Graduate Student Handbook
Master of Science in Biomaterials

New York University College of Dentistry (NYUCD)

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1 Foreword and Mission Statement

Welcome to the Master of Science Program in Biomaterials Science. The M.S. degree in Biomaterials Science is awarded by the College of Dentistry of New York University (NYU) with courses offered by the Department of Biomaterials and Biomimetics of the New York University College of Dentistry (NYUCD).

The mission of the program is to provide education, and training in biomaterials science and immersion in state-of-the-art technology, while ultimately contributing to improving human health through biomaterials-based treatment modalities.

The goals of this program are to:
- Provide students with state of the art knowledge and training in biomaterials science that will prepare them for careers in research and development in academia and industry
- Enhance the students’ understanding of biomaterials-based treatment modalities by providing them with a broad background in biomaterials structure, fabrication, function and interactions with cells and tissues
- Serve as a basis for further advanced studies, e.g. Ph.D. programs in biology, physical and health sciences
- Provide clinician’s with the knowledge for materials selection and application

The department is located at the New York University College of Dentistry, a world-class craniofacial research and healthcare institution, the largest dental school in the world. The Department of Biomaterials and Biomimetics is uniquely positioned to build upon its existing strengths in biomaterials fabrication, characterization, and testing to achieve the goal of the program and to bridge the gap between bench top research and clinical application. The Department will be moving to a new state of the art facility in the new Nursing, Dentistry, and Biomedical Engineering Building located on First Avenue and 26th Street to be completed in January 2015

This Graduate Student Handbook is designed to provide specific information on policies, procedures, courses, and timeframes for completion of the requirements pertaining to the Master of Science program in Biomaterials Science.

2 The Program - An Overview

The program includes the study of basic material properties and structure of a full range of biomaterials used in medicine and dentistry. The biologic interactions of these materials related to their composition, surface, architectural features and function; and the methods employed to investigate structure, function, and biologic interactions are presented and explored.
Two degree options are available to the student dependent on their scholastic requirements.

1. Thesis option

The program represents a challenge to students in managing course work while designing and completing a thesis research project. Completion of the M.S. program in Biomaterials Science requires 36 credit hours of course work as well as completion and acceptance of a research thesis based on the student's original work. Of the 36 required credit hours, 2-6 credit hours may be approved for the student's research work. The time required to complete the program is not specified and will vary as it is affected by time commitment, motivation and the uncertainties of research. Most of the didactic portion of the program for full time students can be completed over approximately two regular semesters (one academic year). The research for the thesis will overlap with the didactic program. A full time student can complete the program, including research, in approximately two academic years.

A part time student is encouraged to register for 6 credits a semester and could complete the program in approximately 3 years. All requirements must be satisfied within a period of 5 years from the time of original registration for courses.

The student is responsible for the selection of a mentor and for working with that mentor to develop a research protocol. The protocol must be presented to the faculty for approval before the research can commence. Students are free to propose their own research topic but final project selection must be approved by the faculty mentor and department. Constraints regarding feasibility, time, cost to the department, safety and regulatory issues, availability of materials, access to fabrication and investigation facilities, and mentor interest are all factors in project selection. The department will try to provide alternatives that are satisfactory to the student.

2. Non-thesis option

In lieu of a thesis the student will be required to conduct an Independent Project in Biomaterials. Completion of the M.S. program in Biomaterials Science, non-thesis option, requires 40 credit hours of course work, 2 credit hours will be utilized for the student's independent project. The time required to complete the program is not specified and will vary as it is affected by time commitment, motivation. Most of the didactic portion of the program for full time students can be completed over approximately two regular semesters (one academic year). A full time student can complete the program, including research, in approximately two academic years.

A part time student is encouraged to register for 6 credits a semester and could complete the program in approximately 3.5 years. A student who is enrolled in an International Clinical program can take 5-8 credits in our program, and still complete both programs in two years if they are motivated to do so. Students must be in continuous enrollment during the period of their participation in the program, either by course registration or by the maintenance of matriculation registration (BIOM-DN 4747). All requirements must be satisfied within a period of 5 years from the time of original registration for courses.

The student is responsible for the selection of a mentor and for working with that mentor to develop an independent project. The protocol must be presented to the faculty for approval before the project can commence. Students are free to propose their own topic but final project selection must be approved by the faculty mentor and department.

For more information contact the Program Administrator.
3 Program Guidelines

3.1 Admission Requirements and Student Status

The NYU College of Dentistry M.S. program in Biomaterials Science offers admission to applicants who hold a Bachelors Degree (or equivalent foreign credentials, DDS, DMD or MD) and who show promise of superior scholarly achievement. Successful applicants will have: (1) distinguished academic records; (2) strong recommendations from instructors or others qualified to evaluate academic ability; and (3) well-articulated research goals for the thesis option. Because of the structure of the program, applications for graduate study are accepted for the fall semester only. All students must apply for fall admission by May 1st. Remedial work to make up any undergraduate deficiencies may be taken prior to, or concurrent with, the master’s program, but in the latter case, must be completed within the first year.

