



Program Portfolio Chemistry/Biochemistry May 2008

Description of Program

Eastern Oregon University's Chemistry and Biochemistry Program prepares students for productive and satisfying careers in research, technology, health, environment, public service and teaching. By enthusiastically sharing its knowledge and love of learning, the Program also serves the general education needs of the University and the geographically broad community.

The Chemistry degree requires 62 hours of major requirements and 34 hours of supportive and prerequisite course requirements in physics, mathematics and computer science. The Biochemistry degree requires 55 hours of chemistry, 33 hours of biology, and 20-23 hours of supportive and prerequisite course requirements in physics and mathematics. Chemistry and biochemistry majors are required to complete a research experience by taking at least one credit of CHEM 401 (Research). Furthermore, our students are strongly encouraged to present the results of their research experiences at scientific meetings and in publications such as the *Eastern Oregon Science Journal*. We encourage our students to get involved in research as early as possible so that they may benefit fully from this experience. Students are deeply involved in all aspects of these research projects, from taking active participation in the design and implementation of experiments to the dissemination of the results at regional, national and international scientific meetings. Finally, we require our majors to complete a capstone class in which students independently research a topic in the chemical sciences chosen by the faculty. Successful completion of the capstone course requires students to write a professional-quality paper and deliver a 40-50 minute oral presentation to the faculty and their peers.

The program also offers a 3/2 transfer program in chemistry and chemical engineering in conjunction with Oregon State University, in which students complete three years of chemistry coursework at EOU and two years of chemical engineering coursework at OSU to receive B.S. Chemistry and B.S. Chemical Engineering degrees.

Recent Programmatic Changes

Since 1998, the Chemistry and Biochemistry Program has made a number of significant changes, resulting in increasing FTE by 1.5. The Program has added a new Biochemistry degree, a minor in environmental chemistry, and a new concentration in physical chemistry. In addition to curriculum changes necessitated by these larger program revisions, the Chemistry and Biochemistry Program has begun to offer Chem Excel courses and peer-led team learning experiences for the 100- and 200-level sequences, introduced more service learning and active learning experiences in the 200-level General Chemistry courses, developed CHEM 402 Service Learning in Chemistry, collaborated with Professor Johnson in the Art Program to offer an upper-division course in Ceramic Glaze Chemistry, further integrated writing into three upper-division courses to meet the University Writing Requirement, and begun to offer the Chemistry Minor and

a number of Chemistry courses via distance delivery. These changes have been enhanced by new facilities, significant upgrades in instrumentation, better computational facilities, and improved access to primary scientific literature.

How Program serves the Mission of the University and needs of region

The Chemistry and Biochemistry Program provides two separate degree programs and supports the physical science liberal arts core. Graduates of these programs are highly sought after in the private and public sectors, and find employment as teachers, research chemists, or chemical technicians in industry, government labs and state or federal agencies. Most graduates continue to pursue advanced degrees in the physical and life sciences, the health professions, and in the MTE program.

Program Objectives/Outcomes

Students will:

- Understand the basic chemical/biochemical principles and content in the major specialty areas, which include inorganic, organic, physical, analytical, and biochemistry.
- Acquire safe chemical/biochemical laboratory practices and techniques including the use of instrumentation and computers.
- Be able to design and conduct chemical/biochemical research with appropriate documentation including literature searches.
- Understand the importance of the discipline to modern society and be able to communicate chemical/biochemical information both orally and in writing to their peers and the public.

Key Programmatic Assessments

The aforementioned outcomes are supported by the chemistry and biochemistry curriculum. A matrix displays the correspondence of teaching and learning opportunities with the intended outcomes of the program (see below).

Correspondence of teaching and learning opportunities with program outcomes

	Chemical principles and content	Safe laboratory skills/ instrumentation operation	Research	Chemical Communication
CHEM 204	x			
CHEM 204L	x	x		
CHEM 205	x			
CHEM 205L	x	x		
CHEM 206	x			

CHEM 206L	x	x		x
CHEM 210	x			
CHEM 285	x	x		
CHEM 320	x			
CHEM 321	x	x		
CHEM 334	x			
CHEM 335	x			
CHEM 336	x			
CHEM 338	x	x		
CHEM 339	x	x		x
CHEM 340	x			
CHEM 401	x	x	x	x
CHEM 407	x		x	x
CHEM 411	x			
CHEM 412	x	x		
CHEM 421	x			
CHEM 422	x	x		
CHEM 437	x	x		
CHEM 440	x			
CHEM 441	x			
CHEM 442	x			
CHEM 443	x	x		
CHEM 444	x	x		
CHEM 445	x	x		
CHEM 450	x			
CHEM 451	x			
CHEM 454	x	x		

The following major assessments are significant and summative samples taken from this learning matrix:

- Chemical principles and content assessment is sampled in key courses using selections from ACS standardized tests for chemistry content knowledge. These tests are applied as pre- and post assessments in CHEM 204, CHEM 450 and CHEM 451. Comprehensive American Chemical Society standardized exams are administered in CHEM 206, at the end of the general chemistry (first-year) sequence, and CHEM 336, at the end of the organic chemistry (second-year) sequence. Data are collected, summarized and reported each biennium (see Appendix I). Additionally, a pre/post assessment is conducted in CHEM 206 to measure knowledge of instrumentation and awareness of environmental issues connected to the service learning experience in this class.
- Safe and proper use of laboratory equipment and instrumentation is assessed using a laboratory final examination in year in the CHEM 204 course. The program plans to implement another

laboratory exam in CHEM 422 Instrumental Analysis Laboratory. CHEM 285 Chemical Safety offers specific instruction in lab safety, lab procedure, and proper use of equipment.

- Students' ability to conduct research is assessed in the CHEM 401 Research (capstone) course. Students work on a stated problem, develop specific methodology to explore, conduct a study, collect data, analyze data, and report findings. Assessment of this outcome is determined by tracking the percentage of students delivering a formal presentation at the Spring Symposium or other professional conference, or publishing a paper in the award-winning *Eastern Oregon Science Journal* or external peer-reviewed scientific journals. Data are collected for these assessments each year (see below and in Appendix II).

Percentage of Graduates with Research Publications or Presentations

Year of graduation	# Chemistry and Biochemistry graduates	# Graduates with research presentations or publications	Percentage graduates with research presentations or publications
2002-03	5	5	100%
2003-04	4	4	100%
2004-05	8	7	88%
2005-06	7	3	43%
2006-07	10	10	100%

- Students' ability to communicate chemical principles and technical information orally and in writing is assessed in the CHEM 407 Seminar (capstone) course. Each student prepares a literature review and delivers a 40-50-min oral presentation, both assessed using a standard rubric (see Appendix III). Data from these experiences are collected each year.

(For a complete assessment plan see: Chemistry/Biochemistry Assessment Plan.doc)

Current Programmatic Assessment Data/Reflections/Recommendations of Curriculum and Instruction

Based on the assessment of student content acquisition using ACS standardized tests, students performed at the national average. Although the ACS test is satisfactory in the assessment of content knowledge, the tool is inadequate in measuring applied laboratory skills. Based on feedback from students and recent alumni, it was determined that the biochemistry curriculum was not adequately preparing students in the use of fundamental chemical instrumentation. The faculty determined that these observations required a program modification to better support student learning in this area. Therefore, a change in the curriculum to include CHEM 421 Instrumental Analysis and CHEM 422 Instrumental Analysis Laboratory was implemented in Fall 2007. Furthermore, we plan on implementing an exit examination for CHEM 422 to ensure that students graduate with a fundamental understanding of modern instrumentation.

Since 2002, the assessment of CHEM 407 Capstone has been extensively modified. Previously, students were expected to give two oral presentations and a written paper on a narrow topic from within a broad subject area chosen by the faculty. Based on the poor quality of the presentations and the paper, the faculty decided that students should only give one high-quality longer presentation and write a paper of expanded scope. A system of faculty and peer review was also implemented for the paper writing and drafting process. Furthermore, with the addition of more electronic resources for scientific literature, students are now expected to research and use scholarly articles on their chosen topic. A specific rubric was developed to provide guidance in specific areas of assessment

Student Accomplishments

Students in the Chemistry and Biochemistry program are part of a vigorous and nationally recognized Student Affiliate Chapter of the American Chemical Society ("EOU chemistry Club"). Club members regularly organize and perform educational outreach events in the local community to promote chemistry and science including hands on activities and magic shows at grade schools and middle schools, promoting and judging science fairs, and organizing science events for Boy Scouts and Girl Scouts. The club regularly supports major institutional outreach programs such as the Girls in Science and the Robotics tournament. The club has also established partnerships with local organizations like the Grande Ronde Model watershed. Club members participate in water monitoring and stream clean up activities.

In addition to regularly presenting research posters at national and regional conferences of the American Chemical Society, Club members are also involved in the organization of sessions or other educational activities. In June 2007 the club organized all undergraduate sessions at the Northwest Regional Meeting of the American Chemical Society (ACS) in Boise, ID. These included inviting the President of the American Chemical Society, Dr. Katie Hunt, to deliver the Eminent Scientist lecture, organizing two poster sessions, coordinating a graduate school recruiting breakfast and organizing two career-oriented workshops and a tour of Micron. In September 2006 the club was responsible for organizing a nanotechnology workshop for

undergraduates at the National Meeting of ACS in San Francisco. The club invited Mrs. Sharyl Majorski from Central Michigan University to lead the hands-on activities and provided assistance to participants during the workshop. Club member Alison McKay also received the great honor to introduce Dr. Robert Grubbs, Nobel laureate in chemistry at a plenary session. In addition, the club regularly takes part in the Chem Demo Exchange at national ACS meetings presenting hands-on activities with household chemicals. The program's emphasis on providing undergraduate research opportunities leads to students presenting research at national conferences (typically 10-15 students present their research each year at the American Chemical Society national meetings) and publishing their research in the *Eastern Oregon Science Journal*, as well as in international peer-reviewed journals such as *Biochemistry*. Faculty in the program have been successful in obtaining extramural funds to support the integration of teaching and undergraduate research (see Faculty Accomplishments Section).

Upon graduating, our students are successful in obtaining employment or gaining entry to post-baccalaureate degrees, including PhD programs, Master of Education, and health care professional schools.

Recent examples of student publications include:

W. M. Huston, C. R. Andrew, A. E. Servid, A. L. McKay, A. P. Leech, C. S. Butler, and J. W. B. Moir. "Heterologous overexpression and purification of cytochrome *c'* from *Rhodobacter capsulatus* and a mutant (K42E) in the dimerization region. Mutation does not alter oligomerization but impacts the heme iron spin state and nitric oxide binding properties" *Biochemistry*, **2006**, 45, 4388-4395.

C. R. Andrew, L. J. Kemper, T. L. Busche, A. M. Tiwari, M. C. Kecskes, J. M. Stafford, L. C. Croft, S. Lu, P. Moënne-Loccoz, W. Huston, J. W. B. Moir, and R. R. Eady, "Accessibility of the distal heme face, rather than Fe-His bond strength, determines the heme-nitrosyl coordination number of cytochromes *c'*: evidence from spectroscopic studies", *Biochemistry*, **2005**, 44, 8664-8672.

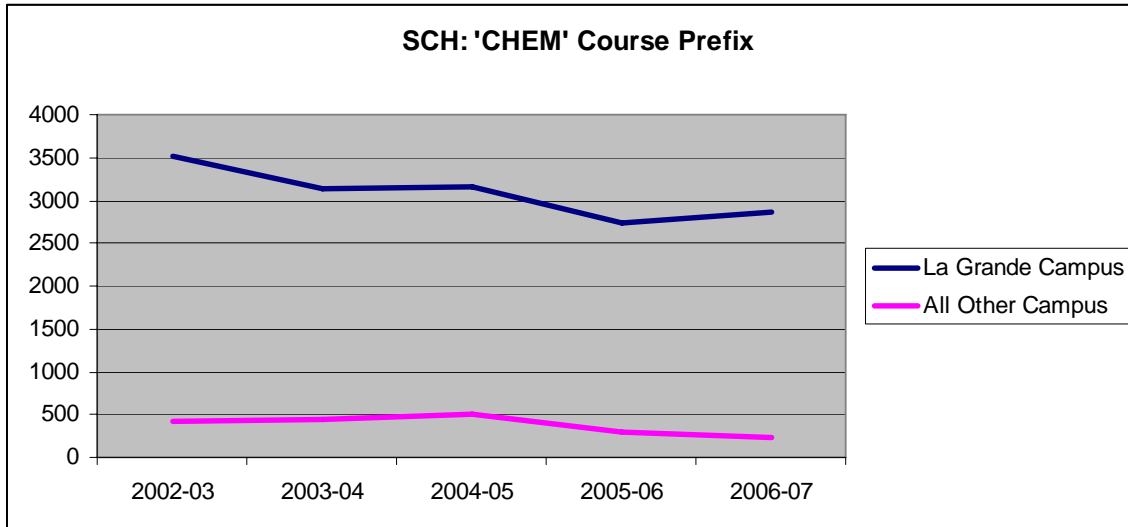
Programmatic Assessment: Synthesis and Recommendations

Based upon programmatic assessment data and student accomplishments that have been analyzed by the faculty, the following programmatic medications or adjustments are recommended:

- The Program plans to administer American Chemical Society graduate school entrance exams to all graduates.
- All biochemistry majors should be required to take an instrumentation course.
- The Program plans to implement an exit examination for CHEM 422 to ensure that students graduate with a fundamental understanding of modern instrumentation.

Enrollment and Program Performance

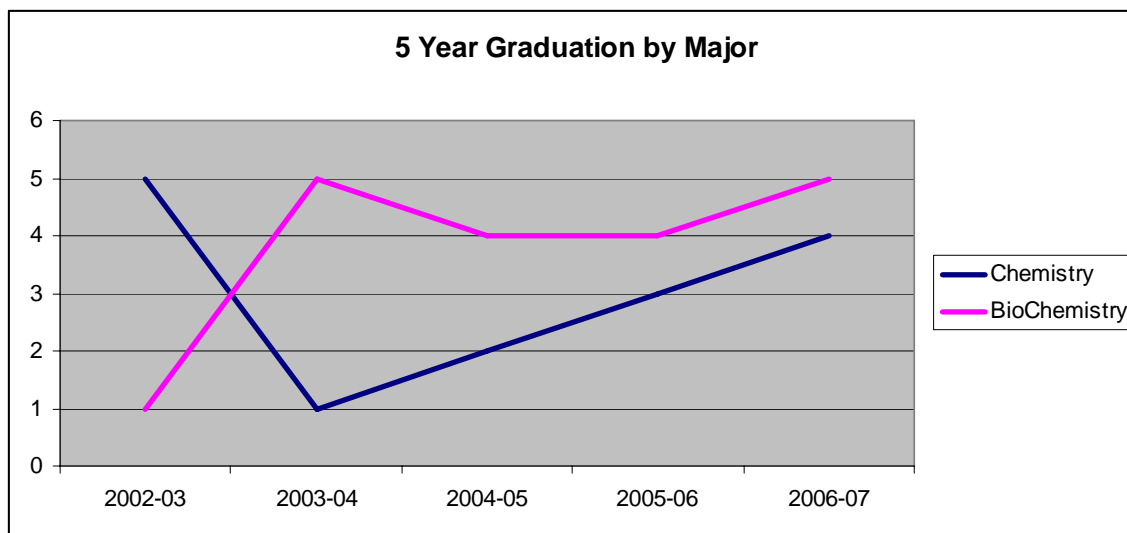
5 Year Student Credit Hours Generated by 'CHEM' Course Prefix



	2002-03	2003-04	2004-05	2005-06	2006-07
La Grande Campus	3511	3132	3166	2747	2868
All Other Campus	428	439	505	305	224
Total	3939	3571	3671	3052	3092

- Data includes all terms, effective end-of-term

Eastern Oregon University
5 Year Graduation by Major



Upon checking the data on graduates, the chemistry and biochemistry program found that while the total number of graduates for the 5 year period is correct, the individual numbers for each year are different (see correct data below). The graph above should be amended to reflect the correct numbers of graduates in each year.

