

**SELF-STUDY
DOCUMENT**

**UNIVERSITY OF KENTUCKY
CENTER OF MEMBRANE SCIENCES**

2005-2010

CENTER OF MEMBRANE SCIENCES

I. OVERVIEW DESCRIPTION

The Center of Membrane Sciences is a multidisciplinary research Center composed of 20 Faculty Associates representing 6 Departments and 5 Colleges located in both the Main Campus and Medical Center. The Center was administratively formed in 1986 by the Dean of the Graduate School with base funding from the National Science Foundation, the Commonwealth of Kentucky, and the University. When the University reorganized its administrative structure, the Center administratively reported to the Vice President for Research and Graduate Studies. On April 8, 1991, the University Senate unanimously voted to approve the creation of the Center as a separate unit of the University administratively housed within the Research and Graduate Studies Sector. The UK board of Trustees officially ratified this proposal on June 18, 1991. Under President Lee Todd, the University reorganized to become "One University." The Center Director now reports to the Vice President for Research.

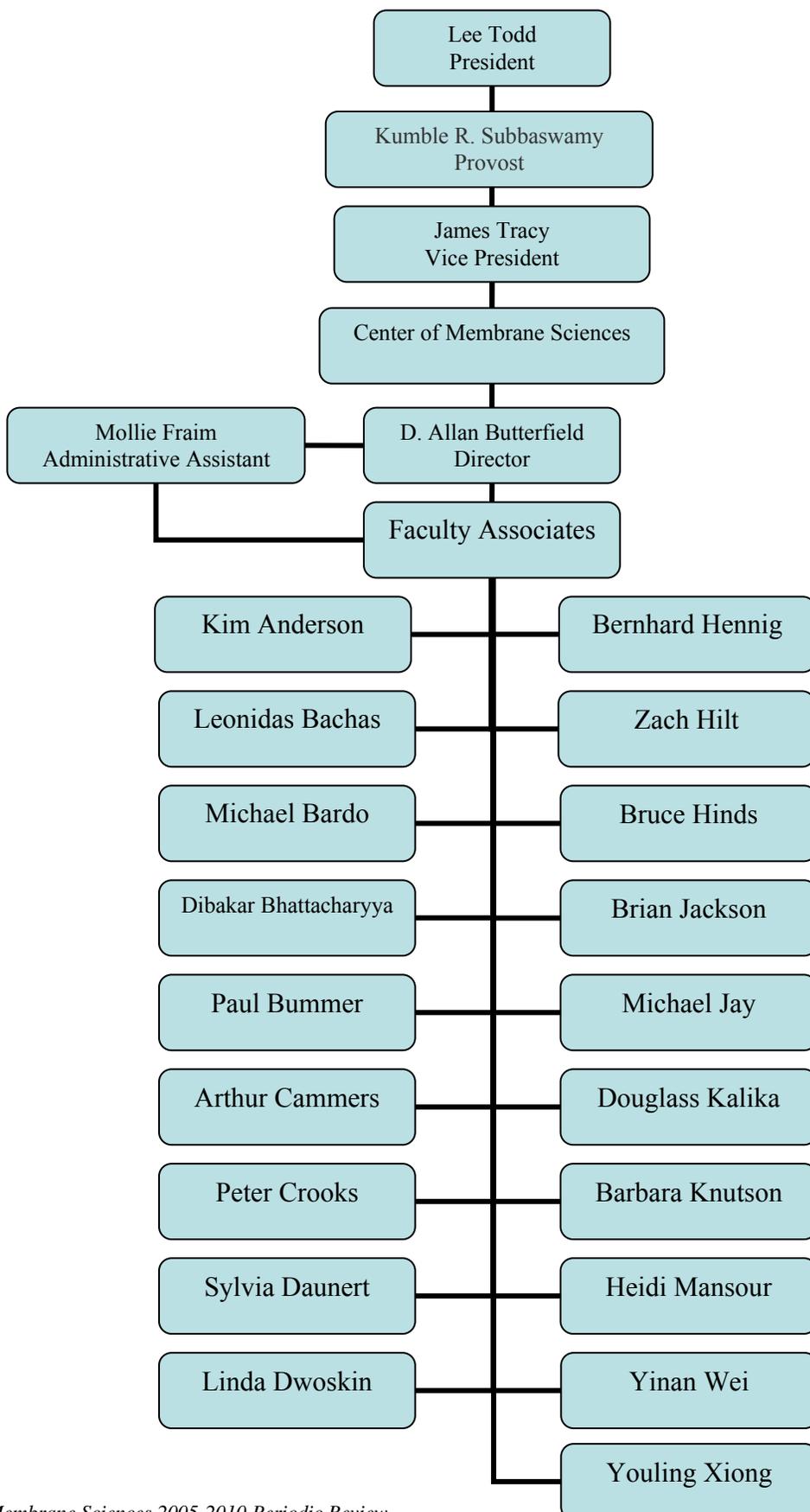
The major activities of the Center are to: (1) provide an administrative structure to promote interdisciplinary membrane research interaction; (2) provide instruction in the totality of membranes, i.e., biological and synthetic membranes and their interface, that together with research efforts, have the aim of producing department-based Ph.D. and M.S. students who can interact equally well with scientists, engineers, and clinicians in the physical, engineering, and life sciences; and (3) increase visibility of membrane sciences at the University. To coordinate these activities, the Center has a Director (15% salary support and 10% Distribution of Effort) and one staff member.

II. MISSION STATEMENT

The mission of the Center of Membrane Sciences is to foster interdisciplinary interactions among biological and synthetic membrane experts in the areas of research, teaching, and service and to enhance the visibility of membrane research at the University.

These activities contribute to the mission of the University in that research is produced, graduate students are educated, and service to the University, academic, and industrial communities is performed.

III. CENTER OF MEMBRANE SCIENCES ORGIZATIONAL CHART (2005-2010)



Center of Membrane Sciences

Faculty Associates

20 Faculty, 6 Departments, 5 Colleges

1. College of Agriculture

Department of Animal Sciences

1. Bernhard Hennig - 1992
2. Youling Xiong - 1997

2. College of Arts and Sciences

Department of Chemistry

3. Leonidas Bachas 1987
4. D. Allan Butterfield - 1986
5. Arthur Cammers-Goodwin - 1995
6. Sylvia Daunert – 1994
7. Yinan Wei - 2010

Department of Psychology

8. Michael Bardo - 1990

3. College of Engineering

Department of Chemical & Material Engineering

9. Kimberly Anderson * - 1987
10. Dibakar Bhattacharyya – 1986
11. Zach Hilt – 2009
12. Bruce Hinds – 2009
13. Douglass Kalika * - 1990
14. Barbara Knutson - 1996

4. College of Medicine

Department of Physiology and Biophysics

15. Brian Jackson - 1988

5. College of Pharmacy

Division Medicinal Chemistry and Pharmaceutics

16. Paul Bummer * - 1990
17. Peter Crooks - 1994
18. Linda Dwoskin – 1999
19. Michael Jay - 1987
20. Heidi Mansour – 2009

* Was recruited in cooperation with the Center of Membrane Sciences and has indicated that he/she would not have come to UK without the Center being here at UK.