3.1.1 Graduate Record Examination (GRE). The College of Dentistry requires all applicants to take the Graduate Record Examination (GRE). The Admissions Committee of the Department of Biomaterials and Biomimetics will take the GRE scores into consideration when evaluating the application.

3.1.2 TOEFL. All accepted applicants are expected to demonstrate the ability to understand and communicate in English, both in oral and in written forms. To evaluate proficiency, the school requires applicants whose native language is not English to take the test of English as a foreign language (TOEFL).

3.1.3 Acceptance of Applicants. The Admissions Committee will take all factors into consideration when evaluating the applicant. In some cases applicants may be required to take one or more semesters of English language instruction as a condition of acceptance to the program.

3.1.4 Non-matriculating status. In special cases, a student may be accepted by the Admissions Committee as a non-matriculate or non-degree student. A non-degree student may take up to twelve points from the regular program of the Department of Biomaterials and Biomimetics before applying for matriculated status in the Master of Science in Biomaterials program. However this does not guarantee acceptance into the program. The application for matriculation is only considered if the student has received a B or better in each course included in the twelve points. Deadlines for applying for non-matriculate status are the same as for the M.S. program.

3.1.5 Health insurance. For students who cannot show proof to NYUCD that they have their own health insurance, they will be required to participate in a University Health Insurance Plan.

3.1.6 Leave of absence. A student in good standing who is obliged to withdraw temporarily for national service, serious illness, or compelling personal reasons may request from the proper NYUCD authorities a leave of absence (normally up to one year). Due to the nature of visa status, foreign students should consult with the Office of Global Services in such cases.

3.1.7 Maintenance of scholastic standing. Students must maintain an average grade for each course of B (3.0) or better to remain in good standing in the program. Remedial and/or extension of
course work approved by the instructor involved and the Director of Graduate Studies may, on a case by case basis, be allowed to improve course grades of less than B, IP or W. Students with three or more incomplete grades will not be considered to be in good standing.

3.1.8 Tuition refunds. Students are entitled to refunds on tuition according to the refund schedule published by the Office of the College of Dentistry Registrar. Non-attendance of a course does not constitute withdrawal. Students are liable for tuition charges if they do not formally drop a course within University guidelines. The student must consult program administration and the Director of Graduate Studies before dropping courses or applying for refunds.

3.2 Research Assistantships, Fellowships, Employment and Travel Awards

3.2.1 Research Assistantships and Fellowships are sometimes arranged if available for advanced students from departmental faculty. Research Assistants receive a stipend, tuition remission for a limited number of credits and are required to work 20 hours per week on the research assigned by the sponsoring faculty. Fellowships, when granted, have similar benefits but require full time employment. Research Assistantships and Fellowships are generally not used to support the student’s thesis research.

3.2.2 Student employment (14 hours a week or less) on projects outside the student’s thesis research project may be available. Foreign students visa status must allow employment.

3.2.3 Travel Awards to attend scientific meetings in Biomaterials Science are sometimes available through NYUCD upon announcement. All students are expected to take the initiative to apply for internal and external fellowships, scholarships, and loans. All students are urged to inquire at the Office of Research early in the fall of the year before they wish to enter the graduate program for information regarding government, foundation, private, or overseas awards for support for graduate study.
4 Degree Requirements

4.11 Thesis option
The M.S. degree in Biomaterials Science is awarded after: (1) completion of 36 points course work with grade of B or better; (2) satisfactory oral defense of a completed research effort; (3) submission of an approved research thesis. Of the 36 points required, 28 must be from the Department of Biomaterials and Biomimetics at New York University.

Only 8 points may be transferred from outside the University and other departments outside the NYU College of Dentistry. In these cases, no courses older than ten years may be transferred. All courses must be approved for transfer by the Associate Dean for Academic Affairs of NYUCD. Application for transfer of courses must be within the first academic year of attendance as a matriculant. Courses for which a degree has already been awarded may not be transferred or applied to the Master’s program. Permission must be received from the Director of Graduate Studies for any course work taken outside the department. As also mentioned above, it is anticipated that full time students (12 – 15 credits per semester) would finish the program in two academic years, depending upon research progress and summer semester attendance. It is anticipated that part time students should finish the program in three years. All students are required to complete the program within five years unless special permission is obtained from the Chair of the Department of Biomaterials and Biomimetics or program director. However, in any case, continuous matriculation is required.

4.12 Non-thesis option
The M.S. degree in Biomaterials Science is awarded after: (1) completion of 40 points course work with grade of B or better; (2) satisfactory submission of an approved independent project in biomaterials. Of the 40 points required, 28 must be from the Department of Biomaterials and Biomimetics at New York University.

Only 8 points may be transferred from outside the University and other departments outside the NYUCD. In these cases, no courses older than ten years may be transferred. All courses must be approved for transfer by the Associate Dean for Academic Affairs of NYUCD. Application for transfer of courses must be within the first academic year of attendance as a matriculant. Courses for which a degree has already been awarded may not be transferred or applied to the Master’s program. Permission must be received from the Director of Graduate Studies for any course work taken outside the department. As also mentioned above, it is anticipated that full time students (12 – 15 credits per semester) would finish the program in two academic years, depending upon progress and summer semester attendance. It is anticipated that part time students should finish the program in about three years. All students are required to complete the program within five years unless special permission is obtained from the Chair of the Department of Biomaterials and Biomimetics or program director.

