioremediation	1
CBE 540/CIVE 540	Advanced Biological Wastewater Processing	3
CBE 570	Biomolecular Engineering/Synthetic Biology	3
CHEM 261	Fundamentals of Inorganic Chemistry	3
CHEM 311	Introduction to Nanoscale Science	3
CHEM 334	Quantitative Analysis Laboratory	1
CHEM 335	Introduction to Analytical Chemistry	3
CHEM 338	Environmental Chemistry	3
CHEM 431	Instrumental Analysis	4
CHEM 433	Clinical Chemistry	3
CHEM 440	Advanced Organic Chemistry Laboratory	2
CHEM 461	Inorganic Chemistry	3
CHEM 522	Methods of Chemical Biology	2
CHEM 532	Advanced Chemical Analysis II	3
CHEM 537	Electrochemical Methods	3
CHEM 539A	Principles of NMR and MRI: Basic NMR Principles	1
CHEM 539B	Principles of NMR and MRI: NMR Diffusion Measurements-2D NMR and MRI	1
CHEM 539C	Principles of NMR and MRI: Advanced NMR and MRI Techniques	1
CHEM 541	Organic Molecular Structure Determination	2
CHEM 543	Structure/Mechanisms in Organic Chemistry	2
CHEM 545	Synthetic Organic Chemistry I	3
CHEM 547	Physical Organic Chemistry	3
CHEM 555	Chemistry of Sustainability	3
CHEM 560	Foundations of Inorganic Synthesis	1
CHEM 566	Bioinorganic Chemistry	3
CHEM 567	Crystallographic Computation	1
CHEM 569	Chemical Crystallography	3
CHEM 570	Chemical Bonding	3
CHEM 575	Fundamentals of Chemical Thermodynamics	1
CHEM 576	Statistical Mechanics	2
CHEM 577	Surface Chemistry	3
CHEM 578A	Computational Chemistry: Electronic Structure	1
CHEM 579	Chemical Kinetics	3
CIVE 322	Basic Hydrology	3
CIVE 330	Ecological Engineering	3
CIVE 360	Mechanics of Solids	3
CIVE 367	Structural Analysis	3
CIVE 401	Hydraulic Engineering	3
CIVE 413	Environmental River Mechanics	3
CIVE 423	Groundwater Engineering	3
CIVE 438	Fundamentals of Environmental Engr	3
CIVE 439	Applications of Environmental Engr Concepts	3
CIVE 440	Nonpoint Source Pollution	3
CIVE 442	Air Quality Engineering	3
CIVE 520	Physical Hydrology	3
CIVE 524/WR 524	Modeling Watershed Hydrology	3
CIVE 531	Groundwater Hydrology	3
CIVE 538	Aqueous Chemistry	3
CIVE 560	Advanced Mechanics of Materials	3
CIVE 562	Fundamentals of Vibrations	3
CM 501	Advanced Cell Biology	4
CM 502/NB 502	Techniques in Molecular & Cellular Biology	2
CS 152	Python for STEM	2
CS 164	CS1--Computational Thinking with Java	4
CS 165	CS2--Data Structures	4
CS 220	Discrete Structures and their Applications	4
CS 253	Software Development with C++	4
CS 270	Computer Organization	4
CS 314	Software Engineering	3
CS 320	Algorithms--Theory and Practice	3
CS 356	Systems Security	3
CS 370	Operating Systems	3
CS 4** - Any 400-level CS course except CS 495		

