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 |

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC 351</td>
<td>Principles of Biochemistry</td>
</tr>
<tr>
<td>BC 401</td>
<td>Comprehensive Biochemistry I</td>
</tr>
<tr>
<td>BC 403</td>
<td>Comprehensive Biochemistry II</td>
</tr>
<tr>
<td>BC 404</td>
<td>Comprehensive Biochemistry Laboratory</td>
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<tr>
<td>BC 411</td>
<td>Physical Biochemistry</td>
</tr>
<tr>
<td>BC 463</td>
<td>Molecular Genetics</td>
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<tr>
<td>BC 465</td>
<td>Molecular Regulation &amp; Cell Function</td>
</tr>
<tr>
<td>BC 505</td>
<td>Molecular Regulation of Cell Function</td>
</tr>
<tr>
<td>BIOM 350A</td>
<td>Study Abroad: Prosthetic Innovation in Ecuador</td>
</tr>
<tr>
<td>BIOM 380A2</td>
<td>Global Challenges and Int’l Collaborations in BiE</td>
</tr>
<tr>
<td>BIOM 421</td>
<td>Transport Phenomena in BiME</td>
</tr>
<tr>
<td>BIOM 422</td>
<td>Quantitative Systems and Synthetic Biology</td>
</tr>
<tr>
<td>BIOM 431</td>
<td>Biomedical Signal and Image Processing</td>
</tr>
<tr>
<td>BIOM 441</td>
<td>Biomechanics and Biomaterials</td>
</tr>
<tr>
<td>BIOM 476A</td>
<td>Biomedical Clinical Practicum (not typically industry-sponsored)</td>
</tr>
<tr>
<td>BIOM 476B</td>
<td>Biomedical Clinical Practicum (not typically industry-sponsored)</td>
</tr>
<tr>
<td>BIOM 495</td>
<td>Independent Study (not typically sponsored)</td>
</tr>
<tr>
<td>BIOM 504</td>
<td>Fundamentals of Biochemical Engineering</td>
</tr>
<tr>
<td>BIOM 518</td>
<td>Biophotonics</td>
</tr>
<tr>
<td>BIOM 522</td>
<td>Bioseparation Processes</td>
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<tr>
<td>BIOM 525</td>
<td>Cell and Tissue Engineering</td>
</tr>
<tr>
<td>BIOM 526</td>
<td>Biological Physics</td>
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<tr>
<td>BIOM 527AF</td>
<td>Biosensors</td>
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<tr>
<td>BIOM 531</td>
<td>Materials Engineering</td>
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<tr>
<td>BIOM 533</td>
<td>Biomedical Tools for Engineers</td>
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<td>BIOM 537</td>
<td>Biomedical Signal Processing</td>
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<tr>
<td>BIOM 557</td>
<td>Biomedical Engineering</td>
</tr>
<tr>
<td>BIOM 573</td>
<td>Biomaterials and Macromolecules</td>
</tr>
<tr>
<td>BIOM 574</td>
<td>Bio-Inspired Surfaces</td>
</tr>
<tr>
<td>BIOM 576</td>
<td>Quantitative Cardiovascular Physiology</td>
</tr>
<tr>
<td>BIOM 578</td>
<td>Musculoskeletal Biomechanics</td>
</tr>
<tr>
<td>BIOM 579</td>
<td>Cardiovascular Biomechanics</td>
</tr>
<tr>
<td>BIOM 580A9</td>
<td>Regenerative Biomechanics with Stem Cells</td>
</tr>
</tbody>
</table>

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>BMS 301</td>
<td>Human Gross Anatomy</td>
</tr>
<tr>
<td>BMS 302</td>
<td>Laboratory in Principles of Physiology</td>
</tr>
<tr>
<td>BMS 310</td>
<td>Anatomy for the Health Professions (online)</td>
</tr>
<tr>
<td>BMS 320</td>
<td>Virtual Laboratory in Physiology (online)</td>
</tr>
<tr>
<td>BMS 325</td>
<td>Cellular Neurobiology</td>
</tr>
<tr>
<td>BMS 345</td>
<td>Functional Neuropathology</td>
</tr>
<tr>
<td>BMS 405</td>
<td>Nerve and Muscle-Toxins, Trauma, and Disease</td>
</tr>
<tr>
<td>BMS 409</td>
<td>Human and Animal Reproductive Biology</td>
</tr>
<tr>
<td>BMS 420</td>
<td>Cardiopulmonary Physiology</td>
</tr>
<tr>
<td>BMS 430</td>
<td>Endocrinology</td>
</tr>
<tr>
<td>BMS 450</td>
<td>Pharmacology</td>
</tr>
<tr>
<td>BMS 500/NB 501</td>
<td>Mammalian Physiology I</td>
</tr>
<tr>
<td>BMS 501</td>
<td>Mammalian Physiology II</td>
</tr>
<tr>
<td>BMS/MB 503</td>
<td>Developmental Neurobiology</td>
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<tr>
<td>BMS/MB 505</td>
<td>Neuronal Circuits, Systems and Behavior</td>
</tr>
<tr>
<td>BZ 310</td>
<td>Cell Biology</td>
</tr>
<tr>
<td>BZ 311</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>BZ 350</td>
<td>Molecular and General Genetics</td>
</tr>
<tr>
<td>BZ 476B/BZ 576</td>
<td>Genetics of Model Organisms</td>
</tr>
</tbody>
</table>
This list reflects a broad idea of topics covered in courses; please let 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.