4.2 Requirements for the First Year:

4.2.1 Introduction to Research and Principles of Biomaterials Science: All beginning graduate students are required to register in their first Fall semester for BIOM-DN 2001, “Introduction to Research” (2 credits), and BIOM-DN 1000, “Principles of Biomaterials Science” (3 credits). For Introduction to Research there are two requirements for obtaining a grade of P (Pass) on this course: (1) Satisfactory
attendance and participation in the course and (2) Submission of a research protocol (not necessarily the thesis protocol).

Also mentioned above, during the first year, the student must secure a faculty mentor from within the department who has formally agreed to supervise the thesis research or independent project. Upon approval by the Biomaterials and Biomimetics Department Chairman, a Co-mentor from another department in the University may be assigned to advise the student.

4.2.2 Thesis research protocol. The thesis proposal (protocol) for the completion of original research must be: (1) approved by the mentor and the Department Chair, (2) filed with the Director of Graduate Studies and the Laboratory Manager, and (3) presented and approved at a department research meeting. The student must have received a grade of P in the Introduction to Research in Biomaterials course.

The plan of study and the thesis research are formulated in consultation with the faculty mentor(s). The thesis must represent original, independent research in a significant area of biomaterials and biomimetics at a level comparable to research published in recognized journals or as professional monographs. When the thesis is completed and has been approved by the mentor(s) and by a research advisory committee (readers) assigned by the Director of Graduate Studies, the candidate defends the results of the research before a faculty committee. No more than twelve months should lapse between the approved proposal and the thesis defense. Exceptions requiring time extension must be approved by the Chair of the Department of Biomaterials and Biomimetics or program director.

4.2.3 Non-thesis option

The nature of the independent project in Biomaterials must be developed in consultation with a faculty mentor and approved by the director of graduate studies.

4.3 Special Program

Special Program Emphasis may be arranged by the Department Chair or program director for students desiring to participate in a Special Emphasis research study (e.g. concentration in another department of the University, but still related to Biomaterials and Biomimetics (physics, chemistry, biology, etc.). Students working with a Special Program Emphasis may, in consultation with the Director of Graduate Studies, be required to take courses in addition to the 36 points mentioned above.

4.4 Departmental Meetings and Seminars.

Mandatory attendance is required of all graduate students to periodic departmental seminars and/or research group meetings and various sessions of Laboratory Safety (see section “Requirements for Participation in Research”). At these seminars and research group meetings, students, faculty and scholars from other institutions discuss their research plans and findings. In addition, the department may co-sponsor special seminars throughout the year for which attendance is also mandatory unless specifically excused by the Director of Graduate Studies.
4.5 Meetings with Program Administrator.

All students are required to schedule regular meetings with the Program Administrator in order to keep current regarding course requirements, regulatory status, research requirements, research progress, thesis defense preparations, and if applicable, visa status.

4.6 Graduation Information.

Information concerning NYUCD graduation dates and participation in NYUCD graduation ceremonies can be obtained from the Program Administrator and NYUCD administration.

5 Courses Offered

Each course consists of a series of lectures (and laboratory sessions when indicated), mid-term and final examination. Courses indicated by an asterisk (*) are required. Announcements of available courses, schedule changes and other information are posted on the Graduate Students Bulletin Board in the hall of 806S.

*Principles of Biomaterials Science BIOM-DN 1000. [3 points. Course Directors: P. Coelho, N. Tovar]. Covers the scientific principles underlying the area of materials science, including concepts of kinetics, thermodynamics, diffusion, and quantum mechanics, etc., as they relate to their structure and properties of materials. Also discussed are the role of interfaces on absorption, nucleation, phase diagrams of interest to materials scientists, the role of dislocations and other defects in the macroscopic formation associated with materials, the solidification of metals and alloys, and mechanisms of strengthening alloys.

*Metal and Ceramic Biomaterials BIOM-DN 1001. [3 points. Course Director: Y. Zhang]. Metals and ceramics are widely used in dental, biomedical, and an array of engineering applications. This course offers graduate students a comprehensive study of the structure and properties of metals and ceramics, as well as their criteria for practical applications. Also discussed are the fundamental structure-property-function relationship of materials, principles that determine the differences between metals and ceramics, and recent advances in the development of metals and ceramics for dental and medical applications. One of the objective, or philosophy, that I strive to maintain throughout the course is that if a topic or concept is important, then it is worth treating in sufficient details so that students can comprehend it without having to consult other sources.

*Polymers & Biopolymers BIOM-DN 1002. [3 points. Course Director: P. Coelho]. Covers the chemistry, structure, and properties of polymers used in dentistry and medicine, both inorganic and organic. Topics include the science of large macromolecules, molecular weights and measurements, polymerization mechanisms, mechanical properties of polymers, thermoplastic and thermosetting resins, chemistry of poly-siloxanes, emulsion and suspension polymerization, polymers associated with restorative materials, ionic polymers, silicones, polymethyl- methacrylate, BIS-GMA, reinforced polymers, composites, etc.