IV. MAJOR ACOMPLISHMENTS OF THE CENTER OF MEMBRANE SCIENCES DURING THE PERIOD 2005-2010.

A. Quality of Faculty Associates

1. General Comments

The Faculty Associates of the Center of Membrane Sciences are distinguished by two principal characteristics: (1) each is actively pursuing scholarly research, teaching, and service in membrane-related areas; and (2) each displays the highly desirable characteristics of being open and receptive to the totality of membrane research. By the latter comment it is meant that Faculty Associates of the Center are extremely willing to share ideas, expertise, and research equipment with each other. They are willing to learn from each other, and to develop new areas of scientific inquiry based on this interaction. This quality is, in fact, one of the major strengths of the UK Center of Membrane Sciences.

As outlined in **Section IV. B** below, many Ph.D. and M.S. students have been (or are being) trained jointly by Faculty Associates in different departments (and different colleges). Some of these Ph.D. students have been jointly trained by two faculty associates of the Center. A large number of papers, presentations, and grant proposals have been jointly written by Faculty Associates of the Center. Whole new areas of research have developed because of this cooperative spirit, and this has helped the University of Kentucky achieve national and international recognition and visibility. One example to illustrate this is the highly successful research by Professor Dibakar Bhattacharyya (Chemical and Materials Engineering) and Leonidas Bachas (Chemistry) on biosensors and metal-ion-binding membranes. In the view of the director, the success of the Center is directly tied to its greatest strength: the strong interaction of biological and synthetic membrane experts to produce innovative, multidisciplinary research.

Others have recognized the achievements of Faculty Associates of the Center during the period over the last review (2005). The following Faculty Associates have received recognition from external constituencies:

2. Honors Received by Center of Membrane Sciences Faculty Associates During the Review Period, 2005-2010:

D. ALLAN BUTTERFIELD

1. Alumni Association Endowed Professor of Biological Chemistry, University of Kentucky, 2002-present
2. Recipient, Award for Most Outstanding PhD Committee Member for Prince of Songkla University, Thailand, 2007
3. International Member, Scientific Review Panel, Ministry of Education, for the Government of Singapore, 2006-present
4. Permanent Member, NIH Study Section on Neural Oxidative Metabolism and Death, 2008-2012
5. Invited Speaker, Gordon Research Conference on Oxygen Radicals, 2010
6. Recipient, Albert D. and Elizabeth H. Kirwan Memorial Prize for Excellence in Research, 2010.

7. Listed as in the Top-40 of most-productive and most-cited investigators in the field of Alzheimer's disease research *in the entire world* as indicated in *the Journal of Alzheimer's Disease* **16**: 451-465 (2009).
8. Tanea Reed, who received the Ph.D. under my aegis, won the 2010 Hermann Esterbauer International HNE Award for junior faculty members for her research performed in my laboratory on proteomics identification of HNE-bound brain proteins in AD and MCI.

LEONIDAS G. BACHAS

1. Frank J. Derbyshire Professorship, University of Kentucky, 2002-2010

MICHAEL BARDO

1. 2005 Distinguished University Scientist, Kentucky Academy of Science
2. 2009 Charter Fellow, Midwestern Psychological Association

DIBAKAR BHATTACHARYYA

1. Gerhold Award (2009) from AIChE for outstanding accomplishments in the field of Separations, Award presented at the 2009 AIChE Annual Meeting, Nashville, TN
2. Epstein Service Award (2010) from AIChE for outstanding service in technical programming and for chemical engineering education, award presented at the AIChE Spring National Meeting, San Antonio, TX
3. Keynote Speaker (Sept 2010) at the Water and Membrane Research Event, Oxford University
4. Main Plenary Speaker for 2009 SIMPAM Membrane Conf, Brazil, 2009
5. Outstanding AIChE Student Chapter (National) Award, Nov 2009
6. Special Technical Session Honoring D. Bhattacharyya, 2007 North American Membrane Society Annual Conference, Orlando, Florida, May 2007; Plenary Speaker
7. Distinguished Lecturer Award at the Indian Chemical Engineering Congress (Dec 2007)
8. University of Kentucky Great Teacher Awards (2008, 1996, 1984), *first UK faculty to receive the highest teaching award for three different decades*

PETER A. CROOKS

1. Most Outstanding Teacher Award, Pharm. D. Class of 2007, College of Pharmacy, University of Kentucky (2005).
2. Invited Keynote Address, Twentieth A. Nelson Voldeng Memorial Lecturship Award in recognition of an outstanding lecture to the Thirty Fourth Annual MALTO Conference, University of Louisiana at Monroe, Monroe, LA, (2007).
3. Robert Blouin Graduate Program Teaching Award, College of Pharmacy, University of Kentucky (2007).
4. Nominated and Elected by the American Association of Pharmaceutical Scientists Membership to the Executive Council Committee as Member-at-Large (2007-2010).
5. Invited Keynote Address, National Symposium on Recent Trends in Organic and Medicinal Chemistry, National Institute of Technology, Warangal, India (2009).

6. Ronald F. Borne Distinguished Lectureship Award in recognition for outstanding contributions in medicinal chemistry, University of Mississippi School of Pharmacy, Department of Medicinal Chemistry, Oxford, MS (2010).
7. Robert Blouin Award for Outstanding Contributions to Graduate Education in the Department of Pharmaceutical Sciences, College of Pharmacy, University of Kentucky (2010).
8. American Association of Pharmaceutical Scientists Research Achievement Award in Drug Design and Discovery (2010).

SYLVIA DAUNERT

1. Gill Eminent Professorship (Endowed Professorship), College of Arts & Sciences, University of Kentucky, 2002-present
2. Albert D. and Elizabeth H. Kirwan Memorial Prize, University of Kentucky, 2009. *This is the highest award that a University of Kentucky faculty member can receive and it is bestowed during the honorary degree recognition at graduation.*
3. The 2009 Bill Barfield Award, Kentucky Water Resources Research Institute, 2009
4. Distinguished Professor, AMC/FUMEC, Instituto Politécnico Nacional, Mexico, 2007
5. University Research Professor Award, University of Kentucky, 2005-200.
6. Distinguished Professor, College of Arts & Sciences, University of Kentucky, 2005-2006

LINDA DWOSKIN

1. 2002-2007 US Surgical-Pfizer Endowed Professorship, UK
2. 2005-2006 University Research Professorship
3. 2007 Endowed Professor of Pharmaceutical Education
4. 2007 Mentor Recognition Award, Clinical and Translational Science Conference
5. 2007 Circle of Power, Leadership Program for Women Faculty
6. 2008-2009 Academic Leadership Fellow, American Association of Colleges of Pharmacy

