Clemson University Libraries

Bioengineering

Information Access Policy

Engineering Librarian:
Jan Comfort

Written by P. Tyler, 01/02
Rev. J. Comfort, 3/10

Bioengineering is the application of engineering and scientific principles to understand and solve medical problems. As medical technology has rapidly developed over the past four decades, the demand for qualified bioengineers has dramatically increased. Career opportunities for bioengineers range from teaching and conducting basic research in academia to research and development work in the growing medical product industry, as well as independent research laboratories, hospitals and federal agencies such as the Food and Drug Administration or the National Institutes of Health.

Clemson University's Bioengineering program is one of the oldest in the world; its PhD program began in 1963 and its MS program was added in 1966. Historically the department is widely recognized to have pioneered the field of biomaterials. Today the Department of Bioengineering maintains its focus on biomaterials and related areas, including tissue engineering, regenerative medicine, drug delivery, biomechanics and biosensing. Although Clemson University does not have a medical school, the Bioengineering Department maintains close collaborative ties with several medical centers in the Carolinas. In particular, Clemson has a formal partnership with the Medical University of South Carolina, located in Charleston, and maintains full-time bioengineering faculty and students at both campuses. Interactions between the two institutions are facilitated by state-of-the-art video-conferencing facilities, which enable students to take classes and interact directly with faculty at either location. A joint MD/PhD program is provided for qualified students as part of this partnership.

The Bioengineering Department offers an undergraduate degree, and two graduate degrees: the MS and Ph.D. The Department's research emphases are biomaterials, biomechanics and cellular biology, particularly for orthopedic and cardiovascular applications.

Course offerings and research projects lie in the following areas: in vivo performance of biomaterials; biological response to implanted biomaterials; biomechanics of tissue, implants, and the tissue/implant interface; wear and lubrication of joints; spinal mechanics; visualization techniques; CAD/CAM-based custom prostheses design; and biomolecular modeling.

Courses include biomaterials, bioinstrumentation, biomechanics, histocompatibilty, biomaterials implantology, cell-material interactions, tissue engineering, vascular engineering, biopolymers, biomedical design, biomolecular engineering, neurobioengineering, orthopedic engineering and pathology, human dynamics, nanobiotechnology, biophotonics, advanced biomechanics and applications, genetic engineering, tribology and many others. Specialty courses are taught in the departments of Genetics and Biochemistry, Biological Sciences, and Animal and Veterinary Science and in the College of Engineering and Science.

Overview of the Graduate Program

http://www.clemson.edu/ces/departments/bioe/grad/index.html

MS Degree Program

The curriculum for the master's program consists of a core of required bioengineering courses supplemented by elective courses that provide greater depth in a specific area of interest. Two degree options are offered:

- **Thesis Option** 30 credit hours (6 of which must be research credits) and the submission and defense of a master's thesis.
- **Non-Thesis Option** 33 credit hours (6 of which must be research credits) followed by the submission of a publishable report on an approved topic.

PhD Program

Students interested in obtaining a doctoral degree are encouraged to apply directly to the PhD program from their BS degree program, with the PhD program typically requiring about five years to complete following the BS degree or about four years following the MS degree. The selection of courses for the doctoral degree is flexible and depends on the background and objectives of each candidate. A typical program includes 12 or more credit hours of graduate-level courses beyond the MS degree requirements. The PhD program culminates with the presentation and successful defense of a doctoral dissertation, which is scheduled following the completion of the student's approved research plan.

MD/PhD or DMD/PhD Degree Program

A joint research training program is established between the Clemson University and the Medical University of South Carolina. Students enrolled as Clemson students or MUSC students can take advantage of this program, and students can do a joint MD/PhD or Dental MD/PhD with the PhD in Bioengineering and MD or DMD from MUSC.

Overview of the Undergraduate program:

http://www.clemson.edu/ces/departments/bioe/undergrad/index.html

The Undergraduate program

The undergraduate program in Bioengineering is built upon a rigorous engineering science foundation that is, in turn, based upon a broad curriculum of applied and life sciences, mathematics, electives in humanities, social science, and design. Students select a formal focus that concentrates in a subfield of interest in bioengineering: Biomaterials Concentration or Bioelectrical Concentration.

Combined Bachelor's/Master's Plan

Bioengineering undergraduates may begin a Master of Science degree program while completing the Bachelor of Science degree and use a limited number of courses to satisfy the requirements of both the undergraduate and graduate degrees. The MS degree can be in Biosystems Engineering or Bioengineering.

See Appendix 1 for a list of Graduate Courses and Appendix 2 for a list of Undergraduate Courses

1. Purpose of Collection:

To support the teaching, research, and information needs at the undergraduate and graduate level in Bioengineering.

Primary Users:

- Graduate Bioengineers pursuing either the MS or PhD degree
- Bioengineering majors pursuing the combined MS/BS Degree
- Undergraduate bioengineering majors
- Bioengineering faculty (http://www.clemson.edu/ces/departments/bioe/faculty-staff/)
- Students and faculty in Biosystems Engineering
- Clemson University Centers and Institutes - these in particular:
    - South Carolina COBRE Center of Biomaterials for Tissue Regeneration
    - Institute for Biological Interfaces of Engineering
    - Clemson Institute for Biomedical Science and Engineering
- Students and faculty in the Bioengineering Alliance of South Carolina (MUSC)

Secondary Users:

- Students and faculty of departments whose subjects overlap with the interests of Bioengineers, including Materials Science, Chemical and Biomolecular Engineering, Chemistry, Biology, and (to a limited degree) Nursing
- Clemson University Centers and Institutes - these in particular:
    - The Center for Optical Materials Science and Engineering Technology (COMSET)
    - The Clemson Center for Advanced Engineering Fibers and Films (CAEFF)
- Researchers and Engineers at South Carolina companies and medical facilities

2. General Collection Guidelines:

Scope of the Collection - Materials will be selected in electronic formats when available

