APPENDIX 3. IMPACT OF THE MERGER ON THE EDUCATIONAL MISSION OF BIOMATERIALS

Report Prepared by John Ricci, PhD, FBSE, Associate Professor, Department of Biomaterials, Director, MS Program in Biomaterials Science, NYU College of Dentistry, Director, PhD Training Track in Biomaterials Science, Vilcek Institute at NYU Grossman School of Medicine

INTRODUCTION. The educational mission of the Department of Biomaterials at NYU College of Dentistry is threefold. Our department is responsible for teaching biomaterials science for:

1. The predoctoral College of Dentistry DDS program
2. Postgraduate specialty programs at the College of Dentistry
3. Postgraduate MS Biomaterials program (College of Dentistry) and PhD Biomaterials program (Vilcek Institute at NYU Grossman School of Medicine)

The contributions of Biomaterials to the dental school curriculum are for the most part, integrated into multiple courses. There is no single dental biomaterials course. Materials and subjects covered range from dental impression materials to various restorative materials, adhesives, crown and bridge materials, implants, and biocompatibility.

THE EXPERTISE OF OUR FACULTY. Our faculty specialize in research in specific areas and are very diverse. Their teaching is always related to their areas of expertise. They are (in alphabetical order):

- Tim Bromage, PhD (primary appointment in MPB, adjunct appointment in Biomaterials) — Bone and tooth imaging and analysis. Chemical analysis of materials ranging from fossilized teeth to seawater.
- Paulo Coelho, DDS, PhD — Bone response to implants, bone grafting biomaterials, and 3-D printed bone grafts. Surgical applications of bone repair techniques and materials. Note: Paulo is currently on sabbatical.
- Ronaldo Hirata, DDS, PhD — Dental restorative materials, composites, and adhesives. Extensive expertise in predoctoral dental education.
- John McDevitt, PhD — Lab-on-a-chip diagnostic design and implementation, polymer chemistry and processing, immunology.
- Dindo Mijares, MS, DDS — Materials characterization of bone and tooth mineral, ceramic, and other materials using x-ray diffraction, electron microscopy, surface chemistry analysis.
- John L. Ricci, PhD FBSE — Cell and tissue response to microstructured implant surfaces, development of implant surfaces and bone grafting materials, bone response to 3-D printed grafts. Administration of MS and PhD programs and student mentoring.
- Lukasz Witek, PhD — 3-D printing technology including design and chemical engineering of specialized printer inks, bone response to 3-D bone grafts, surgical models for testing for implant and graft testing.

GENERAL TEACHING CONTRIBUTION OF FACULTY. Of our faculty, Dr. Hirata contributes a tremendous amount of teaching (his specialty) to the predoctoral dental program. Drs. Witek, Ricci, and usually Coelho (currently on sabbatical) all contribute significantly to predoctoral teaching as well. Drs. Hirata and Ricci contribute significantly to postgraduate teaching. All Biomaterials faculty except Dr. Hirata contribute to postgraduate MS/PhD teaching.

EDUCATIONAL PROGRAMS AND MERGER IMPACT

Predoctoral College of Dentistry (D1-D4) Biomaterials teaching contribution is integrated into, and is limited to basic dental biomaterials science in these courses:

- D1 General Pathology
- D1 Single Tooth Restoration
- D2 General Dental Simulation II-Restorative Dentistry
- D2 Simulation — Fixed and Implant Prostheses
- D2 Diagnosis and Treatment of Oral Disease
- D3 Advanced Restorative and Biomaterials

Anticipated impact of merger — no impact.

Postgraduate Programs

- Fundamental of Prosthodontics — Prosthodontic Biomaterials
- Clinical Advances and Applications in Wound Healing

Anticipated impact of merger — A positive impact is anticipated in the Clinical Advantages and Applications in Wound Healing course. This is a biology-based course and would benefit from the advanced biomolecular and therapeutic perspective that would be available from MPB faculty.