	2002-03	2003-04	2004-05	2005-06	2006-07
Chemistry	4	3	3	2	3
Biochemistry	1	1	5	5	7

- There were no Biochemistry degrees awarded prior to 2002-03 academic year

Commentary on Enrollment and Graduate Trends

The Chemistry and Biochemistry Program serves many EOU students. Prior to the 2005-06 academic year, the program averaged 300-500 students per year in the 100-level Introductory Chemistry sequence. In 2005, OHSU removed CHEM 101, 102, 103 from their required coursework for pre-nursing. Since then, the Chemistry and Biochemistry Program has averaged approximately 200 students per year in the Introductory Chemistry sequence. For the past 4 years the program has also typically served 200 students per year in the 200-level General Chemistry sequence for science and pre-professional majors, 110 students annually in the upper-division Organic Chemistry sequence, and 60 annually in the Research course. The combined total of graduates in Chemistry and Biochemistry has risen from 3 in 1999 to 10 in 2007, with 11 projected for 2007-08.

Program and Course Scheduling Requirements

The following course schedule is designed to support both lower division general education and service course needs of the University as well as support a four-year opportunity for students to complete the major in Chemistry or Biochemistry.

Given below are the minimum requirements needed by term over a two-year period to ensure adequate support of student success. In every possible circumstance, historically small enrollment courses offered each academic year are collapsed into larger sections that span a two-year time frame. Where laboratory space controls class size, these maximums are noted.

The following CHEM courses are general education courses:

Course	General Education Category
CHEM 101, CHEM 101L, CHEM 102, CHEM 102L, CHEM 103, CHEM 103L; CHEM 204, CHEM 204L, CHEM 205, CHEM 205L, CHEM 206, CHEM 206L	SMI

The following CHEM service courses are *requirements* outside the chemistry and biochemistry program:

Course	Requirement For
CHEM 101, CHEM 101L, CHEM 102, CHEM 102L, CHEM 103, CHEM 103L	Dental hygiene program
CHEM 204, CHEM 204L, CHEM 205, CHEM 205L, CHEM 206, CHEM 206L, CHEM 334, CHEM 335, CHEM 336	Biology major; Pre-professional health programs (pre-medicine, pre-dentistry, pre-physical therapy, pre-veterinary medicine, pre-pharmacy)
CHEM 450, CHEM 454	Pre-dentistry
CHEM 441, CHEM 444	Physics minor

The following CHEM courses are “CHEM Excel” peer-led courses that support student success in the 100- and 200- level chemistry series.

Chem Excel Course	Supports learning in:
CHEM 105	CHEM 101, CHEM 101L
CHEM 106	CHEM 102, CHEM 102L
CHEM 107	CHEM 103, CHEM 103L
CHEM 210	CHEM 204, CHEM 204L, CHEM 205, CHEM 205L, CHEM 206, CHEM 206L

General Education and Service Course Schedule

FALL YEAR 1			FALL YEAR 2		
Course	Load Hours	Enroll 2005-06	Course	Load Hours	Enroll 2006-07
CHEM 101 (1)	3	50	CHEM 101	3	49
CHEM 101 (2)	3	41	CHEM 101 (2)	3	48
CHEM 101L (1)	2	25	CHEM 101L (1)	2	29
CHEM 101L (2)	2	25	CHEM 101L (2)	2	28
CHEM 101L (3)	2	24	CHEM 101L (3)	2	26
CHEM 101L (4)	2	17	CHEM 101L (4)	2	13
CHEM 105	1	13	CHEM 105	1	9
CHEM 204	4	74	CHEM 204	4	80
CHEM 204L (1)	3	17	CHEM 204L (1)	3	21
CHEM 204L (2)	3	19	CHEM 204L (2)	3	20
CHEM 204L (3)	3	19	CHEM 204L (3)	3	18
CHEM 204L (4)	3	19	CHEM 204L (4)	3	21
CHEM 210	1	13*	CHEM 210	1	13*
CHEM 334	4	32	CHEM 334	4	30
CHEM 450	4	16	CHEM 450	4	20

WINTER YEAR 1

Course	Load Hours	Enroll 2005-06
CHEM 102 (1)	3	43
CHEM	3	40

WINTER YEAR 2

Course	Load Hours	Enroll 2006-07
CHEM 102	3	40
CHEM	3	25

102 (2)		
CHEM		
102L (1)	2	28
CHEM		
102L (2)	2	27
CHEM		
102L (3)	2	27
CHEM		
106	1	7
CHEM		
101	3	18*
CHEM		
101L	2	18*
CHEM		
205	4	54
CHEM		
205L (1)	3	18
CHEM		
205L (2)	3	18
CHEM		
205L (3)	3	18
CHEM		
205L (4)	3	-
CHEM		
210	1	13*
CHEM		
335	4	31
CHEM		
338 (1)	3	14
CHEM		
338 (2)	3	13
CHEM		
338 (3)	3	-
CHEM		
441	1	2
CHEM		
444	3	1
CHEM		
451	4	11
CHEM		1
454	6	0

SPRING YEAR 1

Course	Load Hours	Enroll 2005-06
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102		
CHEM		
102L (1)	2	23
CHEM		
102L (2)	2	16
CHEM		
102L (3)	2	26
CHEM		
106	1	7
CHEM		
101	3	18*
CHEM		
101L	2	18*
CHEM		
205	4	68
CHEM		
205L (1)	3	18
CHEM		
205L (2)	3	18
CHEM		
205L (3)	3	12
CHEM		
205L (4)	3	19
CHEM		
210	1	13*
CHEM		
335	4	27
CHEM		
338 (1)	3	13
CHEM		
338 (2)	3	15
CHEM		
338 (3)	3	4
CHEM		
441	1	4
CHEM		
444	3	4
CHEM		
451	4	16
CHEM		
454	6	11

SPRING YEAR 2

Course	Load Hours	Enroll 2006-07
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CHEM		
103	3	60
CHEM		
103L (1)	2	30
CHEM		
103L (2)	2	30
CHEM		
107	1	7
CHEM		
206	3	46
CHEM		
206L (1)	6	16
CHEM		
206L (2)	6	22
CHEM		
206L (3)	6	20
CHEM		
206L (4)	6	9
CHEM		
210	1	9*
CHEM		
336	4	28
CHEM		
339 (1)	3	12
CHEM		
339 (2)	3	12
CHEM		
339 (3)	3	-

CHEM		
103	3	58
CHEM		
103L (1)	2	26
CHEM		
103L (2)	2	31
CHEM		
107	1	9
CHEM		
206	3	61
CHEM		
206L (1)	6	23
CHEM		
206L (2)	6	19
CHEM		
206L (3)	6	16
CHEM		
206L (4)	6	22
CHEM		
210	1	9*
CHEM		
336	4	26
CHEM		
339 (1)	3	7
CHEM		
339 (2)	3	13
CHEM		
339 (3)	3	3

Major Course Requirements Schedule

FALL YEAR 1

Course	Load Hours	Enroll 2005-06
CHEM		
204	4	74
CHEM		
204L (1)	3	17
CHEM		
204L (2)	3	19
CHEM	3	

FALL YEAR 2

Course	Load Hours	Enroll 2006-07
CHEM		
204	4	80
CHEM		
204L (1)	3	21
CHEM		
204L (2)	3	20
CHEM	3	18

204L (3)		19
CHEM		
204L (4)	3	19
CHEM		
334	4	32
CHEM		
320	3	17
CHEM		
321	6	16
CHEM		
440	4	7
CHEM		
443	3	4
CHEM		
450	4	16
CHEM		
401	8	18
CHEM		
407	1	7

204L (3)		
CHEM		
204L (4)	3	21
CHEM		
334	4	30
CHEM		
320	3	15
CHEM		
321	6	16
CHEM		
440	4	7
CHEM		
443	3	6
CHEM		
450	4	20
CHEM		
401	8	14
CHEM		
407	1	10

WINTER YEAR 1

Course	Load Hours	Enroll 2005-06
CHEM		
205	4	54
CHEM		
205L (1)	3	18
CHEM		
205L (2)	3	18
CHEM		
205L (3)	3	18
CHEM		
205L (4)	3	-
CHEM		
335	4	31
CHEM		
338 (1)	3	14
CHEM		
338 (2)	3	13
CHEM		
338 (3)	3	-
CHEM		
421	3	4
CHEM	6	4

WINTER YEAR 2

Course	Load Hours	Enroll 2006-07
CHEM		
205	4	68
CHEM		
205L (1)	3	18
CHEM		
205L (2)	3	18
CHEM		
205L (3)	3	12
CHEM		
205L (4)	3	19
CHEM		
335	4	27
CHEM		
338 (1)	3	13
CHEM		
338 (2)	3	15
CHEM		
338 (3)	3	4
CHEM		
421	3	5
CHEM	6	5

422		
CHEM		
441	4	2
CHEM		
444	3	1
CHEM		
401	8	16
CHEM		
437	2	10
CHEM		
451	4	11
CHEM		
454	6	10

SPRING YEAR 1

Course	Load Hours	Enroll 2005-06
CHEM		
206	3	46
CHEM		
206L (1)	6	16
CHEM		
206L (2)	6	22
CHEM		
206L (3)	6	20
CHEM		
206L (4)	6	9
CHEM		
285	1	22
CHEM		
336	4	28
CHEM		
339 (1)	3	12
CHEM		
339 (2)	3	12
CHEM		
339 (3)	3	-
CHEM		
340	4	9
CHEM		
401	8	18
CHEM		
442	4	3
CHEM		
445	3	3
CHEM	4	8

422		
CHEM		
441	4	4
CHEM		
444	3	4
CHEM		
401	8	15
CHEM		
437	2	8
CHEM		
451	4	16
CHEM		
454	6	11

SPRING YEAR 2

Course	Load Hours	Enroll 2006-07
CHEM		
206	3	61
CHEM		
206L (1)	6	23
CHEM		
206L (2)	6	19
CHEM		
206L (3)	6	16
CHEM		
206L (4)	6	22
CHEM		
285	1	22
CHEM		
336	4	26
CHEM		
339 (1)	3	7
CHEM		
339 (2)	3	13
CHEM		
339 (3)	3	3
CHEM		
340	4	12
CHEM		
401	8	16
CHEM		
442	4	5
CHEM		
445	3	4
CHEM	4	7

360			411		
CHEM			CHEM		
361	3	3	412	3	2*

Based on 2006-07 enrollment data (from the 5-year enrollment table):

Total SCH required per academic year (General Education and service courses and major courses) = 2868

Total faculty load hours = 225

Staffing

The Chemistry and Biochemistry Program at Eastern Oregon University is composed of six faculty members, each of whom has a Ph.D. in the chemical sciences. Four are tenure/tenure track and two are adjunct faculty.

.5 FTE Anna G. Cavinato, Professor (analytical chemistry), Chair of the Division of Science, Mathematics, and Technology, and faculty advisor to the award-winning Student Affiliate of the American Chemical Society

1.0 FTE Ronald B. Kelley, Associate Professor (organic chemistry)

1.0 FTE Jeffrey N. Woodford, Associate Professor (physical chemistry)

1.0 FTE Colin R. Andrew, Associate Professor (biochemistry/inorganic chemistry), Discipline Representative, and faculty advisor to the award-winning *Eastern Oregon Science Journal* which features student publications of undergraduate research

1.0 FTE Lorna Williamson, Assistant Professor (organic chemistry/introductory chemistry)

.75 FTE Abel Mendoza, Assistant Professor (analytical/environmental chemistry)

Faculty Accomplishments

Faculty are actively engaged in research projects leading to publications in peer-reviewed journals. Dr. Cavinato's research interests include the development of nondestructive methods of analysis and environmental monitoring. Dr. Kelley's research interests include the investigation of naturally occurring compounds in plant sources. Dr. Woodford's research interests include the theoretical study of materials possessing strong hydrogen bonding. Finally, Dr. Andrew's research centers on the structure and reactivity of metal-containing proteins. Faculty regularly publish their research in peer-reviewed journals. Some recent examples include: Dr. Colin Andrew's "Molecular basis for nitric oxide dynamics and

affinity with *Alcaligenes xylosoxidans* cytochrome *c*” published in 2007 in the *Journal of Biological Chemistry*, Dr. Anna Cavinato’s “Characterization of sol-gel transitions of food hydrocolloid gelling agents with near infrared spectroscopy” published in 2007 in the *Journal of Agricultural Food Chemistry*, Dr. Jeff Woodford’s 2006 “Temperature Dependent Deuterium Quadrupole Coupling Constants of Short Hydrogen Bonds” published in the *Journal of Molecular Structure*, and Dr. Ron Kelley’s 2007 “Identification of Quinones from *Lithospermum multiflorum*” forthcoming in *Phytochemistry*. For a full list of faculty accomplishments, including a full list of publications, see faculty CVs in Appendix IV.

Chemistry and Biochemistry faculty are active in securing extramural funding to support research and education from agencies such as the National Science Foundation, the Oregon Sea Grant, and the U.S. Department of Agriculture. For example, Dr. Colin Andrew received a National Science Foundation \$235,617 grant for his project “RUI: Novel Heme Chemistry of Cytochrome *c*” throughout 2004-07. His application to renew this grant for an additional \$395,132 throughout 2008-2012 was recently recommended for funding. Dr. Andrew also serves on the NSF review panel for Molecular Biochemistry. Dr. Anna Cavinato earned \$84,662 from Western Regional Aquaculture in 2007 for her project “Determining Ripeness in white sturgeon females to maximize Center yield and quality of caviar,” and the collaboration among Drs. Cavinato, Woodford, and Kelley was successful in obtaining \$182,640 from the National Science Foundation in 2002 to implement curricular transformations across most laboratory courses with the introduction of gas-chromatography/mass spectrometry and Fourier Transform Infrared Spectroscopy. Over the years, Dr. Cavinato has organized several symposia at national and regional meetings and has served on the ACS Taskforce for Undergraduate Programming at national meetings. She also serves on the NSF review panel for the Course, Curriculum, Laboratory Improvement (CCLI) program. Dr. Cavinato is also a board member of the Division of Analytical Chemistry of the American Chemical Society as well as the Richland local section of the ACS. Dr. Woodford served as chair of the local ACS Richland section (2007), and is currently serving on the General Chemistry First Term Exam Committee of the ACS Examinations Institute. He has also served as the co-director of the EOU Honors Program (2005-present).