- Reference Books, including handbooks, dictionaries, and encyclopedias (for example *Encyclopedia of Materials Science* and *Kirk-Othmer Encyclopedia of Chemical Technology*).
- Monographs – print and electronic – will be selected to support the research and coursework of undergraduate and graduate students as well as the research and teaching needs of the faculty. E-book packages from Knovel and Springer are especially valued. During budget crisis times (such as now) books will be chosen very selectively, primarily in response to requests from faculty and students. A formal analysis of the monographs collection will begin in Spring 2011.
- Industry standards play an important role in the research process. Therefore, we will maintain a subscription to ASTM standards, and bibliographic access to additional standards through ANSI. Standards will be purchased on an as-needed basis, with a budget of $5,000. per year.
- Journals /serials / periodicals will be selected to support undergraduate research and coursework, and to support graduate and faculty research. General interest titles and trade publications generally are included in Aggregators (databases such as Academic Search Premier, Lexis / Nexis, and General Business file, so will not be purchased individually.

See Appendix 5 for a list of Important Journals in Bioengineering.

- The primary databases supporting Bioengineering are: Engineering Village (Compendex, Engineering Index historical, and Inspec), SciFinder Scholar, Medline, IEEE Xplore, and Web of Knowledge (Science Citation Index and Inspec)
- Textbooks used in Clemson classes will not be purchased, unless they are deemed to be useful for other reasons. Nor can Clemson textbooks be borrowed on Interlibrary Loan.

Languages
Unless otherwise requested by a faculty member, all material will be written in English.

Date of Publication
Most materials purchased will have been published within the preceding two years. Older works will be purchased at the request of a faculty member, to replace heavily-used volumes that have been lost, or for which demand has been shown through Interlibrary Loan borrowing.

Geographical Guidelines
I recognize the global nature of research, and the importance of representing a wide variety of points of view and international perspectives. However, due to serious budget constraints, materials originating/published in the United States will be the primary focus.

Format
Wherever possible, reference works, indexes, and journals will be purchased in electronic format and made available from the Libraries' Web site for access by students and faculty, on and off campus. Print materials will also be selected. Micro formats will be purchased if it is the only format available. Appropriate materials will be purchased on CD-ROM or DVD, when requested by a faculty member.

3. Access to Information Not Available at Clemson

Interlibrary Loan
The primary means of access to materials not owned or accessible by the library is Interlibrary Loan, a service available free to Clemson University students, faculty, and staff.

PASCAL Delivers
Books available from other research institutions in South Carolina can be supplied by Pascal Delivers, also free to Clemson University students, faculty and staff.

4. Selection, Evaluation, and Assessment Tools:

- Faculty requests and recommendations
- Review sources, e.g. *Choice*
- Approval slips from YBP ensure notification of titles that fit the needs of the library's circulating collection. The approval plan is reviewed yearly to ensure that it remains relevant. During bad budget years (as now), the approval plan will be suspended.
- Publishers' catalogs

- Vendor's databases (GOBI)
- Indexes, bibliographies, and series lists
- Teaching and research interests of the Bioengineering faculty
- *Books for College Libraries* and *Magazines for Libraries*
- Interlibrary loan activity
- Circulation activity
- Usage statistics for databases, e-journals and e-books

5. Weeding Guidelines

Books will be weeded from the collection if they are in poor condition and cannot be repaired. A replacement copy will be purchased, if available, for important titles. Duplicate copies of books that have not circulated, and material that is clearly outdated and not of historical interest will also be considered for weeding.

6. Summary of Primary Subject Classifications, LC Call Numbers, and Collecting Levels

Subject	LC Class	Collecting Level
Bioengineering/Biomedical Engineering	R856 - R857; TA164	undergraduate/graduate
Biomechanics	QH513	undergraduate/graduate
Biotechnology	TP248	undergraduate/graduate
Biomedical Materials	R857.M3	undergraduate/graduate
Cell interaction	QH604.2	undergraduate/graduate
Orthopedic Surgery	RD701	graduate/research
Ophthalmology	RE986 – 990	graduate/research
Tissue Engineering	R857.T55	graduate/research
Microbiology (medical, dental)	QK46 – 47	graduate/research
Administration of Drugs/Drug Delivery Devices	RM147-190; RS210	graduate/research
Artificial joints, joint replacements, prosthetics	RD686, RD549, RD130	undergraduate/graduate