BERNHARD HENNIG

1. Charles E. Ragus Award for the Best JACN Scientific Research Paper of 2009
2. Fulbright Award recipient, 2009; Universidad de Antioquia, Medellín, Colombia
3. Bobby Pass Excellence in Grantsmanship Award, University of Kentucky, 2007
4. Helen LeBaron Hilton Award for Outstanding Leadership and Distinguished Achievement; Iowa State University, 2006

ZACK HILT

1. 2009-2010 Outstanding Chemical Engineering Teacher Award – University of Kentucky
2. 2008-2009 Outstanding Chemical Engineering Teacher Award – University of Kentucky
3. 2008 Invited Participant – 2008 NAE German-American Frontiers of Engineering
4. 2008-present Associate Editor – International Journal of Nanomedicine (IJN)
5. 2007-present Area 22b (Bionanotechnology), Co-Chair – American Institute of Chemical Engineers
6. 2007-2009 Secretary/Treasurer of the Drug Delivery SIG – Society for Biomaterials

BRUCE HINDS

1. Kavli Frontiers of Science Fellow, National Academy of Science 2010
2. Elected vice-chair Gordon Conference 'Membranes: Materials & Processes 2012'
3. Presidential Early Career Award (PECASE, NIH) 2009

BRIAN JACKSON

1. 04/09 - present: Member, American Heart Association (AHA) Region 1 / 2 Cardio-Renal Research Review Committee
2. 03/09: Vice-Chair, Minority Biomedical Research Support Panel, National Institute of General Medical Sciences
3. 06/07 - 05/08: Member, Professional Science Master's Program Development Committee
4. 12/04 - 04/06: Chair, Study Section #4, AHA, Southern/Ohio Valley Research Consortium

MICHAEL JAY

1. Bluegrass Pharmacists Association – Distinguished Service Award 2005
2. Fellow, American Association of Pharmaceutical Scientists, 2006
3. Robert A. Blouin Excellence in Pharmaceutical Graduate Education Award. Department of Pharmaceutical Sciences, College of Pharmacy, University of Kentucky 2006.

DOUGLAS S. KALIKA

1. 2006-2007 Henry Mason Lutes Award for Undergraduate Engineering Education, University of Kentucky College of Engineering
2. 2006-2007 Tau Beta Pi Outstanding Teacher Award; U.K. College of Engineering

BARBARA KNUTSON

1. 1998-99, 2001-2002 Outstanding Chemical Engineering Teacher Award, University of Kentucky
2. 2001 Inductee of the Georgia Institute of Technology College of Engineering Outstanding Young Alumni Council
3. American Institute of Chemical Engineers (AIChE); American Chemical Society (ACS); Society of Women Engineers (SWE)

HEIDI MANSOUR

1. World Academy of Science, Engineering, and Technology (WASET): Elected Member 2007
2. American Academy of Nanomedicine: Academy Fellow 2008
3. Mercer SOP AAPS Student Chapter "Researcher of the Issue"-Pharmabeat-Inaugural Issue 2010
4. Scholarship of Teaching & Learning Certificate (STLC) Award, UK College of Pharmacy, 2010

YOULING L. XIONG

1. Fellow, Institute of Food Technologists (IFT), 2010.
2. Thomas Poe Cooper Distinguished Research Award, College of Agric., Univ. of Kentucky, 2009.
3. Best Presentation Award, American Oil Chemists Society annual meeting, Protein Co-products Div., 2005.

B. Measures of Quality

The following table summarizes the achievements of the Faculty Associates of the Center of Membrane Sciences from 2005-2010 inclusive. The curriculum vitae of all Faculty Associates are on file in the Center office. Details of each column are provided in appendices to this Self Study. By any measure, one can state that the Faculty Associates have been highly successful in research and graduate education. For example, more than 203 extramural grants totaling over \$129 million have supported research that has led to nearly 900 refereed publications and produced approximately 164 Ph.D. and M.S. students and trained postdoctoral scholars. In addition, nearly 700 presentations at national and international meetings were given by Faculty Associates and/or their students. This group of outstanding Faculty Associates produced nearly 250 patents during this period. *These are truly remarkable achievements that reflect the high quality of the Center's Faculty Associates and support our notion that outstanding graduate education and exceptional multidisciplinary research at the cutting-edge of science and technology are being produced by Faculty Associates of the UK Center of Membrane Sciences.* Please note even in the difficult economic environment of the past six years, the CMS Faculty Associates have nearly doubled the amount of grant dollars obtained in the preceeding six years compared to the six years of the previous review period.

TABLE I.
Achievements of the Faculty Associates of the
Center of Membrane Science during the Period since the Last
Review: 2005-2010 ** * **

Faculty Associate	Honors and Awards	Refereed Papers – Published	Patents	Presentations at Nat./Int. Meetings	# Grants Funded/\$ (No duplications)		Students Graduated MS / Ph.D. / PF Postdoctoral Fellow		
D.A. Butterfield	8	183		15	9	\$9,378,246	1	10	12
K. Anderson		11		34	9	\$5,124,457	1	3	1
L. Bachas	1	49	3	94	17	\$12,276,276	2	6	7
M. Bardo	2	46	1	16	11	\$15,897,965		5	2
D. Bhattacharyya	8	35		22	11	\$1,603,320	2	9	
P. Bummer		10			1	\$500,000			
A. Cammers		5			1	\$2,101,735			
P. Crooks	8	186	184	279	20	\$9,027,784		4	14
S. Daunert	6	51	11	5	38	\$11,910,978	2	6	5

L. Dwoskin	6	63	46	21	12	\$12,662,764	1	5	10
B. Hennig	4	49		37	8	\$20,312,887		3	6
Z. Hilt	6	30		25	13	\$2,950,633		1	1
B. Hinds	3	17		47	15	\$15,881,300		5	5
B. Jackson	4	2		3	3	\$1,628,900			
M. Jay	3	10	2	15	4	\$1,809,438		3	9
D. Kalika	2	16		13	4	\$260,302	2	2	
B. Knutson	3	26			10	\$3,719,681		3	
H. Mansour	4	25		13	6	\$530,000			3
Y. Wei		13		19	5	\$660,276			
Y. Xiong	3	63		23	9	\$2,107,534	4	6	3
TOTALS	71	890	247	681	206	\$129,120,547	15	71	78
Totals from Last Review	86	833	184	1,154	204	\$67,493,566	23	65	70
** Detailed data provided in Appendices A-E									
*** Every attempt was made to avoid duplication in constructing this table									

C. Honors

Listed above are the honors received by Center Faculty Associates. Both internal and external recognition of our Faculty Associates is outstanding.

