BME+MECH Technical Electives

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

BME+MECH students must take6 credits of BME TEs and 3 credits of MECH TEs chosen from the following lists.

Key:	
F - Fall	* Available Every Other Year (Even)
S - Spring	** Available Every Other Year (Odd)
SS - Summer	
◆ See last page of this document for information on how to obtain course overrides	

NOTE: 1. Classes otherwise required for the degree are not allowed for TE credit.
2. Course availability changes frequently. Please check with individual departments regarding course availability.
3. Crosslisted courses (e.g. BIOM/MECH 570) are in italics and must be taken as *BIOM* courses to count for BME Technical Elective credit.

●BME-MECH students must take 6 credits from the following BME Technical Electives:

BME Technical Electives

COURSE	COURSE NAME & DESCRIPTION	Prerequsites	TERM	CR
BC 351	Principles of Biochemistry: Structure and function of biological molecules; biocatalysis; metabolism and energy transduction; gene expression.	(BZ 110 or BZ 120 or LIFE 102) and (CHEM 245 or CHEM 341 or CHEM 345).	F, S, SS	4
BC 401	Comprehensive Biochemistry I: Macromolecular structure and dynamics; membranes; enzymes; bioenergetics.	(CHEM 245, CHEM 343, or CHEM 346, may be taken concurrently) and (MATH 155	F	3
BC 403	Comprehensive Biochemistry II: Metabolic pathways and their regulation; cellular biochemistry.	CHEM 245 or CHEM 341 or CHEM 345.	S	3
BC 404	Comprehensive Biochemistry Laboratory: Experimental approaches to studying macromolecules, metabolism, and gene expressions.	(BC 401, may be taken concurrently) and (CHEM 246 or CHEM 344 or CHEM 346) and (LIFE 212 and LIFE 203).	F,S	2
BC 411	Physical Biochemistry: Thermodynamics; reaction rates; quantum chemistry; spectroscopy; macromolecular folding and interactions; ligand binding; enzyme kinetics; membranes.	(BC 351 with a minimum grade of B or BC 401) and (CHEM 113) and (MATH 161 or MATH 255).	F	4
BC 463	Molecular Genetics: Molecular basis of gene structure, replication, repair, recombination, and expression.	(BC 401, or BC 351 with a minimum grade of C) and (LIFE 201B or BZ 350 with a minimum grade of C).	F	3
BC 465	Molecular Regulation & Cell Function: Molecular regulation of cell organization, membrane formation, organelle biogenesis, cell communication, shape and motility, growth, aging, and death.	(LIFE 210) and (BC 403, or BC 351 may be taken concurrently).	S	3
BC 565	Molecular Regulation of Cell Function: Molecular regulation of cell organization, membrane formation, organelle biogenesis, cell communication, shape and motility, growth, aging, and death.	(LIFE 210) and (BC 351 or BC 403, may be taken concurrently).	S	4
BIOM 421	Transport Phenomena in Biomedical Engineering: Engineering models of active and passive mechanisms of momentum. Heat and mass transport in mammalian cells, tissues, and organ systems.	(BMS 300) and (CBE 332 or MECH 344).	F	3
BIOM 422	Kinetics of Biomolecular and Cellular Systems: In-depth analysis of the systems approach to biology and biological engineering at the molecular and the cellular scales.	BIOM 421 or CBE 320	S	3
BIOM/ ECE 431	Biomedical Signal and Image Processing		S	3
BIOM 476 A-B	Biomedical Clinical Practicum (formerly BIOM 486): Biomedical lab work or exposure to the hospital/clinical environment.	BMS 300 and BIOM 470	F,S,SS	2 or 4

BME Technical Electives (Continued)