Testing Methods in Biomaterials (Biomechanics) BIOM-DN 1004. Lecture [3 points. Course Directors: P. Coelho]. Covers the principles governing tensile tests, compressive tests, creep tests, and other mechanical properties testing as it relates to the biomechanics of the human body. This will include
joints like the TMJ, and total joint replacements, as well as other medical devices including dental implants.

*Biomaterials-Tissue Interface I, II* BIOM-DN 1005, 1006 [3 points per semester. *Course Director: J. Ricci*]. Provides background knowledge on the response of cells in vitro and tissues in vivo to different types of biomaterials used in dentistry and medicine. Covers surface chemistry of biomaterials, protein interaction with surfaces, effects of surface chemistry and microstructure on cell and tissue response, and other topics.

**Degradation of Biomaterials** BIOM-DN 1007. [2 points. *Course Directors: Y. Zhang, J. Ricci*]. 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 discussed are 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.

**Introduction to Electron Microscopy** BIOM-DN 1008. *Lecture and laboratory.* [3 points. *Course Directors: J. Ricci, T. Bromage, D. Mijares*]. Covers the physical construction of scanning electron microscope and the theory of its use, the signals emitted when a high velocity beam of electron is allowed to scan a specimen target, and principles of resolution and contrast. The principles and uses of backscattered electron imaging and x-ray microanalysis are also covered. Students will become familiar with specimen preparation, instrumental use for microstructural examination, and interpretation. The course provides hands on experience.

*Physical & Chemical Methods in Biomaterials* BIOM-DN 1011, *Lecture and Laboratory.* [3 points. *Course Directors: D. Mijares, J. Ricci*]. Introduces students to the principles and techniques used in the study of materials an hard tissues, including x-ray diffraction, infrared spectroscopy, inductive coupled plasma, and mechanical testing. The course provides an introduction to testing instrumentation and equipment.

*Experimental Design in Biomaterials Research I* BIOM-DN 1012. [3 points. *Course Director: M. Janal*]. Covers mathematical and statistical tools that are useful in biomaterials research. Students are trained 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. Reliability, Live Testing, and Weibull Analysis are also covered.

**Seminars in Biomaterials** BIOM-DN 1015. [3 points. *Course Director: Department Faculty*]. Covers aspects of the materials used in clinical dentistry and medicine including restorative materials, alloys, cements, impression materials, gypsum products, and cell-biomaterial interactions.

**Readings in Biomaterials and Biomimetics** BIOM-DN 2000. [1 to 4 points. 1 point per semester] *Course Director: Faculty*. Covers reviews of scientific literature related to biomaterials and biomimetics as designated by a faculty mentor. Requires students to prepare extensive reviews of selected topics.

*Research in Biomaterials* BIOM-DN 3000. [Course Director: Department Faculty. 1 to 6 points.] The student may use additional credits (1 to 6 points) each semester for thesis research.

*Introduction to Research* BIOM-DN 2001 [2 points. *Course Director: D. Mijares*]. This course offers much of the necessary information for conduct thesis research and preparing the Masters thesis. It includes how to prepare scientific abstracts, papers, and presentations, use of reference databases, and also includes information on the different research program and topics that are actively being studied by department faculty.
Imaging Science: BIOM-DN 1016. [4 points. Course Director: T. Bromage,]. This course will highlight basic principles of preparation and imaging relevant to biomaterials research, particularly as they relate to 2D and 3D transmitted and reflected light microscopy, and scanning electron microscopy of bone and tooth microanatomy. Each student will have the opportunity to work with samples, the purpose being to integrate preparation methods for some specific imaging mode(s). Students will also be exposed to and perform digital processing, analysis, and measurements of images acquired from their prepared samples.

Complex Material Systems: BIOMA-DN 1017 [3 credits. Course Director: Y. Zhang] Many structural and biomedical components encounter service conditions that require materials performance to vary with location within the component. Conventional design using monolithic materials often fail to meet the application demands. This course offers graduate students a comprehensive study of structure-function-property relationships in composites across a range of applications. A background in composite 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. A number of lecturers from a broad range of disciplines give presentations in this integrated course.

Independent Project in Biomaterials: BIOM-DN 3001 [2 credits. Course Directors: Faculty] This course requires an independent project that can be a thorough review of an advanced literature topic, evidenced based review, or researched subject resulting in manuscript or presentation on a topic previously accepted by the department.

Additional courses are available through arrangement with other Dental School and NYU Programs.

6 Requirements for Participation in Research

All students must complete a series of training modules in order to start a research project in the Department of Biomaterials. Students must take lab safety training from the Environmental Services Department at NYUCD or from qualified laboratory personnel at the Department of Biomaterials and Biomimetics. The student must provide documentation of this training to the Department before starting activity in the department laboratories. All students are also required to take the Laboratory Orientation session offered by the department before starting activity in the laboratories. All students, as part of their overall training, must take Lab Safety, Hazardous Waste, Biosafety/Bloodborne Pathogens, HIPAA, and the human subjects tutorial during the course of their training. However, if the student does not directly need these modules to start their research project, they may take these training sessions when available at any time during the program.

