

## Biomedical Engineering Technical Electives

Technical Electives (TEs) are designed to provide additional depth and breadth in the Biomedical and partner major degrees.

**BME+CBE = 3 – 5 Cr of BME TE (check DARS)**

**BME + CPE = 3 cr of BME TE**

**BME+EE = 6 cr of BME TE**

**BME+EE/L&O = 0 cr BME TE**

**BME+MECH = 6 cr of BME TE**

		Anatomy/Physiology	Biology	Biomaterials	Biomechanics	Cardiovascular	Chemistry	Computational Biology	Disease	Genetics	Imaging and Diagnostics	Medical Devices Instrumentation	Neuro	Pharmaceuticals	Tissue Engineering	Scientific Engineering processes
BC 351	Principles of Biochemistry		x			x		x								
BC 401	Comprehensive Biochemistry I		x			x		x								
BC 403	Comprehensive Biochemistry II		x			x		x								
BC 404	Comprehensive Biochemistry Laboratory		x			x		x								
BC 411	Physical Biochemistry		x			x		x								
BC 463	Molecular Genetics		x					x	x							
BC 465	Molecular Regulation & Cell Function		x					x								
BC 565	Molecular Regulation of Cell Function		x					x								
BIOM 350A	Study Abroad: Prosthetic Innovation in Ecuador			x						x						
BIOM 380A2	Global Challenges and Int'l Collaborations in BME *DARS Changes Pending									x		x				x
BIOM 421	Transport Phenomena in BME		x				x	x								
BIOM 422	Quantitative Systems and Synthetic Biology		x				x	x	x			x				
BIOM 431	Biomedical Signal and Image Processing									x						
BIOM 441	Biomechanics and Biomaterials		x	x	x					x						
BIOM 476A <sup>1</sup>	Biomedical Clinical Practicum (2 cr; typically industry+faculty sponsor)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
BIOM 476B <sup>1</sup>	Biomedical Clinical Practicum (4 cr; typically industry+faculty sponsor)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
BIOM 495 <sup>1</sup>	BME Independent Study (1 - 6 cr; faculty sponsor)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
BIOM 504	Fundamentals of Biochemical Engineering		x			x						x				
BIOM 518	Biophotonics									x						
BIOM 522	Bioseparation Processes												x			x
BIOM 525	Cell and Tissue Engineering		x	x									x			x
BIOM 526	Biological Physics									x						
BIOM 527 (A-F)	Biosensors									x						
BIOM 531	Materials Engineering			x											x	x
BIOM 533	Biomolecular Tools for Engineers			x				x		x		x	x			
BIOM 537	Biomedical Signal Processing									x						
BIOM 570	Bioengineering			x				x	x	x		x	x			
BIOM 573	Structure and Function of Biomaterials			x						x		x	x			
BIOM 574	Bio-Inspired Surfaces			x						x		x	x			
BIOM 576	Quantitative Systems Physiology		x	x		x	x	x				x				
BIOM 578	Musculoskeletal Biosolid Mechanics		x		x											
BIOM 579	Cardiovascular Biomechanics		x	x	x	x		x	x					x	x	
BIOM 580A9	Regenerative Bioengineering with Stem Cells *DARS Changes Pending		x												x	
BMS 301	Human Gross Anatomy	x														
BMS 302	Laboratory in Principles of Physiology	x														
BMS 310	Anatomy for the Health Professions (online)	x														
BMS 320	Virtual Laboratory in Physiology (online) *DARS Changes Pending	x														
BMS 325	Cellular Neurobiology		x					x				x				
BMS 345	Functional Neuroanatomy							x				x				
BMS 405	Nerve and Muscle-Toxins, Trauma, and Disease							x				x				
BMS 409	Human and Animal Reproductive Biology	x	x					x								
BMS 420	Cardiopulmonary Physiology	x				x		x								
BMS 430	Endocrinology	x						x						x		
BMS 450	Pharmacology	x						x						x		
BMS 500/NB 501	Mammalian Physiology I	x				x		x				x				
BMS 501	Mammalian Physiology II	x						x								
BMS/NB 503	Developmental Neurobiology		x						x		x					
BMS/NB 505	Neuronal Circuits, Systems and Behavior		x								x	x				
BZ 310	Cell Biology		x													
BZ 311	Developmental Biology		x													
BZ 350	Molecular and General Genetics		x							x						
BZ 476*/BZ 576	Genetics of Model Organisms		x							x						

		Anatomy/Physiology	Biology	Biomaterials	Biomechanics	Cardiovascular	Chemistry	Computational Biology	Disease	Genetics	Imaging and Diagnostics	Neuro	Pharmaceuticals	Tissue Engineering	Scientific/Eng processes
CBE 330	Process Simulation						x								x
CBE 505	Biochemical Engineering Laboratory	x				x						x			
CHEM 334	Quantitative Analysis Laboratory					x									
CHEM 335	Intro to Analytical Chemistry					x									
CHEM 343	Modern Organic Chemistry II					x									
CHEM 344	Modern Organic Chemistry II Laboratory					x									
CHEM 346	Organic Chemistry II					x									
CHEM 433**	Clinical Chemistry					x									x
CHEM 539A-C	Principles of NMR and MRI					x			x						
CM 501	Advanced Cell Biology	x													
CM/NB 502	Techniques in Molecular and Cellular Biology	x													
ECE/MECH 569*	Micro-Electro-Mechanical Devices								x	x					
ERHS 450	Introduction to Radiation Biology	x					x		x						
ERHS 502	Fundamentals of Toxicology	x				x	x					x			
ERHS 510/VS 510	Cancer Biology	x					x				?				
ERHS 540	Principles of Ergonomics				x		x								
FSHN 470	Integrated Nutrition and Metabolism	x					x								
HES 307	Biomechanical Principles of Human Movement				x										
HES 319	Neuromuscular Aspects of Human Movement	x			x							x			
HES 403	Physiology of Exercise	x													
HES 420	Electrocardiography and Exercise Management <small>*BMS Classes Prereq</small>	x				x		x	x	x		x			
HES 476	Exercise and Chronic Disease	x			x			x							
MATH 455**	Mathematics in Biology and Medicine		x												
MECH 543**	Biofluid Mechanics					x									
MIP 300	General Microbiology		x												
MIP 302	General Microbiology Laboratory		x												
MIP 342	Immunology							x							
MIP 343	Immunology Laboratory							x							
MIP 351	Medical Bacteriology							x							
MIP 352	Medical Bacteriology Laboratory							x							
MIP 420	Medical and Molecular Virology		x					x							
MIP 436*	Industrial Microbiology		x					x					x		
MIP 443	Microbial Physiology		x					x					x		
MIP 450	Microbial Genetics		x					x	x						
MIP/BSPM 576	Bioinformatics						x			x					
NB 500/BMS 502	Readings into Cellular Neurobiology							x				x	x		