Appendix 1 BioE Graduate Courses

BIO E 612	Orthopedic Engineering and Pathology	Interdisciplinary study of clinical orthopaedic cases (bone growth, bone remodeling, osteoarthritis, implant fixation and joint replacements); biomechanical, biomaterials, tribology and clinical diagnosis of failed implants (total joint replacements, fracture fixation and spinal instrumentation); basic concepts of orthopaedic pathology for engineers.
BIO E 615	Research Principles and Concepts	Introduces seniors and graduate students to principles and practices of scientific research. Topics include developing scientific concepts, developing projects, pursuing research, collaborating in multidisciplinary teams, patenting and publishing technical and scientific information, and reviewing professional and ethical standards of performance.
BIO E 640	Biotechnology for Bioengineers	Explores the principles necessary to use microorganisms, tissue culture, and enzymes in bioengineering applications, including molecular techniques, fermentation, process scale-up, purification processes, and FDA regulations. Emphasizes production of biopharmaceuticals derived from recombinant systems, including uses in medical systems.
BIO E 800	Seminar in Bioengineering Research	Original research in bioengineering; weekly one-hour seminar associated with weekly recitation covering seminar preparation, presentation, professional writing, bioengineering ethics, and related topics.
BIO E 801	Biomaterials	Structure and properties of the main classes of materials used in artificial organs and surgical implants; metals, ceramics, polymers, composites, and materials of biological origin; mechanical properties, corrosion, and design.
BIO E 802	Compatibility of Biomaterials	Determining compatibility of biomaterials with the physiological environment; optical microscopy, microradiography, and ultraviolet fluorescence; normal histology of tissues, basic pathological reactions, and tissue reactions to materials.
BIO E 803	Polymeric Biomaterials	Interplay of physicochemical properties of polymeric materials and the design of biomedical devices and their in vitro and in vivo performance; critical manufacturing aspects of selected augmentation and prosthetic devices for soft and hard tissues; analysis of case studies and reports on recent research findings.
BIO E 807	Nanotechnology and Biomaterials	The emerging field of nanotechnology and its relation to solving bioengineering and health-related problems is treated. Also considers the promise of nanotechnology in the creation and utilization of materials and devices at the level of atoms and molecules. New scientific approaches, research tools, clinical tools, and devices are presented.
BIO E (612) 812	Orthopedic Engineering and Pathology	Interdisciplinary study of orthopedic cases (bone growth, bone remodeling, osteoarthritis, implant fixation, and joint replacements); biomechanical, biomaterials, and clinical diagnosis of failed implants (total joints, fracture fixation, and spinal instrumentation); basic concepts of orthopedic pathology for engineers.
BIO E 820	Structural Biomechanics	Mechanical functions of the human body treated as an engineering structure and the devices used to assist and supplement these functions; movement of the musculoskeletal system; locomotion; gait; prehension; lifting; function of artificial limbs; orthopedic prostheses and braces; effect of vibration and impact on the body; mathematical and other models of the body. Preq: Consent of instructor.
BIO E (623) 823	(Cardio-)Vascular Engineering and Pathology	Medical and bioengineering aspects of artificial vascular and cardiovascular devices; physiology and pathological aspects of patients with need for such devices; diagnostic techniques and surgical management of diseases and pathology; design aspects of current devices and selection; state-of-the-art in experiments and human clinical trials.

BIO E 824	Cellular and Molecular Analysis in Tissue Engineering	Describes the molecular basis for cell regulation by extracellular stimuli including growth factors, matrix, and force. Also describes theoretical and laboratory instruction in research methods used to analyze cellular signaling and functional response in the design and evaluation of tissue engineering constructs.
BIO E 846	Biomedical Basis for Engineered Replacement	Form and function of human organs, major systems, and examples of engineering repair and replacement methods are presented in light of pathological or traumatic organ malfunction. Core for all Bioengineering graduate students, taken preferably during their first fall semester.
BIO E 847	Transport Processes in Bioengineering	Cardiovascular systems and regulation; physiology of blood, heart, and organ blood flow; properties of blood as a fluid; fluid flow equations; turbulence; pulse propagation; respiration and control of breathing; gas exchange; heart-lung bypass devices; renal function and control; artificial kidney devices; heat flow and temperature regulation. Preq: BIOSC 459.
BIO E 848	Cellular Interactions with Biomaterials	Cell biological concepts and issues relevant to cell-biomaterial interactions; methods for studying cell structure and function including basic cell culture techniques and in vitro biocompatibility analyses; biomaterial physio-chemical properties which influence cellular interactions; interactions between implant materials and host tissues at the cellular and molecular level; overview of tissue engineering.
BIO E 849	Tissue Engineering	Principles and practices of bioartificial organ and tissue development; cellular/material interaction and translation of information from two-dimensional surfaces to three-dimensional scaffolds; selection and processing of biomaterials to form tissue scaffolds; analysis of tissue engineered devices, standards, and regulation. Preq: BIO E 801, 846.
BIO E 850	Selected Topics in Biomedical Engineering	Advanced topics in bioengineering intended to develop in-depth areas of particular student interest. Credit may be earned for more than one semester.
BIO E 870	Bioinstrumentation	Concepts and techniques of instrumentation in bioengineering emphasizing effects of instrumentation on the biological system under investigation; transducers and couplers; data conversion; conditioning and transmission; experimental problems in acute and chronic procedures with static and dynamic subjects.
BIO E (671) 871	Biomedical Imaging in Biophotonics	Study of biophotonics, an interdisciplinary subject of applying photonics to diagnose and manipulate biological samples from individual cells to the entire human body. Introduces fundamental and frontier topics in the optical imaging aspect of biophotonics for graduate students to gain the ability to solve bioimaging-related biomedical problems.
BIO E 882	Biomaterials Implantology	All phases of experimental surgery including selection of animal models, preparation of animals for surgery, general and special surgical techniques, and basic and applied instrumentation.
BIO E 890	Internship	Observation and assignment in a medical college, dental college, hospital, veterinary clinic, dental clinic, health service, or industrial department.
BIO E 891	Master's Thesis Research	
BIO E 892	Nonthesis Independent Study in Bioengineering	May be repeated for additional credit. To be taken Pass/Fail only.
BIO E 991	Doctoral Dissertation Research	

Appendix 2 BioE Undergraduate Courses

BIO E 101	Biology for Bioengineers 1(1,0)	Provides basic introduction to fundamental principles of molecular and cellular biology. Preq: CH 101.
BIO E 201	Introduction to Biomedical Engineering	Provides engineering, biological, and physical science students with an overview of the replacement of human body parts and the problems related to artificial devices.
BIO E 302	Biomaterials	Study of metallic, ceramic, and polymer materials used for surgical and dental implants; materials selection, implant design, physical and mechanical testing; corrosion and wear in the body. In addition, physical and mechanical properties of tissue as related to microstructure are studied.
BIO E 320	Biomechanics	Study of relation between biological and mechanical functions of musculoskeletal tissues such as bone, ligaments, muscles, cartilage, etc.; mechanics of human joints; analysis of implants and implant failure.
BIO E 370	Bioinstrumentation and Bioimaging	Introduction of fundamental topics in bioinstrumentation and bioimaging focused on the acquisition and monitoring of vital signals. Basic principles for the selection and appropriate use of instruments for solving bioengineering and medical problems such as microscopy, magnetic resonance imaging, and ultrasounds, among others, are addressed.
BIO E 400	Senior Seminar	Addresses problems to be encountered by bioengineering graduates in professional practice. Invited lecturers and faculty provide lectures and demonstrations. Pertinent information on job interview skills, career placement and guidance, professional registration, professional ethics in bioengineering, entrepreneurship and patents, and business management are provided.
BIO E 401	Bioengineering Design Theory	Introduces principles of engineering design and applies them to the design of medical devices. Covers materials selection, fabrication processes, performance standards, cost analysis, and design optimization. Students defend a design project proposal in written and oral form before a faculty jury.
BIO E 402	Biocompatibility	Determining compatibility of biomaterials with the physiological environment using optical microscopy, microradiography, and ultraviolet fluorescence. Histological evaluation of implant-tissue interface and basic pathological reactions and tissue reactions to materials combined with the design of histotechnological processing for new biomaterials.
BIO E 403	Applied Biomedical Design	Creative application of bioengineering and design principles to solving clinically relevant design problems. Team-based development, construction and evaluation of design prototypes in accordance with design theory. Students present results to faculty jury and external collaborators through written reports and oral presentations.
BIO E (C M E) 415, H415, 615	Research Principles and Concepts	Introduces seniors and graduate students to principles and practices of scientific research. Topics include developing scientific concepts, developing projects, pursuing research, collaborating in multidisciplinary teams, patenting and publishing technical and scientific information, and reviewing professional and ethical standards of performance.