If the student's proposed research project involves contact with any human material, patient contacted products, or patient information; before research may begin, the student will be required to take the following training and submit documentation indicating completion to the Program Administrator: Bloodborne Pathogen training; Human subjects tutorial; and HIPAA tutorial. In addition, the student must submit through the Lab Manager and the Dean of Research a copy of an approved thesis proposal and application to do research on human material to the Institutional Review Board (IRB).

7 Guide Lines for Completing Research Requirements (Thesis option):
The following section outlines a stepwise process for completion of the Master’s Thesis research, dissertation, and defense.

7.1 Formulation of a Thesis Proposal. The first step in this process is formulation of a preliminary proposal for a research project. This project can be based on the student’s background or interests, literature review, or consultation with potential mentors or with peers. The student should conduct a preliminary literature survey on the proposed thesis project, and then compose this preliminary proposal as a concise document (1-3 pages, single spaced, 12 pt type) containing introduction, rationale, and specific aims sections. This must be submitted to the department, Director of Graduate Studies (DGS) and, laboratory manager (LM), and Department Chair for approval.

7.2 Selection of a Thesis Mentor. Based on the area of interest of the preliminary proposal, the student should select a committee and a thesis mentor who heads the committee. The committee comprises the mentor and a minimum of two additional faculty mentors. Based on the preliminary proposal a mentor may be suggested by program administration. The primary mentor must be selected from department faculty. Of the committee members, one of these can be from outside the department or from another institution. Faculty from outside of the department are encouraged to be involved in the mentoring process. Students should consult the department administration, including the laboratory manager (LM) and Director of Graduate Studies (DGS) if they have questions identifying faculty appropriate for the project. Upon selection of a thesis mentor and committee the student must notify departmental administration of the selections. The selections must be approved by the program administration. The thesis mentor and committee members must approve their selections and the primary mentor must approve the preliminary proposal to the Director of Graduate Studies (DGS).

7.3 Preparation of the Thesis Proposal. Once the preliminary proposal and thesis mentor selections have been approved by department administration, the student must prepare a formal thesis proposal. This proposal comprises a detailed plan for the student’s thesis research and, if it is composed properly, it will become the introductory and technical (Materials and Methods) basis of the thesis. This proposal is in a format similar to those used for industrial and basic science research proposals and preparation of this document is part of the training process for the degree. The thesis proposal must have the following sections and content (this is covered in detail during the Introduction to Research Course):

- **Introduction** — This section must contain the background (critical review of the literature on the research subject), significance of and rationale for the proposed research project, a summary of the specific aims, and the hypothesis (working hypothesis and null hypothesis) of the proposal.
- **Materials and Methods** — This section must contain the specific technical procedures, experimental plan, and statistical analysis methods to be used in the project. Whenever applicable, a statistical power analysis should be included to ensure that adequate statistical power is incorporated into the proposed work. Materials and devices that are required from corporate sponsors must be specified here.
- **Expected Results** — This section should contain a summary of the specific expected outcomes of the proposed research. It should also include potential problems and suggested solutions to those problems.
- **Proposed Timeline** — A proposed timeline for the research should be included. This will include timelines for specific experiments, expected milestones related to specimen preparation, analysis, data analysis, and thesis preparation.
- **Budget** — A detailed list of material, lab, outside testing costs.

7.4 Submission of the Thesis Proposal. Students are strongly encouraged to submit intermediate stages of this proposal to their mentors. A thesis proposal should never be submitted in its expected final
form. Program administration, in particular the Laboratory Manager, must be involved with formulation of the proposal in order to ensure that all student training, laboratory safety, animal protocol, and institutional review (for human clinical studies) requirements are met. In addition, it is extremely important that the Lab Manager reviews all protocols to ensure that the proposed work can be conducted in an efficient and timely manner within the department and college facilities. The finished thesis proposal must be approved by the mentor and accepted by the department faculty at the time of presentation before further work is conducted.

7.5 Presentation of the Thesis Proposal. The last stage in thesis proposal preparation is presentation of the proposal at one of the Biomaterials Group Meetings. This represents both a valuable training exercise for public presentation of research as well as a way to get feedback from faculty and students regarding all aspects of the project.

7.6 Conducting Thesis Research. The student's thesis research comprises the most technically difficult aspect of the Master's program. There are several aspects of this work that deserve consideration:

7.6.1 Clinical studies, or studies that; (a) utilize any human tissue or fluids, (b) utilize biomaterials, devices, or instrumentation that has come in contact with human patients are subject to Institutional Review Board (IRB) approval. Students conducting this type of research must have special training for Blood Borne Pathogens, HIPAA, and human subjects (see Section 2.2) and submit appropriate protocols to IRB before the research commences. Students must work closely with the Laboratory Manager and program administration to make sure these requirements are met. IRB applications must be prepared in coordination with the Lab Manager and submitted to the Associate Dean for Research for approval before being submitted to the IRB. IRB approval must be documented with the Lab Manager prior to project initiation.

