TOPIC: University of Maryland Eastern Shore: Master of Science (M.S.) in Chemistry

COMMITTEE: Education Policy

DATE OF COMMITTEE MEETING: June 1, 2011

SUMMARY: As reported by the Maryland Workforce Exchange (2007), nearly 25% of all job openings projected through the year 2014 will be in occupations requiring a Bachelor of Science degree or higher. Specifically, the projected job market increase for chemists/chemical engineers is approximately 13%. The current mean annual wage for chemists in Maryland is $89,775, while that of a chemical technician is $44,850.

Through the proposed Master of Science (M.S.) in Chemistry, the Department of Natural Sciences seeks to prepare students, especially those from underrepresented minority groups and women, for employment and continued development of student research training in the discipline of chemistry. The goal of the proposed program is to provide a challenging educational opportunity that will prepare students for careers in research, industry, and for entrance into doctoral degree programs.

The Department currently offers rigorous curricula for students majoring in Biology, Chemistry, and Environmental Science at the baccalaureate level as well as the Master of Science degree and Doctor of Philosophy degree in both toxicology and marine, estuarine, and environmental sciences. The proposed program builds upon the existing strength of the faculty and the existing graduate programs offered by the Department of Natural Sciences. In addition, the faculty members of the DNS maintain several modern research facilities and various types of specialized instrumentation, including several mass spectrometers, a nuclear magnetic resonance spectrophotometer, a high pressure liquid chromatograph, electrophoresis equipment, DNA analyzer, thermogravimetric analyzer, fluorimeter, scintillation counter, microarray scanner, scanning electron microscope, and fluorescence-activated cell sorter.

ALTERNATIVE(S): The Regents may not approve the program or may request further information.

FISCAL IMPACT: No additional funding is necessary. The program will be supported through tuition.

CHANCELLOR'S RECOMMENDATION: That the Committee on Education Policy recommend that the Board of Regents approve the proposal from the University of Maryland Eastern Shore to offer the Master of Science in Chemistry

COMMITTEE RECOMMENDATION: DATE:

BOARD ACTION: DATE:

SUBMITTED BY: Irwin Goldstein (301) 445-1992 irv@usmd.edu

UNIVERSITY SYSTEM OF MARYLAND INSTITUTION PROPOSAL FOR

x **New Instructional Program**

_____ Substantial Expansion/Major Modification

_____ Cooperative Degree Program

University of Maryland Eastern Shore
Institution Submitting Proposal

Master of Science Degree Program in Chemistry
Title of Proposed Program

Master of Science, Chemistry	**Fall 2011**
Degree to be Awarded	Projected Implementation Date
040102 Chemistry	**Chemistry 260101**
Proposed HEGIS Code	Proposed CIP Code
Natural Sciences	**Dr. Joseph M. Okoh**
Department in which program will be located	Department Contact
410-651-6015	**Jmokoh@umes.edu**
Contact Phone Number	Contact E-Mail Address
Signature of President or Designee	Date

Mission

The proposed Master of Science (M.S.) Program in Chemistry (subsequently referred to as "Program") provides the educational opportunity to prepare students, especially those from underrepresented minority groups and women, for employment and continued development of student research training in the disciplines of chemistry.

This program addresses the mission of UMES. UMES is a teaching, research, and doctoral degree-granting institution that nurtures and prepares leaders in a student-centered environment, particularly from among minorities and women. Committed to providing high quality programs in an ethnically diverse environment, the University prepares students who will serve and shape the global economy. UMES values and promotes the scholarship of faculty, discovery and dissemination of new knowledge, and applying that knowledge to the benefit of the extended community. The University recognizes its responsibility for developing human potential, enriching cultural expressions, and sharing its expertise with individuals, businesses, educational, governmental, and non-governmental organizations.

While the Carnegie Foundation classifies UMES as a Masters Comprehensive University, MA 1, the University aspires to achieve Doctoral/Research University-Intensive classification. Consequently, UMES has developed and implemented freestanding doctoral degree programs in (a) Food Science & Technology, (b) Physical Therapy, (c) Organizational Leadership, (d) Toxicology and (e) Educational Leadership.

The proposed Program addresses the mission of the 2004 Maryland Higher Education Commission (MHEC) state plan for postsecondary education. The M.S. Program in Chemistry will expand academic course offerings and programs in the Department of Natural Sciences. Specifically, the proposed Program will be congruent with Goals 2, 3, and 5 of the MHEC Maryland State Plan:

Goal 2 - Achieve a system of postsecondary education that promotes accessibility and affordability for all Marylanders.
Goal 3 – Ensure equal educational opportunity for Maryland's diverse citizenry.
Goal 5 – Promote economic growth and vitality through the advancement of research and the development of a highly qualified workforce.