BIO E 420	Sports Engineering	Study of engineering principles involved in sports: body systems in human motion, analysis of gait, basic performance patterns in athletic movements, performance improvements, design of sports equipment.
BIO E 440, 640	Biotechnology for Bioengineers	Explores the principles necessary to use microorganisms, tissue culture, and enzymes in bioengineering applications, including molecular techniques, fermentation, process scale-up, purification processes, and FDA regulations. Emphasizes production of biopharmaceuticals derived from recombinant systems, including uses in medical systems.
BIO E 448	Tissue Engineering	Explores the application of engineering principles toward the development of biologically based substitutes that restore, maintain, or improve tissue function. Topics include biodegradable scaffolds, wound healing and tissue repair, cell-matrix interactions, immunology and biocompatibility, stem cells.
BIO E 450, H450	Special Topics in Bioengineering	Comprehensive study of a topic of current interest in the field of biomedical engineering under the direct supervision and guidance of a faculty member. May be repeated for a maximum of six credits, but only if different topics are covered. Preq: Consent of instructor.
BIO E 451	Creative Inquiry—Bioengineering	Disciplinary and multidisciplinary team research projects with the goal of developing the students' skills in literature research, engineering design, and data analysis. May be repeated for a maximum of six credits. Preq: Consent of instructor.
BIO E 460	International Special Research Topics in Bioengineering	Comprehensive study and research exposure relating to bioengineering research topics at an international institution through the Bioengineering study abroad program. Students are exposed to laboratory and research methods while under the direct supervision and guidance of approved international mentors. Preq: Consent of instructor.
BIO E 461	International Study in Bioengineering	Introduction to selected bioengineering topics through participation in international study abroad summer programs. Offers an international study experience to undergraduates through lectures, guest speakers, tours, and/or laboratory exposure on a selected bioengineering topic chosen annually by the department. Preq: Consent of instructor.
BIO E 471, 671	Biomedical Imaging in Biophotonics	Biophotonics is an interdisciplinary subject of applying photonics to study biological samples from individual cells to the entire body. Introduces fundamental and frontier topics in optical imaging aspects of biophotonics for senior-level undergraduates and graduate students to gain the ability to solve bioimaging-related biomedical problems.
BIO E 476	Biosurface Engineering	Study of how surface design influences the interactions of biomolecules with biomaterials and how this in turn influences implant biocompatibility. Laboratory addresses both the theory and application of various analytical instruments commonly used in bioengineering to characterize biomaterials surfaces and investigate biomolecule-surface interactions.
BIO E 490	Internship	Observation and assignment in a medical school, dental school, hospital, regulatory agency, or industrial department. May be repeated for a maximum of two credits.

Appendix 3

College of Engineering and Science, Centers, Alliances and Affiliated Institutes

Bioengineering Alliance of South Carolina
Dr. Richard Swaja, Director
BSB 612, Medical Univ. of South Carolina, 171 Ashley Ave., Charleston, SC 29425
(Voice) 843-792-0430; swajar@musc.edu

National Brick Research Center
Dr. Denis Brosnan, Director
The Bishop Center, Clemson Research Park
(Voice) 656-0603; bdenis@clemson.edu

Center for Advanced Engineering Fibers and Films (CAEFF)
Dr. Amod A. Ogale, Director
203 Earle Hall
(Voice) 656-5483; ogale@clemson.edu

Construction Industry Cooperative Alliance (CICA)
Dr. Steve Sanders, Director
114 Lowry Hall
(Voice) 656-3661; steves@clemson.edu

Center for Research in Wireless Communication
Dr. Wilson Pearson
301 Fluor Daniel Building
(Voice) 656-3946; PL@clemson.edu

Center for Optical Materials Science and Engineering Technologies (COMSET)
Dr. John Ballato, Director
AMRL, 91 Technology Dr., Clemson Res. Park
(Voice) 656-1035; jballat@clemson.edu

CU Electrical Power Research Association (CUEPRA)
Dr. Adly A. Girgis, Director
303 Riggs Hall
(Voice) 656-5936; adly.girgis@ces.clemson.edu

Center of Excellence in Mathematics & Science Education (CEMSE)
Dr. Calvin Williams
Mathematical Sciences, O323 Martin Hall
(Voice) 656-5241; CALVINW@CLEMSON.EDU

Center for Advanced Materials for Thermoelectric Energy Conversion (CAMTEC)
Dr. Terry Tritt, Director
103 Kinard Lab
(Voice) 656-5319; ttritt@clemson.edu

Conservation Center

Dr. Michael J. Drews, Director
268 Sirrine Hall
(Voice) 656-5955; DMICHAE@CLEMSON.EDU