7.6.2 Animal studies, or studies that utilize any animal tissue or fluids, are subject to Institutional Animal Care and Use Committee (IACUC) approval. Students conducting this type of research must have special training, and submit appropriate protocols to IACUC before the research commences. Students must work closely with the Lab Manager to make sure these requirements are met.

7.6.3 Use of laboratory facilities. Students are responsible for learning to properly use the laboratory facilities necessary to conduct their research. In many cases this will require special instruction from laboratory faculty and staff. Students should be prepared to arrange appointments with appropriate personnel for this training, and must be prepared to arrange and keep appointments for use of laboratory facilities. In many cases it is necessary to use a sign-in schedule or log. It must be anticipated that some facilities will be over utilized, so facilities scheduling must be arranged and strictly followed in order to optimally utilize existing facilities and available time.

When using laboratory facilities the student is responsible for the care of those facilities. This means using the facilities in a proper and safe manner, keeping the facilities clean and in working condition, and reporting any and all malfunctioning or broken equipment to the laboratory manager. The department recognizes that malfunction and breakage are a normal part of facilities use and wear. All malfunctions and breakage must be immediately reported to keep the facilities safe and working properly.
7.6.4 Research materials and contract research. Many projects involve the use of components, devices, materials or parts provided by companies or entities outside of NYU. All arrangements for funding or use of materials from outside the department MUST be made through the program administration and not directly between the student and the company. In this way, the administration can make sure that contract studies are properly funded, can track the contributions of suppliers, and prevent conflict of interest problems.

7.6.5 Research record keeping. Students must keep a detailed laboratory notebook of all research conducted in the laboratories. This includes thesis research as well as preliminary projects and side projects that do not become part of the thesis. The laboratory notebook(s) must be kept in the laboratory, and all observations, data, and statistical analysis must be documented here.

7.7 Preparing the Master's Thesis. While conducting the thesis research project, the student should begin writing the Master's dissertation. The thesis proposal should represent the starting document for this effort. A summary of the final format of the thesis is included in the appendix section of this document. All students are encouraged to read dissertations available in the department library as examples of proper thesis format.

Students must submit drafts of sections of the dissertations to their primary mentor for review. They are encouraged to get significant input from their mentor at every stage of thesis writing. The mentor will assist in editing the thesis and will determine when the thesis is ready for distribution to the other thesis committee members. Along with the thesis committee, the final thesis must be submitted to the Director of Graduate Studies and to the department chair. At this time the Master’s Degree Checklist must be completed (see Appendix). The committee will not sign final documentation for graduation without the completion of this checklist.

7.8 Setting the Thesis Defense Date. A date acceptable to the student, the mentor, and the committee will be scheduled for the thesis defense by the program administrator. This date must be at least three weeks after the semi-final thesis is submitted to the thesis committee. Announcement of the defense will be posted within the school.

7.9 The Thesis Defense. The thesis defense is public and will follow this format: the student, after being introduced by the mentor or Director of Graduate Studies will present an oral presentation summarizing the thesis research. This should be conducted using the same organizational format as the dissertation, and should take approximately 40 minutes. This will be followed by a question and answer period in which the audience can participate. After this period the audience will be excused and the committee members will question the student. After this period the student will be excused and the thesis committee will consider which of the following grades should be awarded to the student: ‘pass without revisions’, ‘pass with revisions’, or ‘fail’. In the case of a ‘pass without revision’ grade, the committee will sign the final documents for submission to the Graduate School of Arts and Science for graduation. This however is rare as revision is usually required. The ‘pass with revisions’ option means the committee will sign the final documentation only when revisions acceptable to the committee are submitted. In the case of a failing grade, the committee may or may not propose an optional plan for the student to conduct additional thesis research. A student accepting the plan may be considered for thesis defense at a later date.

7.10 The Final Steps. The student who has passed the thesis defense and completed the checklist must provide a minimum of four (4) bound copies of the thesis: one each for the department
library, the school library, the mentor, and the student. Additional bound copies may be ordered at the student’s discretion. All bound copies must be identical and comprise the final form of the dissertation.

8 Time frame for Degree Completion

This time frame is based on a two-year completion plan for full time students for the Master’s Degree. It is anticipated that the student will complete most of the course requirement in the first academic year and the research requirements in the second year.

8.1 First Semester: Begin coursework. Begin selection process for thesis research project as well as mentor and committee selection.

8.2 Second Semester: At this time the mentor and committee should be selected and a preliminary proposal should be prepared. By mid semester these steps should be complete. By the end of this semester the student should have submitted their first draft of a thesis proposal.

8.3 Third Semester: By the beginning of the third semester of graduate study, the student should have an approved thesis proposal or independent project and be starting their writing. The student should also begin writing the final dissertation. The bulk of the thesis work and data acquisition should be conducted during this semester.