Currently, the health and science programs are the University's distinct academic emphases. As such, the Department of Natural Sciences (DNS) offers rigorous curricula for students majoring in Biology, Chemistry, and Environmental Science at the baccalaureate level as well as master of science degree and doctor of philosophy degree in both toxicology and marine, estuarine, and environmental sciences.

Characteristics of the Proposed M.S. Program in Chemistry

Articulated Workforce Needs

The United States is currently a world leader in scientific knowledge, research, and development; to maintain that position, the nation, as a whole, must continue to train scientists who excel in learning and discovery.

As reported by the Maryland Workforce Exchange (2007), nearly 25% of all job openings projected through the year 2014 will be in occupations requiring a bachelor of science degree or higher. Specifically, the projected job market increase for chemists/chemical engineers is approximately 13%. The current mean annual wage for chemists in Maryland is $89,775, while that of a chemical technician is $44,850.

Admissions and Enrollment

Applicants must meet the general requirements for graduate admission as outlined by the Graduate School at UMES. Perspective students should have a Bachelor of Science (B.S.) in Chemistry, Natural Sciences, or related field from an accredited institution. The following courses with their laboratories are prerequisites for admission into the Program: eight credits of General Chemistry I & II, eight credits of Organic Chemistry I & II, four credits of Analytical Chemistry, four credits of Physical Chemistry, eight credits of Physics, four credits of Biochemistry, eight credits of General Biology, and four credits of Calculus. A satisfactory grade (grade of B) must be earned in these courses, with a cumulative grade point average of

3.0 or higher. Students failing to meet these prerequisites may be required to complete them during their first year in the program.

In addition, a minimum score of 550 in each section of the Graduate Records Examination (GRE) is preferred. Students who pass the Chemistry Advanced Area Test of the GRE will be given admission preference. If required, students are expected to have acceptable TOEFL scores, as determined by the Office of Graduate Studies.

A complete application package should include the applicant's: official college transcripts, three letters of recommendation, a brief statement of research interest, results of the Graduate Records Examination (GRE) and results of Test of English as a Foreign Language (TOEFL).

The above requirements may be waived for any promising student at the discretion of the majority of the graduate faculty members in addition to the DNS Chairman. In such a case, the student can be admitted into the Program on a provisional basis and required to remove deficiencies.

It is estimated that four full-time students will enroll in this Program during the first year of its offering. Enrollment will increase slowly through a five-year period to the projected goal of six students. The Program will be offered to full-time and part-time students.

Program Degree Requirements

The goal of the Program is to provide a challenging educational opportunity that will prepare students for careers in research, industry, and for entrance into doctoral degree programs. To accomplish this goal, the Program will:

- Impart the skills necessary to succeed in academic, professional, and social environments that will facilitate lifelong learning.
- Teach students to assume leadership roles in professional activities and organizations that advance the chemical sciences.

Students will be required to interview at least three graduate faculty members in the DNS during their first semester and select a graduate advisor by the end of the second semester. The student will complete the "Advisor Selection Form" at the conclusion of their interviews. The graduate advisor will appoint a permanent committee, the advisory committee, by the end of the second semester by completing the "Committee Selection Form" and returning it to the DNS Chairman.

A program of study will be developed by the advisory committee and approved the DNS Chairman: this may include any missing prerequisites, and required core courses. The total number of required course credit hours may exceed the usual 30 hour minimum for the M.S. Degree Program in Chemistry in some cases. Although graduate courses taken elsewhere may serve to fulfill requirements, only six credits of such courses may be transferred. Transferable credit hours must be approved by the DNS Chairman. Courses used to satisfy requirements for a previously awarded degree may not be used for credits.

Students enrolled in the Program must successfully complete a series of cumulative exams beginning in their third semester of registration in the graduate program. A student will be required to accrue a minimum of 12 points in a series of seven consecutive cumulative exams (3 points each) to attain candidate status. Failure to pass the cumulative exams will result in disqualification from the Program.

Students will be required to successfully complete 30 credit hours for the Program in the following areas: 12 credit hours of Core Courses*, nine credit hours of Electives, three credit hours of Graduate Seminars, and six credit hours of Thesis Research. Elective courses must be at the 600 level to fulfill credit hour requirements. Up to three credit hours of seminar courses may be applied to the Program degree requirements.