**Available every other year (odd)**

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### Course List

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Available</th>
<th>BIOM 476</th>
<th>BIOM 495</th>
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<tbody>
<tr>
<td>CBE 330</td>
<td>Process Simulation</td>
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<td>CBE 505</td>
<td>Biochemical Engineering Laboratory</td>
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<tr>
<td>CHEM 334</td>
<td>Quantitative Analysis Laboratory</td>
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<tr>
<td>CHEM 335</td>
<td>Intro to Analytical Chemistry</td>
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<tr>
<td>CHEM 343</td>
<td>Modern Organic Chemistry II</td>
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<td>Modern Organic Chemistry II Laboratory</td>
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<td>CHEM 346</td>
<td>Organic Chemistry II</td>
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<td>CHEM 433**</td>
<td>Clinical Chemistry</td>
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<tr>
<td>CHEM 630A-C</td>
<td>Principles of NMR and MRI</td>
<td>X</td>
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<td>CM 501</td>
<td>Advanced Cell Biology</td>
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<tr>
<td>CMNB 502</td>
<td>Techniques in Molecular and Cellular Biology</td>
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<tr>
<td>ECE/MECH 569*</td>
<td>Micro-Electro-Mechanical Devices</td>
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<tr>
<td>ERHS 450</td>
<td>Introduction to Radiation Biology</td>
<td>X</td>
<td>X</td>
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<td>ERHS 502</td>
<td>Fundamentals of Toxicology</td>
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<td>ERHS 510/VS 510</td>
<td>Cancer Biology</td>
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<td>FSHN 470</td>
<td>Integrated Nutrition and Metabolism</td>
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<td>HES 307</td>
<td>Biomechanical Principles of Human Movement</td>
<td>X</td>
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<tr>
<td>HES 310</td>
<td>Neuromuscular Aspects of Human Movement</td>
<td>X</td>
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<td>HES 403</td>
<td>Physiology of Exercise</td>
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<td>HES 420</td>
<td>Electrocardiography &amp; Exercise Mgmt.</td>
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<td>HES 476</td>
<td>Exercise and Chronic Disease</td>
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<tr>
<td>MATH 455**</td>
<td>Mathematics in Biology and Medicine</td>
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<td>MATH 569 A-D</td>
<td>Linear Algebra for Data Science</td>
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<td>*DAPC Changes Pending</td>
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<td>MECH 543**</td>
<td>Biofluid Mechanics</td>
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<td>General Microbiology</td>
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<td>General Microbiology Laboratory</td>
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<td>MIP 342</td>
<td>Immunology</td>
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<td>Immunology Laboratory</td>
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<td>MIP 351</td>
<td>Medical Bacteriology</td>
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<td>MIP 352</td>
<td>Medical Bacteriology Laboratory</td>
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<tr>
<td>MIP 420</td>
<td>Medical and Molecular Virology</td>
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<td>MIP 436*</td>
<td>Industrial Microbiology</td>
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<tr>
<td>MIP 443</td>
<td>Microbial Physiology</td>
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<tr>
<td>MIP 450</td>
<td>Microbial Genetics</td>
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<tr>
<td>MIP/BSPM 576</td>
<td>Bioinformatics</td>
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<td>X</td>
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<tr>
<td>NB 500/BMS 502</td>
<td>Readings into Cellular Neurobiology</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

*Available every other year (even) **Available every other year (odd)

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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 – 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* ¹
*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* ¹
*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* ¹
*Potential Term Offered:* Fall, Spring, Summer
*Prerequisite:* None.