V. INSTRUCTION

The CMS organized occasional colloquia (6 during the review period (See Appendix G)) provided three important benefits to the Center: (a) instruction for our students in the latest developments in membrane science and technology; (b) a highly visible marketing tool of the Center for outside experts in membrane sciences and technology – experts who review grants and papers of the Center Faculty Associates; and (c) a focal point for discussions among Faculty Associates.

VI. STRATEGIC PLAN

The current Strategic Plan of the Center of Membrane Sciences is described below. To begin, a brief discussion of factors beyond UK and internal to UK is given.

A. External Environment

1. Factors Facilitating the Work of the Center

- (a) Growing attention being given to science and technology. Increased emphasis on multidisciplinary approaches to science and technology. Intersecting problems in science and engineering are extremely complex; the cooperative interaction among scientists and engineers, a distinction of the Center, positions us well to take

advantage of this emerging and on-going trend. NIH, NSF, etc. seek multidisciplinary proposals.

- (b) Improving industrial environment around Lexington. With Toyota have come ancillary industries, some of which use membrane technology. It is hoped that greater involvement of these firms in the Center will occur. Several companies have visited the Center, though none recently. Rather, web site facilitated contact with Faculty Associates and the Center as a whole has occurred.

2. Factors Distracting or Hindering the Work of the Center

- (a) Although the Center is ranked as tier 1 in the materials area by the RCTF Committee, because no degree programs are located in the Center, resources were not available through the Research Challenge Trust Fund (RCTF).
- (b) Retention of active Center Faculty Associates in the University is a concern. During the review period, we lost from the Center and the University highly productive faculty including Professors Michael Jay, Leonidas Bachas and Sylvia Daunert.
- (c) Federal Granting Agencies budget demands. With the strong downturn in the economy, coupled with recent political trends that presage static, if not declining, budgets for NSF, NIH and other federal agencies, there will be even greater competition for shrinking grant funds.

B. Internal Environment

1. Strengths

- (a) Diversity of Units. The greatest strength of the Center of Membrane Sciences is the strong interaction among experts in biological membranes with those in synthetic membranes. This has been recognized in the past by federal granting agencies and by the North American Membrane Society, as evidenced by grants obtained and being selected to host their 1992 and 2001 National meetings of NAMS. Having faculty of diverse expertise at the University aids in the work of the Center. Presently (December 2010), there are 20 UK Faculty Associates in the Center from 5 departments representing 5 colleges.
- (b) Identification of Membrane Sciences as an area for institutional investment. Support by the Vice President for Research for the operation of the Center, though quite low (~ \$4.2K/year plus one staff person and a modist amount for the Director) has been essential and greatly appreciated, although the Center could achieve even more with additional resources.

2. Weaknesses

- (1) The need for extramural grant-generated incentive funds to be returned to the Center of Membrane Sciences. Currently, even though Faculty Associates of the Center obtained numerous membrane-related grants of substantial funding (see

table above), the Center gets no indirect cost (IDC) return, unless a department chair and college dean agree to waive some portion of the IDC that returns to them. This, of course, rarely happens. The argument that, because the Center has no centralized laboratory space and therefore should receive no IDC, fails to recognize that the single most costly item on most proposals is personnel. This is true of proposals from any unit, no matter if there is centralized laboratory space or not. Thus, in the opinion of the Faculty Associates and director, the Center of Membrane Sciences should receive a fraction of IDC (even as low as 0.5-1% for example) of membrane-related grants obtained by Faculty Associates without diminishing the IDC to departments and colleges. Note that such a proposal achieves three goals at once: (a) Good relations between the Center and departments and colleges is maintained, since no IDC funds are siphoned from these units; (b) Incentive for even more proposal writing is provided to Center Faculty Associates, since they would then know that a small portion of the IDC return on funded grants would help the programmatic efforts of the Center; and (c) The IDC return to the Center would permit programmatic expenditures currently not possible. For example, such funds would support a sustainable colloquium series of outside speakers on current membrane topics, thereby increasing the visibility of the Center to influential membrane scientists and engineers and exposing our students and Faculty Associates to the latest understanding of membrane science and technology. In addition, such funds would permit seed grants to encourage new multidisciplinary membrane-related proposals in emerging areas. Finally, we might be able to support RA lines as we recommend (see below).

C. Goals and Objectives of the Center of Membrane Sciences

1. The two major goals of the Center are:
 - a. To increase national/international recognition for membrane research at the University of Kentucky.
 - b. To produce well-educated and highly-trained Ph.D. students who appreciate the totality of membranes, who can interact well with scientists, engineers, and clinicians in academia, industry, and government.

An additional goal of the Center is, to the extent possible and where appropriate to the nature of the Center, to help the Vice President for Research and the University to achieve their goals.

2. The objectives to be met in achievement of these goals are:
 - a. Concerning Increased national/International Recognition of Membrane Research at UK:
 - (1) To ensure that innovative membrane research continues to be produced in the Center.
 - b. Concerning the Production of Highly-Trained Ph.D. Students:

- (1) To ensure graduate student mastery of the type of membrane system in which he/she is pursuing research (e.g., biological or synthetic), and to the extent possible to ensure significant familiarity with the other type of membrane system and its interface with his/her own membrane system.

D. Enabling Strategies/Intended/Anticipated Outcomes/Results

1. Concerning Increased National/International Recognition of Membrane Research at UK.
 - a. *The Center will keep the number of Faculty Associates of the Center at approximately 20. **Results:** Now numbering 20, this goal has been achieved.*
 - b. *The Faculty Associates of the Center will increase the number of proposals submitted to extramural funding agencies over the next five years. Each Faculty associate will apply for at least one federal grant in this period. **Results:** In the 5-year period 2005-2010, Faculty Associates of the Center secured grant funding totaling over \$129M, indicating success in this area. [See Table pps. 9-10].*
 - c. *The Faculty Associates of the Center will increase the number of refereed journal publications. **Results:** Based on our track record for the period of this review [2005-2010], in which Center Faculty Associates published almost 900 papers, this outcome appears quite feasible [See Table pps. 9-10].*
 - d. *The Faculty Associates of the Center will increase the number of presentations at national/international scientific conferences over the next five years. **Results:** Based on our track record for 2005-2010, during which almost 700 presentations were made, we achieved remarkable success, albeit fewer presentations than the preceeding five year period. We attribute this decline from the previous review period to the economic downturn, high airfare prices, and decisions made by PIs to allocate funds more for research and less for travel. [See Table pps. 9-10].*
 - e. *The Center will remain committed to technology transfer. **Results:** In addition to the many scientific publications by Faculty Associates, the Center may submit a proposal to organize and host the National Meeting of the North American Membrane Society. The Center of Membrane Sciences organized and hosted the NAMS National Meeting in 1992 and 2001.*
 - f. Assuming sufficient new funding the Center will:
 - (1) Help identify Departments to hire and jointly fund a faculty position with joint appointment in the Center. This person would have research interests in the interface of biological and synthetic membranes. **Results:** This strategy has not been realized.
 - (2) Be in the top 20 of public Universities. **Results:** The Center of Membrane Sciences actually is already in the top 20. Currently, there are seven Centers of