COURSE	COURSE NAME & DESCRIPTION	Prerequsites	TERM	CR
BMS/ NB 505	Neuronal Circuits, Systems and Behavior: Anatomical and physiological organization of the nervous system.	BMS 325 or BMS 500 or NB 501.	S	3
BZ 311	Developmental Biology		S,SS	4
BZ 350	Molecular and General Genetics: Mendelian, molecular, and population genetics emphasizing the molecular basis of genetics.	(BZ 110 or BZ 120 or LIFE 102) and (STAT 201, STAT 301, STAT 307, or ERHS 307, may be taken concurrently).	F,S,SS	4
BZ 476* BZ 576	Genetics of Model Organisms: Advanced topics in model genetic systems including molecular and developmental genetics.	BZ 350 or LIFE 201A or LIFE 201B or SOCR 330.	F	3
CBE 330	Process Simulation: Analysis of chemical and biological engineering problems by numerical simulation.	CBE 210 with a minimum grade of C and MATH 340.	F	3
CHEM 334	Quantitative Analysis Laboratory: Laboratory applications of principles presented in CHEM 335.	CHEM 114 and CHEM 335, may be taken concurrently.	F, S	1
CHEM 335	Intro to Analytical Chemistry: Modern and classical applications and methods in analytical chemistry including statistical, kinetic, spectroscopic, and chromatographic analysis.	CHEM 113 with a minimum grade of C and CHEM 334, may be taken concurrently.	F,S	3
CHEM 343	Modern Organic Chemistry II: Continued studies of reactions and mechanisms of organic molecules and biological chemistry	CHEM 245 or CHEM 341 or CHEM 345	F,S,SS	3
CHEM 344	Modern Organic Chemistry Laboratory: Laboratory applications of modern organic chemistry.	CHEM 114 and CHEM 343, may be taken concurrently	F,S,SS	2
CHEM 346	Organic Chemistry II: Continue studies of reactions and mechanisms of organic molecules. Laboratory applications of principles presented in lecture.	CHEM 345	F,S	4
CHEM 433**	Clinical Chemistry: Principles and methodology of clinical chemistry. Lab experience in methodology and method development.	CHEM 334 and (BC 351 or BC 401).	S	3
CHEM 539A-C	Principles of NMR and MRI:	CHEM 474	S	1

BIOM 495[1]	BME Independent Study (4 credits max allowed of BIOM 476 and/or 495)	NA	F,S,SS	1-6

●BME-MECH students must take 6 credits from the following BME Technical Electives:

BME Technical Electives

BIOM/ CBE 504	Fundamentals of Biochemical Engineering: Application of chemical engineering principles to enzyme kinetics, fermentation and cell culture, product purification, and bioprocess design.	(MIP 300) and (MATH 255 or MATH 340) and (BIOM 306, BTEC 306, or CBE 320, may be taken concurrently).	S	3
BIOM/ ECE 518	Biophotonics: Engineering design principles of optical instrumentation for medical diagnostics. Light propagation and imaging in biological tissues.	ECE 342 or ECE 457 or MATH 340 or MATH 345.	F	3
BIOM/ CBE 522	Bioseparation Processes: Analysis of processes to recover and purify fermentation products.	CBE 331	F	3
BIOM/ MECH 525	Cell and Tissue Engineering: Cell and tissue engineering concepts and techniques with emphasis on cellular response, cell adhesion kinetics, and tissue engineering design.	BC 351 or BMS 300 or BMS 500 or BZ 310 or NB 501.	S	3
BIOM/ ECE 526	Biological Physics: Mathematical and physical modeling of biological systems. Mass transport in cellular environments. Electrical/mechanical properties of biomolecules.	(MATH 340 or MATH 345) and (PH 122 or PH 142).	S	3
BIOM/ MECH 531	Materials Engineering: Selection of structural engineering materials by properties, processing, and economics; materials for biomedical and biotechnology applications.	MECH 331 or MECH 431	S	3
BIOM/ CIVE 533	Biomolecular Tools for Engineers: Theoretical and practical aspects of biomolecular laboratory tools--PCR, cloning, sequencing, single-molecule optical techniques and live-cell imaging	BMS 300 or MIP 300.	F	3
BIOM/ ECE 537	Biomedical Signal Processing: Measuring, manipulating, and interpreting biomedical signals.	MATH 340 or ECE 311 or STAT 303.	S	3
BIOM/ CBE 543	Membranes for Biotechnology and Biomedicine: Polymeric membrane formation, modification, module design and applications to bioseparation and biomedical separations and tissue engineering.	CHEM 343 and CBE 310.	F	3
BIOM/ MECH 570	Bioengineering: Physiological and medical systems analysis using engineering methods including mechanics, fluid dynamics, control electronics, and signal processing.	MECH 307 and MECH 324.	F	3
BIOM/ MECH 573	Structure and Function of Biomaterials: Structure-function relationships of natural biomaterials; application to analysis of biomimetic materials and biomaterials used in medical devices.	MECH 331	S	3
BIOM/ MECH 574	Bio-Inspired Surfaces: Analysis of surface functionalities of various biological species; identification of design principles.	MECH 342 and CHEM 111.	S	3
BIOM/ MECH 576	Quantitative Systems Physiology: Quantitative, model-oriented approach to cellular and systems physiology with design examples from biomedical engineering.	BMS 300 and CHEM 113 and MATH 340 and PH 142.	S	4
BIOM/ MECH 578	Musculoskeletal Biosolid Mechanics: Application of engineering concepts to quantify the mechanical behavior of load-bearing biological tissues and orthopaedic implant performance.	CIVE 360	F	3