Laboratory for Emerging Materials

Dr. Ya-Ping Sun, Director
469 Hunter
(Voice) 656-5026; syaping@clemson.edu

Nuclear Environmental Sciences and Radiation Waste Management (NESRWM)

Robert Fjeld, Director
166 Rich Lab/Research Park
(Voice) 656-5569; FJELD@clemson.edu

SC COBRE Center of Biomaterials for Tissue Regeneration (SCBioMat)

Dr. Naren Vyavahare, Director
501 Rhodes Research Center
(Voice) 864-656-5558; narenv@clemson.edu

Affiliated Institutes

Campbell Graduate Engineering Center (CGEC)

Dr. Imtiaz Haque, Executive Director
Campbell Graduate Engineering Center @ CU-ICAR
4 Research Dr., Greenville, SC 29607
(Voice) 864-283-7212; sih@clemson.edu

Automotive Safety Research Institute (CU-ASRI)

Kim E. Alexander
D141 Poole AG Center
(Voice) 656-0664; KALXNDR@CLEMSON.EDU

Institute of Biological Interfaces of Engineering

Dr. Karen J. L. Burg, Director
401 Rhodes
(Voice) 656-6462; KBURG@CLEMSON.EDU

South Carolina's Coalition for Mathematics and Science

Dr. Tom Peters, Director
Sears House #3, Highway 93
(Voice) 656-1863; tpeters@ssi.edc.org

Clemson Engineering Technology Lab (CETL)

Donald L. Erich
100 Technology Dr., Research Park, Pendleton, SC
(Voice) 646-2413; derich@clemson.edu

Clemson University International Center for Automotive Research

Robert T. Geolas
CU-ICAR, 10 Falcon Crest Dr., Greenville, SC 29603
(Voice) (864) 298-2292; GEOLAS@CLEMSON.EDU

Clemson Apparel Research (CAR)

Dr. Christine W. Cole, Director
500 Lebanon Road, Pendleton, SC 29670
(Voice) 646-8454; cwjrv@clemson.edu

SC Institute for Energy Studies (SCIES)

Dr. Robert Leitner, Director
200 Dillard Building, 400 Klugh Ave., Clemson, SC 29634
(Voice) 656-2267; RLEITNE@CLEMSON.EDU

Supply Chain Optimization and Logistics (CISCOL)

Dr. William G. Ferrell, Jr.
200 Freeman Hall
(Voice) 656-2724; FWILLIA@CLEMSON.EDU

Institute for Modeling and Simulation Applications

Dr. Steve (Dennis E.) Stevenson, Director
442 Edwards Hall
(Voice) 656-5880; STEVE@clemson.edu

Clemson Environmental Institute (CIES)

Dr. Alan Elzerman
Rich Lab, Clemson Research Park
(Voice) 656-5568; AWLZRMN@CLEMSON.EDU

Clemson Institute for Biomedical Science and Engineering

Dr. Martine LaBerge
301 Rhodes
(Voice) 656-5557; LABERGE @CLEMSON.EDU

Center for Motorsports Excellence

Dr. Thomas Kurfess, Director
4 Research Dr., Greenville, SC 29617
(Voice) (864)283-7219; kurfess@clemson.edu

Clemson University Computational Center for Mobility Systems
Dr. James Leylek, Executive Director
74 Research Dr., CU-ICAR Campus, Greenville, SC 29607
(Voice) (864) 283-7300; jleylek@clemson.edu

Appendix 4 BioE Faculty Research Interests

LC Call Number	LC Subject Headings	Keyword	Faculty
R856-7	**bioengineering**	bioengineering	all
TA164	**biomedical engineering**	biomedical engineering	
QH431	**genetic engineering**	gene manipulation	Dan Simionescu
T59.7	human engineering	systems integration by energy design	Richard Figliola
	systems engineering	engineering and machine design	Desjardins
R857.M3	**biomedical materials**	biomaterials	Burg, Latour, Metters
	biomedical materials--design	biomedical design	Zhang, LaBerge
	bioactive compounds	biomaterials tribology	Desjardins, LaBerge
		polymeric biomaterials	Vyavahare
		in-vivo performance of biomaterials	
		biomaterials implantology	
		cardiovascular biomaterials	A. Simionescu
		ECM-derived cardiovascular biomaterials	Ramamurthi
		smart materials for biomedical applications	Vertegel
		cardiovascular biomaterials	
QP525	Colloids	degradable hydrogels	Metters
R857	polymers in medicine	synthetic and biopolymers as biomaterials	Vyavahare
		polymeric biomaterials	Metters
		biopolymers, absorbable polymers	Burg, Ramamurthi
		hyaluronan-based biopolymers	Ramamurthi
TP968	cyanoacrylates	drug-loaded cyanoacrylate tissue adhesives	Lee
		living-radical polymerizations	Metters
TJ1075	tribology	tribology, biomaterials tribology	John Desjardins
TA418.9.N35	**Nanostructured materials**	bionanomaterials	Vertegel
		biological nanomaterials	Dean
R857 .M3	**biocompatibility**	biomaterial compatibility	D. Simionescu
	metals in the body--biocompatibility	blood-material interaction	Ramamurthi
	(material)--biocompatibility		
	biomedical materials--toxicology		
	histocompatibilty		
QH499	**Regeneration (Biology)**	regenerative medicine	Wen
		patient-tailored regenerative medicine	A. and D. Simionescu
QH604.2	**cell interaction**	cell-surface interaction	Webb
		cell-cell interaction	Ramamurthi, Dean
		cell-cell interaction in a microengineered environment	Gao
		cell-matrix interaction	Ramamurthi, Dean
		ECM-cell interactions	Vyavahare
QH604-604.5	cellular control mechanisms	cell mechanics, cell mechanics modeling	Dean

