

University at Buffalo

GRADUATE DEGREE PROGRAM

Master of Science in Biomaterials

Graduate Degree Program

Quick Facts:

Biomaterials

- MS degree
- Duration of two to three years
- Requires completion of 30 credit hours and a masters thesis
- Provides comprehensive, interdisciplinary knowledge of prosthetic materials, from bio/surface and molecular interactions to device design and surgical requirements.

Biomaterials

Description

The interdisciplinary graduate program in Biomaterials is an outgrowth of a masters degree program in dental materials, sponsored by the School of Dental Medicine since 1971. Through policies established by the Graduate School of the University at Buffalo, courses and research topics have been developed to provide comprehensive knowledge of prosthetic materials, from biosurface and molecular interactions to device design and surgical requirements. Supporting themes include safe processing of biological materials and devices and global regulatory perspectives. The emphasis of the Biomaterials Program is on the application of materials to biomedical and dental engineering.

Following the Masters degree in Biomaterials, a doctoral program in a related field of specialization would be appropriate if the student is interested in further research training. Our former students have specialized in mechanical engineering, biophysics, immunology, pharmaceutical sciences, and other fields at our university and other universities. The Biomaterials Program is carefully articulated with the School of Engineering and Applied Sciences, the School of Medicine and Biomedical Sciences, and the Roswell Park Cancer Institute Graduate Division of UB, so that our graduates can smoothly move on to PhD programs in Mechanical Engineering and Biophysics. Students who do not wish to pursue advanced research training usually follow one of these career paths: a) working in the biomedical industry, b) entering a professional clinical program (DDS or MD program), or c) if they already are licensed clinicians, entering a post-graduate clinical specialty program.

Over the past 10 years graduates of our program have this profile: 10/24 are faculty members, 8/24 are practicing dentists, 3/24 employed in biomedical industry, and 6/24 are pursuing additional education.

Didactic Requirements/Offerings

Program Requirements

A minimum of 30 credit hours is required to complete the program, including research and preparation of a thesis:

- a) required "core" courses (10 credits)
- b) required seminar course each semester (2 credits total over 2 years)
- c) elective courses (6-12 credits), including lecture courses taken in other departments
- d) laboratory research and thesis (6-12 credits)

During the first year, students are required to complete 10 credit hours of core courses.

BMA 501 Biomaterials Science of Cell/Surface Contact Phenomena (3 cr, fall)

“Epigenetics” refers to living cell behavioral phenomena determined by factors beyond the genetic code. Living cells’ contacts with synthetic materials are clearly different as the materials’ surface properties change. The goal of this Course is to refine and build upon the student's prior knowledge of the basic properties of fabricated plastics (polymers), metals, ceramics, and natural substances, by adding a detailed understanding of contact interactions between living and nonliving substances, and their consequences for public and environmental health.

BMA 513 Polymeric Biomaterials (3 cr, fall)

This course familiarizes the student with the vocabulary, definitions, compositions, and unique features of natural and synthetic polymeric materials, so that (1) practical decisions can be made regarding "biocompatibility" of these materials in different circumstances and (2) research articles in the current biomaterials peer-reviewed literature can be perused, comprehended, and authoritatively critiqued by course participants.

BMA 520 Evaluation of Biomedical Materials (4 cr, spring)

This course serves a multidisciplinary group of students, assuming a starting level of Bachelor's degree knowledge. From that point, we will address (1) characteristics of specific materials used for various types of devices; (2) selection criteria based on function and longevity; (3) performance testing *in vitro* and *in vivo*; (4) evaluation of material breakdown in biological media, and potential toxicologic consequences; (5) design of clinical trials; (6) surgical considerations; and (7) ethical, regulatory, and legal issues. The course utilizes the student's primary field of expertise as a guide to specific topics of biomaterials evaluation. A "case study" midway through the course allows them to work together to actually design and promote a new implant device for an unmet medical need, with particular attention to regulatory requirements and market realities. They are encouraged to share their own expertise with the faculty and colleagues in the class.

During the first and second years of study, students must also enroll in BMA 507 Biomaterials Seminar (0.5 cr) during each semester for a total of 2 credits.