CS 5** - Any 500-level CS course		
DSCI 320	Optimization Methods in Data Science	3
DSCI 369	Linear Algebra for Data Science (credit not allowed for both DSCI 369 and MATH 369)	3-4
or MATH 369	Linear Algebra I	
ECE 204	Introduction to Electrical Engineering	3
ECE 312	Linear System Analysis II	3
ECE 4** - any ECE course at the 400-level except ECE 495		
ECE 5** - any ECE course at the 500-level		
ENGR 300	3D Printing Lab for Engineers	1
ENGR 422	Technology Entrepreneurship	3
ENGR 502	Engineering Project and Program Management	3
ENGR 510	Engineering Optimization: Method/ Application	3
ENGR 525	Intellectual Property and Invention Systems	3
ENGR 531	Engineering Risk Analysis	3
ENGR 570	Coupled Electromechanical Systems	3
ERHS 320	Environmental Health--Water Quality	3
ERHS 332	Principles of Epidemiology	3
ERHS 400	Radiation Safety	3
ERHS 410	Environmental Health-Air and Waste Management	3
ERHS 430	Human Disease and the Environment	3
ERHS 446	Environmental Toxicology	3
ERHS 448	Environmental Contaminants	3
ERHS 450	Introduction to Radiation Biology	3
ERHS 502	Fundamentals of Toxicology	3
ERHS 503	Toxicology Principles	1
ERHS 510/VS 510	Cancer Biology	3
ERHS 530	Radiological Physics and Dosimetry I	3
ERHS 540	Principles of Ergonomics	3
ERHS 542	Biostatistical Methods for Qualitative Data	3
ERHS 547	Equipment and Instrumentation	3
ERHS 560	Health Impact Assessment	2
ESS 353	Global Change Impacts, Adaptation, Mitigation	3
F 311	Forest Ecology	3
FIN 305	Fundamentals of Finance	3
FSHN 470	Integrative Nutrition and Metabolism	3
FTEC 447	Food Chemistry	2
GEOL 150	Physical Geology for Scientists and Engineers	4
GEOL 452	Hydrogeology	4
GEOL 454	Geomorphology	4
GES 441	Analysis of Sustainable Energy Solutions	3
GES 542	Biobased Fuels, Energy, and Chemicals	3
HES 207	Anatomical Kinesiology	4
HES 307	Biomechanical Principles of Human Movement	3
HES 319	Neuromuscular Aspects of Human Movement	4
HES 403	Physiology of Exercise	3
HES 420	Electrocardiography and Exercise Management	3
HES 476	Exercise and Chronic Disease	3
HORT 579	Mass Spectrometry Omics-Methods and Analysis	3
IDEA 310B	Design Thinking Toolbox: 3D Modeling	2
IDEA 310D	Design Thinking Toolbox: Digital Imaging	1
IDEA 310H/CS 310H	Design Thinking Toolbox: Mixed Reality Design	3
IDEA 455/MGT 455	Designing for Defense	3
LIFE 201B	Introductory Genetics: Molecular/ Immunological/Developmental (GT-SC2)	3
LIFE 202B	Introductory Genetics Recitation: Molecular	1
LIFE 203	Introductory Genetics Laboratory	2
LIFE 210	Introductory Eukaryotic Cell Biology	3
LIFE 211	Introductory Cell Biology Honors Recitation	1
LIFE 212	Introductory Cell Biology Laboratory	2
LIFE 320	Ecology	3
MATH 229	Matrices and Linear Equations	2
MATH 235	Introduction to Mathematical Reasoning	2
MATH 301	Introduction to Combinatorial Theory	3
MATH 317	Advanced Calculus of One Variable	3
MATH 331	Introduction to Mathematical Modeling	3
MATH 332	Partial Differential Equations	3
MATH 360	Mathematics of Information Security	3
MATH 366	Introduction to Abstract Algebra	3
MATH 405	Introduction to Number Theory	3
MATH 417	Advanced Calculus I	3
MATH 418	Advanced Calculus II	3
MATH 419	Introduction to Complex Variables	3
MATH 430/ECE 430	Fourier and Wavelet Analysis with Apps	3
MATH 450	Introduction to Numerical Analysis I	3
MATH 451	Introduction to Numerical Analysis II	3
MATH 455	Mathematics in Biology and Medicine	3
MATH 460	Information and Coding Theory	3
MATH 466	Abstract Algebra I	3
MATH 467	Abstract Algebra II	3
MATH 469	Linear Algebra II	3
MATH 470	Euclidean and Non-Euclidean Geometry	3
MATH 474	Introduction to Differential Geometry	3
MATH 525	Optimal Control	3
MATH 530	Mathematics for Scientists and Engineers	3
MATH 532	Mathematical Modeling of Large Data Sets	3
MATH 535	Foundations of Applied Mathematics	3
MATH 546	Partial Differential Equations II	3
MATH 550/ ENGR 550	Numerical Methods in Science and Engineering	3
MATH 560	Linear Algebra	3
MATH 569A	Linear Algebra for Data Science: Matrices and Vectors Spaces	1
MATH 569B	Linear Algebra for Data Science: Geometric Techniques for Data Reduction	1

