Proposal for a  
“Graduate Certificate in Nanobiotechnology”

Sponsoring Department or Unit Name: Department of Biomedical Engineering

First Term the Certificate Would be Offered: Fall 2013

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Overview:  
This is a proposal to establish a new Graduate Certificate in Nanobiotechnology (GCNBT). This new program will prepare graduates for careers in the region’s growing nanobiotechnology industry. Tremendous advances in development of nanoscale, nanostructured, and nano-enabled materials for biotechnology applications are currently taking place. In particular, the development of advanced materials (e.g., electronic materials, optical materials, biologically-derived materials, and nanoscale materials) will allow for the development of next generation systems for use in medicine, homeland defense, and agriculture. These systems will provide integration of multiple functions, miniaturization of devices, an increase in stability, and a decrease in cost. In order for universities, companies, and governmental agencies to pursue this highly specialized work, students must be trained at the graduate level to perform work at the interface of nanoscale science and biotechnology. The proposed nanobiotechnology certificate is aligned with the need for highly trained professionals to nurture rapid growth of nanobiotechnology infrastructure in North Carolina. The keystone of the proposed GCNBT is a required nanobiotechnology course (BME 540, 3 credit hours) and three additional elective courses. Lectures, open discussion, and student presentations will be used to introduce students to this area of study. Groups of four-six students will investigate nanobiomaterial selection, processing, characterization, packaging, reliability, and function for a given application; one case study will be provided to the students each week over the eleven-week course. The participants will also acquire teamwork skills by working together in group activities. Public speaking (e.g., mock scientific presentations) and scientific writing activities will be integrated into BME 540 activities in order to provide students with appropriate skills for working on scientific issues in academic, industrial, or government environments. Students will consider societal and financial factors that guide nanobiotechnology-based device development during BME 540. In addition, case studies on ethical
research conduct will be integrated within the lecture and the case study components of BME 540. Rounding out the program are nine credit hours of nanoscience, materials characterization, and biotechnology courses that will provide students with a well-rounded understanding of important issues in the area of nanobiotechnology. To encourage the GCNBT students to build relationships with research activities related to nanobiotechnology on both campuses, attendance at relevant campus seminars will be required; seminar attendance will be confirmed using a procedure that is currently in use by the BME department. Graduates may choose to receive their Certificates at the BME department’s Spring graduation ceremony. The North Carolina Biotechnology Center is providing startup funding ($20,000) to initiate this program.

Beneficiaries:

A certificate program is necessary due to the interdisciplinary nature of nanobiotechnology. Graduate students in the Department of Biomedical Engineering on both campuses will be the primary beneficiaries. However, students and faculty in other departments in the College of Engineering at NC State and the College of Arts and Sciences at UNC will also benefit. The proposed nanobiotechnology certificate will be open to all students regardless of their home department or school. Opportunities for such structured interactions on topics at the interface of nanoscale science and biotechnology are currently very restricted. For example, neither UNC nor NCSU currently offers any graduate degrees in nanobiotechnology.

In addition, we anticipate that this program will generate significant positive publicity; modern technology solutions to important health problems commonly get regional and national coverage. As a sponsor of this new program, the North Carolina Biotechnology Center and its affiliates will benefit from this project because its success will add to their long list of achievements. In addition, the North Carolina Center of Innovation for Nanobiotechnology is a strong supporter of the proposed certificate program. The North Carolina Center of Innovation for Nanobiotechnology has offered to commit resources in order to ensure the development and successful launch of the certificate, which they describe as a “high-value educational offering.” The Director of Innovation Projects with the North Carolina Center of Innovation for Nanobiotechnology has also offered to promote the development of this educational offering with the reality of industry needs in mind.

Program Requirements:

Credit hours: Twelve, from approved listing of required and elective courses

Courses:

Required Course. 3 credit hours:

Biomedical Engineering (BME 540) Nanobiotechnology Processing 3 credit hours. Topics at the interface of nanoscale and biotechnology will be discussed. Chemical, physical, and biological properties of nanostructured biomaterials, devices and systems. Lectures and problem-based learning will be used to present development of nanobiotechnology-enhanced materials and devices.