BME Technical Electives (Continued)

CM 501	Advanced Cell Biology: Cell structure and organelle function.	BZ 310	F	4
CM/NB 502	Techniques in Molecular & Cellular Biology: Current methods in molecular and cellular neurobiology.	BIO 100 to 481,BZ 100 to 481, LIFE 100 to 481 - at least 4 credits	F	2
ECE/ MECH 569*	Micro-Electro-Mechanical Devices: Micro-electro-mechanical processes and applications in sensors, optics, and structures.	ECE 331 or MECH 344 with a minimum grade of C.	S	3
ERHS 450	Introduction to Radiation Biology: Genetic and somatic effects of radiation on cells, tissues, and the whole organism; tumor therapy; carcinogenesis; risks vs. benefits of radiation.	LIFE 102 and PH 122, may be taken concurrently	S	3
ERHS 502	Fundamentals of Toxicology: Fundamental principles of toxicology; dose-response, organ targets, toxic agents	BMS 300 or BMS 360 and CHEM 245 or CHEM 341 or CHEM 345	F	3
ERHS 510	Cancer Biology: Cancer biology, from epidemiology/classification through molecular basis of phenotypes to detection/treatment.	BC 351 or BC 403, may be taken concurrently or BZ 310 or CM 501.	S	3
ERHS 540	Principles of Ergonomics: Theory and practice of ergonomics	NA	F	3
FSHN 470	Integrated Nutrition & Metabolism: Influence of nutrition on roles and action of hormones and gene expression on metabolism.	BC 351 and FSHN 350	F,S	3
HES 307	Biomechanical Principles of Human Movement: Study and elementary analysis of human motion based on anatomical and mechanical principles.	HES 207 or BMS 301 and PH 121 or PH 141	F,S,SS	4
HES 319	Neuromuscular Aspects of Human Movement: Neuromuscular anatomy and physiology of human movement. Applied/integrated topics: aging, muscle fatigue, training, force control, and neuromuscular disease	BMS 300 and HES 207	F,S	4
HES 403	Physiology of Exercise: Effects of exercise on tissues, organs, and systems of the body.	(BMS 300 or BMS 360) and (LIFE 102).	F,S,SS	4
HES 476	Exercise and Chronic Disease: Interaction of physical activity with pathophysiology and treatment of chronic diseases and conditions.	BC 351 and FSHN 350 and HES 403.	F,S,SS	3
MATH 455**	Mathematics in Biology and Medicine: Models in population biology, cell division, host-parasoid systems, bacterial growth and predator-prey systems.	BZ 348 or MATH 255 or MATH 340 or MATH 345 or MATH 348.	F	3
MECH 432	Engineering of Nanomaterials: Structure, properties, and processing of extremely small (10 to the minus 9 m) synthetic and natural materials.	MECH 331	F	3
MECH 543**	Biofluid Mechanics: Fluid dynamic concepts for understanding fluid motion in living organs/organisms; advanced research applications.	MECH 342, CIVE 300, BMS 300 and PH 121 or BMS 300 and PH 141 or BMS 420	S	3

●BME-MECH students must take 6 credits from the following BME Technical Electives:

BME Technical Electives				
BMS 301	Human Gross Anatomy: Structure and function of the human body. Study of prosected human cadavers; clinical applications; living anatomy.	BZ 110 or LIFE 102.	F,S,SS	5
BMS 302	Laboratory in Principles in Physiology: Basic physiology lab exercises.	BMS 300 or BMS 360, may be taken concurrently.	F,S	2
BMS 310	Anatomy for the Health Professions (Online): Gross anatomy of the human body from a regional perspective, utilizing clinical applications as a basis for anatomical understanding.	LIFE 000 to 499	F, S, SS	4
BMS 325	Cellular Neurobiology: Cellular and molecular bases of nervous system function and behavior.	BMS 300 or BMS 360	F	3
BMS 345	Functional Neuroanatomy: Functional systems and circuits of the human brain and spinal cord.	BMS 300 or BMS 360.	S	4
BMS 405	Nerve and Muscle-Toxins, Trauma and Disease: Structure, composition, function of nerves and muscles, etiology of genetic and autoimmune neuromuscular diseases, alteration by toxins and nerve gas.	BMS 325 or BMS 345.	S	3
BMS 409	Human and Animal Reproductive Biology: Basis for male and female reproductive function in humans and animals.	BMS 300 or BMS 360	F	3
BMS 420	Cardiopulmonary Physiology: Normal and pathophysiology of cardiovascular and pulmonary systems.	BMS 300 or BMS 360	F	3
BMS 430	Endocrinology: Physiology of the glands of internal secretion.	BMS 300 or BMS 360	F	3
BMS 450	Pharmacology: Pharmacologic principles, absorption, distribution, metabolism, excretion, side effects, and actions of drugs.	BMS 300 or BMS 360	S	3
BMS 500	Mammalian Physiology I: Cell physiology of nerve, skeletal, cardiac and smooth muscle with an emphasis on how cellular functions integrate into systems behavior.	BMS 300 or BMS 360	F	4
BMS 501	Mammalian Physiology II: Respiratory, renal, digestive, endocrine, metabolic, and reproductive function.	BMS 300 or BMS 360	S	4
BMS/ NB 503	Developmental Neurobiology: Molecular mechanisms involved in development of nervous system including differentiation, growth, pathfinding, and synaptogenesis	BIO 100 to 481, BZ 100 to 481, LIFE 100 to 481 - at least 1 course each) and (1 course: BC 100 to 481, PH 100 to 481) and (MATH 141, MATH 155, MATH 160 to 161 - at least 1 course or MATH 255 or MATH 261).	S	3

BME Technical Electives (Continued)				
MIP 300	General Microbiology: Structure, function, development, physiology, and molecular biology of microorganisms emphasizing bacteria.	(BZ 110, BZ 120,or LIFE 102) and (CHEM 245, CHEM 341, or CHEM 345, may be taken concurrently).	F,S,SS	3
MIP 302	General Microbiology Laboratory: Laboratory skills and techniques for isolating, characterizing, and identifying bacteria.	MIP 300, may be taken concurrently.	F,S	2
MIP 342	Immunology: Principles of immunology: components of the immune system, interactions of humoral and cellular elements, and clinical applications of basic concepts	(CHEM 245, CHEM 341, or CHEM 345 may be taken concurrently) and (LIFE 201B or LIFE 210 or MIP 300)	F,S	4
MIP 343	Immunology Laboratory: Techniques used in research and clinical immunology, including diagnostic problem solving and data analysis.	MIP 302 and MIP 342, may be taken concurrently	S	2
MIP 351	Medical Bacteriology: Bacteria which cause human and veterinary diseases; host-parasite relat'sps, disease mech'sms, prevention, therapy	MIP 342	S	3
MIP 352	Medical Bacteriology Lab: Laboratory skills and techniques necessary for identifying medically important bacteria.	MIP 302 and MIP 351, may be taken concurrently.	S	3
MIP 420	Medical and Molecular Virology: Principles of animal virology: structure, classification, assay, diagnosis, control, replication, genetics, host-parasite relationships	(MIP 342) and (BC 351, may be taken concurrently or BC 401, may be taken concurrently).	F	4
MIP 436*	Industrial Microbiology: Use of microorganisms for producing commercially valuable products.	LIFE 206 or MIP 302	F	4
MIP 443	Microbial Physiology: tructure, function of bacterial constituents; comparison with other organisms. Bacterial growth, energy production, biosynthesis	(MIP 300) and (BC 351 or BC 401).	S	4
MIP 450	Microbial Genetics: Principles of genetics at molecular level; mutation, recombination, complementation, suppression, control of gene expression, and recombinant DNA.	MIP 300 and (BC 351, or BC 401, may be taken concurrently).	F	3
MIP/ BSPM 576	Bioinformatics: Technical computing across platforms using bioinformatics tools in molecular analysis.	BC 463, BZ 310 or, 155, ERHS 332, MIP 275, MIP 300, MIP 450 or STAT 307.	F,S	3
NB 500	Readings in Cellular Neruobiology: Membrane properties of nerve and muscle; molecular mechanisms of synaptic function; neuro-muscular units.	(BZ 100 to 481, BIO 100 to 481 -LIFE 100 to 481 - at least 1 course) and (BC 100 to 481, PH 100 to 481 - at least 1 course).	F	1
NB 501	Cellular and Molecular Neurophysiology: Membrane properties of nerve and muscle; molecular mechanisms of synaptic function; neuromuscular units.	(BZ 100 to 481, BIO 100 to 481, LIFE 100 to 481 - at least 1 course) and (BC 100 to 481, PH 100 to 481 - at least 1 course) and (MATH 141, MATH 155, MATH 160 to 161 - at least 1 course or MATH 255 or MATH 261).	F	2