Innovative teaching by Chemistry and Biochemistry faculty includes: POGIL, the integration of instrumentation in the upper-division lab curriculum, student research, service learning, installation and application of MicroLAB interfaces in the General Chemistry Lab, General Chemistry Lab manual written by Prof. Jeff Woodford and Professor Emeritus Richard Hermens, Chem Excel, the development of DDE courses and labs-at-a-distance and on-campus weekend DDE labs. Dr. Andrew serves as the faculty advisor for the *Eastern Oregon Science Journal*, a journal featuring the research of undergraduate students at EOU. The journal has received numerous national commendations, including “First Place Special Merit” awards from the American Scholastic Association in 2007 and 2008.

Chemistry and Biochemistry faculty provide outreach activities in the community including: Girls in Science coordinated by Prof. Cavinato (this acclaimed outreach program to promote science to sixth-eighth grade girls has garnered four national awards from the American Chemical Society as one of the most outstanding outreach activities to young women.. Dr.

Cavinato is also the faculty advisor to the award-winning Student Affiliate of the American Chemical Society (EOU Chemistry Club). Over the past ten years the club has received ten national awards (commendable or outstanding). In 2007 the club was one among twenty-eight in the nation to receive an outstanding award out of over 300 chapters nationwide. Other outreach activities of the chemistry club include: Science Fair judging at the elementary school, K-12 career days, other K-12 school visits, Chemistry Extravaganza, Chemistry Scouting Merit Badges, Chemistry Olympiad, service learning. Other outreach accomplishments of faculty include Dr. Colin Andrew's service on the La Grande Air Quality Commission and Dr. Cavinato's appointment as board member of the Grande Ronde Model Watershed.

Minimum Staffing Requirements

1) Current assessment of Faculty

Based on the current faculty in chemistry, the following total FTE are available:

Total = 5.25 FTE -----?????

2) Efficiency Ratios

Load/Faculty On Campus

Based on the 2006/7 SCH (2868), the ratio of SCH to faculty in CHEM prefix courses is 546. Teaching load hours/5.25 FTE = 42.86 load hours per faculty member.

Total SCH is 3092

ON Campus SCH 2868

ONLINE SCH 224

ON SITE SCH ?

SCH/Faculty Need

On campus cr hr/ 36

Summary Recommendations/Observations

The Chemistry and Biochemistry Program should be commended for supporting student accomplishments such as the nationally recognized EOU Chemistry Club and the *Eastern Oregon Science journal*. Additionally, the program continues to increase its numbers of Chemistry and Biochemistry majors and to provide outstanding undergraduate research

opportunities. The program's graduates are successful in obtaining employment and admission to post-baccalaureate degree programs. The Girls in Science outreach event also receives national awards, and the program's faculty members are successful in obtaining extramural funding and publishing.

To continue and build on these successes, the Chemistry and Biochemistry Program faculty must have time to do student-centered research, the program must expand physical capacity for research, and the program should seek another tenure-track faculty member.

Administrative Review of Program

Appendix I.

Course Assessments for CHEM 204 and CHEM 450 (Fall 2004)

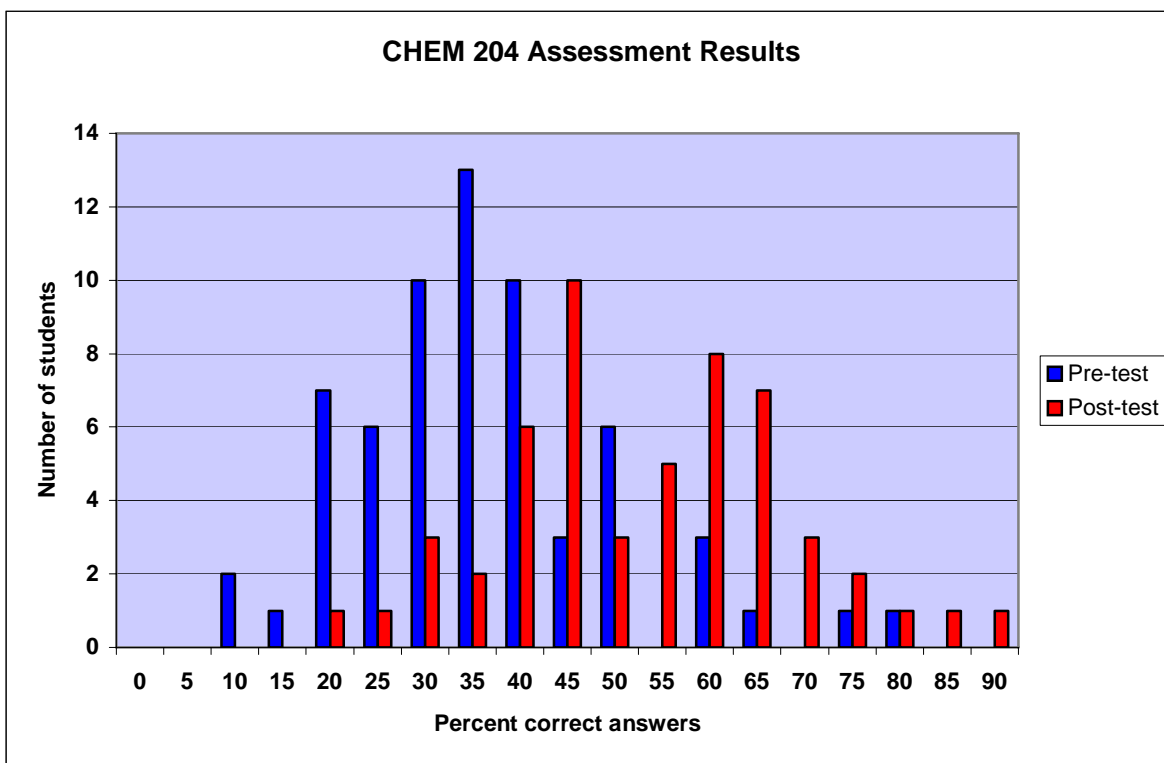
Assessment results:

The American Chemical Society (ACS) provides standardized examinations which are used throughout the country to assess students' learning in core required courses for a chemistry degree. The chemistry program routinely administers the General Chemistry Full Year Examination at the end of spring term. To assess the efficacy of CHEM 204 to contribute to the fundamental program outcome of "*understanding the basic chemical principles in the major specialty areas which include inorganic, organic, physical and analytical chemistry*", a pre-test and a post-test were administered at the beginning and the end of Fall term 2004. The test, comprising of 20 questions taken from ACS standardized exams, aims at assessing students' ability to understand fundamental principles of matter composition and the electronic configuration of elements, use appropriate chemical nomenclature, balance chemical reactions and apply simple stoichiometric relationships to the solution of problems related to chemical reactivity. A copy of the pre-test and post-test are enclosed.

The following table summarizes the results of the assessment:

	PRE-TEST	POST-TEST
Total points possible	20	20
Students in this group	64	54
Mean score	7.23	10.63
Median score	7.00	11.00
Standard deviation	2.77	3.00
Highest score	16	18
Lowest score	2	4
% correct answers	36.15	53.15

The following graph presents the distribution of students' answers for pre-test and post-test.



Clearly these results show a strong improvement in students' performance. The percentage of correct answers rose from 36.15 to 53.15, representing a 32% improvement over the course of the term. The national norm reported for a similar test by the ACS is 41.03. Thus the performance of our students in CHEM 204 exceeds the national standards.

Outcomes in CHEM 450 was also measured in part by comparing class performance in standardized tests administered to students at the beginning and the end of the course. In the case of structural biochemistry, the assessment consisted of 20 multiple choice questions, selected from the ACS standardized biochemistry exam. The data are summarized in Tables 1 and 2,

Table 1. Pre-course test results (CHEM 450)

Distribution of scores (out of 20)

11	9	9	9	9	9	7	7	6	5	5	4	3
----	---	---	---	---	---	---	---	---	---	---	---	---

13 students

Mean score = 7.15 (35.8%)

Table 2. Post-course test results (CHEM 450)

Distribution of scores (out of 20)

13	12	12	10	10	10	9	9	9	8	8	7	6
----	----	----	----	----	----	---	---	---	---	---	---	---

13 students

Mean score = 9.46 (47.3%)

The data show the following.

(i) comparison of the class score before (35.8%) and after the course (47.3%) shows a clear improvement in performance.

(ii) the overall class score compares favorably with national average (*e.g.* mean score of the 1992 ACS Biochemistry exam was 44%).

Appendix II

Assessment of Student Research Outcome

- Be able to design and conduct chemical/biochemical research with appropriate documentation including literature searches.

Year of graduation	# Chemistry and Biochemistry graduates	# Graduates with research presentations or publications	Percentage of graduates with research presentations or publications	
2002-03	5	5	100%	
2003-04	4	4	100%	
2004-05	8	7	88%	
2005-06	7	3	43%	
2006-07	10	10	100%	

Student Presentations (regional, national, and international)

*Indicates EOU student author

2003

Poster Presentation: J. B. Nusser, T. D. Millsap*, A. J. Sunday, B. C. Byrne, D. A. Huffman, A. G. Joly, and J. N. Woodford, "A Theoretical and Experimental Investigation of the Two-Photon Absorption Cross Section of Flavonoid and Anthocyanidin Dyes", *Abstracts of Papers*, 225th National Meeting of the American Chemical Society, New Orleans, LA; American Chemical Society: Washington, DC, **2003**; CHED 819.

Davis, C.A.*, Thompson, R.S., Cavinato, A.G. "Investigation of PCB Contamination in Steelhead Livers". 225th National Meeting of the American Chemical Society, New Orleans, LA, April **2003**.

Hampton, K.* Cavinato, A.G., Boe, S.T., Hoffnagle, T., Mayes, D.M. "Classification of gender and maturity status in Chinook and Coho salmon by Short Wavelength Near Infrared spectroscopy", 225th National Meeting of the American Chemical Society, New Orleans, LA, April **2003**.

Hampton, K.* Cavinato, A.G., Mayes, D.M. "Characterization of optical probe light penetration depth for non invasive analysis", 225th National Meeting of the American Chemical Society, New Orleans, LA, April **2003**.

Wutzke, J.L.*, Fahlstrom, C.A.*, Cavinato, A.G., Wang, Z., Lin, M., Rasco, B.A. "Investigation of near-infrared optical parameters in fish tissue by photon time-of-flight analysis", 225th National Meeting of the American Chemical Society, New Orleans, LA, April **2003**.

R. B. Kelley, T. J. Wood*, and M. L. Conrad*, "Determination and Comparison of Pyrrolizidine Alkaloids from the Genus *Omphalodes*," presentation at the 2003 Annual Meeting of Phytochemical Society of North America, Peoria, IL, August 9 - 13, 2003.

R. B. Kelley, R. D. Champion*, M. F. Auble*, D. R. Kuenzi*, and B. J. Hall*, "Characterization of Naphthazarins and Pyrrolizidine Alkaloids found in *Lithospermum multiflorum*," presentation at the 2003 Annual Meeting of Phytochemical Society of North America, Peoria, IL, August 9 - 13, 2003.

R. D. Champion*, M. F. Auble*, D. R. Kuenzi*, B. J. Hall*, and **R. B. Kelley**, "Isolation and Characterization of Naphthazarins and Pyrrolizidine Alkaloids found in *Lithospermum multiflorum*," presentation at the 225th American Chemical Society Meeting, New Orleans, LA, March 23 - 27, 2003.

T. L. Kaneshiro*, A. K. Miller*, J. S. Shirley*, and **R. B. Kelley**, "Quinolizidine and Piperidine Alkaloids in *Lupinus leucophyllus* and *L. sulphureus*," presentation at the 225th American Chemical Society Meeting, New Orleans, LA, March 23 - 27, 2003

R. A. Feierabend*, J. W. Stoddard*, T. L. Ferguson*, and **R. B. Kelley**, "Structural Determination of the Pyrrolizidine Alkaloids from *Heliotropium convolvulaceum*," presentation at the 225th American Chemical Society Meeting, New Orleans, LA, March 23 - 27, 2003.

2004

T. L. Busche*, L. J. Kemper*, J. L. Wilford*, R. R. Eady, D. M. Lawson, and C. R. Andrew, "Heme-ligand dissociation kinetics as a probe of coordination geometry in cytochrome *c'*", 227th American Chemical Society National Meeting, Anaheim, CA, **April 2004**.

A. McRoberts*, J. N. Woodford, and C. R. Andrew, "Theoretical study of the binding of nitric oxide to a heme model system", 227th American Chemical Society National Meeting, Anaheim, CA, **April 2004**.

J. N. Woodford, P. Lapke, T. Royce*, G. Attebury*, R. Edwards*, and G. S. Harbison, "Theoretical Investigation of Intramolecular Hydrogen Bonding in Derivatives of Malonamide", *Abstracts of Papers*, 227th National Meeting of the American Chemical Society, Anaheim, CA; American Chemical Society: Washington, DC, **2004**; CHED 313.

Tache, R.A.*, Lin, M., Rasco, B.A., Cavinato, A.G. "Rapid and non-destructive detection of bacterial spoilage in meat". 227th National Meeting of the American Chemical Society, Anaheim, CA, March **2004**.

Davis, C.A.*, Peters, H.M.*, Cavinato, A.G., Hoffnagle, T. "Classification of gender and maturity status in Chinook salmon by short wavelength near infrared spectroscopy", 227th National Meeting of the American Chemical Society, Anaheim, CA, March **2004**.

M. L. Conrad*, B. J. Hegtvedt, J. W. Bechaver*, Blake M. Acton, and **R. B. Kelley**, "Natural Product Isolation Using High Speed Counter Current Chromatography," presentation at the 227th American Chemical Society Meeting, Anaheim, CA, March 28 – April 1, 2004.

T. L. Kaneshiro*, J. S. Shirley*, W. R. Peale,* and **R. B. Kelley**, "Determination of Alkaloids Occurring in *Lupinus sabinianus*," presentation at the 227th American Chemical Society Meeting, Anaheim, CA, March 28 – April 1, 2004.

A. K. Miller*, C. L. Smith*, A. M. Jones*, and **R. B. Kelley**, "Investigation of the Naphthazarins Found in *Lithospermum canescens* and *Lithodora diffusa*," presentation at the 227th American Chemical Society Meeting, Anaheim, CA, March 28 – April 1, 2004.

L. K. Rathbone*, R. A. Feierabend, M. D. Gali*, and **R. B. Kelley**, "Structural Elucidation of the Pyrrolizidine Alkaloids from *Heliotropium convolvulaceum*," presentation at the 227th American Chemical Society Meeting, Anaheim, CA, March 28 – April 1, 2004.

2005

A. M. Tiwari*, A. E. Servid*, M. C. Kecskes*, J. M. Stafford*, J. W. B. Moir, W. Huston, R. R. Eady, and C. R. Andrew, "Heme coordination chemistry of ferric cytochromes *c'*", 229th American Chemical Society National Meeting, San Diego, CA, **April 2005**.

Z. E. Goude* and J. N. Woodford, "The Fourier Grid Hamiltonian Method for Calculation of Vibrational Frequencies in Nitromalonamide", *Abstracts of Papers*, 229th National Meeting of the American Chemical Society, San Diego, CA; American Chemical Society, Washington, DC, **2005**; CHED 936.

Tache, R.*, Rathbone, L.K.*, Davis, C.A.*, Cavinato, A.G., Kelley, R.B, Cox, J., Harris, S. "Connecting to the community: service learning opportunities in environmental chemistry" 229th National Meeting of the American Chemical Society, San Diego, CA, August **2005**.

Davis, C.A.*, Cavinato, A.G., Hoffnagle, T., Mayes, DM. "Non-invasive determination of gender and maturity status in Chinook salmon by short wavelength near infrared (SW-NIR) and Fourier transform infrared spectroscopy", 229th National Meeting of the American Chemical Society, San Diego, CA, March **2005**.

