

# BIOMATERIALS (BIOMS-DN)

## BIOMS-DN 1000 Principles of Biomaterials Science (3 Credits)

*Typically offered Fall*

The course introduces students to the different basic aspects of materials science, chemistry, and engineering. Biomaterials have direct impact on modern society, and its ability to develop and use biomaterials is a measure of its technical sophistication and technological future. The lectures emphasize the theoretical background of all materials classes utilized in the most common engineering applications while assignments represent real-life problems in application of materials testing and characterization. This course prepares students for later, more specific biomaterials courses in our inventory.

**Grading:** Dental Graded

**Repeatable for additional credit:** No

## BIOMS-DN 1001 Metal and Ceramic Biomaterials (3 Credits)

*Typically offered Spring*

Covers the structure and properties of metals, alloys, and ceramics generally used in dentistry and medicine and their criteria for clinical applications. Also discusses fundamental processes involving deformation, precipitation, order-disorder transformations, principles involving phase diagrams, recent advances in the development of titanium and other alloys for dental and orthopedic implants, low golds, and nonprecious alloys, and development of advanced ceramics.

**Grading:** Dental Graded

**Repeatable for additional credit:** No

## BIOMS-DN 1002 Polymers & Biopolymers (3 Credits)

*Typically offered Spring*

The word polymer comes from the Greek words "poly", meaning many, and "mer", meaning parts. Like the macrostructures we see every day, such as a house built of brick, the larger structures of polymers have very different properties from their smaller chemical building blocks. The uniqueness of polymer and biopolymers properties provide most of the materials we interact with on a regular basis, including our clothes, plastics, paper, adhesives, and even our bodies themselves. Through this interdisciplinary course, students will obtain basic knowledge related to polymers, biopolymers and biosensors. The course will cover the chemistry, structure, and properties of polymers/biopolymers used in dentistry and medicine. Topics include the science of large macromolecules, molecular weights and measurements, polymerization mechanisms, mechanical properties of polymers, thermoplastic and thermosetting resins, chemistry of emulsion and suspension polymerization, polymers associated with restorative materials, ionic polymers, silicones, polymethylmethacrylate, reinforced polymers, and composites.

**Grading:** Dental Graded

**Repeatable for additional credit:** No

## BIOMS-DN 1003 Bioceramics (3 Credits)

Covers the preparation, structure, chemical compositions, and thermal and mechanical properties of crystalline and glassy phases of ceramics used in dentistry and medicine.

**Grading:** Dental Graded

**Repeatable for additional credit:** No

## BIOMS-DN 1004 Testing Methods in Biomaterials (3 Credits)

Covers the principles governing tensile tests, compressive tests, creep tests, thermal and setting expansions, corrosion and tarnish tests, microstructural examination, and familiarization with the testing and use of instruments.

**Grading:** Dental Graded

**Repeatable for additional credit:** No

## BIOMS-DN 1005 Biomaterials -- Tissue Interface I (3 Credits)

*Typically offered Fall*

Covers the basic interaction between biomaterials and tissues, as related to the body's response to medical devices. The first semester of this course covers basic properties of this response. This includes the basic microstructure and mechanical properties of soft and hard tissues, healing of tissues after surgery, pertinent surface properties of biomaterials, and early events after surgical implantation of a medical device. These include protein interactions with material surfaces, cell response with surfaces, and new tissue formation at the biomaterial/tissue interface.

**Grading:** Dental Graded

**Repeatable for additional credit:** No

## BIOMS-DN 1006 Biomaterials -- Tissue Interface II (3 Credits)

*Typically offered Spring*

Builds upon the basics of tissue healing and cell and tissue response to biomaterials from BIOM-DN 1005. In semester two, the general rules for biomaterial use in medical devices in various fields from orthopaedics to cardiovascular will be discussed. Several types and applications of tissue engineering, drug delivery, and lab-on-a-chip technology will also be covered. In general, in this class the myriad of ways that different biomaterials can be applied in different fields will be discussed. Various types of device failures and their mechanisms will also be discussed.

**Grading:** Dental Graded

**Repeatable for additional credit:** No

## BIOMS-DN 1007 Degradation of Biomaterials (2 Credits)

Covers the principles and testing of in vivo and in vitro corrosion. Describes electrochemical mechanisms, corrosion tendency and electrode potentials polarization and corrosion rates, passivity, and crevice corrosion. Also discusses testing methods involving anodic potentiostatic and potentiodynamic polarization techniques, stress corrosion cracking, intergranular corrosion, corrosion fatigue, oxidation and tarnish phenomena, and principles governing corrosion-resistant alloy development.