Elective Courses. Select 9 credit hours from:

Biomanufacturing (BEC/CHE) 562. Fundamentals of Bio-Nanotechnology. Three Credit hours. Concepts of nanotechnology are applied in the synthesis, characterization, recognition and application of biomaterials on the nanoscale. Emphasis will be given to hands-on experience with nanostructured biomaterials; students will also be familiarized with the potential impact of these materials on different aspects of society and potential hazards associated with their preparation and application.

Chemistry (CH) 747. Nanobiotechnology. Three Credit hours. An introduction to nanobiotechnology, with a focus on biological applications such as bioimaging and biosensing. Principles underlying methods of nanomaterials fabrication and characterization will be introduced, and major characterization techniques
will be discussed. Au nanoparticles, quantum dots, and carbon nanotubes will be used as representative examples of novel nanomaterials with unique properties. The strengths and weaknesses of various nanomaterials in biological applications will be compared through in-class discussions.

Biotechnology (BIT) 501. Ethical Issues in Biotechnology. One Credit Hour. Students investigate and discuss current controversial issues in biotechnology. This course emphasizes thinking about new technologies in a rational and thoughtful way.

Biomedical Engineering (BME) 510. Biomaterials. Three Credit Hours. Chemical, physical engineering and biocompatibility aspects of materials, devices or systems for implantation in or interfering with the body cells or tissues. Food and drug administration and legal aspects. Web enrollment currently available.

Biomedical Engineering (BME) 566. Polymeric Biomaterials Engineering. Three Credit Hours. In-depth study of the engineering design of biomedical polymers and implants. Polymeric biomaterials, including polymer synthesis and structure, polymer properties as related to designing orthopedic and vascular grafts. Designing textile products as biomaterials including surface modification and characterization techniques. Biodegradable polymers. Web enrollment to be made available.

Materials Engineering (MSE) 539. Advanced Materials. Three Credit Hours. Introduces production/structure/property/function relation and application of a number of materials mainly for biomedical, mechanical and aerospace applications. Topics include ultra light materials (production, processing and applications of cellular solids), biomaterials (classes and application of materials in medicine and dentistry), composites (classes and application), refractory materials and coatings for high temperature applications, thin film shape memory alloys for micro-electro mechanical systems (MEMS).

With approval from the GCNBT coordinator, three credit hours of other related courses at NCSU or from UNC Chapel Hill. Initial list of UNC Chapel Hill courses include-


Biology (BIOL) 631. Advanced Molecular Biology I. Three Units. DNA structure, function, and interactions in prokaryotic and eukaryotic systems, including chromosome structure, replication, recombination, repair and genome fluidity.

Biology (BIOL) 632. Advanced Molecular Biology II. Three Units. RNA structure, function and processing in biological systems including transcription, gene regulation, translation and oncogenes. Three lecture hours a week.

Biomedical Engineering (BMME) 510. Biomaterials. Three Units. Chemical, physical engineering and biocompatibility aspects of materials, devices or systems for implantation in or interfering with the body cells or tissues. Food and drug administration and legal aspects. Web enrollment currently available.

Pharmacology (PHCO) 701. Introduction To Molecular Pharmacology. Two Units. A first-year pharmacology course outlining the basic of molecular pharmacology, including molecular biology, drug/receptor interactions, receptors and ion channels, regulation of second messengers and drug metabolism.

Pharmacology (PHCO) 715. The Molecular Pharmacology Of Cancer. Two Units. This course deals with the molecular and cellular basis of anticancer and antiviral chemotherapy, with emphasis on novel
approaches including immunotherapy, antisense oligonucleotides and gene therapy. The course includes faculty lectures and student presentations.

Pharmacology (PHCO) 738. Nanomedicine. Two Units. This course offers an introduction to the nascent interdisciplinary field of nanomedicine for students with physical/biological science backgrounds; course will be based on student-led discussions of current literature.