Croft, L.C.*, Hagar, D., Cavinato, A.G., Lin, M., Rasco, B.A. "Rapid and non-destructive detection of bacterial spoilage in trout fillets by short wavelength near infrared spectroscopy", 229th National Meeting of the American Chemical Society, San Diego, CA, March **2005**.

A. M. Jones, D. S. Kelley, A. K. Miller, and **R. B. Kelley**, "Determination and Comparison of Pyrrolizidine Alkaloids from Pacific Northwest Senecioideae Taxa," presentation at the 229th American Chemical Society Meeting, San Diego, CA, March 13 – 17, 2005.

M. L. Conrad, B. J. Hegtvedt, J. Brockey, T. D. Holcomb, and **R. B. Kelley**, "Pyrrolizidine Alkaloid Determination and Comparison from the Cynoglossaceae Tribe," presentation at the 229th American Chemical Society Meeting, San Diego, CA, March 13 – 17, 2005.

R. A. Tache, L. K. Rathbone, C. A. Davis, A. G. Cavinato, **R. B. Kelley**, J. Cox, and S. G. Harris, "Connecting to the Community: Service-learning Opportunities in Environmental Chemistry," presentation at the 229th American Chemical Society Meeting, San Diego, CA, March 13 – 17, 2005.

L. K. Rathbone, M. R. Bruck, J. L. Platt, A. L. Marlette, and **R. B. Kelley**, "Structural Elucidation of the Pyrrolizidine Alkaloids from *Heliotropium convolvulaceum*," presentation at the 229th American Chemical Society Meeting, San Diego, CA, March 13 – 17, 2005.

2006

C. R. Andrew, A. L. McKay*, A. E. Servid*, A. M. Tiwari*, W. Huston, J. W. B. Moir, "Spectroscopic and kinetic studies of NO binding to ferrous heme in the K42E mutant of *Rhodobacter capsulatus* cytochrome *c*" 232nd American Chemical Society, National Meeting, San Francisco, CA., **September 2006**.

A. E. Servid*, A. M. Tiwari*, M. C. Kecskes*, J. M. Stafford*, and C. R. Andrew "Spectroscopic characterization of ferric heme nitrosyl cytochromes *c*' and the identification of a putative nitro nitrosyl complex", 232nd American Chemical Society, National Meeting, San Francisco, CA, **September 2006**.

J. C. Deutsch*, M. J. Bechaver*, A. M. Tiwari*, A. E. Servid*, M. C. Kecskes*, J. M. Stafford*, R. R. Eady, and C. R. Andrew, "Inner-Sphere Redox Reactions of Cytochrome *c*" 231st American Chemical Society National Meeting, Atlanta, GA, **April 2006**.

Hammers, M.M.*, Cavinato, A.G., Mayes, D.M., Lin, M. Rasco, B.A.. " Detecting deep muscle bruising in salmon by near infrared spectroscopy". 231st American Chemical Society National Meeting, Atlanta, GA, March **2006**.

Boethin, T.*, Hoffnagle, T., Cavinato, A.G. " Nonlethal screening method for detection of bacterial kidney disease in Pacific salmon". 231st American Chemical Society National Meeting, Atlanta, GA, March **2006**.

Justesen, A.*, Cavinato, A.G., Lin, M. Rasco, B.A."Rapid near infrared spectroscopic method for the detection of spoilage in rainbow trout filet"., 231st American Chemical Society National Meeting, Atlanta, GA, March **2006**.

A. M. Jones*, D. S. Kelley*, B. M. Acton,* and **R. B. Kelley**, "Determination of Pyrrolizidine Alkaloids in *Cacaliopsis nardosmia*," presentation at the 232nd American Chemical Society Meeting, San Francisco, CA, September 10 – 14, 2006.

M. R. Bruck, K. A. Headings, C. M. Jones, and **R. B. Kelley**, "Structural Elucidation of the Pyrrolizidine Alkaloids in *Heliotropium greggii*," presentation at the 232nd American Chemical Society Meeting, San Francisco, CA, September 10 – 14, 2006.

2007

L. J. Kemper*, T. L. Busche*, J. L. Wilford*, A. M. Tiwari*, J. C. Deutsch*, A. A. Porter*, Y. Cho*, A. E. Servid*, A. L. McKay*, and C. R. Andrew. "Heme-NO dissociation kinetics as a probe of proximal and distal coordination in *Alcaligenes xylosoxidans* cytochrome c'" *Gordon Research Conference on Metals in Biology*, Ventura, CA, **January 2007**.

Y. Cho*, J. C. Deutsch*, A. L. McKay*, C. A. Petersen*, A. A. Porter*, E. Samakai,* A. E. Servid*, A. M. Tiwari*, and C. R. Andrew, "Heme-ligand dissociation kinetics as a probe of proximal and distal coordination in *Alcaligenes xylosoxidans* cytochrome c'" 62nd Meeting of the Northwest Region American Chemical Society, Boise, ID, **June 2007**.

K. Wade Elliott*, Douglas W. Brown, Matthew Lewis*, Ryan Hansen*, Wesley Richards and J. N. Woodford, "DFT Calculations on Intramolecular Hydrogen Bond Energies", *Abstracts of Papers*, 233rd National Meeting of the American Chemical Society, Chicago, IL; American Chemical Society, Washington, DC, **2007**; CHED 1391.

Boethin, T.,* Hammers, M.M .,* Troutman, K.*, Hoffnagle, T., Greenlee, A., Cavinato, A.G., "Nonlethal detection of bacterial kidney disease in Pacific salmon by near infrared spectroscopy". 234th American Chemical Society National Meeting, Boston, MA, **August 2007**.

Hammers, M.M,* Lin, M., Mayes, D.M., Rasco, B.A., Cavinato, A.G., "Nondestructive detection of deep muscle bruising in salmon by near infrared spectroscopy". 234th American Chemical Society National Meeting, Boston, MA, **August 2007**.

Taisacan, D.L.,* Lee, Y.H.,* Mitchell, K.*, Cavinato, A.G., "Chlorinated pesticides and other water quality measurements at End Creek: an environmental stewardship project at Eastern Oregon University". 62nd Northwest Regional Meeting of the American Chemical Society, Boise, ID, **June 2007**.

Boethin, T.*, Hammers, M.M .*, Troutman, K., Hoffnagle, T., Mayes, D.M., Cavinato, A.G., " Nonlethal detection of bacterial kidney disease in Pacific salmon by near infrared spectroscopy". 62nd Northwest Regional Meeting of the American Chemical Society, Boise, ID, **June 2007**.

Hammers, M.M.*, Cavinato, A.G., Mayes, D.M., Lin, M. Rasco, B.A.. "Nondestructive detection of deep muscle bruising in salmon by near infrared spectroscopy". 62nd Northwest Regional Meeting of the American Chemical Society, Boise, ID, **June 2007**.

T. D. Holcomb*, A. M. Justesen*, W. R. Parker, and **R. B. Kelley**, "Structural Elucidation of Pyrrolizidine Alkaloids from *Onosmodium virginianum*," presentation at the 234th American Chemical Society Meeting, Boston, MA, August 19 – 23, 2007.

D. S. Kelley*, B. M. Acton*, S. L. Savage*, D. W. Erickson*, and **R. B. Kelley**, "Analysis of Pyrrolizidine Alkaloids in *Cacaliopsis nardosmia*," presentation at the 233rd American Chemical Society Meeting, Chicago, IL, March 25 – 29, 2007.

M. J. Bechaver*, R. G. Edwards*, J. L. Simpson*, and **R. B. Kelley**, "Structural Determination and Chemotaxonomic Analysis of Pyrrolizidine Alkaloids of *Cynoglossum occidentale*," presentation at the 233rd American Chemical Society Meeting, Chicago, IL, March 25 – 29, 2007.

2008

Servid, S.A.*, Cavinato, A.G. "Noninvasive characterization of maturity status to optimize caviar yield and quality in white sturgeon". 235th American Chemical Society National Meeting, New Orleans, LA, **April 2008**.

Troutman, K.*, Boethin, T.*, Hammers, M.M.*, Twombly, L.R.*, Servid, S.A.*, Cavinato, A. G. "Rapid screening method for nonlethal detection of bacterial kidney disease in Pacific salmon". 235th American Chemical Society National Meeting, New Orleans, LA, **April 2008**.

C. A. Petersen*, D. A. Pixton*, R. van Eldik, and C. R. Andrew, "Activation Parameters for Nitric Oxide Binding to *Alcaligenes xylosoxidans* cytochrome *c'*: Probing the Putative Dinitrosyl Heme Intermediate" 235th National Meeting of the American Chemical Society, New Orleans, LA, **April 2008**.

James P. Barnett*, Nicholas Root*, Christopher S. Mello*, Nolan Schmidt*, K. W. Wade Elliott*, and J. N. Woodford, "Calculation of Equilibrium Self-Assembly Constant of 2-Amidopyrimidine", 235th National Meeting of the American Chemical Society, New Orleans, LA

K. Wade Elliott* and J. N. Woodford, "Vibrational Averaging of Chemical Shielding for Self-Assembling Molecules", 235th National Meeting of the American Chemical Society, New Orleans; LA.

D. S. Kelley*, D. W. Erickson*, D. L. Canavan*, and R. B. Kelley, "Analysis of pyrrolizidine alkaloid in *Cacaliopsis nardosmia*" 235th National Meeting of the American Chemical Society, New Orleans; LA.

W. R. Parker*, K. L. Miller*, and R. B. Kelley, "Comparing pyrrolizidine alkaloids in *Onosmodium decipiens* and *O. virginianum*", 235th National Meeting of the American Chemical Society, New Orleans; LA.

Student Publications

(Peer-reviewed journals and the Eastern Oregon Science Journal)

2002

Hampton, K.A., Cavinato, A.G., Mayes, D.M., Boe, S.J., Hoffnagle, T.L. **2002**. Near Infrared Spectroscopic Classification of Gender and Maturity in Chinook Salmon (*Oncorhynchus tshawytscha*) *Eastern Oregon Science J.*, Volume XVII, 31-36.

Nord, S.P., DuBreuil, R., Cavinato, A.G., Mayes, D.M., Lin, M. and Rasco, B.A. **2002**. Penetration depth studies in cod tissue using short-wave near infrared spectroscopy. *Eastern Oregon Science J.*, Volume XVII, 37-41.

2003

R. A. Feierabend*, J. W. Stoddard*, T. L*. Ferguson*, and **R. B. Kelley**, 2003, "Structural Determination of the Pyrrolizidine Alkaloids from *Heliotropium convolvulaceum*," Eastern Oregon Science Journal 18 : 39-43.

R. D. Champion*, M. F. Auble*, D. R. Kuenzi*, B. J. Hall*, and **R. B. Kelley**, 2003, "Characterization of Quinones and Pyrrolizidine Alkaloids found in *Lithospermum multiflorum*," Eastern Oregon Science Journal 18 : 33-38.

T. L. Busche*, L. J. Kemper*, R. R. Eady, and C. R. Andrew, "Nitric oxide release from cytochrome *c'*: a model for the deactivation of soluble guanylate cyclase", *Eastern Oregon Science Journal*, 2002-2003, Vol. XVIII, 10-13.

R. K. Clark Jr.*, A. D. McRoberts*, and J. N. Woodford, "A theoretical investigation of the two-photon absorption cross section of flavanoid and anthocyanidin dyes" *Eastern Oregon Science Journal*, 2002-2003, Vol. XVIII, 44-51.

Hampton, K.A., Wutzke, J.L., Cavinato, A.G., Mayes, D.M., Lin, M., Rasco, B.A., 2003. Characterization of optical probe light penetration depth for non invasive analysis. *Eastern Oregon Science J.*, Volume XVIII, 14-18.

Wutzke, J.L., Fahlstrom, C.A., Cavinato, A.G., Wang, Z., Lin, M., Rasco, B.A. 2003. Investigation of near-infrared optical parameters in fish tissue by photon time-of-flight analysis. *Eastern Oregon Science J.*, Volume XVIII, 27-32.

2005

C. R. Andrew, L. J. Kemper, T. L. Busche, A. M. Tiwari, M. C. Kecskes, J. M. Stafford, L. C. Croft, S. Lu, P. Moëne-Loccoz, W. Huston, J. W. B. Moir, and R. R. Eady, "Accessibility of the distal heme face, rather than Fe-His bond strength, determines the heme-nitrosyl coordination number of cytochromes *c'*: evidence from spectroscopic studies", *Biochemistry*, **2005**, *44*, 8664-8672.

2006

J. C. Deutsch*, M. J. Bechaver*, A. L. McKay*, A. E. Servid*, A. M. Tiwari*, J. M. Stafford*, M. C. Kecskes*, Y. Cho*, C. R. Andrew, and R. R. Eady, "Reactivity of cytochrome *c'* with oxygen", *Eastern Oregon Science Journal*, **2004-2006**, Vol. XIX, 24-26.

M. C. Kecskes*, J. M. Stafford*, C. R. Andrew, and R. R. Eady, "The reaction of nitric oxide with the ferric heme center of *Alcaligenes xylosoxidans* cytochrome *c'*: A UV-visible absorption study", *Eastern Oregon Science Journal*, **2004-2006**, Vol. XIX, 18-23.

A. E. Servid*, A. M. Tiwari*, C. R. Andrew, W. Huston, and J. W. B. Moir, "Spectroscopic Characterization of the ferric heme center in *Rhodobacter capsulatus* cytochrome *c'* and its reactivity with nitric oxide", *Eastern Oregon Science Journal*, **2004-2006**, Vol. XIX, 12-17.

A. McRoberts*, J. N. Woodford, and C. R. Andrew, "Theoretical study of the binding of nitric oxide to a heme model system", *Eastern Oregon Science Journal*, **2004-2006**, Vol. XIX, 8-11.

W. M. Huston, C. R. Andrew, A. E. Servid*, A. L. McKay*, A. P. Leech, C. S. Butler, and J. W. B. Moir. "Heterologous overexpression and purification of cytochrome *c'* from *Rhodobacter capsulatus* and a mutant (K42E) in the dimerization region. Mutation does not alter oligomerization but impacts the heme iron spin state and nitric oxide binding properties" *Biochemistry*, **2006**, *45*, 4388-4395.

Davis, C.A., Cavinato, A.G., Hoffnagle, T., 2006. Non-invasive determination of gender and maturity status in Chinook salmon by short wavelength near infrared spectroscopy. *Eastern Oregon Science J.*, Volume XIX, 30-33.

2007

"Spectroscopic studies of ferric cytochrome *c'* from *Alcaligenes xylosoxidans* and its reactivity with nitric oxide", A. E. Servid, A. L. McKay, A. M. Tiwari, M. C. Kecskes, J. M. Stafford, L. J. Kemper, and C. R. Andrew, *Eastern Oregon Science Journal*, **2007**, Vol. XX, 9-13.

Hammers, M. M., Cavinato, A.G., Mayes, D.M. Lin Mengshi, Rasco, B.A., Smiley, S. 2007. Non-destructive Detection of Deep Muscle Bruising in Salmon by Near Infrared Spectroscopy. *Eastern Oregon Science J.*, Volume XX, 25-29.