QH623	cell adhesion	cell adhesion	Burg
QR96.8	bacteria--adhesion	bacterial adhesion	Kang
QR77.35	bacterial cell surfaces	cardiac and stem cell mechanics	Dean
QH588.S83	stem cells	stem cell plasticity, stem cell biology	Zhang, Wen
QH607	cell differentiation	adult stem cell differentiation into cardiac cells	Gao
QH585.2-.45	**cell culture**	cell printing, organ printing	Boland
QP551	Protein Array analysis	protein printing	Boland
	proteins--analysis		
QP517	protein binding	thermodynamics of protein-surface and protein-cell interactions	Bob Latour
TP248.27	recombinant proteins	Bioprocessing of Recombinant Organisms	Harcum
QH450.6	post-translational modification	protein glycosylation	Harcum
RD94	**wound healing**	wound healing, tissue scaffolds	Webb
		biomaterials-centered infections	Kang
RS210	**drug delivery devices**	nitric oxide delivery system	Metters
RS201.P75	polymeric drug delivery systems	Polymeric micelle nanoparticle system for drug/gene delivery	Lee
RS195.5-210	drug delivery systems	controlled drug delivery	Metters
		colon-specific drug delivery system;	Lee
		drug/gene site specific delivery	Vyavahare
R857 .T55	**tissue engineering**	tissue engineering,	all
		functional tissue engineering,	Nagatomi
		MRI for tissue engineering,	Burg
		diabetes tissue engineering,	A. Simionescu
		drug-loaded cyanoacrylate tissue adhesives,	
		cardio- and vascular tissue	Ramamurthi
		constitutive modeling of biological tissues	Yao
		transport phenomena in biological tissues	Yao
QP105	**cardiovascular system**	multi-scale modeling of single ventricle hearts	Figliola
	hemodynamics--mathematical models	pulmonary prosthetic valve evaluation and design	Figliola
RD598.55	blood vessel prosthesis		
RD598	cardiovascular instruments, implanted	cardiovascular implants	Vyavahare
RD598.5	vascular grafts	vascular engineering	Laberge
RC666-701	cardiovascular system--diseases	cardiovascular pathology	D. Simionescu
RK667.I45	**dental implants**	dental tissue engineering devices	Burg
QP371-376	spinal cord	spinal mechanics	classes
QP517.S87	biological interfaces	biointerfaces	Boland
QR180-189.5	Immunology	Applied immunology	A. Simionescu
QH513	**biomechanics**	biomechanics	Benson, LaBerge
QP301-321	human mechanics	biomechanics of tissue/implants, tissue/implant	Jiro Nagatomi

		interface,	
		musculoskeletal biomechanics	Benson, Nagatomi
		orthopedic biomechanics	Desjardins
		mechanobiology	Nagatomi
		implant biomechanics	Latour
QP88.2	bones--mechanical properties	wear and lubrication of joints	classes
RD686	**artificial joints**		classes
RD549	total hip replacement		classes
RD549	artificial hip joints		classes
RD561	artificial knee		classes
RD561	total knee replacement		classes
RD686	arthroplasty	total joint replacement simulation	John Desjardins
RD755.5	orthopedic implants	orthopedic engineering	Desjardins
RD734-	Orthopedics--diagnosis	orthopedic pathology	Desjardins
R857	**prosthesis, artificial organs**	prosthetics	classes
RD130	artificial organs	CAD/CAM-based custom prosthetic design	classes
R8560858	medical instruments and apparatus	medical devices	Laberge
QH323.5	**bioinformatics**	biomolecular modeling	Dean, Dooley, Kara
		computational modeling	Dean, Dooley
		bio-neuro informatics	Kara
TK7882.I6	information visualization	Scientific visualization	Larry Dooley
QH324	biological apparatus and supplies	bioinstrumentation	
QP356	molecular neurobiology	neurobioengineering	Prakash Kara
		visual neuroscience	Kara
		brain plasticity	Kara
QH515	photobiology, photonics	biophotonics	
QP517	bioelectrochemistry	bioelectrical engineering, bioelectric devices	Alexy Vertegel
QH212.A78	atomic force microscopy,	atomic force microscopy,	Boland
QH212.S32	scanning probe microcopy	scanning probe microcopy	Vertegel
QP519.5.L37	laser spectroscopy	two-photon microscopy	Kara
TS171.4	rapid prototyping	stereolithography	Dooley
	prototypes, engineering	prototyping	Dooley
QP105	**fluid mechanics**	biofluid mechanics	Richard Figliola
RC669	cardiovascular system--mechanical properties		
R857.O6	**Imaging systems in medicine**	optical imaging techniques for biomedical applications	Gao
R857.L37	lasers in medicine	programmable laser cell micropatterning system	Gao
		laser interactions with cells/tissues	Gao
QC373.O59	optical detectors		classes
RC78.7.D53	diagnostic imaging		classes

QA275	error analysis, mathematics	error analysis	Figliola
TP248.27	recombinant proteins	Bioprocessing of Recombinant Organisms	Harcum
QH450.6	post-translational modification	protein glycosylation	Harcum
QL55	animal models in research	orthopaedic animal models and related histology and biomechanics;	Kang
RJ482.C35	cartilage diseases	cartilage repair	Qian Kay Kang
QP88.2	cartilage		
QP491	visual perception	binocular disparity	Kara
QP341	electrophysiology	multi-site and multi-electrode electrophysiology	Kara
QP517	computational biology	Computational-chemistry based biomolecular modeling;	Bob Latour
SF757.8	veterinary diagnostic imaging	Small animal imaging	Yao
	self-assembly (Chemistry)	biologically-inspired self-assembly	Vertegel
R857.H64	holography in medicine	early detection of oral cancers using digital holography	Gao
R857	biosensors	biomedical biosensors, whole cell biosensors for neurotoxicity testing	Guiseppi-Elie
QP624.5.D726	DNA microarrays	prognostic and diagnostic DNA biochips	Guiseppi-Elie