8.4 Fourth Semester: Work in the fourth semester should revolve around completion of thesis research, writing of the final dissertation, and completion of the Master’s Degree Checklist. At the middle of this semester arrangements should be made for submission of the final dissertation and arrangement of the thesis defense date. By the end of the semester, all thesis requirements should be completed so the student can graduate.

9 Department Faculty and Facilities

9.1 Faculty mentors: Students may conduct research with investigators listed below who are working on a variety of topics:

Timothy Bromage, MA PhD Professor, Department of Biomaterials and Biomimetics and Department of Basic Science. Comparative bone and skeletal development and environmental reconstruction, Craniofacial development and architecture, human paleontology, skeletal changes in outer space, light and scanning electron microscopy, digital image processing, skeletal abnormalities resulting from gene knockout mouse experimentation, African Pilo-Pleistocene and Mediterranean Pleistocene fieldwork.

Paulo Coelho, DDS, PhD, Assistant Professor, Department of Biomaterials and Biomimetics. Implant surface modification technologies, dental implant design and biomechanics, bone response to implants and surfaces. Finite Element Analysis (FEA) of implants and bone response. Animal models and histologic analysis for bone and tissue response to medical devices.
Ronaldo Hirata, MS, DDS, PhD, Assistant Professor, Department of Biomaterials and Biomimetics. Research in dental restorative materials with emphasis on composite and ceramic biomaterials.

Dindo Mijares, MS, DMD. Co-Director of Graduate Studies, Lab Manager, Department of Biomaterials and Biomimetics. Bone and calcium-phosphate based biomaterials, and surface modification of implant coatings.

John L. Ricci, PhD, Associate Professor, Department of Biomaterials and Biomimetics, Director of Graduate Studies; Cell and tissue response to permanent and resorbable biomimetics and medical devices; effects of surface microstructure and other surface modifications on cell and tissue response; bone and soft tissue repair and regeneration.

Cristina M. C. Teixeira, DDS, DMD, MSc, PhD, Assistant Professor, Chairperson, Departments of Orthodontics, Craniofacial Biology, and Basic Science; Cell and molecular biology of growth plate chondrocyte differentiation, maturation and apoptosis, Mechanism of Pi induced apoptosis in chondrocyte and the role of mitochondria in this process, nitrous oxide in chondrogenesis, endothelial nitric oxide synthasise (eNOS) in knockout mouse with marked limb defects. Studies of overexpression of nitric oxide synthesis affecting endochondral bone formation, and tissue engineering of endochondreal bone.

Nick Tovar, PhD, Postdoctoral Fellow, Department of Biomaterials. Implant surface modification technologies, dental implant design and biomechanics, bone response to implants and graft materials. Soft tissue repair. Animal models and histologic analysis for bone and soft tissue response to medical devices.

Yu Zhang, PhD, Assistant Professor, Department of Biomaterials and Biomimetics; Materials and design research in dental ceramics, bioactive glass materials.

9.2 Faculty co-mentors:

Gary Robert Goldstein, DDS, Professor, Department of Prosthodontics, and Department of Biomaterials and Biomimetics; Dental implants, restorative materials, biotechnical devices.

Malvin N. Janal, PhD, Pain syndromes of unknown etiology, experimental design and statistics (applied epistemology), pain measurement technologies.

Bapanaiah Penugonda, MS, DDS, Associate Professor, Department of General Dentistry; Clinical research; evaluation and development of dental restorative biomaterials.

Teresita Salgado, DDS, MS, Adjunct Clinical Assistant Professor, Department of Biomaterials and Biomimetics; Titanium surface modifications; tooth surface modifications.

10 Department Facilities

The following research facilities of the Department of Biomaterials and Biomimetics and the Calcium Phosphate Laboratory are available for graduate student research projects: Instron mechanical testing
system; Biodent micro indenter, Hysitron/Ti950 Tribometer, Chatillon tensile tester with bencor mult-t attachment; EnduraTEC Elf 3300 biaxial fatigue testing systems with mouth motion wear simulation; a thermocycling device; Hitachi S3500 and Zeiss Evo50 Scanning Electron Microscopes (SEM) with energy dispersive X-ray analysis (EDAX) and backscatter electron imaging systems; Scanco Medical μCT 40 microcomputed tomography system; Hard tissue histology processing laboratory including Exakt processing and sectioning system; Philips X’PERT X-ray diffraction (XRD) unit; BioQuant and other Image analysis systems; Laser confocal and confocal microscopes; Fourier transform infrared (FTIR) spectroscopy with ATR; Perkin Elmer high resolution dual grating IR spectrometer; Thermodyne Inductive Coupled Plasma (ICP); Texas-Instrument Thermogravimetry (TGA/DTA); Micromeretics Flowsorb Specific Surface Analyzer; Micromeretics AccuPic density analyzer; and various metallographic and SEM, TEM sample preparation equipment and wet chemical synthesis apparatus (pH stat systems, electrochemical deposition system, auto titrations, refrigerated centrifuges, etc.)

The NYUCD library is located on the second floor of the VA hospital.