[1] A maximum total of 3 credits of BIOM 476 and/or BIOM 495 may be applied towards BME technical elective degree requirements.

●BME-MECH students must take 6* credits from the following approved MECH Technical Electives:

MECH Technical Electives

All students may choose from:

COURSE	COURSE NAME & DESCRIPTION	Prerequsites	TERM	CR
MECH 303	Energy Engineering: Energy generation (coal, oil, natural gas, solar, wind, geothermal, hydropower, tidal, biofuel, nuclear...), conversion, distribution, storage, efficiency	CBE 310 or ECE 341 or MECH 237 or MECH 337 or PH 361	F	3
Any 400-	**EXCEPT** MECH 486A, MECH 486B, MECH 495, and MECH 498A, or MECH498B. Please refer to the full university			

MECH Technical Electives

Students with a 3.0 GPA or higher may also choose from:

COURSE	COURSE NAME & DESCRIPTION		TERM	CR
MECH 495	Requires written permission from Associate Department Head			
MECH 49	Requires written permission from Associate Department Head			
Any 500-	**EXCEPT** MECH 509, MECH 510, MECH 513 (distance courses for			

NOTE: Certain courses courses are "Alternative TEs" (e.g. CS 163/164, MGT 305) for standalone MECH students but do not qualify as MECH TEs for MECH+BMEs. MECH TEs for BME+MECHs must have a MECH prefix.

*** - Change pending that removes MECH 402 as required and increases MECH TE requirement for BME+MECH students from 3 credits to 6 credits.**

To Request Overrides - Include your CSU ID and verification that you meet prerequisites; If you do not meet prerequisites, request permission from the prof and indicate why you think you would be successful in the course. If granted permisstion, forward as indicated below.

- For 500-level BIOM courses, request approval from the course professor; once obtained, forward permission to Sara.Mattern@colostate.edu (BME grad adviser) to request override
- For 500-level CBE courses, you should be able to register if you meet the pre-requisistes. If you need an override, get permission from the professor and forward that to Claire.Lavelle@colostate.edu and she will input the override.
- For 500-level ECE courses, you should be able to register if you meet the pre-requisistes. If you need an override, forward permission to Courtney.Johnsrud@colostate.edu
- For CIVE courses, email your BME adviser with the reason you want the override (e.g. meet requirements but not in the major) and she will forward request to the department on your behalf.
- For MECH courses, request approval via your BME adviser, who will forward to MECH on your behalf. If you do not meet prerequisites for 500-level courses (cum 3.0+ gpa or coursework), request permission from the prof and forward to your BME adviser.
- To request overrides for other courses (e.g. 500-level or prereq override), email the course professor or the department teaching the course.