**Grading:** Dental Graded

**Repeatable for additional credit:** No

## BIOMS-DN 1008 Intro to Electron Microscopy (3 Credits)

*Typically offered Fall*

Covers the theory and practical use of electron microscopy, in this case scanning electron microscopy (SEM), which is extensively used in biomaterials research. The course covers the basic physics of the electron microscope, electron interactions with samples of different types, use of different detectors to gain different types of information, and processing of all types of samples, from metals to biologic specimens. The course progresses from lectures on the theory and use of the microscopes, to supervised use in the lab, after which the students are approved to run the equipment on their own. They then begin to schedule their own time on the microscope and begin work on their individual projects. The final evaluation in the course is based on a combination of a final exam and an independent project, done partially with faculty supervision, and partly on an independent basis.

**Grading:** Dental Graded

**Repeatable for additional credit:** No

**BIOMS-DN 1011 Physical & Chemical Methods in Biomaterials (3 Credits)***Typically offered Fall*

Physical and Chemical Methods in Biomaterials is a laboratory course that comprises, learning the use of multiple equipment and analytical tools in research and in some cases hands-on experience that includes XRD, MicroCT, 3D printer, ICP, imaging, Universal testing machine, biosensors, cell culture, and more. Most relevant techniques in biomaterials research are covered in this course, and it is designed to assist students who are doing active research. Course grade determination is based on the student's participation and a final exam (Pass/Fail)

**Grading:** Dental Pass/Fail**Repeatable for additional credit:** No**BIOMS-DN 1012 Biostatistics I (3 Credits)***Typically offered Spring*

Combined with CLSCI-DN.7040 Biostatistics is a rigorous, 15-week course consisting of 13 lectures, a midterm, and a final exam. It covers basic probability, descriptive and inferential statistics, and the role of biostatistics in the practice of clinical research. Specific attention will be given to common probability distributions in clinical research and medicine, t-tests, Analysis of Variance, multiple linear and logistic regression, categorical data analysis, and survival analysis. Statistical topics are presented conceptually with little derivation, and applications are demonstrated using common statistical software.

**Grading:** Dental Graded**Repeatable for additional credit:** Yes**BIOMS-DN 1013 Biostatistics II (3 Credits)**

Covers mathematical and statistical tools that are useful in biomaterials research. Trains students to (1) evaluate the technical and economic feasibility of a study; (2) design research protocols taking into account required statistical power and sample size; (3) use appropriate statistical analysis tools; and (4) interpret the significance of the experimental results. Also covers reliability, life testing, and Weibull analysis.

**Grading:** Dental Graded**Repeatable for additional credit:** No**BIOMS-DN 1015 Seminar in Biomaterials (3 Credits)**

Covers aspects of the materials used in clinical dentistry and medicine including restorative materials, alloys, cements, impression materials, gypsum products, and cell-biomaterial interactions.

**Grading:** Dental Graded**Repeatable for additional credit:** Yes**BIOMS-DN 1016 Imaging Science (4 Credits)***Typically offered Fall*

This course is about the science and practice of using microscopes and it examines the (human) capacity to form images with aesthetic, technological, and existential purpose in mind. Our objective will be to ask and answer such questions as: How does the eye-brain complex form images, how a microscope works, and what we must do to provide the highest scientific and aesthetic content in our images that our experience allows. The science of imaging, and goal of this course, concerns how to manipulate microscope hardware and software to answer these questions.

**Grading:** Dental Graded**Repeatable for additional credit:** No**BIOMS-DN 1017 Complex Materials Systems and Biosensors (3 Credits)***Typically offered Spring*

Many structural and biomedical components encounter service conditions that require complex materials performance to vary with location within the component. The design, development and use of complex materials is essential for many important medical and dental applications. The study of complex materials requires an understanding of the materials science and engineering themes while at the same time creating a knowledge bridge to biology and medicine/dentistry. Conventional design using monolithic materials often fail to meet the stringent medical/dental application demands. Similarly, the maintenance and optimization of human health requires individuals and their healthcare providers from time to time to complete complex clinical tests. This course offers graduate students a comprehensive study of structure- function-property relationships in complex materials including composites across a broad range of applications. A background in complex materials design is provided, including multiphase metal, ceramic and polymer systems. This background is supplemented by study of the interactions between micro, meso and macro structures within several biological structures as a basis for biomimetic materials design. Several lecturers from a broad range of disciplines give presentations in this integrated course. Further, the course will include recent advances in biosensors, nano-devices and biomedical microsystems with particular emphasis on those clinical measurements that are tied to human health. Collectively, these lectures will provide students with a modern understanding of both complex materials and how these can impact the lives of patients and providers alike as well as complex biosensor systems and their impact on human health.