The Elmer Holmes Bobst Library, covering a full square block and the east corner of Washington Square and housing more than 3.3 million volumes, 20 thousand journals, and over 3.5 million microforms, is one of the country’s largest open – stack reference, journal, and circulating collections. Many of the most commonly used journals are available on-line through the library.

11 Appendix

11.1 Research and Laboratory Use: Guidelines and Policies

After the student’s research protocol has been approved, a laboratory space will be assigned by the Laboratory Manager.

Students are expected to adhere to the following policies and guidelines:

- **Laboratory notebook:** Proposed and actual Materials and Methods used in the student study and results obtained should be recorded in your laboratory notebook. The laboratory notebook will be kept in the laboratory at ALL times.

- **Chemicals:** A list of chemicals required for your study should be presented to the Laboratory Manager. When using chemicals, it is important that proper procedures be observed to prevent contamination of chemical stocks. Leftover chemicals should be disposed of appropriately (cf. Laboratory Training information). You should be familiar with the MSD of the chemicals that you use. In many cases standard operating procedures (SOPs) are in place for use of hazardous chemicals. These should be followed at all times.

- **Glassware and plastic ware:** If your study requires special glassware, consult the Laboratory Manager. For ordinary glassware and plastic ware, you are expected to clean them properly after your use. Disposable plastics should be disposed of appropriately. (cf your Laboratory Training Session).

- **Use of minor equipment (e.g., balances, pH meters, ovens):** Appropriate weighing devices should be used. The balance and the weighing area should be cleaned after use. pH electrodes should be stored in appropriate buffers.
• **Use of major equipment (e.g., Instron, IR, XRD, SEM, etc):** The use of the major equipment will be on a schedule basis that should be arranged with your mentor and/or the Laboratory Manager. Your mentor will decide when you can use the equipment without supervision.

• **Working hours:** *No one will be allowed to work in the lab without the presence of faculty or research/administration personnel.*

• **Consultations:** Other members of the faculty and research personnel are available for consultation, by appointment, on your project (e.g., use of specific equipment, statistical analysis, etc).

• **Problems:** *The Laboratory Manager should be notified immediately in case of equipment problems, damage or breakage of equipment or supplies, or accidents.*

• **Scientific Honesty and Integrity** is expected in the conduct of your research and in the presentation and interpretation of your results.

• **Interpersonal relationships:** Common courtesy, mutual respect and professionalism are expected from and among students, research and administration personnel, and faculty.

### 11.2 Components of a Research Thesis

Dissertations should be composed in Microsoft Word using Endnote for all references.

**Opening pages**

**Title page**
**Dedication** (optional)
**Table of Contents**
**Abstract** (limit to one page)

**A. Introduction and Specific Aims**
- Background (critical literature review)
- Identification of the research problem
- Previous reported studies addressing the problem
- Objectives of the research. Significance of proposed study

Specific Aims: Include when applicable null hypothesis and (working) research hypothesis, and detailed specific aims

**B. Materials and Methods**
- Materials used in the research
- All Methods (synthesis, analytical methods, test methods)
- Data management and statistical analysis

**C. Results**
- Detailed descriptions, accounts, and results of each experiment
- Results should include preliminary data and data not used as in final version or versions of experiments. This should include justify for exclusion of data.
- Tables and graphs of results
- Figures and appropriate legends (see figure caption document)
D. Discussion
Data interpretation addressing each specific aim
Comparison of results obtained with results reported in the literature (if any, or in part as they apply)
Significance of findings and limitations of findings related to specific aims as appropriate

E. Summary and Conclusion
Brief summary of results
Significance of results
Clinical relevance (if any)
Detailed conclusions resulting from the studies

F. Recommendations for Further Studies
Proposed next steps in the research and rationale for the proposed studies

G. References
These should be included in the text and in the reference list in a consistent format (numbered or alphabetical) using the reference format in the Journal of Dental Research.

H. Acknowledgements

I. Appendix (if necessary)

11.3 Master’s Degree Checklist

The following requirements must be met before degree is granted.

1. Student’s lab notebook must be complete, legible, and detailed enough for someone to understand and reproduce research and data. Notebook must be submitted to thesis mentor. The notebook must contain all lab notes and raw data, as well as statistically processed data.
2. All electronic files (including digital images) and non-electronic data (print and slide film photographs and micrographs) from instrumentation and all other raw and processed data must be turned in to mentor in electronic format (on CD or DVD) or in print form. All graphics, digital images, and data files must be removed from instrumentation computers.
3. A summary list of the above data must also be supplied to the mentor.
4. Students must empty all lab space and drawers of samples and equipment. All relevant to study materials should be turned in to the mentor, with documentation. Materials and instrumentation that can be recycled (i.e. SEM stubs) or of further use in the laboratories should be turned in to the Lab Manager.
5. All materials that are no longer of use to the student or mentor and are not recyclable should be disposed of in the appropriate manner.
6. Student must submit the final version of thesis, and an electronic copy to both the mentor and the department chair.
7. The thesis with the signature first page must be bound. A minimum of four (4) bound copies are required: one each for the department, the graduate school, the mentor, and the student. The student is responsible for all costs and arrangements for binding.