Minimum grade to receive course credit: C
Credit-only courses: Not allowed
Transfer credit: None allowed from universities other than UNC and NC State inter-institutional registration program
Seminar attendance: Ten seminars from an approved list
Presentation: A project seminar to both campuses using BME’s teleconference facilities
Time limit: Four calendar years
Overall GPA Required: 3.0

Administration:

The program will be administered by the GCNBT Coordinator (appointed by the Deans of Engineering and Medicine) and the GCNBT Program Committee (composed of representatives of the UNC/NCSU Department of Biomedical Engineering). The committee currently includes Sean Washburn (College of Arts & Sciences, UNC-CH), Behnam Pourdeyhimi (College of Textiles, NCSU), Ibraheem T. Badejo (Research Fellow, Ethicon Biosurgery R & D, Raleigh), and Brooks Adams (Executive Director & President, NC Center of Innovation in Nanobiotechnology). The Coordinator will nominate candidates for the Program Committee with approval by the Deans of Engineering and Medicine. The initial GCNBT Coordinator will be R. J. Narayan.

Other than the required course (BME 540), the certificate will not require the creation of any additional courses; it will operate within the usual academic activities of the associated faculty. Students will be able to draw from a wide range of graduate level courses that are already offered by faculty at UNC and NCSU. This certificate is designed in such a way that additional supervisory work for faculty will not be created. The administrative load for this program will consist of meetings with prospective students and biannual meetings to review applications. No additional staff or resources will be required.

Students who have completed the program will fill out an online exit survey and be interviewed by certificate program director. The interviews will allow the program director to evaluate how the students felt about their experiences in the program. We will also track the future activities of students in order to evaluate the impact of this program on professional development. The program committee will meet once a year to discuss the results of the exit surveys and interviews.

Admissions Requirements:
Applications will be evaluated using the graduate admissions criteria of the BME department. Initially, only enrolled graduate students at UNC and NCSU will be admitted. In future years, the program might be expanded to include non-UNC, non-NCSU graduate students in a fee-based executive education program. However, such an expansion is not part of this initial proposal.

Application Process & Fees:
Students will apply online through a website hosted by the UNC-NCSU Department of Biomedical Engineering. The GCNBT Program Committee will evaluate and rank applicants. The GCNBT Coordinator will determine the number of new students who can enter each spring. Standard university tuition and application fees will be charged for the program.

Enrollment Projections:
During its initial offering in Fall 2011, the required course enrolled 9 students. By Spring 2014, the annual enrollment should grow to 16-24 students.
Participants

The initial participants will be the faculty and students of the Department of Biomedical Engineering (BME). In year two, additional departments will be added. Candidates include UNC Biology, UNC Chemistry, UNC Pharmacology, UNC Physics, NCSU Chemistry, NCSU Chemical and Biomolecular Engineering, NCSU Materials Science and Engineering, NCSU Mechanical and Aerospace Engineering, and NCSU Textiles Engineering. Participants will be expected to maintain a minimum overall GPA of 3.00.

Assessment statement

An assessment plan will be developed for the certificate.

Timeline

The timetable for launching the GCNBT is shown below:

<table>
<thead>
<tr>
<th>Phase</th>
<th>Semester</th>
<th>Activities</th>
<th>Milestones &amp; Deliverables</th>
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</thead>
<tbody>
<tr>
<td>Planning</td>
<td>Spring 2013</td>
<td>Submit to the NCSU Graduate School</td>
<td>NCSU campus approval</td>
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<tr>
<td></td>
<td>Spring 2013</td>
<td>Revise proposal as needed; advertise across both campuses students for Fall 2013</td>
<td>Approved GCNBT</td>
</tr>
<tr>
<td>Launch</td>
<td>Spring 2014</td>
<td>Offer nanobiotechnology required course (BME 540); begin publicity for certificate</td>
<td>First GCNBT students enter the program</td>
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<tr>
<td>Sustaining</td>
<td>Fall 2014</td>
<td>Open admission to students from other departments at UNC and NCSU; open admission to executive education students</td>
<td>Funding for the program assumed by BME</td>
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Measures of Success

Specific measures that will be reported each year are:

- Number of enrolled students
- Number of departments who participate
- Student and faculty evaluation surveys
- Department chairs’ feedback

Sustainability

Once the North Carolina Biotechnology Center startup funding for the GCNBT is exhausted, the BME department will continue the program. The Chair of this department is committed to improving the infrastructure for nanobiotechnology education at UNC and NC State. The nanobiotechnology required course (BME 540) will become a standard BME department offering. BME will provide the instructor for the required course. Support for student internships, plant visits, and seminars will be sought from the local industry as well as private foundations.