Membrane Sciences based in academic institutions in the United States, and some, unlike UK, are only loosely organized. These academic research centers are located at the University of Texas; New Jersey Institute of Technology; University of Toledo; Rennselear Polytechnic Institute; University of Colorado; University of Cincinnati; and University of Kentucky. Further, the UK Center enjoys a national and international reputation for biological and synthetic membrane research, especially for research at the interface of these two types of membranes. For example, numerous Faculty Associates have given invited presentations at national and international conferences. In addition, Drs. Butterfield and Hinds were two of six speakers at a NAMS National Meeting Symposium in Honor of Professor Dibakar Bhattacharyya in 2007. These talks highlighted the achievements of the Faculty Associates, especially Dr. Bhattacharyya, and highlighted the clear advantage our Center has over the other six USA-based academic membrane research centers in the field of biofunctional membranes. Taken together, it is the director's opinion that the UK CMS is among the five most active academically based membrane research centers in the United States.

- (3) With the assistance of the Vice President for Research develop an External Advisory Committee. The Committee composed of outstanding academic, government, and industrial membrane scientists will critique the progress of the Center and advise on new trends in membrane research. **Results:** Progress has been slow here due to a lack of resources. As an alternative, at North American Membrane Society National Meetings, to which the director and/or one or more Faculty Associates attend, UK CMS material is presented to selected influential membrane experts, and their oral counsel on how the Center is doing is sought. This may be the better practical approach given available resources.
- (4) Distribute to UK, other academic institutions, and industrial contacts a new one-page flyer describing the research and programmatic capabilities and programs of the Center. **Results:** Rather than use outdated approaches, we developed, with great input from Ms. Mollie Fraim, the Center of Membrane Sciences Staff Associate, a visible website that highlights the Center of Membrane Sciences.
- (5) The Center will produce a newsletter to be sent to academic and industrial membrane scientists and engineers and to federal funding agencies. The newsletter will highlight research and educational programmatic accomplishments of the Center. **Results:** Instead of a newsletter, as noted we decided to produce a website that outlines the programs and accomplishments of the Center Faculty Associates, facilities available, and research opportunities in the Center, as well as means to interact with research partnership. As also noted, this website [<http://www.research.uky.edu/Membrane>] is due in large part to the Herculean efforts of the one staff person, Ms. Mollie Fraim, in our Center.

2. Concerning the production of Highly-Trained Ph.D. Students:

- a. The number of Ph.D. and M.S. degrees awarded to students working under the aegis of Faculty Associates of the Center will increase over the next five years. **Results:** Based on our performance during the current review period (2005-2010), in which 86 Ph.D.

and M.S. degrees were conferred based on research supervised by Center Faculty Associates, we more than reached this goal (See Table pps. 9-10). Although the Center has been highly successful in this area, one way to increase this number is by submission of training grant proposals to federal agencies. This has been an unmet goal that hopefully will be rectified in the next few years.

The director was honored to be a recipient of the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring. The \$10,000 grant associated with this award, together with the help of the directors' past graduate students, the Vice President for Research, and the RCTF match program, has enabled a permanent endowment to be established to assist graduate student investment in Membrane Sciences. Several Center of Membrane Sciences Mentoring Fellowships, provided from the earnings of the endowment, have been awarded for 2005-2010:

Graduate Student Mentoring

Fellowship Recipient

Lin Wang
Kim May
Vasile Smuleac

Kristin Alvers
Josh Eldridge
Xiaojian Li

MS Faculty Associate Ph.D. Advisor

Professor Youling Xiong
Professor Kimberly Anderson
Professor(s) D. Allan Butterfield and Dibakar
Bhattacharyya
Professor Michael Bardo
Professor Peter Crooks
Professor Heidi Mansour

- b. With new resources, the Center will implement a RA program in Membrane Sciences. Such a program, competitively based on the progress of Faculty Associates, would provide two RAs to Departments. **Results:** No university (including IDC return) or federal resources were secured to achieve this objective.
- c. Exposure of undergraduates to graduate research, with the aim of increasing the number of graduate students pursuing Ph.D. degrees, will take place through NSF-funded Research Experiences of Undergraduates in Materials and Thin Films administrated through the Center of Membrane Sciences. **Results:** Organized by Faculty Associate, Leonidas Bachas, with participation of several Faculty Associates, this program has been highly successful. Undergraduates, including women and minority students, have participated in this program. The normal lifespan for a REU grant is 6 years. That Dr. Bachas was so successful to keep this REU program going for 15 years evinces not only his skill, but also the great research success of the Faculty Associates of the CMS and their commitment to training a new generation of membrane scientists. Currently, with the departure of Professor Bachas to the University of Miami, a new leader in this effort is needed, and endeavors to find such a leader will be emphasized.

E. Relation of the Center's Goals and Objectives to Those of Research and the Institution:

1. Annual Progress Reports.

Annual Progress Reports for the period 2005-2010, submitted to the Research Assessment & Student Research Programs, show the linkages to the UK Strategic Plan, are provided below. *Only those Annual Reports that are web based are attached.*

Annual Review Report 2005-2006 APPROVED

Area:	VP Research	College/Unit:	Center for Membrane Sciences
Department:	N/A	Degree:	N/A
Data Entry	Mollie S Frain	Approver	Bessie M Guerrant

Unit Mission: The mission of the Center is to foster interdisciplinary interactions among biological and synthetic membrane experts in the areas of research, teaching, and service and to enhance the visibility of membrane research at the University.

Unit Goals and Specific Strategies

Obj. #	Unit Goals and Specific Strategies	Assessment Methods, Criteria and Timelines	Results of Assessments	Use of Results to Improve	Relationship to UK Strategic Plan:					
					UK Mission	UK Goal	UK Measure of Progress			
01	To expand research at the interface of biological and synthetic membranes with applications for biofunctional membranes.	Increase faculty publications by 5%.	Faculty Associates of the Center of Membrane Sciences publish more than 150 or more papers per year.	Continue to increase numbers of publications.	Research	4. New Knowledge	1.1	1.1	1.1	1.1
02	To continue to train graduate students in the totality of membranes.	Increase the number of trained students by 5%	The Center Faculty Associates continue to graduate significant numbers of M.S. and Ph.D. students and train Postdoctoral Scholars.	The Graduate Student Endowment of the Center, used for the first time in 2004-2005, is now building monies for distribution for Graduate Student Fellowships in the future.	Research	2. Outstanding Students	4.3	4.3	1.1	4.3
03	To continue technology transfer efforts designed to	National and international recognition through publications and	The director of the Center continues to serve on and chair an international task	The Center will continue work toward research goals and the enhancement of	Research	4. New Knowledge	6.4	1.1	0	1.1