\*Available every other year (even)

\*\*Available every other year (odd)

**This list reflects a broad idea of topics covered in courses; please let [Brett.Beal@colostate.edu](mailto:Brett.Beal@colostate.edu) know if you find errors**

- Classes otherwise required or taken for the degree are not allowed for TE credit.
- Course availability changes frequently. Please check with departments regarding course availability.
- **Courses cross-listed with a BIOM prefix (e.g. BIOM 5XX/MECH 5XX) MUST be taken as BIOM 5XX to count as a BME TE.**
- A maximum total of 3 credits of BIOM 476 and/or BIOM 495 may be applied towards BME TE degree requirements. These are independent projects that have a faculty sponsor, so content will vary depending on the project.

**Info on How to Request Overrides is on pp. 14 – 15**

## Biomedical Engineering Technical Elective Course Descriptions

(Courses that do NOT have 'DARS Changes Pending' can be found, with hyperlinks to course descriptions, in the BME section of the catalog. Below course information is also from [Catalog.colostate.edu](http://Catalog.colostate.edu) – pls refer there for most updated info)

### **BC 351 – Principles of Biochemistry**

**4 credits**

*Potential Term Offered:* Fall, Spring, Summer

**Prerequisite:** (BZ 110 or BZ 120 or LIFE 102) and (CHEM 241 or CHEM 245 or CHEM 341 or CHEM 345).

**Course Description:** Structure and function of biological molecules; biocatalysis; metabolism and energy transduction.

### **BC 401 – Comprehensive Biochemistry I**

**3 credits**

*Potential Term Offered:* Fall

**Prerequisite:** (CHEM 245 or CHEM 343, may be taken concurrently or CHEM 346, may be taken concurrently) and (MATH 155 or MATH 160).

**Course Description:** Macromolecular structure and dynamics; membranes; enzymes; bioenergetics.

### **BC 403 – Comprehensive Biochemistry II**

**3 credits**

*Potential Term Offered:* Spring

**Prerequisite:** CHEM 245 or CHEM 341 or CHEM 345.

**Course Description:** Metabolic pathways and their regulation; cellular biochemistry.

### **BC 404 – Comprehensive Biochemistry Laboratory**

**2 credits**

*Potential Term Offered:* Fall, Spring

**Prerequisite:** (BC 401, may be taken concurrently) and (CHEM 246 or CHEM 344 or CHEM 346) and (LIFE 212 and LIFE 203).

**Course Description:** Experimental approaches to studying macromolecules, metabolism, and gene expressions.

### **BC 411 – Physical Biochemistry**

**4 credits**

*Potential Term Offered:* Fall

**Prerequisite:** (BC 351 with a minimum grade of B or BC 401) and (CHEM 113) and (MATH 161 or MATH 255).

**Course Description:** Thermodynamics; reaction rates; quantum chemistry; spectroscopy; macromolecular folding and interactions; ligand binding; enzyme kinetics; membranes.

### **BC 463 – Molecular Genetics**

**3 credits**

*Potential Term Offered:* Fall

**Prerequisite:** (BC 401 with a minimum grade of C, may be taken concurrently or BC 351 with a minimum grade of C) and (LIFE 201B with a minimum grade of C or BZ 350 with a minimum grade of C).

**Course Description:** Molecular basis of gene structure, replication, repair, recombination, and expression.

### **BIOM 476A – Biomedical Clinical Practicum I**

**2 credits <sup>1</sup>**

*Potential Term Offered:* Fall, Spring, Summer

**Prerequisite:** (BMS 300) and (BIOM 470 or MECH 470).

**Course Description:** Biomedical lab work or exposure to the hospital/clinical environment.

### **BIOM 476B – Biomedical Clinical Practicum II**

**4 credits <sup>1</sup>**

*Potential Term Offered:* Fall, Spring, Summer

**Prerequisite:** (BMS 300) and (BIOM 470 or MECH 470).

**Course Description:** Biomedical lab work or exposure to the hospital/clinical environment.

### **BIOM 495 – Independent Study**

**Var (1-6) credits <sup>1</sup>**

*Potential Term Offered:* Fall, Spring, Summer

**Prerequisite:** None.

<sup>1</sup>A maximum total of 3 credits of BIOM 476 and/or BIOM 495 may be applied towards BME TE degree requirements. These are independent projects that have a faculty sponsor, so content will vary depending on the project.