**Grading:** Dental Graded**Repeatable for additional credit:** No**BIOMS-DN 2000 Readings in Biomaterials and Biomimetics (1-2 Credits)***Typically offered Fall and Spring*

Readings in Biomaterials Science is a 1 credit independent study course. Students taking this course will review current literature on an advanced biomaterials-related topic and summarize this literature in report form consistent with a review paper. The topic is to be determined by the student in conjunction with one of the faculty members in the Division of Biomaterials who will act as a mentor on the project. Students are encouraged to interact extensively with their mentors on this project. They are encouraged to choose an advanced topic that is current and specific in scope so that the numbers of available references are manageable. Broad topics are discouraged. According to accreditation guidelines a 1-credit independent study course should represent at least 25 hours of total preparation time – a combination of literature survey, review, and report writing. All submitted work must be original and submitted reports and presentations will be graded according to the 25-hour standard. Note: This course may be taken up to four times during the student's participation in the Masters program.

**Grading:** Dental Graded**Repeatable for additional credit:** Yes

**BIOMS-DN 2001 Intro to Research (2 Credits)***Typically offered Fall*

This course covers the basic skills and knowledge necessary to complete the masters degree in Biomaterials Science. There are two parts to this course. The first part comprises a skill set including training in how to prepare abstracts and research papers, use of EndNote software, how to prepare PowerPoint presentations, and how to prepare a research protocol. The second part of the course is a series of lectures by departmental faculty on their individual areas of research and specific ongoing projects. The emphasis here is on how this research is driven by specific protocols and hypotheses. It is also designed to inform the students of the ongoing projects that may be options for research projects or thesis projects. The final project in this course involves preparation and presentation of a mock research protocol.

**Grading:** Dental Graded**Repeatable for additional credit:** No**BIOMS-DN 3000 Research in Biomaterials (1-6 Credits)***Typically offered Fall and Spring*

These are research project credits taken by students who are actively working on research in a department laboratory. The number of credits depends on the number of hours spent on the research project. The project can be done in support of a thesis project or can be done for the research experience by students on the non-thesis option. One credit of research must equal or exceed 45 hours of independent study research time (1 credit = 3 hours per week x 15 weeks), and multiple credits represent multiples of this standard. Students are encouraged to complete research credits as part of their training.

**Grading:** Dental Pass/Fail**Repeatable for additional credit:** Yes**BIOMS-DN 3001 Independent Project in Biomaterial (2 Credits)***Typically offered Fall and Spring*

Independent Projects in Biomaterials Science is a 2-credit independent study course meant to be the capstone project, or the final course and project completed by students in the non-thesis option Masters in Biomaterials Science program. Students taking this course will review current literature on an advanced biomaterials-related topic and summarize this literature in the form of a written literature review. The topic is to be determined by the student in conjunction with one or more of the faculty members in the Division of Biomaterials who will act as a mentor or mentors on the project. Students are encouraged to interact extensively with their mentors on this project. They are encouraged to choose an advanced topic that is current and specific in scope so that the numbers of available references are manageable. Broad topics are discouraged. Students that are actively working on research project (and taking research credits) can combine their research and a related literature survey for this project. According to accreditation guidelines a 2-credit independent study course should represent 50 hours of total preparation time — a combination of literature survey, review, and report writing. If research work, in the form of research credits, are also part of this project, these are to be evaluated separately, although the results may be used in the capstone project. All submitted work must be original and submitted reports and presentations will be graded according to the 50-hour standard. This will represent the final two credits to be completed for the non-thesis Masters Program options.

**Grading:** Dental Pass/Fail**Repeatable for additional credit:** No**BIOMS-DN 3003 Integrative Seminars in Oral Biology I (3 Credits)***Typically offered Fall*

Combined with BASCI-DN 8048 This course will introduce students to current topics in oral biology research, primarily focusing on the connection between oral diseases and systemic diseases and medical conditions. The aim of the course is to help students develop an integrated understanding of the current state of oral biological science by combining lectures, presentations, discussions, and critical reviews of scientific literature assigned by faculty members in their areas of expertise. Topics include periodontal disease, phage therapy, oral facial pain, tobacco, alcohol, e-cigarettes and cancer, some molecular and clinical characteristics of oral cancers, correlations between oral pathogens and chronic systemic inflammatory diseases, Sjogén's Disease.