	increase knowledge of and applications for biofunctional membranes. In many cases, biofunctional membranes may have direct applicability to enhanced diagnosis and treatment of disease	presentations will increase by 5%. Patent disclosures will increase.	force based in Rome, Italy, on antioxidants for neurodegenerative disorders. Opportunities to present research increased by 5%. A large number of refereed papers by Faculty Associates of the Center of Membrane Sciences have been published.	membrane science and technology.						
04	Aggressively pursue targeted strategies to increase extramural research funding.	The Center Faculty Associates will utilize the strength of the Center of Membrane Sciences in the interface of biological and synthetic membranes to submit research proposals in catalysis, analysis, and separation using biofunctional membranes. This area of research holds great promise for emerging applications of membrane technology in industries related to health, agriculture, the environment,	The Center of Membrane Sciences is internationally known for its unique focus on research at the interface of biological and synthetic membranes.	Faculty Associates will submit more multidisciplinary grant proposals to federal funding agencies. Indirect cost return allocated to the Center (Center Enhancement Funds) would provide greater chance of success for this effort. For example, such funds would be used to bring potential grant reviewers to UK to interact with faculty associates of the Center. The Center underwent a Periodic Review in 2004-2005. A recommendation produced by the Review	Research	1. National Prominence	4.1	6.3	1.1	4.1

	pharmaceuticals, and issues related to Homeland Security.		Committee was, in fact, to return a portion of the IDC obtained by Faculty Associate generated grants to the CMS. However, inspite of this recommendation by the Review Committee, the EVPR did not agree to implement this recommendation.							
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Highlights Narrative						
Narrative	Relationship to UK Strategic Plan:					
	UK Mission	UK Goal	UK Measure of Progress			
The Center of Membrane Sciences brings together University of Kentucky faculty and students from a wide variety of academic specialties in collaborative, multidisciplinary research and graduate education efforts. Representatives from the pharmaceutical, medical, biological, physical sciences, agriculture, and engineering disciplines are currently researching biological and synthetic membranes and their interface. The Center sponsors a periodic colloquium series designed to facilitate interaction and cross-fertilization of ideas and expertise among faculty, research associates, graduate students, and postdoctoral scholars. The Center also supports technology transfer, through occasional national and international conferences sponsored by the Center, books on membranes edited by Center Faculty Associates, and by peer-reviewed papers published by Faculty Associates.	Research	1. National Prominence	4.1	6.3	1.1	4.1

Annual Review Report 2006-2007			
Area:	VP Research	College/Unit:	Center for Membrane Sciences
Department:	N/A	Degree:	N/A
Data Entry	Mollie S Fraim	Approver	
Unit Mission:	The mission of the Center is to foster interdisciplinary interactions among biological and synthetic membrane experts in the areas of research, teaching, and service and to enhance the visibility of membrane research at the University.		

Unit Goals and Specific Strategies

Obj. #	Unit Goals and Specific Strategies	Assessment Methods, Criteria and Timelines	Results of Assessments	Use of Results to Improve	Relationship to UK Strategic Plan:					
					UK Mission	UK Goal	UK Measure of Progress			
01	To expand research at the interface of biological and synthetic membranes with applications for biofunctional membranes.	Increase faculty publications by 5%.	Faculty Associates of the Center of Membrane Sciences publish more than 150 or more papers per year.	Continue to increase numbers of publications.	Research	4. Nurture Diversity	1.1	1.1	1.1	1.1
02	To continue to train graduate students in the totality of membranes.	Increase the number of trained students by 5%	The Center Faculty Associates continue to graduate significant numbers of M.S. and Ph.D. students to train Postdoctoral Scholars.	The Graduate Student Endowment of the Center, used for the first time in 2004-2005, is now building monies for distribution for Graduate Student Fellowships in the future.	Research	2. Prepare Students	4.3	4.3	4.3	4.3
03	To continue technology transfer efforts designed to increase knowledge of and applications for biofunctional membranes. In many cases, biofunctional membranes may have direct applicability to enhanced diagnosis	National and international recognition through publications and presentations will increase by 5%. Patent disclosures will increase.	The director of the Center continues to serve on and chair an international task force based in Rome, Italy, on antioxidants for neurodegenerative disorders. Opportunities to present research increased by 5%. A large number of refereed papers by Faculty Associates of the Center of Membrane Sciences have been published.	The Center will continue work toward research goals and the enhancement of membrane science and technology.	Research	4. Nurture Diversity	6.4	1.1	0	1.1

	and treatment of disease									
04	Agressively pursue targeted strategies to increase extramural research funding.	The Center Faculty Associates will utilize the strength of the Center of Membrane Sciences in the interface of biological and synthetic membranes to submit research proposals in catalysis, analysis, and separation using biofunctional membranes. This area of research holds great promise for emerging applications of membrane technology in industries related to health, agriculture, the environment, pharmaceuticals and issues related to Homeland Security.	The Center of Membrane Sciences is internationally known for its unique focus on research at the interface of biological and synthetic membranes.	Faculty Associates will submit more multidisciplinary grant proposals to federal funding agencies. Indirect cost return allocated to the Center (Center Enhancement Funds) would provide greater chance of success for this effort. For example, such funds would be used to bring potential grant reviewers to UK to interact with faculty associates of the Center. The Center underwent a Periodic Review in 2004-2005. A recommendation produced by the Reveiw Committee was, in fact, to return a portion of the IDC obtained by Faculty Associate generated grants to the CMS. However, inspite of this recommendation by the Review Committee, the VPR did not agree to implement this recommendation.	Research	1. Enhance Stature	4.1	6.3	1.1	4.1

Annual Review Report 2008-2009

Area:	VP Research	College/Unit:	Center for Membrane Sciences
Department:	N/A	Degree:	N/A

Data Entry	Mollie S Frain	Approver
Unit Mission:	The mission of the Center is to foster interdisciplinary interactions among biological and synthetic membrane experts in the areas of research, teaching, and service and to enhance the visibility of membrane research at the University.	