**BC 465 – Molecular Regulation of Cell Function****3 credits***Potential Term Offered:* Spring**Prerequisite:** (LIFE 210) and (BC 403, may be taken concurrently or BC 351).**Course Description:** Molecular regulation of cell organization, membrane formation, organelle biogenesis, cell communication, shape and motility, growth, aging, and death.**BC 565 – Molecular Regulation of Cell Function****4 credits***Potential Term Offered:* Spring**Prerequisite:** (LIFE 210) and (BC 351 or BC 403, may be taken concurrently).**Course Description:** Molecular regulation of cell organization, membrane formation, organelle biogenesis, cell communication, shape and motility, growth, aging, and death.**BIOM 350A – Study Abroad –Ecuador: Prosthetics****Var (1-2) credits***Potential Term Offered:* Summer**Prerequisite:** None.**Course Description:** Design and fabricate prosthetics for under-served populations in Ecuador. Course experience will occur in Quito, Ecuador in partnership with Range of Motion Project (ROMP), a non-profit healthcare organization.**BIOM 380A2 – Global Challenges and Collaborations in BME****3 credits***Potential Term Offered:* Spring**Prerequisite:** BIOM 100 or BIOM 101**Course Description:** Provides a foundation for cross-cultural competence in the biomedical engineering field, considering social, political, and economic differences in areas such as medical device design, regulation, technology transfer and ethics**BIOM 421 – Transport Phenomena in Biomedical Engineering****3 credits***Potential Term Offered:* Spring**Prerequisite:** (BMS 300) and (CBE 332 or MECH 344).**Course Description:** Engineering models of active and passive mechanisms of momentum. Heat and mass transport in mammalian cells, tissues, and organ systems.**BIOM 422 – Quantitative Systems and Synthetic Biology****3 credits***Potential Term Offered:* Fall**Prerequisite:** BIOM 421 or CBE 320.**Course Description:** In-depth analysis of the quantitative systems approach to biology and biological engineering at the molecular and cellular scales.**BIOM 431 – Biomedical Signal and Image Processing****3 credits****Also Offered As:** ECE 431.*Potential Term Offered:* Spring**Prerequisite:** (ECE 303 with a minimum grade of C or STAT 303 with a minimum grade of C) and (ECE 311 with a minimum grade of C and PH 142 with a minimum grade of C).**Course Description:** Principles, features and mathematical processing of biomedical signals and images including interference and noise filtering and feature enhancement.**BIOM 441 Biomechanics and Biomaterials Credits: 3 (3-0-0)***Potential Term Offered:* Fall**Prerequisite:** BMS 300, may be taken concurrently and CIVE 360 and MECH 324, may be taken concurrently and MECH 331, may be taken concurrently and MECH 342.**Course Description:** Principles of biomechanics, biofluids, and biomaterials**BIOM 504 – Fundamentals of Biochemical Engineering****3 credits****Also Offered As:** CBE 504.*Potential Term Offered:* Spring**Prerequisite:** CBE 205 and MIP 300.**Course Description:** Application of chemical engineering principles to enzyme kinetics, fermentation and cell culture, product purification, and bioprocess design.

- BIOM 518 – Biophotonics** **3 credits**  
**Also Offered As:** ECE 518.  
*Potential Term Offered:* Fall  
**Prerequisite:** ECE 342 or ECE 457 or MATH 340 or MATH 345.  
**Course Description:** Engineering design principles of optical instrumentation for medical diagnostics. Light propagation and imaging in biological tissues
- BIOM 522 – Bioseparation Processes** **3 credits**  
**Also Offered As:** CBE 522.  
*Potential Term Offered:* Fall  
**Prerequisite:** CBE 331.  
**Course Description:** Analysis of processes to recover and purify fermentation products.
- BIOM 525 – Cell and Tissue Engineering** **3 credits**  
**Also Offered As:** MECH 525.  
*Potential Term Offered:* Spring, Even Years  
**Prerequisite:** BC 351 or BMS 300 or BMS 500 or BZ 310 or NB 501.  
**Course Description:** Cell and tissue engineering concepts and techniques with emphasis on cellular response, cell adhesion kinetics, and tissue engineering design.
- BIOM 526 – Biological Physics** **3 credits**  
**Also Offered As:** ECE 526.  
*Potential Term Offered:* Fall  
**Prerequisite:** (MATH 340 or MATH 345) and (PH 122 or PH 142).  
**Course Description:** Mathematical and physical modeling of biological systems. Mass transport in cellular environments. Electrical/mechanical properties of biomolecules.
- BIOM 527A – Biosensing: Cells as Circuits** **1 credit**  
**Also Offered As:** ECE 527A.  
*Potential Term Offered:* Fall, Spring, Summer  
**Prerequisite:** (BIOM 101 or LIFE 102) and (CHEM 111) and (MATH 340 or MATH 345) and (PH 142).  
**Course Description:** Treatment of biological cells as circuits and their electrical time-dependent function and frequency-dependent impedance. Topics include the Hodgkin–Huxley circuit model, diffusion equation, and modeling action potential propagation.
- BIOM 527B – Biosensing: Signal and Noise in Biosensors** **1 credit**  
**Also Offered As:** ECE 527B.  
*Potential Term Offered:* Fall, Spring, Summer  
**Prerequisite:** (MATH 340, may be taken concurrently or MATH 345, may be taken concurrently) and (PH 142).  
**Course Description:** Quantitative treatment of concepts of noise, interference and signal including noise types and spectra, filtering, and limitations imposed by noise. Example applications to Biosensors.
- BIOM 527C – Biosensing: Sensor Circuit Fundamentals** **1 credit**  
**Also Offered As:** ECE 527C.  
*Potential Term Offered:* Fall, Spring, Summer  
**Prerequisite:** (BIOM 101 or LIFE 102) and (MATH 340, may be taken concurrently or MATH 345, may be taken concurrently) and (PH 142).  
**Course Description:** Introduction to circuit concepts used in sensors, including review of basic circuit elements of resistors, capacitors, and MOS (Metal-Oxide-Semiconductor transistors) elements. Fundamentals of the application of MOS circuits for signal conditioning and amplification and how sensor's backend signal processing is carried out after the sensor signal transduction stage.
- BIOM 527D – Biosensing: Electrochemical Sensors** **1 credit**  
**Also Offered As:** ECE 527D.  
*Potential Term Offered:* Fall, Spring, Summer  
**Prerequisite:** (BIOM 101 or LIFE 102) and (CHEM 111) and (MATH 255 or MATH 261) and (PH 142).  
**Course Description:** Introduction to the electrochemistry, and applications of electrochemical methods, used for detection of certain classes of chemicals and molecules.