MATH 569C	Linear Algebra for Data Science: Matrix Factorizations and Transformations	1
MATH 569D	Linear Algebra for Data Science: Theoretical Foundations	1
MECH 200	Introduction to Manufacturing Processes	3
MECH 307	Mechatronics and Measurement Systems	4
MECH 324	Dynamics of Machines	4
MECH 325	Machine Design	3
MECH 331	Introduction to Engineering Materials	4
MECH 4** - Any 400-level MECH course except MECH 495		
MECH 5** - Any 500-level MECH course		
MGT 305	Fundamentals of Management	3
MGT 340	Fundamentals of Entrepreneurship	3
MIP 300	General Microbiology	3
MIP 302	General Microbiology Laboratory	2
MIP 315	Pathology of Human and Animal Disease	3
MIP 334	Food Microbiology	3
MIP 335	Food Microbiology Laboratory	2
MIP 342	Immunology	4
MIP 343	Immunology Laboratory	2
MIP 351	Medical Bacteriology	3
MIP 352	Medical Bacteriology Laboratory	3
MIP 420	Medical and Molecular Virology	4
MIP 425	Virology and Cell Culture Laboratory	2
MIP 432/ESS 432	Microbial Ecology	3
MIP 433/ESS 433	Microbial Ecology Laboratory	1
MIP 443	Microbial Physiology	4
MIP 450	Microbial Genetics	3
MIP 530	Advanced Molecular Virology	4
MIP 543	RNA Biology	3
MIP 550	Microbial and Molecular Genetics Laboratory	4
MIP 555	Principles and Mechanisms of Disease	3
MKT 305	Fundamentals of Marketing	3
MSE 501	Materials Technology Transfer	1
MSE 502A	Materials Science & Engineering Methods: Materials Structure and Scattering	1
MSE 502B	Materials Science & Engineering Methods: Computational Materials Methods	1
MSE 502C	Materials Science & Engineering Methods: Materials Microscopy	1
MSE 502D	Materials Science & Engineering Methods: Materials Spectroscopy	1
MSE 502E	Materials Science & Engineering Methods: Bulk Properties and Performance	1
MSE 502F	Materials Science & Engineering Methods: Experimental Methods for Materials Research	1
MSE 503	Mechanical Behavior of Materials	3
MSE 504	Thermodynamics of Materials	3
MSE 505	Kinetics of Materials	3
NR 319	Introduction to Geospatial Science	4
NR 323/GR 323	Remote Sensing and Image Interpretation	3
NR 505	Concepts in GIS	4
PH 314	Introduction to Modern Physics	4
PH 315	Modern Physics Laboratory	2
PH 341	Mechanics	4
PH 351	Electricity and Magnetism	4
PH 353	Optics and Waves	4
PH 361	Physical Thermodynamics	3
PH 425	Advanced Physics Laboratory	2
PH 451	Introductory Quantum Mechanics I	3
PH 452	Introductory Quantum Mechanics II	3
PH 462	Statistical Physics	3
PH 517	Chaos, Fractals, and Nonlinear Dynamics	3
PH 521	Introduction to Lasers	3
PH 522	Introductory Laser Laboratory	1
PH 531	Introductory Condensed Matter Physics	3
PH 561	Elementary Particle Physics	3
PH 571	Mathematical Methods for Physics I	3
PHIL 322	Biomedical Ethics	3
PHIL 410	Gödel's Incompleteness Theorems	3
PSY 253	Human Factors and Engineering Psychology	3
SOCR 330	Principles of Genetics	3
SOCR 400	Soils and Global Change-Impacts and Solutions	3
SOCR 455	Microbiomes of Soil Systems	3
SOCR 456	Soil Microbiology Laboratory	1
SOCR 467	Soil and Environmental Chemistry	3
SOCR 470	Soil Physics	3
SOCR 471	Soil Physics Laboratory	1
SOCR 567	Environmental Soil Chemistry	4
STAR 512	Design and Data Analysis for Researchers II	4
STAT 158	Introduction to R Programming	1
STAT 305	Sampling Techniques	3
STAT 331	Intermediate Applied Statistical Methods	3
STAT 341	Statistical Data Analysis I	3
STAT 342	Statistical Data Analysis II	3
STAT 400	Statistical Computing	3
STAT 420	Probability and Mathematical Statistics I	3
STAT 421	Introduction to Stochastic Processes	3
STAT 430	Probability and Mathematical Statistics II	3
STAT 460	Applied Multivariate Analysis	3
SYSE 501	Foundations of Systems Engineering	3
SYSE 534	Human Systems Integration	3
VS 333	Domestic Animal Anatomy	4

[1] Select a total of 5 credits from Approved BME Technical Electives for BME+CBE Program. A maximum of 3 total credits of BIOM 476 and BIOM 495 may count as BME Technical Elective credit.

Major Completion Map

Distinctive Requirements for Degree Program:

TO DECLARE MAJOR: Engineering is a controlled major: students are admitted into the major only if they meet established academic standards. Please see competitive major requirements or the advisor in the Department for more information.

TO PREPARE FOR FIRST SEMESTER: The curriculum for this major assumes students enter college prepared to take calculus and chemistry.

To qualify for graduation, students in the biomedical engineering combined with chemical and biological engineering program must achieve a minimum 2.000 grade point average at CSU in all courses in engineering, mathematics, computer science, statistics, physics, and chemistry as well as courses taken as technical electives.