Unit Goals and Specific Strategies

Obj. #	Unit Goals and Specific Strategies	Assessment Methods, Criteria and Timelines	Results of Assessments	Use of Results to Improve	Relationship to UK Strategic Plan:					
					UK Mission	UK Goal	UK Measure of Progress			
01	To expand research at the interface of biological and synthetic membranes with applications for biofunctional membranes.	Increase faculty publications by 5%.	Faculty Associates of the Center of Membrane Sciences published more than 150 or more papers per year. The quality of the Faculty Associates of the Center of Membrane Sciences is exemplified by: (Prof. D.B Bhattacharyya was the recipient of the 2009 Gerhold Award by the Separations Division of the American Institute of Chemical Engineers (AIChE); (2) Prof. Allan Butterfield was identified as 39 th in the Top 100 researchers in Alzheimer's disease throughout the world; (3) Prof. Youling L. Xiong received the Thomas Poe Cooper's Award in the College of Agriculture; (4) Prof. Sylvia Daunert was recently honored with the 2009 Bill Barfield Award for Outstanding	Continue to increase numbers of publications.	Research	Expand Research	13	15	15	15

			Contributions in Water Resources Research from the Kentucky Water Resources Research Institute and the 2009 Albert and Elizabeth Kirwan Award.								
02	To continue to train graduate students in the totality of membranes.	Increase the number of trained students by 5%	The Center Faculty Associates continue to graduate significant numbers of M.S. and Ph.D. students and train Postdoctoral Scholars. In addition, one female minority postdoctoral scholar was trained by the Director.	The Graduate Student Endowment of the Center is now building monies for distribution for Graduate Student Fellowships in 2009-2010.	Research	Prepare Students	6	6	6	6	
03	To continue technology transfer efforts designed to increase knowledge of and applications for biofunctional membranes. In many cases, biofunctional membranes may have	National and international recognition through publications and presentations will increase by 5%. Patent disclosures will increase.	A great number of presentations of research at national and international meetings by Faculty Associates of the CMS were given a large number of refereed papers by Faculty Associates were published. The Director is a permanent member of the NIH Study Section, Neuronal Oxidative Metabolism of	The Center will continue work toward research goals and the enhancement of membrane science and technology. In addition, Faculty Associates of the CMS will continue to have visibility on national and international review panels and NIH Study Sections.	Research	Nurture Diversity	12	13	12	12	

	direct applicability to enhanced diagnosis and treatment of disease. In addition, to utilize expertise of CMS Faculty Associates on Federal review panels and NIH Study Sections.		Death. Other Faculty Associates are on NIH Study Sections (Daunert) or NSF panels (Butterfield; Bhattacharyya).								
04	Agressively pursue targeted strategies to increase extramural research funding.	The Center Faculty Associates will utilize the strength of the Center of Membrane Sciences in the interface of biological and synthetic membranes to submit research proposals in catalysis, analysis, and separation using biofunctional membranes. This area of research holds great promise for emerging applications of membrane technology in industries related to health, agriculture, the environment, pharmaceuticals	The Center of Membrane Sciences is internationally known for its unique focus on research at the interface of biological and synthetic membranes.	Faculty Associates will submit more multidisciplinary grant proposals to federal funding agencies. Indirect cost return allocated to the Center (Center Enhancement Funds) would provide greater chance of success for this effort. For example, such funds would be used to bring potential grant reviewers to UK to interact with faculty associates of the Center.	Research	Enhance Stature	13	8	12	13	

		and issues related to Homeland Security.									
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F. Assessment Process

The assessment of the effectiveness of the Center of Membrane Sciences currently is conducted in a two-fold manner: (A) Periodic compilation of Faculty Associate achievements; (B) follow-up survey of graduates associated with the Center. Each type of assessment will provide information that will be shared with the Faculty Associates of the Center, and where appropriate, modifications of the Center’s plans and programs will be formulated.

1. Annually, compilation and review of faculty achievements will be based on the CV’s and data provided. Results will be measured against expected outcomes.
2. The graduate students who were granted departmentally-based degrees through the units of the Faculty Associates will be surveyed post graduation to learn their views of the education/research/training they received through activities of the Center. The survey instrument is like that below. The Faculty Associates will address difficulties/barriers in the Center that are apparent from the surveys and, if found to be appropriate, corrected.
3. Opinions of key national figures in membrane sciences research at national meetings of the NAMS are used to help gauge our success.

VII. PLANNING AND DECISION MAKING

A. Programmatic Decision Making

Programmatic decision making is formulated by three mechanisms; (1) infrequent meetings of the Faculty Associates, including occasional colloquia; (2) Periodic memos seeking advice on various topics from Faculty Associates; (3) Solicitations to a subset of Center Faculty Associates who are most active on the day-to-day research and programmatic activities of the Center. These approaches appear to the director to be working.

B. Graduate Student Surveys

During this review period a survey of graduated, former graduate students has been performed. The survey instrument and the results of the survey are listed below:

Summary of Responses from Survey of Graduate Students (December, 2010)

Center of Membrane Sciences

**FOLLOW-UP SURVEY OF RECENT GRADUATE DEGREE RECIPIENTS WHO
STUDIED UNDER THE SUPERVISION OF A CENTER OF MEMBRANE SCIENCES
FACULTY ASSOCIATE**

**On a scale of 1- 5
5 = Excellent -----1 = Poor**

1. Please rate your experience in graduate research under the aegis of your graduate advisor:

RESPONSE: Mean +/- S.D. (N = 20): 4.55 +/- 0.82

2. Please indicate the extent to which you agree with the following statement: My experience in membrane-related research while a graduate student at UK prepared me well for my post-UK career. Extent of Agreement:

RESPONSE: Mean +/- S.D. (N = 20): 4.30 +/- 0.86

3. Any comments you wish to provide about your experience in membrane-related research will be greatly appreciated.

RESPONSE:

“I learned a lot more technical skills like laboratory methods than academic skills like writing manuscripts and grant applications. The technical skills were valuable, but I would have also liked to have learned more academic skills.”

“Dr. Butterfield was a tremendous mentor. I have only been at my post-doc position at the University of Washington for 2 weeks and feel as though I am competent when speaking and discussing research ideas. In particular, I learned a great deal about oxidative stress and the sequelae of this condition to cellular components, including cell membranes. This knowledge is applicable to multiple diseases including the disease I am studying currently, diabetes mellitus. The training I received at UK has helped me to adjust to my now position rather well and will carry me through the duration of my post-doc.”

“I enjoyed my time at UK.”

“I had an excellent experience at UK. The guidance and mentorship that I received was invaluable.”

“Only a small portion of my experience was in membrane-related research (thus the level 3 rating in question 2).”

All responses will have no attribution to the person responding. Therefore, please be as candid as you feel comfortable.

Results of Survey: There was great satisfaction with the thesis/dissertation advisor and with the research performed. In general, it would appear that Center students strongly believe that the Center is performing its duties well. This kind of information gives confidence to the Center

Faculty Associates that their programmatic, educational, and research efforts seem to be viewed positively by their students. Bolstering this assessment, comments submitted by survey respondents were uniformly positive, exemplified by comments stated in the survey response noted above.

VIII. QUALITY OF DEGREE PROGRAMS

The Center does not offer any degree programs.

IX. MAJOR PROGRAMMATIC INITIATIVES OF THE CENTER DURING THE REVIEW PERIOD

In addition to the excellence in research in membrane sciences as evidenced by the table above (pages 9-10), the UK Center of Membrane Sciences has been involved in a number of programmatic initiatives as well.

A. PAESMEM Fellowships

The director was honored to be a recipient of the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring. The \$10,000 grant associated with this award, together with the help of the directors' past graduate students, the Vice President for Research, and the RCTF match program, has enabled a permanent endowment totaling \$50K to be established to assist graduate student investment in Membrane Sciences. The list of Center of Membrane Sciences Mentoring Fellowships, provided from the earnings of the endowment, is given above.