**BIOM 527E – Biosensing: Affinity Sensors****1 credit****Also Offered As:** ECE 527E.*Potential Term Offered:* Fall, Spring, Summer**Prerequisite:** (BIOM 101 or LIFE 102) and (CHEM 111) and (MATH 340, may be taken concurrently or MATH 345, may be taken concurrently) and (PH 142).**Course Description:** Fundamentals of affinity sensor application and design, including optical and electrical approaches and technologies.**BIOM 527F – Biosensing: Biophotonic Sensors Using Refractive Index****1 credit****Also Offered As:** ECE 527F.*Potential Term Offered:* Fall, Spring, Summer**Prerequisite:** (BIOM 527F or ECE 527F) and (MATH 340, may be taken concurrently or MATH 345, may be taken concurrently) and (PH 142).**Course Description:** Operating principles of optical biosensors based on changes in refractive index, such as thin films, ring-resonators, Mach-Zehnder interferometers, and other evanescent wave sensors. Basic supporting optical concepts, including thin-film interference, optical waveguides and evanescent waves.**BIOM 531 – Materials Engineering****3 credits****Also Offered As:** MECH 531.*Potential Term Offered:* Spring, Odd Years**Prerequisite:** MECH 331 or MECH 431.**Course Description:** Selection of structural engineering materials by properties, processing, and economics; materials for biomedical and biotechnology applications.**BIOM 533 – Biomolecular Tools for Engineers****3 credits****Also Offered As:** CIVE 533.*Potential Term Offered:* Fall**Prerequisite:** BMS 300 or MIP 300.**Course Description:** Theoretical and practical aspects of biomolecular laboratory tools--PCR, cloning, sequencing, single-molecule optical techniques and live-cell imaging.**BIOM 537 – Biomedical Signal Processing****3 credits****Also Offered As:** ECE 537.*Potential Term Offered:* Spring**Prerequisite:** ECE 303 or ECE 311 or MATH 340 or STAT 303.**Course Description:** Modeling and classification of biosignals (e.g. EEG, ECG, EMG), covering adaptive filtering, wavelets, support vector machines, neural networks, and handling problems with overfitting of noisy data.**BIOM 570 – Bioengineering****3 credits****Also Offered As:** MECH 570.*Potential Term Offered:* Fall**Prerequisite:** MECH 307 and MECH 324.**Course Description:** Physiological and medical systems analysis using engineering methods including mechanics, fluid dynamics, control electronics, and signal processing.**BIOM 573 – Structure and Function of Biomaterials****3 credits****Also Offered As:** MECH 573.*Potential Term Offered:* Spring**Prerequisite:** MECH 331.**Course Description:** Structure-function relationships of natural biomaterials; application to analysis of biomimetic materials and biomaterials used in medical devices.**BIOM 574 – Bio-Inspired Surfaces****3 credits****Also Offered As:** MECH 574.*Potential Term Offered:* Spring**Prerequisite:** MECH 342 and CHEM 111.**Course Description:** Analysis of surface functionalities of various biological species; identification of design principles.

**BIOM 576 – Quantitative Systems Physiology****4 credits****Also Offered As:** MECH 576.*Potential Term Offered:* Spring**Prerequisite:** BMS 300 and CHEM 113 and MATH 340 and PH 142.**Course Description:** Quantitative, model-oriented approach to cellular and systems physiology with design examples from biomedical engineering.**BIOM 578 – Musculoskeletal Biosolid Mechanics****3 credits****Also Offered As:** MECH 578.*Potential Term Offered:* Fall**Prerequisite:** CIVE 360.**Course Description:** Application of engineering concepts to quantify the mechanical behavior of load-bearing biological tissues and orthopaedic implant performance. *(Note For BIOM 578: Students with 3.3+GPA and prereqs, o/r will be granted; 3.0 – 3.299 and prereqs, o/r may be granted – check with [Sara.Mattern@Colostate.edu](mailto:Sara.Mattern@Colostate.edu); less than 3.0 GPA, o/r will likely not be granted.)***BIOM 580A9 – Regenerative Bioengineering with Stem Cells****3 credits***Potential Term Offered:* Spring**Prerequisite:****Course Description:** Current status and future direction of bioengineering and regenerative technologies with stem cells, including sorting, creation and preservation technologies with stem cells, large scale stem cell manufacturing and bioengineering strategies, mechanobiology of stem cells, genetic and epigenetic engineering of stem cells, engineering of stem cells for transitional and clinical success.**BMS 301 – Human Gross Anatomy****5 credits***Potential Term Offered:* Fall, Spring, Summer**Prerequisite:** BZ 110 or LIFE 102.**Course Description:** Structure and function of the human body. Study of prosected human cadavers; clinical applications; living anatomy.**BMS 302 – Laboratory in Principles of Physiology****2 credits***Potential Term Offered:* Fall, Spring**Prerequisite:** BMS 300, may be taken concurrently or BMS 360, may be taken concurrently.**Course Description:** Basic physiology lab exercises.**BMS 310 – Anatomy for the Health Professions****4 credits***Potential Term Offered:* Fall, Spring, Summer**Prerequisite:** LIFE 000 to 499.**Course Description:** Gross anatomy of the human body from a regional perspective, utilizing clinical applications as a basis for anatomical understanding.**BMS 320 - Virtual Laboratory in Physiology Credits: 2 (0-4-0)***Potential Terms Offered:* Fall, Spring.**Prerequisite:** **BMS 300**, may be taken concurrently or **BMS 360**, may be taken concurrently.**Course Description:** Physiology lab exercises using a virtual laboratory simulation system.**BMS 325 – Cellular Neurobiology****3 credits***Potential Term Offered:* Fall**Prerequisite:** BMS 300 or BMS 360.**Course Description:** Cellular and molecular bases of nervous system function and behavior.**BMS 345 – Functional Neuroanatomy****4 credits***Potential Term Offered:* Spring**Prerequisite:** BMS 300 or BMS 360.**Course Description:** Functional systems and circuits of the human brain and spinal cord.