Graduate Chemistry Courses by Title

Core Courses

CHEM 620 Advanced Inorganic Chemistry	3 cr.
CHEM 632 Advanced Organic Chemistry	3 cr.
CHEM 670 Advanced Biochemistry	3 cr.
CHEM 680 Quantum Mechanics	3 cr.
CHEM 690 Principles of Chemical Separations	2 cr.
CHEM 695 Applied Spectroscopy	3 cr.
CHEM 799 Masters Thesis Research	6 cr.

Electives

CHEM 697 Department of Natural Sciences Graduate Seminar	1 cr.
CHEM 601 Chemical and Statistical Thermodynamics	3 cr.
CHEM 622 Bioinorganic Chemistry	3 cr.
CHEM 621 Advanced Environmental Chemistry	3 cr.
CHEM 671 Protein Chemistry and Enzymatic Catalysis	3 cr.
CHEM 672 Carbohydrate Chemistry	3 cr.

A grade of B or better must be earned in each course to receive credit toward graduation. A student will not be permitted to graduate with a grade of I on his/her transcript. If a student's grade point average falls below a 3.0 at any time, the student will be placed on academic probation and subject to review by their advisory committee and the DNS Chairman. The advisory committee and Chairman will ultimately decide the fate of the student.

The proposed Program offers the Thesis Option only. The advisory committee will administer the thesis defense after all other degree requirements, as enumerated above, have been fulfilled. The advisory committee will also decide the outcome of the candidate's defense examination. The student is required to provide each committee member with a copy of his/her thesis two weeks prior to his/her defense. One copy each of the successfully defended thesis must be submitted to the Graduate School and Department of Natural Sciences offices.

Information Technology

Students in the Program will be required to be competent in programs commonly used in science such as Excel to process scientific data, SigmaPlot to produce graphs and develop calibration models, Microsoft PowerPoint for the development of quality presentations, Microsoft Publisher to create poster presentations, CHEMDRAW for the creation of molecular structures, and Microsoft Word in the preparation of manuscripts. Student must also be proficient in online literature searches using various databases. The president assures that the institutional library resources meet the new program goals.

Program and Support Faculty

All graduate faculty members possess a terminal degree in an area of chemical science.

Faculty	**Rank**	**Area of Expertise**
Dr. Joseph Okoh	Professor	Inorganic Chemistry
Dr. Anthony Nyame	Professor	Biochemistry, Glycobiology
Dr. Yan Waguespack	Professor	Physical Chemistry
Dr. Uche Udeochu	Assistant Professor	Analytical Chemistry
Dr. Jennifer Hearne	Assistant Professor	Biochemistry, Enzymology
Dr. Ghislain Mandouma	Assistant Professor	Organic Chemistry
Dr. Jack Pinion	Adjunct	Organic Chemistry
Dr. Gurbax Singh	Professor	App. Spectroscopy/Quantum Mech.
Dr. Marcos Cheney	Associate Professor	Surface Chemistry

The faculty members of the DNS maintain several modern research facilities and various types of

instrumentation. The facilities are housed in Trigg Hall, George Washington Carver Hall, and Richard Hazel Hall. Instrumentation in these facilities includes: Gas Chromatograph Mass Spectrometer, Nuclear Magnetic Resonance Spectrophotometer, Ion Chromatograph, Inductively Coupled Plasma Mass Spectrometer, High Pressure Liquid Chromatograph with Diode Array and Fluorescence Detection, Solution Phase Synthesizer, Electrophoresis Equipment, Microtiter Plate Reader with Fluorescence Detector, DNA Analyzer, Thermogravimetric Analyzer, Laser Zee Meter, Differential Thermal Analyzer, Porosimter, Fluorimeter, Infrared Spectrometer, UV-VIS Spectrophotometer, Atomic Absorption Spectrophotometer, X-Ray Diffractometer, Toxicity Analyzer, Scintillation Counter, Microarray Scanner, Scanning Electron Microscope, Matrix-Assisted Laser Desorption/Ionization Spectrometer, and Fluorescence-Activated Cell Sorter. The president assures that the institutional facilities meet the new program needs.