B. Research Experiences for Undergraduates in Membrane Sciences

For about 15 years, the Center has received continuous NSF funding for a program entitled "Research Experiences for Undergraduates (REU) in Membrane Sciences at the University of Kentucky" through several grants. Dr. Leonidas Bachas has been the chief organizer of this effort. In the disciplines of science and engineering, there has been a traditional underrepresentation of women and minorities. The Center has targeted this lack of Ph.D. and M.S. female and minority scientists by mentoring both groups both in the past and currently. In addition, there has been a traditional under representation of science and engineering students from Appalachia. The Center has trained over 180 undergraduate students through the NSF-sponsored summer program, "Research Experience for Undergraduates in Membrane Sciences" since 1989. In the period 2005-2010, 32 undergraduates took part in this NSF-Sponsored program. Of these, 14 were female and 5 were minority. These undergraduate students are so talented that many of these students are co-authors on refereed scientific publications based in part on their undergraduate research under the aegis of Center Faculty. In the past, one Appalachian student won the Waldo Semon Award of the best undergraduate chemistry research in the United States as judged by the University of Akron. Others have won numerous awards at National American Institute of Engineering meetings. As noted above, of the large number of undergraduate students trained in research in the Center, many have been female chemistry and chemical engineering majors, and a significant fraction has been minority students. A large percentage of these students (over half) have gone onto graduate school. Some of these students chose to come to UK for graduate school. Some of this group received graduate fellowships from the Ford Foundation, the Office of Naval Research, and the

National Science Foundation upon entering graduate school at UK. The endowment associated with the Presidential Award to the director for mentoring female and Appalachian Ph.D. and M.S. graduate students of Center Faculty Associates was mentioned above.

The list of REU students involved over the review period (2005-2010) is given in Appendix F. A significant challenge for the future will be to recruit a new PI to shepherd this REU program given the recent departure of Dr. Bachas from UK to the University of Miami.

C. Center of Membrane Sciences Colloquium

Without sustainable funding, this colloquium has not been organized formally. Periodically, the director has used Center funds to support colloquia related to membrane research in the Departments of Chemical and Material Engineering and Chemistry. With an infusion of IDC funds from Center Faculty Associate-generated grants, as recommended in this Self-Study, this program could be more active. Other positive outcomes of a Membrane Sciences Colloquium were enumerated above. The list of colloquia supported by the Center of Membrane Sciences in the review period is given in Appendix G.

D. Development of a Center of Membrane Sciences WebPage

Largely through the efforts of the Centers Staff Associate, Ms. Mollie Fraim, a Center web site has been developed. Links to each Faculty Associate and the North American Membrane Society have been established. Updated information about the Research Experience for Undergraduates program, including application requests, and the Centers Colloquia are also available.

[See <http://www.research.uky.edu/Membrane>].

E. Development of a National Web Page for Recipients of the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring

The Director of the UK Center of Membrane Sciences encouraged Ms. Mollie Fraim, to implement and design the website [<http://www.research.uky.edu/Membrane/PAESMEM/index.html>] and listserv for the recipients of the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM), a White House and National Science Foundation Program. This website serves as a form for sharing best practices in mentoring among PAESMEM recipients and staff of the EHR Division of the National Science Foundation.

F. Staff Position Employee Development

Ms. Mollie Fraim is the single staff person in the UK Center of Membrane Sciences. Ms. Fraim provides extraordinary assistance to the Director of the Center of Membrane Sciences by managing many tasks simultaneously. I believe that Ms. Fraim has done a fantastic job in our Center. Her selection as a Finalist for the Nestor Award (Appendix H) and selection as an awardee of the UKAdvance Leadership Development Institute indicate that it is clear that others at UK feel the same way. Ms. Fraim is highly organized on budget matters, including grants management. Other examples of excellence are numerous. One of the important reasons for the clear success of the efforts of the Center of Membrane Sciences is the dedication and focus exhibited by Ms. Fraim in

all that she does in and for the Center. The CMS director has made the Faculty Associates of the Center aware that they have access to Ms. Fraim (upon approval of the director for help in grant proposals, manuscripts, or PowerPoint preparation).

With the encouragement of the Director, Ms. Fraim has availed herself of the opportunities offered by the University of Kentucky OSPA to advance her competency in financial matters related to research administration. In addition, Ms. Fraim regularly attends monthly meetings associated with research budgets and web development (Appendix H).

In 2007, the Director proposed and the university agreed that this staff position should be upgraded to a higher category based on the increased responsibilities of the Center Staff Associate since inception of the Center of Membrane Sciences. Ms. Fraim is now an Administrative Support Associate I.

IX. SUMMARY of GOALS/PRIORITIES/PLANS for 2005-2010.

- To ensure that innovative research continues to be produced in the Center.
- To continue to ensure graduate student familiarity of both biological and synthetic membranes.
- To maintain the number of Faculty Associates in the Center
- To continue and even increase collaborations, joint papers, and proposal submissions among the Faculty Associates of the Center.
- Assuming sufficient new funding for the Center (via IDC fund return to the Center):
 - Help Faculty Associates-relevant departments as they recruit faculty with membrane research interests.
 - Implement a RA program in Membrane Sciences. Such a program, competitively based on the progress of Faculty Associates, would provide two RAs to Departments.
 - Re-invigorate the Center of Membrane Sciences Colloquium.
 - Establish a Seed Grant Program to foster new, high risk, and high reward research on membranes, success of which will be measured by submission and funding of federal grants.
 - Continue the PAESMEM based Graduate Student Mentoring Fellowship Program.

X. RECOMMENDATIONS FOR ENSURING CONTINUED SUCCESS AND IMPROVEMENT IN THE CENTER

1. As our highest recommendation, we propose a mechanism to partially fund the initiatives described above and/or recommended below and to provide support for programmatic efforts of the Center of Membrane Sciences. It is recommended that incentive funds paid on grants submitted by Center of Membrane Sciences Faculty Associates based on membrane research be returned to the Center as well as to the home department in which the Faculty Associates reside. In particular, currently where 10% of the indirect costs are returned to the home department, we propose that an additional 0.5-1% of the indirect costs be returned to the CMS. Of course, grants written solely through the Center would continue the current IDC return policy. This proposal has the effect of keeping funds in the respective departments, as well as providing funds to the Center of Membrane Sciences for programmatic efforts and initiatives outlined above. An additional incentive for writing grants by Faculty Associates of the Center is provided by implementation of this recommendation. *There is a value-added aspect to this*

proposal: proposals are written about multidisciplinary research that would not be accomplished in absence of the Center.

2. Based on the clear success of the Faculty Associates of the Center (see Table, pps. 9-10), implementation of two permanent RA lines for the Center for allocation to Faculty Associates on a rotating basis and based on success in grants, papers, presentations, awards, etc.