- BMS 405 – Nerve and Muscle-Toxins, Trauma and Disease** **3 credits**  
*Potential Term Offered:* Spring  
*Prerequisite:* BMS 325 or BMS 345.  
*Course Description:* Structure, composition, function of nerves and muscles, etiology of genetic and autoimmune neuromuscular diseases, alteration by toxins and nerve gas.
- BMS 409 – Human and Animal Reproductive Biology** **3 credits**  
*Potential Term Offered:* Fall  
*Prerequisite:* BMS 300 or BMS 360.  
*Course Description:* Basis for male and female reproductive function in humans and animals.
- BMS 420 – Cardiopulmonary Physiology** **3 credits**  
*Potential Term Offered:* Fall  
*Prerequisite:* BMS 300 or BMS 360.  
*Course Description:* Normal and pathophysiology of cardiovascular and pulmonary systems.
- BMS 430 – Endocrinology** **3 credits**  
*Potential Term Offered:* Fall  
*Prerequisite:* BMS 300 or BMS 360.  
*Course Description:* Physiology of the glands of internal secretion.
- BMS 450 – Pharmacology** **3 credits**  
*Potential Term Offered:* Spring  
*Prerequisite:* (BMS 300 or BMS 360) and (BC 351 or LIFE 210).  
*Course Description:* Pharmacologic principles, absorption, distribution, metabolism, excretion, side effects, and actions of drugs.
- BMS 500 – Mammalian Physiology I** **4 credits**  
**Also Offered As:** NB 501  
*Potential Term Offered:* Fall  
*Prerequisite:* BMS 300 or BMS 360.  
*Course Description:* Cell physiology of nerve, skeletal, cardiac and smooth muscle with an emphasis on how cellular functions integrate into systems behavior.
- BMS 501 – Mammalian Physiology II** **4 credits**  
*Potential Term Offered:* Spring  
*Prerequisite:* BMS 300 or BMS 360.  
*Course Description:* Respiratory, renal, digestive, endocrine, metabolic, and reproductive function.
- BMS 503 – Developmental Neurobiology** **3 credits**  
**Also Offered As:** NB 503.  
*Potential Term Offered:* Spring  
*Prerequisite:* (BIO 100 to 481 or BZ 100 to 481 or LIFE 100 to 481) and (BC 100 to 481 and PH 100 to 481) and (MATH 141 or MATH 155 or MATH 160 to 161 or MATH 255 or MATH 261).  
*Course Description:* Molecular mechanisms involved in development of nervous system including differentiation, growth, pathfinding, and synaptogenesis.
- BMS 505 – Neuronal Circuits, Systems and Behavior** **3 credits**  
**Also Offered As:** NB 505.  
*Potential Term Offered:* Spring  
*Prerequisite:* BMS 325 or BMS 500 or NB 501.  
*Course Description:* Anatomical and physiological organization of the nervous system.
- BZ 310 – Cell Biology** **4 credits**  
*Potential Term Offered:* Fall, Spring, Summer  
*Prerequisite:* (BZ 110 or BZ 120 or LIFE 103) and (CHEM 113).  
*Course Description:* Structure and function of cells emphasizing molecular mechanisms. Communication, metabolism, motility, genetics, growth, and reproduction.
- BZ 311 – Developmental Biology** **4 credits**  
*Potential Term Offered:* Spring, Summer  
*Prerequisite:* BZ 310.  
*Course Description:* Developmental aspects of growth and differentiation stressed in higher plants and animals.