Freshman

Semester 1		**Critical**	**Recommended**	**AUCC**	**Credits**
BIOM 100	Overview of Biomedical Engineering	X			1
CHEM 111	General Chemistry I (GT-SC2)	X		3A	4
CHEM 112	General Chemistry Lab I (GT-SC1)	X		3A	1
LIFE 102	Attributes of Living Systems (GT-SC1)	X		3A	4
MATH 160	Calculus for Physical Scientists I (GT-MA1)	X		1B	4
	Total Credits				**14**
Semester 2		**Critical**	**Recommended**	**AUCC**	**Credits**
CBE 160	MATLAB for Chemical and Biological Eng	X			1
CHEM 113	General Chemistry II	X			3
MATH 161	Calculus for Physical Scientists II (GT-MA1)	X		1B	4
PH 141	Physics for Scientists and Engineers I (GT-SC1)	X		3A	5
Select one group from the following:					3
Group A:					
CBE 101	Introduction to Chemical and Biological Engr				
Group B:					
CBE 101A	Introduction to Chemical and Biological Engr: Lecture				
CBE 101B	Introduction to Chemical and Biological Engr: Laboratory				
	Total Credits				**16**

Sophomore

Semester 3		**Critical**	**Recommended**	**AUCC**	**Credits**
CBE 201	Material and Energy Balances	X			3
CBE 205	Fundamentals of Biological Engineering	X			3
CHEM 114	General Chemistry Lab II	X			1
CHEM 341	Modern Organic Chemistry I	X			3
CO 150	College Composition (GT-CO2)		X	1A	3
MATH 261	Calculus for Physical Scientists III	X			4
	Total Credits				**17**
Semester 4		**Critical**	**Recommended**	**AUCC**	**Credits**
CBE 210	Thermodynamic Process Analysis	X			3
CHEM 343	Modern Organic Chemistry II	X			3
CHEM 344	Modern Organic Chemistry Laboratory	X			2
MATH 340	Intro to Ordinary Differential Equations	X			4
MECH 262	Engineering Mechanics		X		4
	Total Credits				**16**

Junior

Semester 5		**Critical**	**Recommended**	**AUCC**	**Credits**
BMS 300	Principles of Human Physiology	X			4
CBE 310	Molecular Concepts and Applications	X			3
CBE 330	Process Simulation	X			3
CBE 331	Momentum Transfer and Mechanical Separations	X			3
STAT 315	Intro to Theory and Practice of Statistics				3
	Total Credits				**16**

Semester 6		Critical	Recommended	AUCC	Credits
BC 351	Principles of Biochemistry		X		4
BIOM 300	Problem-Based Learning Biomedical Engr Lab	X			4
CBE 320	Chemical and Biological Reactor Design	X			3
CBE 332	Heat and Mass Transfer Fundamentals	X			3
CBE 393	Professional Development Seminar	X			1
Social and Behavioral Sciences (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences)				3C	3
	Total Credits				**18**
Senior					
Semester 7		**Critical**	**Recommended**	**AUCC**	**Credits**
BIOM 421	Transport Phenomena in Biomedical Engineering	X			3
CBE 333	Chemical and Biological Engineering Lab I	X			2
CBE 442	Separation Processes	X			4
CBE 451	Chemical and Biological Engineering Design I	X			3
BME Broad Elective (see list below)					3
	Total Credits				**15**
Semester 8		**Critical**	**Recommended**	**AUCC**	**Credits**
BIOM 422	Quantitative Systems and Synthetic Biology	X			3
CBE 430	Process Control and Instrumentation				3
CBE 443	Chemical and Biological Engineering Lab II	X			2
PH 142	Physics for Scientists and Engineers II (GT-SC1)		X	3A	5
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)				3B	3
	Total Credits				**16**
Fifth Year					
Semester 9		**Critical**	**Recommended**	**AUCC**	**Credits**
BIOM 486A	Biomedical Design Practicum: Capstone Design I	X		4A,4B,4C	4
BME Technical Elective (See List on Requirements Tab)			X		3
CBE Technical Elective (See List on Requirements Tab)			X		2
Diversity, Equity, and Inclusion (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-equity-inclusion)				1C	3
Advanced Writing (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing)				2	3
	Total Credits				**15**
Semester 10		**Critical**	**Recommended**	**AUCC**	**Credits**
BIOM 486B	Biomedical Design Practicum: Capstone Design II	X		4A,4B,4C	4
BME Technical Elective (See List on Requirements Tab)		X			2
CBE Technical Elective (See List on Requirements Tab)		X			3
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)				3B	3
Historical Perspectives (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives)				3D	3
The benchmark courses for the 10th semester are the remaining courses in the entire program of study		X			
	Total Credits				**15**
	Program Total Credits:				**158**