Appendix 5 Important BioE Journals

Journal Title	Holdings	Faculty Publish
AATCC REVIEW	2001-date print	2
Acta Biomaterialia	2005-date, Science Direct	2
Advanced Drug Delivery Reviews	1995-date, Science Direct	1
ADVANCED FUNCTIONAL MATERIALS	2001-date, Wiley	1
ADVANCED MATERIALS	**1998-date, Wiley**	**1**
ADVANCED MATERIALS & PROCESSES	**1994-date, several publishers**	**2**
American Journal of Pathology	1925-date, several	4
Anatomical Record	2007-date	2
ANNALS OF BIOMEDICAL ENGINEERING	**1972-date, several publishers**	**3**
ANNUAL REVIEW OF BIOMEDICAL ENGINEERING	1999-date, several publishers	
APPLIED BIOCHEMISTRY AND BIOTECHNOLOGY	1996-date, several publishers	5
APPLIED OPTICS	1962-date, several publishers	1
APPLIED PHYSICS LETTERS	1962-date, several publishers	2
ARCHIV DER PHARMAZIE	1998-date, Wiley	
ARTIFICIAL CELLS BLOOD SUBSTITUTES AND BIOTECHNOLOGY	2001-date, several publishers	
ARTIFICIAL INTELLIGENCE IN MEDICINE	1995-date, Science Direct	
ARTIFICIAL ORGANS	**1997-date, several publishers**	
ASAIO JOURNAL	Can't tell date range	
ASTM Special Technical Publications	ASTM Digital Library	1
Biochemical and Biophysical Research Communications	**1995-date, AP Ideal**	**1**
BIOMACROMOLECULES	**2000-date, ACS**	**7**
BIOMATERIALS	**1995-date, Science Direct**	**26**
Biomechanics and Modeling in Mechanobiology	2002-date, Springer	1
Biomedical Engineering Online	1997-date, Springer	
BIO-MEDICAL MATERIALS AND ENGINEERING	1997-9 months ago, Acad. Search Prem.	
BIOMEDICAL MICRODEVICES	1998-date, Springer	3
BIOORGANIC & MEDICINAL CHEMISTRY	1995-date, Science Direct	
BIOORGANIC & MEDICINAL CHEMISTRY LETTERS	1995-date, Science Direct	
BIOTECHNOLOGY AND BIOENGINEERING	**1996-date, Wiley**	**4**
Biotechnology Journal	2006-date, Science Direct	2
BIOTECHNOLOGY PROGRESS	1990-date, several publishers	3
Brain Research Brain / Research Reviews	1995-date, Science Direct	1
Cardiovascular Pathology	1995-date, Science Direct	1
CHEMBIOCHEM	2000-date, Wiley	
CHEMICAL & PHARMACEUTICAL BULLETIN	1958-date	
CHEMICAL RESEARCH IN TOXICOLOGY	1988-date, ACS	
CHIRALITY	1996-date	
Circulation	1950-date, HighWire Press	2
CLINICAL BIOMECHANICS	1995-date, Science Direct	

CLINICAL ORAL IMPLANTS RESEARCH	1997-date, Blackwell	
COMPUTER METHODS AND PROGRAMS IN BIOMEDICINE	1995-date, Science Direct	
COMPUTER METHODS IN BIOMECHANICS AND BIOMEDICAL ENGINEERING	**1997-date, Science Direct**	
COMPUTERS IN BIOLOGY AND MEDICINE	1995-date, Science Direct	
CURRENT MEDICINAL CHEMISTRY	2000-date, Acad. Search Premier	
CURRENT TOPICS IN MEDICINAL CHEMISTRY	2001-a year ago	
DRUG DEVELOPMENT AND INDUSTRIAL PHARMACY	1999-a year ago	
DRUG DEVELOPMENT RESEARCH	1996-date, Wiley	
EUROPEAN JOURNAL OF MEDICINAL CHEMISTRY	1995-date, Science Direct	
FITOTERAPIA	1999-date, Science Direct	
IEEE ENGINEERING IN MEDICINE AND BIOLOGY MAGAZINE	IEEE Xplore	1
IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING	**IEEE Xplore**	
IEEE TRANSACTIONS ON MEDICAL IMAGING	**IEEE Xplore**	
IEEE TRANSACTIONS ON NEURAL SYSTEMS AND REHABILITATION ENGINEERING	IEEE Xplore	
ISOKINETICS AND EXERCISE SCIENCE	1998-a year ago, Health Source	
JOURNAL OF APPLIED BIOMECHANICS	**2003-date, print**	
JOURNAL OF APPLIED POLYMER SCIENCE	1959-date, Wiley	1
JOURNAL OF ASIAN NATURAL PRODUCTS RESEARCH	1998-date, several publishers	
JOURNAL OF BIOMATERIALS SCIENCE-POLYMER EDITION	**1999-date**	**3**
JOURNAL OF BIOMECHANICAL ENGINEERING-TRANSACTIONS OF THE ASME	**1980-date, ASME**	**3**
JOURNAL OF BIOMECHANICS	**1995-date, Science Direct**	**2**
JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART A	**2003-date, Wiley**	**23**
JOURNAL OF BIOMEDICAL MATERIALS RESEARCH PART B-APPLIED BIOMATERIALS	2003-date, Wiley	7
JOURNAL OF BIOTECHNOLOGY	**1995-date, Science Direct**	**2**
Journal of Chemical Physics	1933-date, several publishers	2
Journal of Colloid Interface Science	1995-date, several publishers	1
JOURNAL OF COMBINATORIAL CHEMISTRY	1999-date, ACS	
Journal of Computational Chemistry	1996-date, Wiley	1
Journal of Controlled Release	1995-date, Science Direct	2
Journal of Drug Targeting	1997-date, Informaworld	1
JOURNAL OF DYNAMIC SYSTEMS MEASUREMENT AND CONTROL-TRANS. OF THE ASME	1980-date, several publishers	1
Journal of Endovascular Therapy	2004-date, several publishers	1
JOURNAL OF ENZYME INHIBITION AND MEDICINAL CHEMISTRY	2001-a year ago, Academic Search Prem.	
JOURNAL OF ETHNOPHARMACOLOGY	1995-date, Science Direct	
Journal of Industrial Microbiology and Biotechnology	1997-date, Springer	1
JOURNAL OF LABELLED COMPOUNDS & RADIOPHARMACEUTICALS	1996-date, Wiley	
Journal of Macromolecular Science Part A-Pure and Applied Chemistry	1997-date, several publishers	1