¹A 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
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
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
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
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
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
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
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
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.
<table>
<thead>
<tr>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisite</th>
<th>Potential Term Offered</th>
<th>Course Description</th>
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</thead>
<tbody>
<tr>
<td>BIOM 518 – Biophotonics</td>
<td>3</td>
<td>ECE 342 or ECE 457 or MATH 340 or MATH 345.</td>
<td>Fall</td>
<td>Engineering design principles of optical instrumentation for medical diagnostics. Light propagation and imaging in biological tissues</td>
</tr>
<tr>
<td>BIOM 522 – Bioseparation Processes</td>
<td>3</td>
<td>CBE 331.</td>
<td>Fall</td>
<td>Analysis of processes to recover and purify fermentation products.</td>
</tr>
<tr>
<td>BIOM 525 – Cell and Tissue Engineering</td>
<td>3</td>
<td>BC 351 or BMS 300 or BMS 500 or BZ 310 or NB 501.</td>
<td>Spring, Even Years</td>
<td>Cell and tissue engineering concepts and techniques with emphasis on cellular response, cell adhesion kinetics, and tissue engineering design.</td>
</tr>
<tr>
<td>BIOM 527A – Biosensing: Cells as Circuits</td>
<td>1</td>
<td>BIOM 101 or LIFE 102 and CHEM 111 and MATH 340 or MATH 345 and PH 142.</td>
<td>Fall, Spring, Summer</td>
<td>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.</td>
</tr>
<tr>
<td>BIOM 527B – Biosensing: Signal and Noise in Biosensors</td>
<td>1</td>
<td>MATH 340, may be taken concurrently or MATH 345, may be taken concurrently and PH 142.</td>
<td>Fall, Spring, Summer</td>
<td>Quantitative treatment of concepts of noise, interference and signal including noise types and spectra, filtering, and limitations imposed by noise. Example applications to Biosensors.</td>
</tr>
<tr>
<td>BIOM 527C – Biosensing: Sensor Circuit Fundamentals</td>
<td>1</td>
<td>BIOM 101 or LIFE 102 and MATH 340, may be taken concurrently or MATH 345, may be taken concurrently and PH 142.</td>
<td>Fall, Spring, Summer</td>
<td>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.</td>
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<tr>
<td>BIOM 527D – Biosensing: Electrochemical Sensors</td>
<td>1</td>
<td>BIOM 101 or LIFE 102 and CHEM 111 and MATH 255 or MATH 261 and PH 142.</td>
<td>Fall, Spring, Summer</td>
<td>Introduction to the electrochemistry, and applications of electrochemical methods, used for detection of certain classes of chemicals and molecules.</td>
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</table>
BIOM 527E – Biosensing: Affinity Sensors  
Also Offered As: ECE 527E.  
1 credit  
**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  
Also Offered As: ECE 527F.  
1 credit  
**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  
Also Offered As: MECH 531.  
3 credits  
**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  
Also Offered As: CIVE 533.  
3 credits  
**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  
Also Offered As: ECE 537.  
3 credits  
**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  
Also Offered As: MECH 570.  
3 credits  
**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  
Also Offered As: MECH 573.  
3 credits  
**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  
Also Offered As: MECH 574.  
3 credits  
**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  
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  
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; less than 3.0 GPA, o/r will likely not be granted.)

BIOM 580A9 – Regenerative Bioengineering with Stem Cells  
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  
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  
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  
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  
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  
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**  
*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**  
*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**  
*Potential Term Offered: Fall*  
*Prerequisite:* BMS 300 or BMS 360.  
*Course Description:* Normal and pathophysiology of cardiovascular and pulmonary systems.

**BMS 430 – Endocrinology**  
*Potential Term Offered: Fall*  
*Prerequisite:* BMS 300 or BMS 360.  
*Course Description:* Physiology of the glands of internal secretion.

**BMS 450 – Pharmacology**  
*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**  
*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**  
*Potential Term Offered: Spring*  
*Prerequisite:* BMS 300 or BMS 360.  
*Course Description:* Respiratory, renal, digestive, endocrine, metabolic, and reproductive function.

**BMS 503 – Developmental Neurobiology**  
*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**  
*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**  
*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**  
*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.
CHEM 539A  Principles of NMR and MRI: Basic NMR Principles  
Prerequisite: CHEM 474.  
Potential Term Offered: Spring  
1 credit

CHEM 539B  Principles of NMR and MRI: NMR Diffusion Measurements-2D NMR and MRI  
Prerequisite: CHEM 474.  
Potential Term Offered: Spring  
1 credit

CHEM 539C  Principles of NMR and MRI: Advanced NMR and MRI Techniques  
Prerequisite: CHEM 474.  
Course Description:

CM 501  Advanced Cell Biology  
Potential Term Offered: Fall  
Prerequisite: BZ 310.  
Course Description: Cell structure and organelle function.  
4 credits