A minimum of 6 credits of elective courses must be taken to meet degree requirements usually beginning in the first year. Electives can be other BMA courses and/or graduates courses in other departments. Electives are best selected in consultation with the Director of the Biomaterials Graduate Program, and should be closely related to the student's interests and research goals. Courses in mechanical engineering and biophysics are encouraged. Recent popular electives include:

- BMA 502 Basic Aspects of Biomaterials Testing (3 cr)
- BMA 503 Regulatory Aspects of Medical Products (2 cr)
- ODS 603 Medical Biophysics (1 cr)
- OS 506 Oral Sciences: Biomaterials (1 cr)
- OS 512 Research Design in Oral Sciences (2 cr)
- OS 518 Statistical Methods in Oral Sciences (4 cr)

The summer preceding the second year of study is usually spent doing research with a faculty advisor. This work often forms the basis of the M.S. thesis. During the second and third year if necessary, students complete their thesis research, which must be reviewed by an expert Outside Reader before eligibility for a formal Oral Defense.

Recent Thesis Topics

Influence of surface coatings and surface-active liquid lubrication on cyclic fatigue of nickel-titanium rotary endodontic files in an artificial canal.

Influence of elastomeric seal plate surface chemistry on interface integrity in biofouling-prone systems: Evaluation of a hydrophobic easy-release silicone-epoxy coating for maintaining water seal integrity of a sliding neoprene/steel interface.

The recontamination of dental and surgical instruments by surgical smoke produced by lasers and electrosurgical devices.

Infrared microscope detection of particulate inclusions in tissues.

Photodynamic therapy as alternative treatment for disinfection of bacteria in oral biofilms.

The 24 graduates from the past ten years have published over 70 articles, abstracts and theses.

Faculty and Research Interests/Publications

Program Director:

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In addition to Dr. Robert Baier, Program Director and Dr. Anne Meyer, who are full-time faculty members providing required didactic training and program administration and research, part-time faculty contribute to the research activities of the students in the role of committee members or mentors for specific aspects of their research proposals. This is a diverse group of faculty coming from UB Departments of Restorative Dentistry, Oral Biology, Oral and Maxillofacial Surgery, Chemistry, and Periodontics and Endodontics. In the past five years, 12 additional faculty have served as committee members or research mentors. The additional departments represented include Geological Sciences, Pediatric and Community Dentistry, Oral Diagnostic Sciences, Anatomy and Pathology, and Physiology and Biophysics. The interdisciplinary nature of the Program is well demonstrated in this faculty and examples of their recent publications and presentations.

Meyer AE, Ganesh R, Nayak SC, Baier RE (2008) In-vitro tissue-on-tissue friction model differentiates performance of dry-mouth products. *J Dent Res (Spec iss)*, abstract no 2912.

Puranik C, Meyer A, Baier R (2009) Optimization of radiofrequency glow discharge treatment to control resorption of polylactide intra-bony space maintainer. 27th Annual Canadian Biomaterials Soc Conf, May 20-23, 2009, Quebec City, Quebec.

Ganesh R, Baier R, Meyer A (2010) Tissue-on-tissue lubricity studies of saliva substitutes as-supplied, mixed with and compared with human saliva from control and xerostomia patients. *Northeast Bioengineering Conf. Proc.*, ISBN:978-1-4244-6923-9, ABS-048, page 66, Mar 26-28, 2010, Columbia U, NY.

Nayak SC, Baier RE, Meyer AE, Abuhaimeed T (2010) Improvement of root canal X-ray imaging by delmopinol pretreatment-assisted contrast media infiltration. *Northeast Bioengineering Conf. Proceedings*, ISBN:978-1-4244-6923-9, ABS-026, p 39, Mar 26-28, 2010, Columbia U, NY.

Gunari, N., Brewer, L.H., Bennett, S.M., Sokolova, A., Kraut, N.D., Finlay, J.A., Meyer, A.E., Walker, G.C., Wendt, D.E., Callow, M.E., Callow, J.A., Bright, F.V., and Detty, M.R. (2011). The control of marine biofouling on xerogel surfaces with nanometer-scale topography. *Biofouling*, 27(2), 137-149.

Ganesh R, Hatton MN, Baier RE, Meyer AE (2011) Tissue-on-tissue lubrication by natural and xerostomic saliva and saliva substitutes. *Soc for Biomaterials Annual Mtg*, April 15, 2011, Orlando, FL.

Mang T, Mikulski L, Tayal D, Baier R. (2011) PDT disinfection of oral biofilm. *Am Soc for Lasers in Med and Surg, Photodynamic Therapy Session, Annual Conf*, April 1, 2011, Grapevine, TX.