Boethin, T.L, Hammers, M. M., Troutman, K., Wright, W., Hoffnagle, T., Greenlee, A., Cavinato, A.G., 2007. Non-lethal Detection of Bacterial Kidney Disease in Pacific Salmon by Near Infrared Spectroscopy. *Eastern Oregon Science J.*, Volume XX, 30-38.

Appendix III

CHEM 407 Seminar Scoring Rubric

STUDENT NAME: _____

MANUSCRIPT TOPIC: _____

OVERALL CONTENT:

	Outstanding 20	Satisfactory 10	Unsatisfactory 0
Technical Information			
Depth of Information			
Command of background material			

Written draft:

	Outstanding 5	Satisfactory 3	Unsatisfactory 0
Organization			
Grammar and spelling			
Notation			
Clarity of writing			
Bibliography and other supporting documentation			

Seminar presentation:

	Outstanding 5	Satisfactory 3	Unsatisfactory 0
Organization			
Grammar and spelling			
Quality of slides			
Length of presentation (45-50 min required)			
Knowledge of subject matter; ability to answer questions			
Speaker's attributes: speaking volume, eye contact; physical appearance, etc.			

Comments:

Appendix IV

Faculty CVs (Chemistry & Biochemistry Program)

Colin R. Andrew, Ph.D.

Associate Professor of Chemistry

Eastern Oregon University
One University Boulevard
La Grande, OR 97850

Phone: 541-962-3322
Fax: 541-962-3873
Email: candrew@eou.edu

Education and Training:

B.Sc. (Honors) chemistry, University of Nottingham, U.K. (1988)
Ph.D. chemistry, University of Newcastle upon Tyne, U.K. (1992)
Postdoctoral research (metallobiochemistry), Oregon Graduate Institute, (1992-1994)

Academic Appointments:

Associate Professor, Eastern Oregon University (2004-present)
Discipline representative, Chemistry and Biochemistry.

Assistant Professor, Eastern Oregon University (2001-2004)

Duties: Teaching in biochemistry, inorganic chemistry, and general chemistry. Research in bioinorganic chemistry. Research mentor to undergraduate students.

Research Assistant Professor, Oregon Graduate Institute (2001)

Duties: Research on nitric oxide interactions with metalloproteins. Graduate teaching in metallobiochemistry seminar course. Supervision of graduate student research.

Senior Research Associate, Oregon Graduate Institute (1999-2000)

Duties: Research on the structure and function of heme proteins using resonance Raman spectroscopy. Graduate teaching in metallobiochemistry seminar course. Supervision of graduate student research.

Teaching and Research Fellow, University of East Anglia, UK (1996-1999)

Duties: Undergraduate and graduate teaching in inorganic chemistry, protein engineering, and spectroscopy. Research on metalloprotein structure. Developed facilities for resonance Raman spectroscopy. Supervised postgraduate students.

Senior Research Associate, Oregon Graduate Institute (1994-1996)

Duties: Research on copper-containing electron-transfer proteins from genetically modified bacteria.

Courses Taught:

Eastern Oregon University

SCI 101 – Scientific method
CHEM 102 – Introduction to chemistry (laboratory)
CHEM 103 – Introduction to chemistry (organic and biochemistry)
CHEM 110 – Chemexcel
CHEM 204L, 205L, 206L – General chemistry laboratory
CHEM 285 – Chemical safety
CHEM 401 – Undergraduate research
CHEM 411 – Inorganic chemistry
CHEM 412 – Inorganic chemistry laboratory
CHEM 450 – Structural biochemistry
CHEM 451 – Metabolic biochemistry
CHEM 454 – Biochemistry Laboratory

University of East Anglia

Protein engineering
Introductory inorganic chemistry
Introductory inorganic chemistry laboratory
Masters-level chemistry laboratory
Spectroscopic techniques
Advanced vibrational spectroscopy
Research mentoring

Oregon Graduate Institute

Metallobiochemistry seminar
Research mentoring

Honors:

2008: As faculty advisor to the *Eastern Oregon Science Journal*, received First Place Special Merit award from the American Scholastic Press Association for Volume XX

2007: As faculty advisor to the *Eastern Oregon Science Journal*, received First Place Special Merit award from the American Scholastic Press Association for Volume XIX

2005-present: Serving member on the National Science Foundation Advisory Panel for Molecular Biochemistry.

2003-2004: EOU Merit Award

2002-2003 EOU Merit Award

2002-2003: two research articles nominated to *Faculty of 1000*: “a database of the most interesting papers published in the biological sciences, based on recommendations of the world’s top researchers”.

2000: research featured in the general interest chemistry web magazine “Reactive Reports”: [http://www.acdlabs.com/webzine/11/11_3.html]

1996: article chosen for cover of the journal *Accounts of Chemical Research*.

Professional Service:

National Science Foundation Advisory Panel for Molecular Biochemistry (2005-present)

Advisor, Eastern Oregon Science Journal (2004-present)

Ph.D. thesis examination committee, Oregon Graduate Institute (2005).

National Science Foundation ad hoc grant reviewer (2004-present)

Member, La Grande Air Quality Commission (2002-present)

Chair, La Grande Air Quality Commission (2004-2006)

Vice-Chair, La Grande Air Quality Commission (2006-present)

American Chemical Society member (2001-present)

Journal of Biological Chemistry, ad hoc reviewer

Journal of the American Chemical Society, ad hoc reviewer

Journal of Biological Inorganic Chemistry, ad hoc reviewer

Biochemistry, ad hoc reviewer

Inorganic Chemistry, ad hoc reviewer

FEBS letters ad hoc reviewer

Research Interests:

Bioinorganic chemistry, biochemistry of nitric oxide, kinetic studies of protein reaction mechanisms, applications of resonance Raman spectroscopy, vibrational spectroscopy of biological systems, involvement of undergraduates in research. Presently involved in collaborative research with Oregon Health and Science University, North Dakota State University, Boston University, University of California, Santa Barbara, Daresbury Laboratory (UK), Martin-Luther University Halle-Wittenberg (Germany), University of Erlangen-Nurnberg (Germany), and Ecole Polytechnique-ENSTA (France).

Grant Funding:

National Science Foundation “RUI: Novel Heme Chemistry of Cytochrome *c*”

	\$395,132 , recommended for funding.
National Science Foundation	“RUI: Novel Heme Chemistry of Cytochrome <i>c</i> ” \$52,382 (2006 –2007).
National Science Foundation	“RUI: Novel Heme Chemistry of Cytochrome <i>c</i> ” \$183,235 (2004- 2006)
EOU Badgley Endowment	“Ultralow-temperature Freezer”, \$6,916 (2004).
EOU Partial Summer Stipend	“Can cytochrome <i>c</i> ’ catalyze the removal of nitric oxide?” \$5,616 (2004).
EOU Foundation	“Student Research Visit to OHSU”, \$501 (2003).
EOU Tech Fee	“A New UV-Visible Spectrophotometer”, \$12,829 (2003).
EOU Summer Stipend	“Nitric Oxide Binding in Hemoproteins”, \$11,232 (2003).
EOU Badgley Endowment	“Chromatographic Equipment”, \$2,298 (2002).
EOU Summer Stipend	“Cytochrome <i>c</i> ’ and its Reactivity with Nitric Oxide”, \$10,800 (2002).
EOU Badgley Endowment	“Microcentrifuge and Spectroscopic Accessories”, \$3958 (2001).
EPSRC Analytical Initiative	“Resonance Raman Gas Sensors”, £50,000 (1998).

Refereed Publications:

S. G. Kruglik, J.-C. Lambry, S. Cianetti, J.-L. Martin, R. R. Eady, C. R. Andrew, and M. Negreie. “Molecular basis for nitric oxide dynamics and affinity with *Alcaligenes xylosoxidans* cytochrome *c*” *J. Biol. Chem.*, **2007**, 282, 5053-5062.

W. M. Huston, C. R. Andrew, A. E. Servid, A. L. McKay, A. P. Leech, C. S. Butler, and J. W. B. Moir. “Heterologous overexpression and purification of cytochrome *c*’ from *Rhodobacter capsulatus* and a mutant (K42E) in the dimerization region. Mutation does not alter oligomerization but impacts the heme iron spin state and nitric oxide binding properties” *Biochemistry*, **2006**, 45, 4388-4395.

C. R. Andrew, L. J. Kemper, T. L. Busche, A. M. Tiwari, M. C. Kecskes, J. M. Stafford, L. C. Croft, S. Lu, P. Moënné-Loccoz, W. Huston, J. W. B. Moir, and R. R. Eady, “Accessibility of the distal heme face, rather than Fe-His bond strength, determines the heme-nitrosyl coordination number of cytochromes *c*’: evidence from spectroscopic

studies", *Biochemistry*, **2005**, *44*, 8664-8672.

C. R. Andrew, K. R. Rodgers, and R. R. Eady, "A novel kinetic trap for NO release from cytochrome *c'*: a possible mechanism for NO release from activated soluble guanylate cyclase", *J. Am. Chem. Soc.*, **2003**, *125*, 9548-9549.

D. M. Lawson, C. E. M. Stevenson, C. R. Andrew, S. J. George, and R. R. Eady, "A two-faced molecule offers NO explanation: the proximal Binding of nitric oxide to haem", *Biochem. Soc. Trans.* **2003**, *31*, 553-557.

C. R. Andrew, S. J. George, D. M. Lawson, and R. R. Eady, "Six- to five-coordinate heme-nitrosyl conversion in cytochrome *c'* and its relevance to guanylate cyclase", *Biochemistry*, **2002**, *41*, 2553-2360.

S. J. George, C. R. Andrew, D. M. Lawson, R. N. F. Thorneley, and R. R. Eady, "Stopped-flow infrared spectroscopy reveals a six-coordinate intermediate in the formation of the proximally bound five-coordinate NO adduct of cytochrome *c'*", *J. Am. Chem. Soc.*, **2001**, *123*, 9683-9684.

C. R. Andrew, E. L. Green, D. M. Lawson, and R. R. Eady, "Resonance Raman studies of cytochrome *c'* support the binding of NO and CO to opposite sides of the heme: implications for ligand discrimination in heme-based sensors", *Biochemistry*, **2001**, *40*, 4115-4122.

D. M. Lawson, C. E. M. Stevenson, C. R. Andrew, and R. R. Eady, "Unprecedented proximal binding of nitric oxide to heme: implications for guanylate cyclase", *EMBO J.*, **2000**, *19*, 5661-5671.

J. P. Hannan, S. L. Davy, G. R. Moore, R. R. Eady, and C. R. Andrew, "Effect of nickel(II) substitution on the resonance Raman and NMR spectra of *Alcaligenes xylosoxidans* azurin II: implications for axial-ligand bonding interactions in cupredoxin active sites", *J. Biol. Inorg. Chem.*, **1998**, *3*, 282-291.

C. R. Andrew, J. Han, T. den Blaauwen, G. van Pouderoyen, E. Vijgenboom, G. W. Canters, and J. Sanders-Loehr, "Cysteine ligand vibrations are responsible for the complex resonance Raman spectrum of azurin", *J. Biol. Inorg. Chem.*, **1997**, *2*, 98-107.

C. R. Andrew and J. Sanders-Loehr, "Copper-sulfur proteins: using Raman spectroscopy to predict coordination geometry", *Acc. Chem. Res.*, **1996**, *29*, 365-372.

C. R. Andrew, R. Fraczkiewicz, R. S. Czernuszewicz, P. Lappalainen, M. Saraste, and J. Sanders-Loehr, "Identification and description of copper-thiolate vibrations in the dinuclear Cu_A site of cytochrome *c* oxidase", *J. Am. Chem. Soc.*, **1996**, *118*, 10436-10445.

S. J. Kroes, C. W. G. Hoitink, C. R. Andrew, J. Ai, J. Sanders-Loehr, A. Messerschmidt, W. R. Hagen, and G. W. Canters, "The mutation Met121→His creates a type-1.5 copper site in

Alcaligenes denitrificans azurin”, *Eur. J. Biochem.*, **1996**, 240, 342-351.

G. van Pouderoyen, C. R. Andrew, T. M. Loehr, J. Sanders-Loehr, S. Mazumdar, H. A. O. Hill, and G. W. Canters, “Spectroscopic and mechanistic studies of type-1 and type-2 Cu sites in *Pseudomonas aeruginosa* azurin as obtained by addition of external ligands to mutant His46Gly”, *Biochemistry*, **1996**, 35, 1397-1407.

H.-D. Projahn, S. Schindler, R. van Eldik, D. G. Fortier, C. R. Andrew, and A. G. Sykes, “Formation and deoxygenation kinetics of oxyhemerythrin and oxyhemocyanin. A pressure dependence study”, *Inorg. Chem.* **1995**, 34, 5935-5941.

C. R. Andrew, P. Lappalainen, M. Saraste, M. T. Hay, Y. Lu, C. Dennison, G. W. Canters, J. A. Fee, C. E. Slutter, N. Nakamura, and J. Sanders-Loehr, “Engineered cupredoxins and bacterial cytochrome *c* oxidases have similar Cu_A sites: evidence from resonance Raman spectroscopy”, *J. Am. Chem. Soc.*, **1995**, 117, 10759-10760.

C. R. Andrew, H.-Y. Yeom, J. S. Valentine, B. G. Karlsson, G. van Pouderoyen, G. W. Canters, T. M. Loehr, and J. Sanders-Loehr, “Raman spectroscopy as an indicator of Cu-S bond length in type 1 and type 2 copper cysteine proteins”, *J. Am. Chem. Soc.*, **1994**, 116, 11489-11498.

C. R. Andrew, J. Han, S. de Vries, J. van der Oost, B. A. Averill, T.M. Loehr, and J. Sanders-Loehr, “Cu_A site of cytochrome *c* oxidase and A-site of N₂O reductase are tetrahedrally distorted type 1 Cu cysteinates”, *J. Am. Chem. Soc.*, **1994**, 116, 10805-10806.

M. van de Kamp, G. W. Canters, C. R. Andrew, J. Sanders-Loehr, C. J. Bender, and J. Peisach, “Effect of lysine ionization on the structure and electrochemical behaviour of the Met44→Lys mutant of the blue-copper protein azurin from *Pseudomonas aeruginosa*”, *Eur. J. Biochem.*, **1993**, 218, 229-238.

C. R. Andrew, G. D. Armstrong, K. P. McKillop, G. A. Salmon, and A. G. Sykes, “Studies relating to the formation of semi-met Cu(I)Cu(II) *Panulirus interruptus* hemocyanin”, *J. Chem. Soc., Dalton Trans.*, **1993**, 2297-2303.

C. R. Andrew, K. P. McKillop, and A. G. Sykes, “Kinetic studies on the reactions of separated *a*, *b*, and *c* subunits of *Panulirus interruptus* hemocyanin”, *Biochim. Biophys. Acta*, **1993**, 1163, 17-25.

C. R. Andrew, K. P. McKillop, and A. G. Sykes, “Kinetics of the equilibration of O₂ with *Panulirus interruptus* hemocyanin subunits *a*, *b*, and *c*”, *Biochim. Biophys. Acta*, **1993**, 1162, 105-114.

B.-J. Zhang, C. R. Andrew, N. P. Tomkinson, and A. G. Sykes, “Reactivity patterns for redox reactions of monomer forms of myoglobin, hemocyanin and hemerythrin”, *Biochim. Biophys. Acta*, **1992**, 1102, 245-252.