Postgraduate MS/PhD Programs:

- Principles of Biomaterials Science
- Introduction to Biomaterials Research
- Biomaterial-Tissue Interface I and II
- Biostatistics
- Metal and Ceramic Biomaterials
- Polymers and Biopolymers
- Complex Biomaterials
- Research in Biomaterials
- Readings in Biomaterials
- Introduction to Electron Microscopy
- Imaging Science
- Physical and Chemical Methods in Biomaterials
- Independent Projects in Biomaterials Science

Anticipated impact of merger — A positive impact is anticipated on the Biomaterial-Tissue Interface I and II course. This is a biology-based course that examines cell and tissue response to biomaterials. This is based on wound healing which is closely related to embryology. Thus, this course would benefit from the expertise available from MPB faculty studying stem cell and developmental biology.

Summary of Merger Impact on Biomaterials Educational Programs. My analysis of our educational mission, based on my familiarity with the subject and discussions with our faculty indicate the following: Our Biomaterials faculty and I agree that there is no negative aspect to this merger, and our materials-based educational mission will not change. However, all Biomaterials programs tend to be heavy on the "materials" side and light on the "bio" side of the equation. The advantages of this merger are that the "bio" aspects of our educational mission will benefit from the added expertise of the MPB biomedical scientists.

A Note About Additional Benefits of the Merger. MPB has no Biomaterials component, and access to that component will result in collaboration that will benefit all of our research and teaching. Two examples of collaborations would comprise the use of 3-D printing of rigid and flexible matrices for 3-D culture of organoid experimental models, and use of controlled solubility biomaterials surfaces, microparticles, and nanoparticles as bioactive molecule delivery systems. An additional positive aspect of this merger involves the availability of PhD projects for the Vilcek Biomaterials PhD students. Collaborations between Biomaterials and MPB faculty will lead to increased numbers and variety of available PhD projects for these students.

BIOMATERIALS COURSES

Predoctoral Dental. The contributions of Biomaterials to the predoctoral dental school curriculum are integrated into multiple courses. There is no single Dental Biomaterials course. Contributions range from one lecture to most of some courses. Materials and subjects covered range from dental impression materials to various restorative materials, adhesives, crown and bridge materials, implants, FDA regulation, biocompatibility, and bioactivity.

D1 (First Year Dental)
General Pathology: BAS06-DN 1608. This course covers general pathology information necessary for the practicing dentist. Biomaterials contribution is minimal: one lecture on osseointegration of dental implants as a pathologic process.
Single Tooth Restoration: PCL03-DN 1608. This covers the different methods for restoring single teeth. Biomaterials contribution is significant and covers composite restorative materials as well as the variety of buildup materials, adhesives, and other materials involved in this process.

D2
General Dentistry Simulation II — Restorative Dentistry: PCL03-DN 2611. This is a basic, hands-on simulation course that teaches general dental procedures. Biomaterials contribution is significant as this covers many of the basic dental procedures from impressions to tooth restorations.
Simulation — Fixed and Implant Prostheses: PCL11-DN 2509. This simulation course covers crown and bridge technology as well as implant supported prostheses. Biomaterials contribution is significant, as this course is biomaterials intensive and involves a variety of metals and technologies as well as ceramics and other types of restorations.
Diagnosis and Treatment of Oral Disease: DGS03-DN 2610. This course covers the basics of diagnosis and treatment of a variety of diseases of the oral cavity. The Biomaterials contribution is moderate as some of these conditions require knowledge of restorative procedures involving biomaterials.

D3
Advanced Restorative Dentistry and Biomaterials: PCL02-DN 3511. This course covers more advanced techniques for dental restoration, most of which involve biomaterials. Biomaterials contribution is very significant (roughly half of the course).

Postgraduate Dental
Fundamentals of Prosthodontics: Prosthodontic Materials: BEHSC-DN 9305. This course is part of the prosthodontics curriculum, which is very biomaterials based. Biomaterials contributes most of the course.