Sharab L, Mang T, Ciancio S, Baier R (2011) Influence of methylene blue-mediated photodynamic therapy on the resistance to detachment of *Streptococcus mutans* biofilm from titanium substrata. *Annual Student Research Day, UB School of Dental Medicine*, Mar 3, 2011. (abstract)

Suri, H., Ionita, C.N., Baier, R.E., and Rudin, S. (2011). New variable porosity flow diverter (VPOD) stent design for treatment of cerebrovascular aneurysms. *Conf Proc IEEE Eng Med Biol Soc*, 2011, 1105-1108.

Velazquez, J.M., Gaikwad, A.V., Rout, T.K., Baier, R.E., Furlani, E.S., and Banerjee, S. (2012). Nanotexturation-induced extreme wettability of an elemental tellurium coating. *J Mater Chem*, 22(8), 3335-3339.

Park, J.H., Olivares-Navarrete, R., Baier, R.E., Meyer, A.E., Tannenbaum, R., Boyan, B.D., and Schwartz, Z. (2012). Effect of cleaning and sterilization on titanium implant surface properties and cellular response. *Acta Biomater*, 8(5), 1966-1975.

Space and Facilities

- Surface Science Laboratories [Professor Baier, Dr. Meyer]

Approximately 1000 square feet of laboratory space, including a 300 sq.ft. Class 100 clean room, contains the following equipment used in the Industry/University Center for Biosurfaces' [IUCB] research program and the Biomaterials Graduate Program's academic courses: contact angle goniometers, infrared spectrophotometers with various internal reflection mirror assemblies, luminescence photometer system, thin film ellipsometers, stylus profilometer, pulsating bubble surfactometer, viscometer, gas plasma devices, automated Langmuir/Adam trough, pin-on-disk friction apparatus, micromechanical testing apparatus with temperature-controlled fluid bath, cell culture hood and supporting equipment, light microscopes, slit-lamp microscope, analytical balances, electronic microbalance, refrigerators, freezers, incubators, pH meters, autoclave, and other supporting equipment/apparatus. These laboratories recently were augmented with state-of-the art instrumentation for air sampling, virus particle analysis, and IR spectroscopy/microscopy.

- South Campus Instrument Center [central facility]

Located in the same building as the surface science laboratories of Professor Baier and Dr. Meyer, the South Campus Instrument Center offers these capabilities: scanning electron microscopes, energy dispersive X-ray analyzers, X-ray photoelectron spectrometer, scanning Auger microprobe analyzer, and image analysis equipment. School of Dental Medicine technical personnel and graduate students are trained to operate several of these instruments. Instrument Center personnel are available to perform project work on instruments for which interested scientists or students have not yet been trained.

- Other Laboratories [Project-specific Collaborations Among Faculty]

The surface science and other instrumentation laboratories, described above, are continually involved in the research of the Industry/University Center for Biosurfaces and provide several "core" capabilities. The laboratories of other collaborating faculty supported by IUCB's Industry Advisory Board are available in accord with the Center's funding and project performance schedule. For instance, in the past few years, Professor Nickerson (Department of Pathology - sectioning, histochemistry, microscopies; histopathology and ultrastructure expertise) has made major scientific contributions to the Center's research program. Another facility in the School of Medicine and Biomedical Sciences that is relevant to current research are the Confocal Microscopy Laboratory (Dr. Wade Sigurdson, Director).

Admissions:

For admission to the M.S. program, the program committee prefers that applicants have a strong baccalaureate record in engineering, the biological sciences, or an associated clinical field (e.g. dentistry). The minimum acceptable grade point average (GPA) is 3.0 on a 0-4.0 scale. We are familiar with grading scales in other countries and evaluate them in accord with our requirements. The Graduate Record Exam [GRE] is not required for application to the Biomaterials Graduate Program, but is highly recommended. The Biomaterials Program Committee considers all aspects of an application: academic performance (particularly in the basic sciences), activities, honors, presentations, publications, and letters of recommendation. A "Statement of Purpose" is also considered in the evaluation. For international applicants, the minimum, acceptable computer-based TOEFL score is 213. The minimum, acceptable paper-based TOEFL score is 550. The approximate minimum, acceptable score for the internet-based TOEFL scores is 79.

Additional program information and links to apply on-line are found at <https://dental.buffalo.edu/Education>

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