**Grading:** Dental Graded**Repeatable for additional credit:** No**BIOMS-DN 3006 Bioethical Issues & IRB Skills (2 Credits)***Typically offered Spring*

Combined with CLSCI-DN.7080 This course explores issues about ethics, ethical reflection, and case studies that apply ethical principles and moral reflection to health care research using human participants. This course goes beyond the subjects at an introductory level and facilitates the development of independent effort in the resolution of ethical dilemmas. Moreover, students will gain knowledge about federal regulations and key documents that guide human subjects research in the U.S. and globally. Given that the students enrolled in the course provide a diversity of experience and career focus, the course will develop several lines of thought. There will be issues relate directly to the ethical aspects of research design, recruitment, and enrollment of subjects into projects. The course will use a textbook and case studies as vehicles to deepen understanding and perspectives about the use of human participants. The course includes special topics like confidentiality, decision-making, informed consent, using confidential information in research, and requirements of the Health Insurance Portability and Accountability Act (HIPAA).

**Grading:** Dental Graded**Repeatable for additional credit:** No**BIOMS-DN 3007 Scientific Writing: Protocols and Grants (3 Credits)***Typically offered Spring*

Combined with CLSC-DN.7090 This course will allow students in the Clinical Research program to gain the basic skills needed to be competent in writing a scientific paper or protocol for a clinical trial study. The course will focus on skills to write for scientific audiences and summarize a clinical research study, consisting of 1) an opening series of class presentations and discussions on the key component parts of a scientific protocol, grant, or paper as well as on grant writing and reviewing skills; 2) sessions in which students acquire skills in evaluating and formally reviewing written protocols or grants; and, 3) sessions which focus on skills in selecting a research topic and writing a protocol or paper for a scientific/research audience.

**Grading:** Dental Graded**Repeatable for additional credit:** No

**BIOMS-DN 3008 Epidemiology (3 Credits)**

*Typically offered Fall*

Combined with CLSCI-DN.8925 Epidemiology is the study of the distribution and determinants of health and disease in different human populations and the application of methods to improve disease outcomes. As such, epidemiology is the basic science of health.

This course is designed to introduce students in all fields of health and medicine to the background, basic principles, and methods of epidemiology. Topics include historical developments, principles of epidemiology, measures of mortality, study design, selection and information bias, confounding, effect modification and causal inference, screening, and outbreak investigations.

**Grading:** Dental Graded

**Repeatable for additional credit:** No

**BIOMS-DN 3010 Fundamentals of Clinical Trials (3 Credits)**

*Typically offered Fall*

Combined with CLSCI-DN.7030 Fundamentals of Clinical Trials I is a foundational course introducing students to randomized controlled trials (RCTs). The course covers basic elements of an RCT, formulation of research questions, study populations, power and sample size, randomization and masking, study recruitment and enrollment, industry and regulatory issues, safety and adverse events, compliance and monitoring, and data analysis.

**Grading:** Dental Graded

**Repeatable for additional credit:** No

**BIOMS-DN 3012 Seminars in Advanced Dental Biomaterials (3 Credits)**

This course introduces fundamental concepts of dental materials science. Lectures focus on restorative dental materials used for general dentistry, prosthodontics, and implant dentistry. The goals of the course are threefold: 1) to provide "fundamental knowledge" of dental materials used in general dentistry, 2) to translate mechanical principles to dental techniques and dental materials, and 3) to develop a critical reading of scientific reports in the research field of Dental Materials.

**Grading:** Dental Graded

**Repeatable for additional credit:** No

**BIOMS-DN 3013 Integrative Seminars in Oral Biology II (3 Credits)**

Combined with BASCI-DN 8049 This course introduces fundamental concepts of skeletal and craniofacial biology, particularly embryonic and adult skeletal and cartilage development. Topics covered are: understanding of craniofacial bone growth, tooth development, cartilage biology, endocrine regulation of the skeletal integrity, and skeletal biomechanical properties. The goals of the course are threefold: 1) to provide "fundamental knowledge" of skeletal and craniofacial growth and development, 2) to apply the principles of biologic processes to their clinical manifestations, and 3) to develop critical reading of scientific reports in the research field of hard tissues.

**Grading:** Dental Graded

**Repeatable for additional credit:** No