CM 502  Techniques in Molecular & Cellular Biology  
Also Offered As: NB 502.  
Potential Term Offered: Fall  
Prerequisite: (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).  
Course Description: Current methods in molecular and cellular neurobiology.  
2 credits

ECE 569  Micro-Electro-Mechanical Devices  
Also Offered As: MECH 569.  
Potential Term Offered: Spring  
Prerequisite: ECE 331 with a minimum grade of C or MECH 344 with a minimum grade of C.  
Course Description: Micro-electro-mechanical processes and applications in sensors, optics, and structures.  
3 credits

ERHS 450  Introduction to Radiation Biology  
Potential Term Offered: Spring  
Prerequisite: LIFE 102.  
Course Description: Genetic and somatic effects of radiation on cells, tissues, and the whole organism; tumor therapy; carcinogenesis; risks vs. benefits of radiation.  
3 credits

ERHS 502  Fundamentals of Toxicology  
Potential Term Offered: Fall  
Prerequisite: (BMS 300 or BMS 360) and (CHEM 245 or CHEM 341 or CHEM 345).  
Course Description: Fundamental principles of toxicology; dose-response, organ targets, toxic agents.  
3 credits

ERHS 510  Cancer Biology  
Also Offered As: VS 510.  
Potential Term Offered: Spring  
Prerequisite: BC 351 or BC 403, may be taken concurrently or BZ 310 or CM 501.  
Course Description: 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.  
3 credits

ERHS 540  Principles of Ergonomics  
Potential Term Offered: Fall  
Prerequisite: None.  
Course Description: Theory and practice of ergonomics.  
3 credits

FSHN 470  Integrative Nutrition and Metabolism  
Potential Term Offered: Fall, Spring  
Prerequisite: BC 351 and FSHN 350.  
Course Description: Influence of nutrition on roles and action of hormones and gene expression on metabolism.  
3 credits
### HES 307 Biomechanical Principles of Human Movement
- **Credit**: 4 credits
- **潜在学期**: Fall, Spring, Summer
- **先修课程**: (HES 207 or BMS 301) and (PH 121 or PH 141).
- **课程描述**: Study and elementary analysis of human motion based on anatomical and mechanical principles.

### HES 319 Neuromuscular Aspects of Human Movement
- **Credit**: 4 credits
- **潜在学期**: Fall, Spring
- **先修课程**: BMS 300 and HES 207.
- **课程描述**: Neuromuscular anatomy and physiology of human movement. Applied/integrated topics: aging, muscle fatigue, training, force control, and neuromuscular disease.

### HES 403 Physiology of Exercise
- **Credit**: 4 credits
- **潜在学期**: Fall, Spring, Summer
- **先修课程**: BMS 300 or BM 360.
- **课程描述**: Effects of exercise on tissues, organs, and systems of the body.

### HES 420: Electrocardiography and Exercise Management
- **Credit**: 3 Credits
- **潜在学期**: Fall Spring
- **先修课程**: BMS 300
- **课程描述**: 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
- **Credit**: 3 credits
- **潜在学期**: Fall, Spring, Summer
- **先修课程**: BC 351 and FSHN 350 and HES 403.
- **课程描述**: Interaction of physical activity with pathophysiology and treatment of chronic diseases/conditions.

### MATH 455 Mathematics in Biology and Medicine
- **Credit**: 3 credits
- **潜在学期**: Fall
- **先修课程**: BZ 348 or MATH 255 or MATH 340 or MATH 345 or MATH 348.
- **课程描述**: Models in population biology, cell division, host-parasoid systems, bacterial growth and predator-prey systems.

### MATH 569 Linear Algebra for Data Science
- **Credit**: 1 credit module
  - **潜在学期**: Fall, Spring, Summer
  - **先修课程**: (MATH 124 or MATH 126)
  - **课程描述**: 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
- **Credit**: 1 credit module
  - **潜在学期**: Fall, Spring, Summer
  - **先修课程**: MATH 569A
  - **课程描述**: 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
- **Credit**: 1 credit module
  - **潜在学期**: Fall, Spring, Summer
  - **先修课程**: MATH 569B
  - **课程描述**: Advanced algorithms for the characterization of data using matrix factorizations and transformations.

### MATH 569D Linear Algebra for Data Science: Theoretical Foundations
- **Credit**: 1 credit module
  - **潜在学期**: Fall, Spring, Summer
  - **先修课程**: MATH 569C
  - **课程描述**: Theoretical development of linear algebraic tools for data science; theorem and proof driven.

### MECH 543 Biofluid Mechanics
- **Credit**: 3 credits
- **潜在学期**: Spring
- **先修课程**: (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).
- **课程描述**: 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
- **ECE courses**: 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 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.
- 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.

**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.
- 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.
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!