Clinical Applications of Advances in Wound Healing: BASCI-DN 8043. This is a biology-based minicourse consisting of approximately 8-9 lectures: three on soft tissue (gingival) healing and grafting, three on bone

healing, bone integration of implants, and bone response to graft materials, and 2-3 lectures on complications. This course is generally taught to Prosthodontics, Periodontics/Implantology, and Endodontics postgraduate students. Biomaterials contribution is roughly one third of the course (bone related topics).

Postgraduate MS/PhD

These postgraduate courses are used for both the MS Biomaterials degree through the College of Dentistry, and the PhD Training Track in Biomaterials through the Vilcek Institute. Students who graduate from the MS in Biomaterials and are accepted in the Vilcek PhD program may transfer most of their credits from the MS degree. Students at the Vilcek Institute, from areas other than Biomaterials, but whose research involves aspects of biomaterials, may take these courses as electives. Courses indicated by an asterisk (*) are required for the MS in Biomaterials Science.

Principles of Biomaterials Science: BIOMS-DN 1000. *[Course Directors: L. Witek, P. Coelho].* This course 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.

Introduction to Research: BIOMS-DN 2001 *[Course Director: D. Mijares].* This course offers much of the necessary information for thesis research and preparation. The final project is preparation and presentation of a research proposal.

Metal and Ceramic Biomaterials: BIOMS-DN 1001. *[Course Director: L. Witek].* 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.

Polymers and Biopolymers: BIOMS-DN 1002. *[Course Director: J. McDevitt].* This course covers the chemistry, structure, and properties of polymers used in dentistry and medicine, both inorganic and organic.

Complex Material Systems: BIOMS-DN 1017 *[Course Director: L. Witek].* This course offers graduate students a comprehensive study of structure-function-property relationships in composite materials across a range of applications. A background in composite materials design is provided, including multiphase metal, ceramic and polymer systems.

Biomaterials-Tissue Interface I, I:I BIOMS-DN 1005, 1006 *[Course Director: J. Ricci].* This course provides background knowledge on the response of cells *in vitro* and tissues *in vivo* to different types of biomaterials used in dentistry and medicine.

Biostatistics I: BIOMS-DN 1012. *[Course Director: M. Janal, Epidemiology and Health Promotions Department].* This course covers mathematical and statistical tools that are useful in all research including 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.

Introduction to Electron Microscopy: BIOMS-DN 1008. *Lecture and laboratory. [Course Directors: D. Mijares, J. Ricci, T. Bromage].* This course covers the use of the scanning electron microscope, and the theory behind its use for different types of analysis. The course provides hands on experience.

Imaging Science: BIOMS-DN 1016. *Lecture and laboratory. [Course Director: T. Bromage,].* This course highlights basic principles of preparation and imaging relevant to biomaterials research, particularly as they relate to 2D and 3D transmitted and reflected light microscopy, as well as scanning electron microscopy of bone and tooth microanatomy.

Physical and Chemical Methods in Biomaterials: BIOMS-DN 1011. *Lecture and Laboratory. [Course Directors: D. Mijares, J. Ricci].* This course introduces students to the principles and techniques used in the study of materials and hard tissues, including x-ray diffraction, infrared spectroscopy, inductive coupled plasma, and mechanical testing, as well as other techniques.

Readings in Biomaterials: BIOMS-DN 2000. *[Course Director: Department Faculty].* This course reviews scientific literature related to biomaterials as approved by a faculty mentor. Students are required to prepare an extensive review of a selected biomaterials topic.

Research in Biomaterials: BIOMS-DN 3000. *[Course Director: Department Faculty]* The student may use variable credits each semester for research. Note: This course is required for Thesis Option students.

Independent Project in Biomaterials: BIOMS-DN 3001. *[Course Directors: Department Faculty].* This course requires an independent project that can be a thorough review of an advanced literature topic, evidenced based review, or a researched subject resulting in a publication-length manuscript on a biomaterials-related topic previously accepted by the department. Note: This course is required for Non-Thesis Option students.