- BZ 350 – Molecular and General Genetics** **4 credits**  
*Potential Term Offered:* Fall, Spring, Summer  
**Prerequisite:** (BZ 110 or BZ 120 or LIFE 102) and (STAT 201, may be taken concurrently or STAT 301, may be taken concurrently or STAT 307, may be taken concurrently or ERHS 307, may be taken concurrently).  
**Course Description:** Mendelian, molecular, and population genetics emphasizing the molecular basis of genetics.
- BZ 476 – Genetics of Model Organisms** **3 credits**  
**Also Offered As:** BZ 576.  
*Potential Term Offered:* Fall  
**Prerequisite:** BZ 350 or LIFE 201A or LIFE 201B or SOCR 330.  
**Course Description:** Advanced topics in model genetic systems including molecular and developmental genetics.
- BZ 576 – Genetics of Model Organisms** **4 credits**  
**Also Offered As:** BZ 476.  
*Potential Term Offered:* Fall  
**Prerequisite:** BZ 350 or LIFE 201A or LIFE 201B or SOCR 330.  
**Course Description:** Advanced topics in model genetic systems including molecular and developmental genetics.
- CBE 330 – Process Simulation** **3 credits**  
*Potential Term Offered:* Fall  
**Prerequisite:** (CBE 210 with a minimum grade of C) and (MATH 340).  
**Course Description:** Analysis of chemical and biological engineering problems by numerical simulation.
- CBE 505 – Biochemical Engineering Laboratory** **1 credit**  
*Potential Term Offered:* Fall  
**Prerequisite:** CBE 504, may be taken concurrently.  
**Course Description:** Fermentation technology, bioprocess control, and protein purification.
- CHEM 334 – Quantitative Analysis Laboratory** **1 credit**  
*Potential Term Offered:* Fall, Spring  
**Prerequisite:** CHEM 114 and CHEM 335, may be taken concurrently.  
**Course Description:** Laboratory applications of principles presented in CHEM 335.
- CHEM 335 – Introduction to Analytical Chemistry** **3 credits**  
*Potential Term Offered:* Fall, Spring  
**Prerequisite:** CHEM 113 with a minimum grade of C and CHEM 334, may be taken concurrently.  
**Course Description:** Modern and classical applications and methods in analytical chemistry including statistical, kinetic, spectroscopic, and chromatographic analysis.
- CHEM 343 Modern Organic Chemistry II** **3 credits**  
*Potential Term Offered:* Fall, Spring, Summer  
**Prerequisite:** CHEM 241 with a minimum grade of C- or CHEM 245 with a minimum grade of C- or CHEM 341 with a minimum grade of C- or CHEM 345 with a minimum grade of C-.  
**Course Description:** Continued studies of reactions and mechanisms of organic molecules and biological chemistry.
- CHEM 344 Modern Organic Chemistry Laboratory** **2 credits**  
*Potential Term Offered:* Fall, Spring, Summer  
**Prerequisite:** CHEM 114 and CHEM 343, may be taken concurrently.  
**Course Description:** Laboratory applications of modern organic chemistry.
- CHEM 346 Organic Chemistry II** **4 credits**  
*Potential Term Offered:* Spring  
**Prerequisite:** CHEM 345.  
**Course Description:** Continue studies of reactions and mechanisms of organic molecules. Laboratory applications of principles presented in lecture.
- CHEM 433 Clinical Chemistry** **3 credits**  
*Potential Term Offered:* Spring  
**Prerequisite:** (CHEM 334) and (BC 351 or BC 401).  
**Course Description:** Principles and methodology of clinical chemistry. Laboratory experience in methodology and method development.

<b>CHEM 539A Principles of NMR and MRI: Basic NMR Principles</b>	<b>1 credit</b>
<i>Potential Term Offered:</i> Spring	
<i>Prerequisite:</i> CHEM 474.	
<b>CHEM 539B Principles of NMR and MRI: NMR Diffusion Measurements-2D NMR and MRI</b>	<b>1 credit</b>
<i>Potential Term Offered:</i> Spring	
<i>Prerequisite:</i> CHEM 474.	
<b>CHEM 539C Principles of NMR and MRI: Advanced NMR and MRI Techniques</b>	<b>1 credit</b>
<i>Potential Term Offered:</i> Spring	
<i>Prerequisite:</i> CHEM 474.	
<i>Course Description:</i>	
<b>CM 501 Advanced Cell Biology</b>	<b>4 credits</b>
<i>Potential Term Offered:</i> Fall	
<i>Prerequisite:</i> BZ 310.	
<i>Course Description:</i> Cell structure and organelle function.	
<b>CM 502 Techniques in Molecular &amp; Cellular Biology</b>	<b>2 credits</b>
<b>Also Offered As:</b> NB 502.	
<i>Potential Term Offered:</i> Fall	
<i>Prerequisite:</i> (BIO 100 to 481 - at least 4 credits or BZ 100 to 481 - at least 4 credits or LIFE 100 to 481 - at least 4 credits) and (BC 100 to 481 - at least 4 credits and PH 100 to 481 - at least 4 credits).	
<i>Course Description:</i> Current methods in molecular and cellular neurobiology.	
<b>ECE 569 Micro-Electro-Mechanical Devices</b>	<b>3 credits</b>
<b>Also Offered As:</b> MECH 569.	
<i>Potential Term Offered:</i> Spring	
<i>Prerequisite:</i> ECE 331 with a minimum grade of C or MECH 344 with a minimum grade of C.	
<i>Course Description:</i> Micro-electro-mechanical processes and applications in sensors, optics, and structures.	
<b>ERHS 450 Introduction to Radiation Biology</b>	<b>3 credits</b>
<i>Potential Term Offered:</i> Spring	
<i>Prerequisite:</i> LIFE 102.	
<i>Course Description:</i> Genetic and somatic effects of radiation on cells, tissues, and the whole organism; tumor therapy; carcinogenesis; risks vs. benefits of radiation.	
<b>ERHS 502 Fundamentals of Toxicology</b>	<b>3 credits</b>
<i>Potential Term Offered:</i> Fall	
<i>Prerequisite:</i> (BMS 300 or BMS 360) and (CHEM 245 or CHEM 341 or CHEM 345).	
<i>Course Description:</i> Fundamental principles of toxicology; dose-response, organ targets, toxic agents.	
<b>ERHS 510 Cancer Biology</b>	<b>3 credits</b>
<b>Also Offered As:</b> VS 510.	
<i>Potential Term Offered:</i> Spring	
<i>Prerequisite:</i> BC 351 or BC 403, may be taken concurrently or BZ 310 or CM 501.	
<i>Course Description:</i> Cancer biology will address each of the hallmarks of cancer, including sustained proliferative signaling, evasion of growth suppression, invasion and metastasis, replicative immortality, angiogenesis, resisting cell death, genome instability and mutation, tumor promoting inflammation, deregulation of cellular energetics and avoidance of immune destruction. Lectures will integrate the biology behind these hallmarks with strategies for the treatment and prevention of cancer.	
<b>ERHS 540 Principles of Ergonomics</b>	<b>3 credits</b>
<i>Potential Term Offered:</i> Fall	
<i>Prerequisite:</i> None.	
<i>Course Description:</i> Theory and practice of ergonomics.	
<b>FSHN 470 Integrative Nutrition and Metabolism</b>	<b>3 credits</b>
<i>Potential Term Offered:</i> Fall, Spring	
<i>Prerequisite:</i> BC 351 and FSHN 350.	
<i>Course Description:</i> Influence of nutrition on roles and action of hormones and gene expression on metabolism.	