Chemistry faculty and students are provided a code by the chemistry program to access online Chemical Abstracts using STN. They can also conduct searches using our library which provides access to ACS Journals, Science Direct and Academic Search Premier as well as over 100 other databases. Off-campus access is provided to the database using Research Port. Students and faculty are able to find/request thousands of articles using Citation Linker which searches the library catalog and databases and conducts Interlibrary Loan using Illiad. The Department allocates about $1000.00 annually for CAS search expenditures. Typically, members of faculty use their grant monies to cover such expenses.

Finance

Currently, the tuition for an in-state graduate student is $225.00/credit hour and $408.00/credit hour for an out-of-state graduate student. The mandatory University fees, per academic year, for a graduate student total $40.00. Each graduate student will pay a research laboratory fee ($150/credit hour) to the Department of Natural Sciences.

It is not anticipated that new funds will be needed or will need to be reallocated to implement the program during its first two years in existence. No new full-time equivalent faculty members, administrative staff, or support for present administrative staff is requested.

Funds ($28,000) for items such as equipment upgrade, library resources and supplies pre-exist through grants and current programs such as the American Chemical-Society-Certified BS Degree Program in Chemistry and MEES MS/PhD programs in the Environmental Chemistry Area of Specialization. Fund for the regular upgrade of equipment will be provided through recurring Historically Black Graduate Institutions' Title III funds for the Department of Natural Sciences.

TABLE 1: RESOURCES					
Resources Categories	(Year 1)	(Year 2)	(Year 3)	(Year 4)	(Year 5)
1.Reallocated Funds	$0	$0	$0	$0	$0
2. Tuition/Fee Revenue	$30,544	$91,512	$144,924	$167,792	$167,792

a. #F.T Students
R=MD Resident
NR=Non-Resident of MD
	4 (4 new)
	R=2
	NR=2
		9 (5 new)
		R=6
		NR=3
			15 (6 new)
			R=11
			NR=4
				17 (6 new)
				R=12
				NR=5
					18 (6 new)
					R=12
					NR=6

Annual Tuition/Fee R=$225/credit hour NR=$408/credit hour Fee = $40/AY	R=$10,800 NR=$19,584 Fee=$160	R=$32,400 NR=$58,572 Fee=$360	R=$51,300 NR=$93,024 Fee=$600	R=$59,400 NR=$107,712 Fee=$680	R=$59,400 NR=$107,712 Fee=$680
c. Annual Full Time Revenue	$30,544	$91,512	$144,924	$167,792	$167,792
d. # Part Time Students, Credit Hour Rate, and Annual Credit Hours	0	0	0	0	0
g. Total Part Time Revenue	$0	$0	$0	$0	$0
3. Grants, Contracts, & Other External Sources	$150,000	$150,000	$150,000	$150,000	$150,000
4. Research Lab Fees	$0	$0	$600	$750	$750
TOTAL (Add 1 - 4)	$180,544	$241,512	$295,524	$318,542	$318,542

TABLE 2: EXPENDITURES					
Expenditure Categories	(Year 1)	(Year 2)	(Year 3)	(Year 4)	(Year 5)
1. Total Faculty Expenses	$0	$0	$0	$0	$0
2. Total Administrative Staff Expenses	$0	$0	$0	$0	$0
3. Total Support Staff Expenses	$0	$0	$0	$0	$0
4. Equipment*	$2000	$2000	$2000	$2000	$2000
5. Library*	$1000	$1000	$1000	$1000	$1000
6. New or Renovated Space	$0	$0	$0	$0	$0
7. Other Expenses*	$25,000	$25,000	$25,000	$25,000	$25,000
TOTAL (Add 1 - 7)	$28,000	$28,000	$28,000	$28,000	$28,000

*Funds for these items pre-exist through grants and current programs such as the American Chemical-Society-Certified BS Degree Program in Chemistry and MEES MS/PhD programs in the Environmental Chemistry Area of Specialization. Fund for the regular upgrade of equipment will be provided through recurring Historically Black Graduate Institutions' Title III funds for the Department of Natural Sciences.

CHEM 620 Advanced Inorganic Chemistry **3 cr.**
This course is intended for first or second year graduate students. Students should gain knowledge of Inorganic Chemistry to solve practical problems. Solids, Symmetry, Ligands, and Chemistry of Main Group and Transition Elements will be covered.