A. G. Sykes, C. R. Andrew, K. Govindaraju, K-Y. Lam, E. Lloyd, G. A. Salmon, and N. P. Tomkinson, "Applications of pulse radiolysis to studies on metalloproteins", *Radiation Research: A 20th Century Perspective*, Academic Press, **1991**, 2, 87-92.

Other Publications:

"Spectroscopic studies of ferric cytochrome *c'* from *Alcaligenes xylosoxidans* and its reactivity with nitric oxide", A. E. Servid, A. L. McKay, A. M. Tiwari, M. C. Kecskés, J. M. Stafford, L. J. Kemper, and C. R. Andrew, *Eastern Oregon Science Journal*, **2007**, Vol. XX, 9-13.

A. McRoberts, J. N. Woodford, and C. R. Andrew, "Theoretical study of the binding of nitric oxide to a heme model system", *Eastern Oregon Science Journal*, **2004-2006**, Vol. XIX, 8-11.

A. E. Servid, A. M. Tiwari, C. R. Andrew, W. Huston, and J. W. B. Moir, "Spectroscopic Characterization of the ferric heme center in *Rhodobacter capsulatus* cytochrome *c'* and its reactivity with nitric oxide", *Eastern Oregon Science Journal*, **2004-2006**, Vol. XIX, 12-17.

M. C. Kecskés, J. M. Stafford, C. R. Andrew, and R. R. Eady, "The reaction of nitric oxide with the ferric heme center of *Alcaligenes xylosoxidans* cytochrome *c'*: A UV-visible absorption study", *Eastern Oregon Science Journal*, **2004-2006**, Vol. XIX, 18-23.

J. C. Deutsch, M. J. Bechaver, A. L. McKay, A. E. Servid, A. M. Tiwari, J. M. Stafford, M. C. Kecskés, Y. Cho, C. R. Andrew, and R. R. Eady, "Reactivity of cytochrome *c'* with oxygen", *Eastern Oregon Science Journal*, **2004-2006**, Vol. XIX, 24-26.

T. L. Busche, L. J. Kemper, R. R. Eady, and C. R. Andrew, "Nitric oxide release from cytochrome *c'*: a model for the deactivation of soluble guanylate cyclase", *Eastern Oregon Science Journal*, 2002-2003, Vol. XVIII, 10-13.

Invited Seminars:

"Spectroscopic studies of ferric cytochrome *c'* from *Alcaligenes xylosoxidans* and its reactivity with nitric oxide" *European Conference on Biological Inorganic Chemistry*, Aveiro, Portugal, **July 2006**.

"Nitric Oxide and its Reactions with Heme Proteins", *Boise State University*, **February, 2006**.

"Nitric Oxide and its Reactions with Heme Proteins", Research in Progress Seminar, Huber Auditorium, *Eastern Oregon University*, **February 2005**.

"A two-faced molecule offers NO explanation: the proximal binding of nitric oxide to

heme”, *University of Idaho*, Moscow, **February 2005**.

“Evaluating Local Air Quality”, Public Lecture, Zabel Hall, *Eastern Oregon Univeristy*, **October 2003**.

“A two-faced molecule offers NO explanation: the proximal binding of nitric oxide to heme”, *Washington State University*, Pullman, **October 2003**.

“A kinetic trap mechanism for release of NO from cytochrome *c'*: implications for inactivation of the NO sensor, soluble guanylate cyclase”, *11th International Conference on Biological Inorganic Chemistry*, Cairns, Australia, **July 2003**.

“Nitric oxide binding to a two-faced protein: insights into mammalian signal transduction”, *North Dakota State University*, Fargo, **August 2002**.

“Interaction of nitric oxide with cytochrome *c'* reveals insights into NO-sensing in mammals”, *Pacific University*, Forest Grove, Oregon, **June 2001**.

Contributed Presentations:

C. A. Petersen, D. A. Pixton, R. van Eldik, and C. R. Andrew, “Activation Parameters for Nitric Oxide Binding to *Alcaligenes xylosoxidans* cytochrome *c'*: Probing the Putative Dinitrosyl Heme Intermediate” *235th National Meeting of the American Chemical Society*, New Orleans, LA, **April 2008**.

Y. Cho, J. C. Deutsch, A. L. McKay, C. A. Petersen, A. A. Porter, E. Samakai, A. E. Servid, A. M. Tiwari, and C. R. Andrew, “Heme-ligand dissociation kinetics as a probe of proximal and distal coordination in *Alcaligenes xylosoxidans* cytochrome *c'*” *62nd Meeting of the Northwest Region American Chemical Society*, Boise, ID, **June 2007**.

L. J. Kemper, T. L. Busche, J. L. Wilford, A. M. Tiwari, J. C. Deutsch, A. A. Porter, Y. Cho, A. E. Servid, A. L. McKay, and C. R. Andrew. “Heme-NO dissociation kinetics as a probe of proximal and distal coordination in *Alcaligenes xylosoxidans* cytochrome *c'*” *Gordon Research Conference on Metals in Biology*, Ventura, CA, **January 2007**.

C. R. Andrew, A. L. McKay, A. E. Servid, A. M. Tiwari, W. Huston, J. W. B. Moir, “Spectroscopic and kinetic studies of NO binding to ferrous heme in the K42E mutant of *Rhodobacter capsulatus* cytochrome *c'*” *232nd American Chemical Society, National Meeting*, San Francisco, CA., **September 2006**.

A. E. Servid, A. M. Tiwari, M. C. Kecsksés, J. M. Stafford, and C. R. Andrew “Spectroscopic characterization of ferric heme nitrosyl cytochromes *c'* and the identification of a putative nitro nitrosyl complex”, *232nd American Chemical Society, National Meeting*, San Francisco, CA, **September 2006**.

J. C. Deutsch, M. J. Bechaver, A. M. Tiwari, A. E. Servid, M. C. Kecskses, J. M. Stafford,

R. R. Eady, and C. R. Andrew, "Inner-Sphere Redox Reactions of Cytochrome *c*" 231st *American Chemical Society National Meeting*, Atlanta, GA, **April 2006**.

A. M. Tiwari, A. E. Servid, M. C. Kecskes, J. M. Stafford, J. W. B. Moir, W. Huston, R. R. Eady, and C. R. Andrew, "Heme coordination chemistry of ferric cytochromes *c'*", 229th *American Chemical Society National Meeting*, San Diego, CA, **April 2005**.

T. L. Busche, L. J. Kemper, J. L. Wilford, R. R. Eady, D. M. Lawson, and C. R. Andrew, "Heme-ligand dissociation kinetics as a probe of coordination geometry in cytochrome *c'*", 227th *American Chemical Society National Meeting*, Anaheim, CA, **April 2004**.

A. McRoberts, J. N. Woodford, and C. R. Andrew, "Theoretical study of the binding of nitric oxide to a heme model system", 227th *American Chemical Society National Meeting*, Anaheim, CA, **April 2004**.

C. R. Andrew, S. J. George, D. M. Lawson, and R. R. Eady, "Six- to five-coordinate heme nitrosyl conversion in cytochrome *c'* and its relevance to guanylate cyclase" 223rd *American Chemical Society, National Meeting*, Orlando, **April 2002**.

C. R. Andrew and R. R. Eady, "Interaction of cytochrome *c'* with nitrite reductase – a possible nitric oxide channeling pathway in denitrifiers", *Gordon Research Conference on the Chemistry & Biology of Tetrapyrroles*, Newport, Rhode Island, **July 2000**.

J. Sanders-Loehr, C. R. Andrew, and N. Nakamura, "Redesign of copper sites in cupredoxins" 34th *Hanford Symposium on Health and the Environment*, Pasco, Washington, **October 1995**.

C. R. Andrew, T. M. Loehr, and J. Sanders-Loehr, "Raman spectroscopy as an indicator of Cu-S bond lengths and coordination geometries in Cu-cysteinate proteins", 208th *American Chemical Society, National Meeting*, Washington DC, **August 1994**.

H. Yeom, Y. Lu, C. R. Andrew, J. Sanders-Loehr, E. B. Gralla, and J. S. Valentine "Probing the active site of yeast copper-zinc SOD with cysteine" 6th *International Conference on Bioinorganic Chemistry*, San Diego, **August 1993**.

C. R. Andrew, J. Han, T. M. Loehr, J. Sanders-Loehr, T. den Blaauwen, and G. W. Canters, "Assignment of the resonance Raman spectra of azurins", 6th *International Conference on Bioinorganic Chemistry*, San Diego, **August 1993**.

C. R. Andrew and A. G. Sykes, "Active site redox interconversions of hemocyanin", *Copper Coordination Chemistry: Bioinorganic Perspectives*, Johns Hopkins University, Baltimore, **August 1992**.

C. R. Andrew and A. G. Sykes. "Kinetic studies on hemocyanin and comparisons with other O₂-carriers", 5th *International Conference on Bioinorganic Chemistry*, Oxford,

U.K. August 1991.

C. R. Andrew and A. G. Sykes, "Reactivity of hemocyanin and other O₂-carriers", 200th
American Chemical Society, National Meeting, Washington DC, August 1990.

Curriculum Vitae

Jeffrey N. Woodford, Ph.D.

Personal

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Research Interests

1. Theoretical studies on novel materials that form strong hydrogen bonds, in collaboration with Professors Gerard S. Harbison and John A. Belot at the University of Nebraska-Lincoln.
2. Theoretical studies on the prediction of NMR properties of important biological molecules, in collaboration with Professor Gerard S. Harbison at the University of Nebraska-Lincoln.
3. Theoretical studies on the binding of nitric oxide to heme-containing active sites in proteins, in collaboration with Professor Colin R. Andrew at Eastern Oregon University.

Education

- Ph.D., Chemistry, University of Nebraska-Lincoln, Lincoln, NE; Conferred August 15, 2000. Dissertation Title: "Measurement and Dispersion of the First Molecular Hyperpolarizability of Organic Molecules using Hyper-Rayleigh Scattering." Advisor: Professor C. H. Wang, Mabel D. Clark Distinguished Professor of Chemistry and Physics.
- B.S., Chemistry/Computer Science Track (ACS Certified), Carnegie Mellon University, Pittsburgh, PA; Conferred May 15, 1994
Undergraduate Research Advisor: Professor Jonathan S. Lindsey, currently the Glaxo Distinguished University Professor at North Carolina State University, Raleigh, NC, jlindsey@ncsu.edu.

Full-Time Employment

- Associate Professor of Chemistry, Eastern Oregon University, La Grande, OR 97850 (September 2005 – present)
- Assistant Professor of Chemistry, Eastern Oregon University, La Grande, OR 97850 (September 2000 – September 2005)

Summer Employment

- Visiting Assistant Professor, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, NE; Summer 2005. Continued research from the previous summer, with Professors Gerard S. Harbison and John A. Belot.
- Visiting Assistant Professor, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, NE; Summer 2005. Taught a summer class of second-semester general chemistry (CHEM 110).
- Visiting Assistant Professor, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, NE; Summer 2004. Continued research from the previous summer, with Professors Gerard S. Harbison and John A. Belot.
- Visiting Assistant Professor, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, NE; Summer 2004. Taught a summer class of second-semester general chemistry (CHEM 110).
- Visiting Assistant Professor, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, NE; Summer 2003. Worked with Professors Gerard S. Harbison and John A. Belot on theoretical studies of the NMR properties of ribose and its derivatives, and theoretical studies of strongly hydrogen-bonded materials.

Related Work Experience

- Graduate Research Assistant, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, NE; Summer 1996 to December 1996; January 2000 to August 2000.
- Graduate Teaching Assistant, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, NE; Fall 1994 to Spring 1996; January 1997 to December 1999.
- Volunteer Undergraduate Chemistry Tutor for the Department of Chemistry, Carnegie Mellon University, Pittsburgh, PA; Fall 1993 to Spring 1994.
- Undergraduate Research Assistant, Department of Chemistry, Carnegie Mellon University, Pittsburgh, PA; Summer 1993 to Spring 1994.

Professional Memberships and Awards

- Recipient of a merit stipend for outstanding service to Eastern Oregon University during the 2002-03 academic year.
- Recognized for outstanding service to the Richland Section of the American Chemical Society, Fall 2003.
- Member, American Chemical Society (since 1991)
- Member, Optical Society of America (since 2001)
- Member, Alpha Phi Omega National Service Fraternity (inducted Fall 1990)
- Member, Phi Lambda Upsilon Honorary Chemistry Society (inducted Spring 1995)
- Member, Omicron Delta Kappa National Leadership Society (inducted Fall 1999)
- Member, The Honor Society of Phi Kappa Phi (inducted Fall 2003)

Instruction

- Responsible for teaching a variety of courses in the chemistry curriculum. Courses I have taught include (asterisks indicate courses I am scheduled to teach this academic year):
 - CHEM 440* Thermodynamics (lecture) and CHEM 443* Thermodynamics Lab; CHEM 441* Quantum Mechanics (cross-listed as PHYS 321); and CHEM 442* Chemical Dynamics (lecture) and CHEM 445* Chemical Dynamics Lab. These courses comprise EOU's physical chemistry sequence.
 - CHEM 204 General Chemistry (lecture and lab*), CHEM 205 General Chemistry (lecture* and lab*), and CHEM 206 Qualitative Analysis (lecture and lab). These three courses comprise EOU's general chemistry sequence for majors.
 - CHEM 310/ART 310 Ceramic Glaze Chemistry. This was an experimental, interdisciplinary class taught in conjunction with Professor Peter Johnson, Department of Art at EOU. The focus of this class was to investigate the chemical properties of glazes in various proportions as they are applied to various substrates.
 - CHEM 102 Introduction to Chemistry (lecture and lab) - winter term introductory chemistry for nonmajors.
 - SCI 101 Scientific Method (lecture and lab), SCI 102 Energy & Work (lecture and lab, and SCI 103 Matter (lecture and lab). These three courses comprise an introductory science series primarily for pre-service teachers.
 - CHEM 210 Chemistry Service Learning.
 - CHEM 410/PHYS 410 Statistical Thermodynamics.
 - CHEM 280 Chemical Literature (1-credit lecture).
 - CHEM 285 Chemical Safety (1-credit lecture).

Curricular Innovations

- **Developed a new course, CHEM 340 Physical Chemistry**, intended to be a junior-level survey course of physical chemistry specifically geared for biochemistry and biology majors.
- **Developed the general chemistry sequence of courses for online delivery.** With this offering, and previous online offerings developed by other chemistry faculty, the university is now able to offer the entire chemistry minor online, one of only a handful of institutions able to do so.
- **Redesigned the laboratory manuals** for CHEM 204 and CHEM 205, with an aim towards designing open-ended, project-oriented laboratory exercises. The laboratory manuals were published in collaboration with Richard Hermens, Professor Emeritus of Chemistry at EOU.
- **Transformed CHEM 443, Thermodynamics Laboratory, into a writing-intensive course.** This course is the laboratory course for first term of physical chemistry. Students work in teams to complete experiments, and then present their results in the form of a professional-style paper written in the style required of the *Journal of the American Chemical Society*.
- **Designed and implemented experiments aimed at introductory-level chemistry utilizing advanced instrumentation** such as a gas chromatograph/mass spectrometer (GC/MS), as a part of a successful NSF CCLI grant. In particular, one experiment

involved the study of isotopes by injection of different chlorinated and brominated organic compounds into the GC/MS and observing their different isotope patterns in the mass spectrum.