- HES 307 Biomechanical Principles of Human Movement** **4 credits**  
*Potential Term Offered:* Fall, Spring, Summer  
*Prerequisite:* (HES 207 or BMS 301) and (PH 121 or PH 141).  
*Course Description:* Study and elementary analysis of human motion based on anatomical and mechanical principles.
- HES 319 Neuromuscular Aspects of Human Movement** **4 credits**  
*Potential Term Offered:* Fall, Spring  
*Prerequisite:* BMS 300 and HES 207.  
*Course Description:* Neuromuscular anatomy and physiology of human movement. Applied/integrated topics: aging, muscle fatigue, training, force control, and neuromuscular disease.
- HES 403 Physiology of Exercise** **4 credits**  
*Potential Term Offered:* Fall, Spring, Summer  
*Prerequisite:* BMS 300 or BMS 360.  
*Course Description:* Effects of exercise on tissues, organs, and systems of the body.
- HES 420: Electrocardiography and Exercise Management** **3 Credits**  
*Potential Term Offered:* Fall Spring  
*Prerequisite:* BMS 300  
*Course Description:* Interpretation of 12-lead ECH tracings, administering exercise tests, and prescribing exercise program for healthy individuals and special populations
- HES 476 Exercise and Chronic Disease** **3 credits**  
*Potential Term Offered:* Fall, Spring, Summer  
*Prerequisite:* BC 351 and FSHN 350 and HES 403.  
*Course Description:* Interaction of physical activity with pathophysiology and treatment of chronic diseases/conditions.
- MATH 455 Mathematics in Biology and Medicine** **3 credits**  
*Potential Term Offered:* Fall  
*Prerequisite:* BZ 348 or MATH 255 or MATH 340 or MATH 345 or MATH 348.  
*Course Description:* Models in population biology, cell division, host-parasoid systems, bacterial growth and predator-prey systems.
- MATH 569A Linear Algebra for Data Science** **1 credit module**  
*Potential Term Offered:* **Fall, Spring, Summer**  
*Prerequisite:* (MATH 124 or MATH 126)  
*Course Description:* A basic introduction to matrices and linear algebra with preparation to further pursue studies in the applications of matrices with an emphasis on the foundations of data science
- MATH 569B Linear Algebra for Data Science: Geometric Techniques for Data Reduction** **1 credit module**  
*Potential Term Offered:* *Fall, Spring, Summer*  
*Prerequisite:* MATH 569A  
*Course Description:* Projections, data fitting and over-determined linear systems, eigenvectors and eigenvalues, the spectral theorem for symmetric matrices, data driven bases, principal component analysis, the singular value decomposition.
- MATH 569C Linear Algebra for Data Science: Matrix Factorizations and Transformations** **1 credit module**  
*Potential Term Offered:* **Fall, Spring, Summer**  
*Prerequisite:* MATH 569B  
*Course Description:* Advanced algorithms for the characterization of data using matrix factorizations and transformations.
- MATH 569D Linear Algebra for Data Science: Theoretical Foundations** **1 credit module**  
*Potential Term Offered:* **Fall, Spring, Summer**  
*Prerequisite:* MATH 569C  
*Course Description:* Theoretical development of linear algebraic tools for data science; theorem and proof driven.
- MECH 543 Biofluid Mechanics** **3 credits**  
*Potential Term Offered:* Spring  
*Prerequisite:* (BIOM 421 or CBE 331 or CIVE 300 or MECH 342) and (BMS 300 and PH 121 or PH 141 and BMS 300 or BMS 420).  
*Course Description:* Fluid dynamic concepts for understanding fluid motion in living organs/organisms; advanced research applications.

- MIP 300 General Microbiology** **3 credits**  
*Potential Term Offered:* Fall, Spring, Summer  
**Prerequisite:** (BZ 110 or BZ 120 or LIFE 102) and (CHEM 245, may be taken concurrently or CHEM 341, may be taken concurrently or CHEM 345, may be taken concurrently).  
**Course Description:** Structure, function, development, physiology, and molecular biology of microorganisms emphasizing bacteria.
- MIP 302 General Microbiology Laboratory** **2 credits**  
*Potential Term Offered:* Fall, Spring  
**Prerequisite:** MIP 300, may be taken concurrently.  
**Course Description:** Laboratory skills and techniques for isolating, characterizing, and identifying bacteria.
- MIP 342 Immunology** **4 credits**  
*Potential Term Offered:* Fall, Spring  
**Prerequisite:** (BZ 310 or BZ 350 or LIFE 201B or LIFE 210 or MIP 250) and (CHEM 245, may be taken concurrently or CHEM 341, may be taken concurrently or CHEM 345, may be taken concurrently) and (MIP 300).  
**Course Description:** Principles of immunology: components of the immune system, interactions of humoral and cellular elements, and clinical applications of basic concepts.
- MIP 343 Immunology Laboratory** **2 credits**  
*Potential Term Offered:* Spring  
**Prerequisite:** MIP 302 and MIP 342, may be taken concurrently.  
**Course Description:** Techniques used in research and clinical immunology, including diagnostic problem solving and data analysis.
- MIP 351 Medical Bacteriology** **3 credits**  
*Potential Term Offered:* Spring  
**Prerequisite:** MIP 342.  
**Course Description:** Bacteria which cause human and veterinary diseases; host-parasite relationships, disease mechanisms, prevention, and therapy.
- MIP 352 Medical Bacteriology Laboratory** **3 credits**  
*Potential Term Offered:* Spring  
**Prerequisite:** MIP 302 and MIP 351, may be taken concurrently.  
**Course Description:** Laboratory skills and techniques necessary for identifying medically important bacteria.
- MIP 420 Medical and Molecular Virology** **4 credits**  
*Potential Term Offered:* Fall  
**Prerequisite:** (MIP 342) and (BC 351, may be taken concurrently or BC 401, may be taken concurrently).  
**Course Description:** Principles of animal virology: structure, classification, assay, diagnosis, control, replication, genetics, host-parasite relationships.
- MIP 436 Industrial Microbiology** **4 credits**  
*Potential Term Offered:* Fall  
**Prerequisite:** LIFE 206 or MIP 302.  
**Course Description:** Use of microorganisms for producing commercially valuable products.
- MIP 443 Microbial Physiology** **4 credits**  
*Potential Term Offered:* Spring  
**Prerequisite:** (MIP 300) and (BC 351 or BC 401).  
**Course Description:** Structure, function of bacterial constituents; comparison with other organisms. Bacterial growth, energy production, biosynthesis.
- MIP 450 Microbial Genetics** **3 credits**  
*Potential Term Offered:* Fall  
**Prerequisite:** (MIP 300) and (BC 351, may be taken concurrently or BC 401, may be taken concurrently).  
**Course Description:** Principles of genetics at molecular level; mutation, recombination, complementation, suppression, control of gene expression, and recombinant DNA.