JOURNAL OF MANUFACTURING SCIENCE AND ENGINEERING-TRANS. OF THE ASME	1996-date, several publishers	1
Journal of Mechanics in Medicine and Biology	2001-a year ago	
Journal of Medical Devices	2007-date, ASME	
JOURNAL OF MEDICINAL CHEMISTRY	1959-date, ACS	
JOURNAL OF MEDICINAL FOOD	1988-date, several publishers	
JOURNAL OF MICROMECHANICS AND MICROENGINEERING	1991-date, several publishers	1
JOURNAL OF MOLECULAR CATALYSIS B-ENZYMATIC	1995-date, Science Direct	1
JOURNAL OF NANOSCIENCE AND NANOTECHNOLOGY	2008-date, print	1
Journal of Nanotechnology in Engineering and Medicine	2010-date, ASME	
Journal of Natural Medicines	2006-date, Springer	
JOURNAL OF NATURAL PRODUCTS	1979-date, ACS	
Journal of Neural Engineering	2004-date, Inst. Of Physics	
Journal of Neuro Engineering and Rehabilitation	2004-date, PubMed	
JOURNAL OF ORTHOPAEDIC RESEARCH	1996-date, Wiley	1
Journal of Orthopedic Surgery and Research	2006-date, PubMed	1
JOURNAL OF PHARMACEUTICAL SCIENCES	1996-date, Wiley	
Journal of Physical Chemistry B	1997-date, ACS	1
JOURNAL OF POLYMER SCIENCE PART A-POLYMER CHEMISTRY	1966-date, several publishers	1
Journal of Rehabilitation Research and Development	1990-date, several publishers	1
JOURNAL OF SUPERCRITICAL FLUIDS	1995-date, Science Direct	2
Journal of the Electrochemical Society	1948-date, E. Society Digital Library	1
Journal of Tissue Engineering and Regenerative Medicine	2007-date, Wiley	6
JOURNAL OF TRIBOLOGY-TRANSACTIONS OF THE ASME	1984-date, several publishers	1
Langmuir	**1985-date, ACS**	**14**
LASERS IN MEDICAL SCIENCE	1997-date, Springer	
Letters in Drug Design & Discovery	2004-a year ago, Academic Search Prem.	
MACROMOLECULAR BIOSCIENCE	2001-date, Wiley	1
MACROMOLECULES	1968-date, ACS	6
Marine Drugs	2007-date, PubMed	
MEDICAL & BIOLOGICAL ENGINEERING & COMPUTING	1999-date	
MEDICAL ENGINEERING & PHYSICS	**1995-date, Science Direct**	
MEDICAL IMAGE ANALYSIS	1996-date, Science Direct	
MEDICINAL CHEMISTRY RESEARCH	2004-date, Springer	
MEDICINAL RESEARCH REVIEWS	1996-date, Wiley	
METABOLIC ENGINEERING	**1999-date, Academic Press**	**2**
MINI-REVIEWS IN MEDICINAL CHEMISTRY	2001-a year ago, Academic Search Premier	
NATURAL PRODUCT REPORTS	1984-date, ACS	
NATURAL PRODUCT RESEARCH	2003-date, Informaworld	
OPTICS EXPRESS	1997-date, Optics InfoBase	1

OPTICS LETTERS	1997-date, Optics InfoBase	1
Osteoporosis International	1997-date, Springer	1
Pharmaceutical Research	1997-date, Springer	1
PHYSICS IN MEDICINE AND BIOLOGY	1956-date, several publishers	
Physiological Genomics	1999-date, several publishers	1
PHYSIOLOGICAL MEASUREMENT	1993-date, several publishers	
PHYTOMEDICINE	2001-date, several publishers	
POLYMER	1960-date, Science Direct	1
PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS PART H-JOURNAL OF NANOENGINEERING...	1989-date, IMechE	11
Protein Expression and Purification	1995-date, Academic Press	1
QSAR & COMBINATORIAL SCIENCE	2003-date, Wiley	
Science	1880-date, several publishers	1
Sports Biomechanics	2002-date, Informaworld	
Tissue Engineering Part A	**1995-date, several publishers**	**4**
Tissue Engineering Part B	2008-date, several publishers	1
TRENDS IN BIOTECHNOLOGY	**1995-date, Science Direct**	**1**
TRIBOLOGY INTERNATIONAL	1995-date, Science Direct	1
Urology	1995-date, Science Direct	1
WEAR	1957-date, Science Direct	2
Zoology	2001-date, Science Direct	1
Titles taken from Journal Citation Reports (JCR), 2008 Sciences, published by Thomson Scientific. Filtered for Bioengineering topics. (titles in bold are listed in ***Magazines for Libraries***)		

Appendix 6

"Core" Journal Packages –Engineering

General

Elsevier (Science Direct)

Springer

Wiley-Blackwell

Professional Societies

ACM Digital Library

ASCE Digital Library

ASME Digital Library

IEEE / IET – IEEE Xplore

SAE Digital Library

SPIE Digital Library

Professional Societies (Great Britain)

ICE – Institution of Civil Engineers

IMechE – Institution of Mechanical Engineers

Specific to Bioengineering

American Society of Agricultural and Biological Engineers (ASABE)

American Society of Biomechanics

Biomedical Engineering Society

IEEE / Engineering in Medicine and Biology Society

Orthopaedic Research Society

Society for Biomaterials

"Core" Databases

General

Engineering Village (Compendex, Historical Engineering Index, and Inspec)

Web of Knowledge (Science Citation Index, Inspec)

Scifinder Scholar (Chemical Abstracts)

Medline (from EBSCO) plus PubMed (free, from the National Library of Medicine)

Refworks (Bibliographic Citation Management package)