Conference Presentations

- Oral Presentation: “Hyper-Rayleigh Scattering of Nonlinear Optical Chromophores at 1064 nm and 1907 nm”, to the Organic Thin Films '99 Conference, Santa Clara, California, September 24-26, 1999; Sponsored by the Optical Society of America and the American Chemical Society.
- Oral Presentation: J. N. Woodford, C. H. Wang, C. Zhang, and L. R. Dalton, “Measurement of the First Molecular Hyperpolarizability of Charge Transfer Chromophores using Hyper-Rayleigh Scattering at Multiple Infrared Wavelengths”, *Abstracts of Papers*, 220th National Meeting of the American Chemical Society, Washington, DC; American Chemical Society: Washington, DC, 2000; PMSE 142.
- Poster Presentation: J. N. Woodford, A. G. Joly, and D. K. Olson, “Investigation of Flavonoid and Anthocyanidin Molecules for Potential Optoelectronic Applications”, *Abstracts of Papers*, 223rd National Meeting of the American Chemical Society, Orlando, FL; American Chemical Society: Washington, DC, 2002; PHYS 334.
- Poster Presentation: D. K. Olson, S. Kittelson, T. Fagala, and J. N. Woodford, “Study of the Copigmentation Effect Between Anthocyanins and Organic Acids”, *Abstracts of Papers*, 223rd National Meeting of the American Chemical Society, Orlando, FL; American Chemical Society: Washington, DC, 2002; CHED 937.
- Poster Presentation: J. B. Nusser, T. D. Millsap, A. J. Sunday, B. C. Byrne, D. A. Huffman, A. G. Joly, and J. N. Woodford, “A Theoretical and Experimental Investigation of the Two-Photon Absorption Cross Section of Flavonoid and Anthocyanidin Dyes”, *Abstracts of Papers*, 225th National Meeting of the American Chemical Society, New Orleans, LA; American Chemical Society: Washington, DC, 2003; CHED 819.
- Poster Presentation: J. N. Woodford, P. Lapke, T. Royce, G. Attebury, R. Edwards, and G. S. Harbison, “Theoretical Investigation of Intramolecular Hydrogen Bonding in Derivatives of Malonamide”, *Abstracts of Papers*, 227th National Meeting of the American Chemical Society, Anaheim, CA; American Chemical Society: Washington, DC, 2004; CHED 313.
- Poster Presentation: A. McRoberts, J. N. Woodford, and C. R. Andrew, “Theoretical Study of the Binding of Nitric Oxide to a Heme Model System”, *Abstracts of Papers*, 227th National Meeting of the American Chemical Society, Anaheim, CA; American Chemical Society: Washington, DC, 2004; CHED 318.
- Poster Presentation: J. N. Woodford, “Theoretical Study of the Two-Photon Absorption Cross Sections of Anthocyanidin Compounds”, *Abstracts of Papers*, 227th National Meeting of the American Chemical Society, Anaheim, CA; American Chemical Society: Washington, DC, 2004; PHYS 369.
- Poster Presentation: Z. E. Goude and J. N. Woodford, “The Fourier Grid Hamiltonian Method for Calculation of Vibrational Frequencies in Nitromalonamide”, *Abstracts of Papers*, 229th National Meeting of the American Chemical Society, San Diego, CA; American Chemical Society: Washington, DC, 2005; CHED 936.

- Poster Presentation: J. N. Woodford and G. S. Harbison, "Effects of Zero-Point and Thermal Vibrational Averaging on Computed NMR Properties of a Model Compound for Purine Nucleosides", *Abstracts of Papers*, 229th National Meeting of the American Chemical Society, San Diego, CA; American Chemical Society, Washington, DC, 2005; PHYS 324.
- Oral Presentation: J. N. Woodford, "Theoretical Studies of Intramolecular Hydrogen Bonding in Malonamide Derivatives", *Abstracts of Papers*, 231st National Meeting of the American Chemical Society, Atlanta, GA; American Chemical Society, Washington, DC, 2006; COMP 87.
- Poster Presentation: K. Wade Elliott, Douglas W. Brown, Matthew Lewis, Ryan Hansen, Wesley Richards and J. N. Woodford, "DFT Calculations on Intramolecular Hydrogen Bond Energies", *Abstracts of Papers*, 233rd National Meeting of the American Chemical Society, Chicago, IL; American Chemical Society, Washington, DC, 2007; CHED 1391.
- Oral Presentation: J. N. Woodford, K. Wade Elliott, Douglas W. Brown, Matthew Lewis, Ryan Hansen and Wesley Richards, "DFT and AIM Studies of Strong Intramolecular Hydrogen Bonding", *Abstracts of Papers*, 233rd National Meeting of the American Chemical Society, Chicago, IL; American Chemical Society, Washington, DC, 2007; COMP 245.
- Poster Presentation: James P. Barnett, Nicholas Root, Christopher S. Mello, Nolan Schmidt, K. W. Wade Elliott, and J. N. Woodford, "Calculation of Equilibrium Self-Assembly Constant of 2-Amidopyrimidine", *Abstracts of Papers*, 235th National Meeting of the American Chemical Society, New Orleans, LA; American Chemical Society, Washington, DC, 2008; CHED 948.
- Poster Presentation: K. Wade Elliott and J. N. Woodford, "Vibrational Averaging of Chemical Shielding for Self-Assembling Molecules", *Abstracts of Papers*, 235th National Meeting of the American Chemical Society, New Orleans; LA; American Chemical Society, Washington, DC, 2008; CHED 1053.
- Oral Presentation: J. N. Woodford, "Nonequilibrium DFT Properties of Intramolecular Hydrogen Bonding in Malonaldehyde, Aminoacrolein, Iminopropenylamine and Derivatives", *Abstracts of Papers*, 235th National Meeting of the American Chemical Society, New Orleans; LA; American Chemical Society, Washington, DC, 2008; COMP 259.
- Oral Presentation: J. N. Woodford and Peter C. Johnson, "Using Glaze Chemistry as an Example of the Integration of Art and Science", *Abstracts of Papers*, 235th National Meeting of the American Chemical Society, New Orleans; LA; American Chemical Society, Washington, DC, 2008; CHED 1549.

Grant Proposals

- "Determination of the Two-Photon Absorption Cross Section of Conjugated Natural Products", submitted as a Faculty Scholar Proposal (internal award), December, 2000. Requested \$10,534 in salary money for Summer 2001. Funded.
- "CAREER: Revitalization of the Physical Chemistry Laboratory Curriculum and Study of the Nonlinear Optical Properties and Complexation of Natural Chromophores",

submitted to the National Science Foundation's Faculty Early Career Development Program, July 2001. Requested \$458,043 over 5 years. Not funded.

- "Integration of Gas Chromatography Mass Spectrometry and Fourier Transform Infrared Spectroscopy into the Undergraduate Curriculum", submitted to the National Science Foundation's Course, Curriculum, and Laboratory Instruction (CCLI) program, June 2001 (Co-PI, with Professors Anna Cavinato (PI) and Ron Kelley (Co-PI)). Requested \$182,640 over 2 years (1:1 EOU match). Funded.
- "Two-Photon Absorption Studies of Naturally-Occurring Dyes", submitted to the American Chemical Society Petroleum Research Fund (Type G), August 2003. Requested \$35,000 over 2 years. Not funded.
- "Study of the Two-Photon Absorption and Intermolecular Complexation of Anthocyanidin Dyes", submitted to the Research Corporation's Cottrell College Science Award Program, February 2002. Requested \$35,279.20 over 2 years (\$10,000 EOU match). Not funded.
- "Acquisition of an Ultrafast Laser System for the Spectroscopic Study of Biological Materials", submitted to the National Science Foundation's Major Research Initiative (MRI) program, January 2003 (PI, with Professors Anna Cavinato (Co-PI) and Tom Herrmann (Co-PI)). Requested \$288,659 over 2 years. Not funded.
- "Strong Hydrogen Bonds", submitted to the National Science Foundation's Chemical Research Centers (CRC) program, October 2003 (Co-PI, with Professors Gerard Harbison (PI) and John Belot (Co-PI)). Requested \$1,386,249 over 2 years (\$105,008 for EOU). Not funded.
- "Strong Hydrogen Bonds", submitted to the National Science Foundation, January 2005 (Co-PI, with Professors Gerard Harbison (PI) and John Belot (Co-PI)). Requested \$488,382 over 2 years. Not funded.
- "Theoretical Studies of Strong Hydrogen Bonding in Nitromalonamide", submitted to the American Chemical Society Petroleum Research Fund (Type B), December 2005. Requested \$50,000 over three years. Not funded.
- "Theoretical Studies of Strong Hydrogen Bonding in Nitromalonamide", submitted as a Faculty Scholar Proposal (internal award), December, 2005. Requested \$5,625 in salary money for Summer 2006. Funded.
- "Theoretical Studies of Strong Hydrogen Bonding in Nitromalonamide", submitted to the National Science Foundation's Research at Undergraduate Institutions (RUI) program, January 2006. Requested \$149,356 over three years. Not funded.
- "Theoretical Studies of Strong Hydrogen Bonding in Nitromalonamide", submitted to the Research Corporation's Cottrell College Science Award Program, March 2006. Requested \$23,246 over two years. Not funded.

Peer-Reviewed Publications

(Reprints of published work available upon request.)

1. J. S. Lindsey and J. N. Woodford, "A Simple Method for Preparing Magnesium Porphyrins", *Inorg. Chem.* **1995**, 34, 1063.
2. J. N. Woodford, M. A. Pauley, and C. H. Wang, "Solvent Dependence of the First Molecular Hyperpolarizability of *p*-nitroaniline Revisited", *J. Phys. Chem. A* **1997**, 101, 1989.

3. O. K. Song, J. N. Woodford, and C. H. Wang, "Effects of Polymerization and Two-Photon Fluorescence on the First Molecular Hyperpolarizability of an Azobenzene Dye", *J. Phys. Chem. A* **1997**, *101*, 3222.
4. J. N. Woodford, C. H. Wang, A. E. Asato, and R. S. H. Liu, "Hyper-Rayleigh Scattering of Azulenic Donor-Acceptor Molecules at 1064 nm and 1907 nm", *J. Chem. Phys.* **1999**, *111*, 4621.
5. B. Grüner, Z. Janoušek, B. T. King, J. N. Woodford, C. H. Wang, V. Vřetecka, and J. Michl, "Synthesis of 12-Substituted 1-Carba-*closo*-dodecaborate Anions and First Hyperpolarizability of the 12-C₇H₆⁺-CB₁₁H₁₁⁻ Ylide", *J. Am. Chem. Soc.* **1999**, *121*, 3122. [Correction: *J. Am. Chem. Soc.* **2000**, *122*, 11274.]
6. C. Zhang, A. S. Ren, F. Wang, J. Zhu, L. R. Dalton, J. N. Woodford, and C. H. Wang, "Synthesis and Characterization of Sterically Stabilized Second-Order Nonlinear Optical Chromophores", *Chem. Mater.* **1999**, *11*, 1966.
7. C. H. Wang and J. N. Woodford, "Characterization and Poling of Second Order Nonlinear Optical Polymers", in *Advanced Functional Molecules and Polymers*, H. S. Nalwa, ed. (Gordon and Breach Science Publishers, Tokyo), 2000.
8. J. N. Woodford, C. H. Wang, and A. K.-Y. Jen, "Measurement of the First Hyperpolarizabilities of Thiophene-Based Charge Transfer Chromophores with Hyper-Rayleigh Scattering at 1064 nm and 1907 nm", *Chem. Phys.* **2000**, *262*, 475.
9. J. N. Woodford, C. H. Wang, C. Zhang, and L. R. Dalton, "Resonant and Nonresonant Hyper-Rayleigh Scattering of Charge Transfer Chromophores", *J. Appl. Phys.* **2001**, *89*, 4209.
10. J. N. Woodford, C. H. Wang, and A. K.-Y. Jen, "Dispersion of the First Molecular Hyperpolarizability of Charge-Transfer Chromophores Studied by Hyper-Rayleigh Scattering", *Chem. Phys.* **2001**, *271*, 137.
11. J. N. Woodford, "A DFT Investigation of Anthocyanidins", *Chem. Phys. Lett.* **2005**, *410*, 182.
12. X. Zhao, P. Rossi, V. Barsegov, J. Zhou, J. N. Woodford, and G. S. Harbison, "Temperature Dependent Deuterium Quadrupole Coupling Constants of Short Hydrogen Bonds", *J. Mol. Struct.* **2006**, *790*, 152.
13. J. N. Woodford and G. S. Harbison, "Effects of Zero-Point and Thermal Vibrational Averaging on Computed NMR Properties of a Model Compound for Purine Nucleosides", *J. Chem. Theory & Comp.* **2006**, *2*, 1464.
14. J. N. Woodford, "Density Functional Theory and Atoms-in-Molecules Investigation of Intramolecular Hydrogen Bonding in Derivatives of Malonaldehyde and Implications for Resonance-Assisted Hydrogen Bonding", *J. Phys. Chem. A* **2007**, *111*, 8519.

University Service

- Currently serve as the **Co-Director of the Honors Program**, along with Prof. Peter Johnson. Duties include undertaking a comprehensive review of the program with an aim towards redesigning the program to better serve the needs of the university community.
- Co-wrote a proposal to create a **new B.S. degree in Biochemistry**, in collaboration with the chemistry and biology faculty. Helped to steer the proposal to final approval at the college, university, and statewide levels. The immediate effect of this degree

offering alone has been to *double* the number of majors that the department serves, from approximately 20 to approximately 40.

- Co-wrote a proposal to create a **new minor in Environmental Chemistry**, in collaboration with the chemistry faculty, and helped to steer this proposal to final approval.
- Co-wrote a proposal to create a **new concentration in Physical Chemistry** (for chemistry majors) and a **new concentration in Chemical Physics** (for physics majors), in collaboration with the physics faculty, and helped to steer the proposal to final approval.
- **Assembly Budget and Planning Committee** (member, 2004-2005; chair: Prof. Greg Monahan). This committee is responsible for making recommendations to upper administration on strategic planning and resource allocation for the entire university.
- **College of Arts & Sciences Dean Search Committee** (member, 2004-2005; chair: Prof. Marie Balaban). This committee is responsible for selecting a slate of qualified candidates for the position of Dean of the College of Arts and Sciences.
- **Honors Committee** (member, 2003-2005; chair: Prof. Elizabeth Boretz). This committee is responsible for overseeing the university's Honors Program. Duties include selection of designated honors courses on campus, and validation of individual candidates' applications for an honors degree.
- **Badgley Endowment Committee** (member, 2003-present; chair: Prof. Karen Antell). This committee is responsible for awarding small equipment grants to the science faculty.
- **Assembly Academic Standards Committee** (member, 2001-03; chair: Prof. Jodi Varon). This committee is responsible for setting and enforcing academic standards for the university. During my term of service, the committee did a major overhaul of the university policy on criteria for academic standing. The new policy is preventive in nature, seeking to address students' obstacles to academic success *before* these obstacles lead to academic difficulty such as probation or expulsion.

Commitment to the Discipline and Community Outreach

- **Served as a member of the First Semester General Chemistry Examination Committee** to write the standardized examination testing student knowledge after completing the first semester of general chemistry, on behalf of the Division of Chemical Education of the American Chemical Society.
- **Elected to serve as Treasurer of the Richland Section** of the American Chemical Society for the 2004 and 2005 calendar years.
- **Elected to serve as Chair-Elect of the Richland Section** of the American Chemical Society for the 2006 calendar year, and subsequently to serve as **Chair of the Richland Section** for the 2007 calendar year.
- Served as the **Richland Section Coordinator for National Chemistry Week**, 2002-03.
- **Served as a judge at the Intel International Science and Engineering Fair (ISEF)**, in the chemistry section, Portland, Oregon, Spring 2004.