**MIP 576 Bioinformatics****3 credits****Also Offered As:** BSPM 576.*Potential Term Offered:* Fall, Spring**Prerequisite:** BC 463 or BZ 310 or BZ 350 or CM 501 or CS 155 or ERHS 332 or MIP 275 or MIP 300 or MIP 450 or STAT 307.**Course Description:** Technical computing across platforms using bioinformatics tools in molecular analysis.**NB 500 Readings in Cellular Neurobiology****1 credit****Also Offered As:** BMS 502.*Potential Term Offered:* Fall**Prerequisite:** (BZ 100 to 481 - at least 1 course or BIO 100 to 481 - at least 1 course or LIFE 100 to 481 - at least 1 course) and (BC 100 to 481 - at least 1 course and PH 100 to 481 - at least 1 course) and (MATH 141 or MATH 155 or MATH 160 to 161 - at least 1 course or MATH 255 or MATH 261) and (BMS 325) and (NB 501, may be taken concurrently or BMS 500, may be taken concurrently).**Course Description:** Faculty directed exploration of key literature in the neurosciences.

## **HOW TO REQUEST OVERRIDES**

### **ENGINEERING COURSES**

#### **300- and 400-level ENGINEERING COURSES**

You should be able to register for TEs if you have prerequisite courses. If you get error codes, forward that info, your name, majors and CSU ID to the following people to troubleshoot these:

- CBE courses: [Claire.Lavelle@colostate.edu](mailto:Claire.Lavelle@colostate.edu)
- ECE courses: [Courtney.Johnsrud@colostate.edu](mailto:Courtney.Johnsrud@colostate.edu)
- CIVE or MECH courses: your BME adviser (pls use the format below)

**Please use this format when requesting overrides:**

Name:

Student ID #:

Course Needing Override:

I meet Prereqs for this class (y/n):

Type of Override (e.g. Prereq, Class Level – leave blank if you don't know...the adviser will complete this):

Cumulative GPA:

#### **500-LEVEL ENGINEERING COURSES**

\*\*\*If your cumulative GPA is less than 3.0, or you do not have prereqs for the course, pls get written permission from prof to take the course and forward that with your request. Be sure to let the prof know why you think you can be successful in the class even though you don't have the gpa and/or prereq courses. You may still have the knowledge!

#### **500-LEVEL BIOM and MECH COURSES**

**Q: How do I register/request an override for a 500-level BIOM or MECH course?**

- Email [Sara.Mattern@colostate.edu](mailto:Sara.Mattern@colostate.edu) with the information above in red (name, ID, reason, etc.) and your request
- NOTE that a course must be BIOM 5XX to count as a BME TE.

#### **500-LEVEL CBE COURSES**

**Q: How do I register for 500-level CBE courses?**

- You should be able to register if you have the pre-requisite course(es). If you have a problem registering, email [Claire.Lavelle@colostate.edu](mailto:Claire.Lavelle@colostate.edu).
- If you don't have the prereqs or 3.0+ cumulative GPA, email the professor and if he/she gives you permission, forward that email to [Claire.Lavelle@colostate.edu](mailto:Claire.Lavelle@colostate.edu).

#### **500-LEVEL ECE COURSES**

**Q: How do I register for 500-level ECE courses?**

- You should be able to register if you have the pre-requisite course(es). If you have a problem registering, pls email [Courtney.Johnsrud@colostate.edu](mailto:Courtney.Johnsrud@colostate.edu).
- If you don't have the prereqs or 3.0+ cumulative GPA, email the professor and if he/she gives you permission, forward that email to [Courtney.Johnsrud@colostate.edu](mailto:Courtney.Johnsrud@colostate.edu).

## **ALL OTHER COURSE OVERRIDE REQUESTS**

Q: How do I register/request an override for a course outside of the College of Engineering?

- Email the professor and/or that department and ask for the override. Be sure to include information regarding the pre-reqs you already have, your name, student ID and majors.
  - If you meet all of the pre-reqs and are still unable to register, give them the error code
  - If you don't have prerequisites but think you can do well in the class, explain why you think you will be successful when requesting the override.
- The prof and/or dept. will grant the override if approved.

**Other questions? Ask your BME Adviser!**