CH**EM 632 Advanced Organic Chemistry** **3 cr.**
Advanced Organic Chemistry addresses two fundamental needs. First, the students will acquire the latest knowledge and expertise in the utilization of modern analytical instrumentation routinely in research laboratories, namely multidimensional NMR and MALDI-TOF Mass Spectrometry. Secondly, this course will provide an in-depth study of reaction mechanisms of the most fundamental reaction in Organic Synthesis, namely the different ALDOL reactions. The course also highlights the latest advances in synthesis, the newly introduced coupling protocols such as the "Heck", the "Suzuki-Miyaura", and the "Negishi" coupling reactions as well as other elegant technologies in the field of study.

CHEM 697 Department of Natural Sciences Graduate Seminar **1 cr.**
Students will be required to present two seminars during the course of the program. Topics for the seminars shall comprise a report on the student's thesis research and a paper selected from a high impact journal dealing with current discoveries and innovations in chemistry and biochemistry. The course grade will be based on evaluations from faculty. Grading will be based on organization, clarity of presentation, knowledge of the subject and scientific merit.

CHEM 680 Quantum Mechanics **3 cr.**
This course will cover Schroedinger Equation, particles in a potential well, angular momentum, variation method, and time-independent perturbation theory. It will also discuss the application of quantum mechanical principles to current problems in chemistry such as: thermodynamic properties of gases, chemical bonding and Born-Oppenheimer Approximation, and molecular spectra.

CHEM 690 Principles of Chemical Separations **2 cr.**
Chemical separations play a central role in many areas of chemistry and other disciplines. For example, the cleaning up of polluted water or soil, the treatment of discharge streams from chemical processes, or modification of a specific process to decrease its environmental impact. Thus, this course will focus on the use of separation technology as a unit operation in chemical and environmental applications. Specifically, this course will describe how property differences are used to generate separations, the use of separating agents, and the selection criteria for particular separation techniques. The general approach for each technology is to present the chemical and/or physical basis for the process and explain how to evaluate it for design and analysis. Topics covered in this class will include: 1. Separations as unit operations; 2. Separations analysis fundamentals; 3. Distillation; 4. Extraction; 5. Absorption and stripping; 6. Adsorption; 7. Ion exchange; 8. Membranes.

CHEM 695 Applied Spectroscopy **3 cr.**
This course involves a practical approach to the application of spectroscopic techniques such as infrared ultraviolet/visible, nuclear magnetic resonance and mass spectroscopy as tools to solving problems in biochemistry, chemistry, and other related fields of study.

CHEM 799 Masters Thesis Research **6 cr.**
Students who are working on their Master of Science thesis register in this course which will count towards the partial fulfillment of curriculum requirements for the MS degree in Chemistry. The student is required to prepare a proposal for a detailed research study, have that proposal approved by an appropriate faculty thesis committee, complete the proposed study, and write and defend the completed Thesis in a final oral examination. The work will be conducted independently by the student outside the context of structured class meetings. The student's role is to identify an appropriate research question, develop a systematic research plan to address it, and then execute this plan themselves, collecting, analyzing and interpreting

the resulting data and writing them up in standard scholarly format. The faculty advisor's role is to provide guidance in these various steps where appropriate, such as in helping to identify the research question and in providing feedback on the student's proposed research design, its execution, and the data.

CHEM 601 Chemical and Statistical Thermodynamics **3 cr.**
This course will cover statistical mechanics, three laws of thermodynamics and chemical kinetics. It includes the discussion of reversible and irreversible thermodynamics of gases, liquids, solution and solids. Reactions and determination of rate laws for simple and complex reaction will be examined. Application of these principles to gases, solution, mixtures, and solid will be discussed.

CHEM 622 Bioinorganic Chemistry **3 cr.**
This course deals with the functions of metallic elements in biology. These functions range from simple structural roles to much more complex roles when they transfer electrons and break bonds. Consequently the roles of metal ions and a variety of non-metals in crucial life processes will be discussed. This course will also examine the physical methods and techniques used in this field (e.g. EXAFS, ESR, Mossbauer, and NMR). In-depth discussion will also cover metalloenzymes and metal complexes used as imaging agents.

BCHM 671 Protein Chemistry and Enzymatic Catalysis **3 cr.**
The course involves the study of the structures and functions of proteins. Emphasis will be placed on the application of the structure-function relationships to the development of experimental protocols for studies in biochemical research.

BCHM 672 Carbohydrate Chemistry **3 cr.**
The course involves detailed studies of the structures and cellular functions of carbohydrates and glycoconjugates of plants and animals. The course will place special emphasis on techniques for the analysis and biosynthesis of complex carbohydrate structures and the relevance of the techniques to biomedical research.