- **Currently serve as a volunteer for “Girls In Science”**, 2002-present. This program is an all-day, inquiry-based series of activities for area middle-school girls, intended to encourage them to pursue careers in science.
- **Taught a service learning course**, CHEM 210 Chemistry Service Learning, Fall 2002. In this course, students developed a modular chemistry learning kit, geared towards sixth graders that educators could use.
- Assisted with various **outreach activities** of the EOU Chemistry Club, such as chemistry “magic shows” and hands-on activities at area elementary schools.

CURRICULUM VITAE

Anna G. Cavinato, Ph.D.

Ph: 541-962-3561

email: anna.cavinato@eou.edu

<http://www.eou.edu/~acavinat/>

Professor of Chemistry

Chair, Division of Mathematics, Science & Technology

Eastern Oregon University

La Grande, OR 97850

Education:

1981, Dottore in Chimica (Ph.D. in Chemistry) with highest honors, Universita' degli Studi di Bari, Bari, Italy.

Training:

Postdoctoral Fellow, Department of Biochemistry, College of Medicine, University of Tennessee at Memphis (Sept. 1984 - June 1986). Purification of opiate receptor proteins from human placenta. Use of chromatographic and electrophoretic techniques.

Postdoctoral Fellow, Department of Chemistry, University of Tennessee, Knoxville and Material Science Division, Oak Ridge National Labs (May 1983 - June 1984). Spectroscopic (ESCA) and electrochemical characterization of tungsten surfaces in molten chloro-aluminate salts in secondary fuel batteries.

Research assistant, Department of Chemistry, University of Bari, Italy (Sept 1979 - Mar. 1983). Characterization of electrode materials in molten nitrates by ESCA-Auger spectroscopies and electrochemical (Voltammetry) techniques. Corrosion studies of alloys for energy storage in Na/S batteries. Semiconductors. Use of Atomic Absorption Spectroscopy in the determination of air pollutants.

Taught General and Organic Chemistry in several Technical High Schools, Italy. Taught Analytical Chemistry Course on Surface Analysis Spectroscopies (XPS, Auger, SIMS) 4th and 5th year Chemistry major students, University of Bari, Italy.

Employment Record:

Professor, Eastern Oregon University, La Grande (2004-present).

Associate Professor, Eastern Oregon University, La Grande (2001-2004).

Assistant Professor, Eastern Oregon University, La Grande (1992-2001). Duties: Teach a variety of chemistry courses including majors and non-majors introductory sequences and upper division courses in the areas of general chemistry, inorganic qualitative analysis, analytical chemistry and instrumental analysis laboratory. Teach physical science courses for education majors. Supervise undergraduate research projects.

Research Assistant Professor, Center for Process Analytical Chemistry, Department of Chemistry, University of Washington, Seattle (Sept. 1988 - June 1992). Duties: Coordinate a multi-disciplinary project involving the development of sensors for process monitoring and control.

Assistant Professor, Department of Chemistry, Memphis State University, Memphis (Aug. 1986 - Aug. 1988). Duties: Teach freshman chemistry for non-chemistry majors and quantitative analysis. Teach electrochemistry at graduate level. Supervise undergraduate and graduate students in research.

Research Associate in the Department of Biochemistry, College of Medicine, University of Tennessee at Memphis, postdoctoral training preceptor M.S. Ahmed (Sept. 1984 - June 1986).

Research Associate in the Department of Chemistry, University of Tennessee, Knoxville, postdoctoral training preceptor G. Mamantov (May 1983 - July 1984).

Courses Taught:

Chem 101-102 -103- General, Organic and Biochemistry
Chem 204-205 - General Chemistry lab and recitation
Chem 206 - Inorganic Qualitative Analysis and lab
Chem 285 – Chemical Safety
Chem 320 - Analytical Chemistry (also offered through DDE)
Chem 321 - Analytical Chemistry laboratory
Chem 360 – Environmental Chemistry
Chem 361 – Environmental Chemistry laboratory
Chem 402 – Service Learning in Chemistry
Chem 407 – Chemistry Seminar
Chem 411 – Advanced Inorganic Chemistry
Chem 412 – Advanced Inorganic Laboratory
Chem 421 - Instrumental Analysis
Chem 422 - Instrumental analysis laboratory
Chem 441/Phys 321 – Quantum Mechanics
Chem 401 - Undergraduate research
Sci 101 - Scientific Method (also offered through DDE)
Sci 102 - Work and Energy (also offered through DDE)
Sci 103 - Matter (also offered through DDE)
Sci 207 – Service Learning

Honors:

2007, Woman of Courage and Vision, President's Commission on the Status of Women, Eastern Oregon University.
2002, Faculty Fellow, Oregon Collaborative for Excellence in the Preparation of Teachers (OCEPT)
2001, Faculty Fellow, Oregon Collaborative for Excellence in the Preparation of Teachers (OCEPT)
2000, Project Kaleidoscope Faculty for the 21st Century (F21).
2000, Faculty Fellow, Oregon Collaborative for Excellence in the Preparation of Teachers (OCEPT)
1998, Faculty Fellow, Oregon Collaborative for Excellence in the Preparation of Teachers (OCEPT)
1997, Associated Western Universities Fellow.
1997, Appointed as Pacific Northwest National Laboratories (PNNL) Affiliate Staff Scientist (PASS) for the next three years.
1997, Listed among the most distinguished scientists in USA and Canada in the upcoming edition of American Men & Women of Science.
1980, Graduate Fellow in Surface Analysis Techniques (ESCA - Auger Spectroscopy) from Perkin-Elmer.

Society Memberships and Professional Service:

American Chemical Society: chair, Richland section, 1999; Women and Minority Affair Committee Chair, 2000-present; alternate councilor, 2007-present; member, 1986-present.

American Chemical Society, Division of Analytical Chemistry, Board member, 2007-present.

American Chemical Society Committee on Education (SOCED), member, 2003-2007.

Oregon Academy of Science: member, 1999-present.

Phi Kappa Phi: president 2002; member, 1999-present.

Society for Applied Spectroscopy: member, 2000-present.

Reviewer for the Journal of Chemical Education, 1999-present.

Reviewer for the Journal of Food Processing and Preservation, 2002-present.

Professional Interests:

Research involving chemical sensors and methodologies for industrial process and bioprocess control; optical spectroscopy; multicomponent analysis; non-destructive analysis of food and biological samples; light propagation in tissue; environmental monitoring.

Development of chemical and science education curricula integrated with other disciplines.

Grant Funding:

Western Regional Aquaculture Center	“Determining Ripeness in white sturgeon females to maximize yield and quality of caviar”, 2007 , \$84,662.
Murdock Charitable Trust	“Partners in Science”, 2006 , \$14,000.
Oregon Sea Grant	“Non-lethal detection of bacterial kidney disease in salmonids”, 2006 , \$97,000.
Oregon Sea Grant	“Early Assessment of Maturity and Sex in Salmonids by Non-Invasive Short Wavelength Near Infrared Spectroscopy”, 2002 , \$94,096.
National Science Foundation	“Integration of GC-MS and FT-IR in the Undergraduate Curriculum”, 2002 , \$ 182,640.
EOU Summer Stipend "Early Assessment of Maturity and Sex in Salmonids by Non-Invasive Short Wavelength Near Infrared Spectroscopy", 2002 , full salary.	
USDA	“Development of Non-Destructive Methods of Analysis by SW-NIR”, 2000 , \$ 16,019.
USDA	“Non-Invasive Method for Predicting Safety and Quality of Foods”, 2000 , \$54,912.
Oregon Sea Grant	“Path length Determination of Short Wavelength Near Infrared Light in Fish Tissue”, 2000 , \$9,996.
Workshop Project Associates	“Adaptation of the ChemExcel Model to the PLTL Workshop Model at Eastern Oregon University”, 2000 , \$4,600.
OCEPT	“ChemExcel at Eastern: A Program to Support Success in Introductory Chemistry”, 2000 , \$3000.

EOU Summer Stipend	"Quantitative Measurements in Scattering Media", 2000 , full salary.
EOU Summer Stipend	"Chemical Characterization of Simulated Liquid Hazardous Waste by Short Wavelength Near Infrared Spectroscopy", 1999 , \$ 2,500.
CUR Travel Grant	"Conducting Polymers", 1999 , \$600.
OCEPT	"Quantitative Activities for Pre-Education Physical Science Students", 1998 , \$ 7,500.
Associated Western Universities	"Collaborative Research Environment for Undergraduate Science Students", 1997 , \$ 6,000.
Oregon Sea Grant	"A Non-Invasive Method for Determining Lipid Content in Live Fish," 1997 , \$10,000.
EOU Badgley Endowment	"WWW Research Innovation for Undergraduate Science Students and Faculty," 1996 , \$5,200.
EOU Summer Stipend	"Exploring New Avenues in Chemical Education: Development of Hypermedia Chemistry Tutorials Using the World Wide Web," 1996 , \$10,000.
Oregon Sea Grant	"A Non-Invasive Method for Determining Lipid Content in Live Fish," 1996 , \$20,000.
EOU Summer Stipend	"Development of Introductory Chemistry Curriculum Through Multimedia Delivery," 1995 , \$5,000.
CPAC (90-18.1)	"Non-Invasive Spectroscopy for Bioprocess Monitoring," 1990 - 1992 , \$170,000.
CPAC (90-18.6)	"Electrochemical Sensors and Fouling in Bioprocess Monitoring", 1990 - 1992 , \$42,590
UW GSF	"Non-Invasive Monitoring of Metabolic Activity in Activated Sludge," 1991 - 1992 , \$7,400.
NSF (ECB-8415075)	"UW/Lehigh TIE Project: Non-Invasive Bioprocess Monitoring and Control", 1989 - 1991 , \$50,000.
MSU, Biomedical. Grant	"Non-Volatile N-Nitroso Compounds Analysis in Biological Research Samples," 1987 , \$4,250.

Curriculum Development:

K. Hixson and A.G. Cavinato, "Virtual FT-ICR," WWW Tutorial on Fourier Transform Ion Cyclotron Resonance Mass Spectrometry, <http://www.eou.edu/%7Eacavinat/mstutorial/html/page1.html>, **1998**.

M. Munck, S.A. Bottoms and A.G. Cavinato, "The Scientific Method", an exploratory science curriculum for education majors, **Fall 1997**.

M. Jaeger, M. Munck and A.G. Cavinato, "Water", an exploratory science curriculum for education majors, **Spring 1997**.

M. Jaeger, M. Munck and A.G. Cavinato, "Energy and Work", an exploratory science curriculum for education majors, **Winter 1997**.

A.G. Cavinato, D.G. Camp, "Chemical Bonds, Molecular Shapes and Molecular Models," WWW Tutorial for Introductory Chemistry, <http://www2.eou.edu/chemweb/molmodel/mmp1.html>, **1996**.

A.G. Cavinato, D.G. Camp, "Chemical Bonds, Molecular Shapes and Molecular Models," VHS Videotape Tutorial for Introductory Chemistry, **1995**.

A.G. Cavinato, D.G. Camp, "Spectral Analysis," VHS Videotape Tutorial for Introductory Chemistry, **1995**.

A.G. Cavinato, P. Yenser, K. Firor, "Organic Chemistry: An Integrated Studies Program in Chemistry, Math and Writing," **1995**.

A.G. Cavinato, P. Yenser, K. Firor, "The Power of Chemistry: An Integrated Studies Program in Chemistry, Math and Writing," **1994**.

Invited Presentations:

Cavinato, A.G. "Service Learning in Chemistry: A three year assessment", 234th ACS National Meeting, Boston, MA, **August 2007**.

Cavinato, A.G. "The End Creek project: instrument-based experiments in the general chemistry laboratory". 62nd Northwest Regional Meeting of the American Chemical Society, Boise, ID, **June 2007**.

Cavinato, A. G.; Nafshun, R. L. "PLTL: A five-year longitudinal study", 232nd ACS National Meeting, San Francisco, CA, **September 2006**.

Cavinato, A. G. "Transforming the analytical chemistry laboratory to address problems relevant to the local community", 231st ACS National Meeting, Atlanta, GA, **March 2006**.

Cavinato, A.G. "The End Creek Project: Monitoring and assessing water quality in the general chemistry laboratory", 230th National Meeting of the American Chemical Society, Washington, DC, **August 2005**.

Cavinato, A.G. "Service Learning in Analytical Chemistry: Extending the laboratory into the community", 230th National Meeting of the American Chemical Society, Washington, DC, **August 2005**.

Cavinato, A.G., Kelley, R. "Remote COSY NMR experiment for structure and sequence determination of simple peptides", 229th National Meeting of the American Chemical Society, San Diego, CA, **March 2005**.

Cavinato, A.G. "Research Supportive Curricula in Environmental Chemistry", *31st Annual Conference of the Federation of Analytical Chemistry and Spectroscopy Societies*, Portland, OR, **October 2004**.

Cavinato, A.G., Kelley, R. "Enhancing research and service learning opportunities in the undergraduate chemistry curriculum", 228th National Meeting of the American Chemical Society, Philadelphia, PA, **August 2004**.

Invited to participate and showcase the accomplishments of my NSF-CCLI grant in "Invention and Impact: Building Excellence in Undergraduate STEM Education," National Science Foundation Course, Curriculum, and Laboratory Improvement (NSF-CCLI) program conference, Crystal City, VA **April 16-18, 2004**.

Cavinato, A.G., Kelley, R., Cox, J. Harris, S. "Extending undergraduate research opportunities beyond the campus: A partnership with tribal communities" 227th National Meeting of the American Chemical Society, Anaheim, CA, **March 2004**.

Cavinato, A.G. "Integrating ion trap mass spectrometry in the undergraduate chemistry curriculum", *30th Annual Conference of the Federation of Analytical Chemistry and Spectroscopy Societies*, Ft. Lauderdale, FL, **October 2003**.

Cavinato, A.G. "Attracting and retaining students from underrepresented groups", panel presentation, *Taking Advantage of New Opportunities for Environmental Sciences, PKAL National Assembly*, Portland, OR, **September 2003**.

Cavinato, A.G. "Connecting to Tribal Communities", *Taking Advantage of New Opportunities for Environmental Sciences, PKAL National Assembly*, Portland, OR, **September 2003**.

Cavinato, A.G. "Successful Activities in Support of Future Science Preparation", *17th Biennial Conference on Chemical Education*, Western Washington University, Bellingham, WA, **July 2002**.

Cavinato, A.G. "Multivariate Analysis Techniques in the Undergraduate Laboratory", *27th Annual Conference of the Federation of Analytical Chemistry and Spectroscopy Societies*, Nashville, TN, **September 2000**.

Cavinato, A.G., Deluca, J.A. Divanfar, H., Hoyt, D. "Extending the Laboratory: Distance Technologies and Undergraduate Research", *Eight National Conference of the Council on Undergraduate Research*, The College of Wooster, OH, **June 2000**.

Cavinato, A.G., Mayes, D.M., Rasco, B.A. "Using Multivariate Techniques to Determine Chemical and Biological Properties In Fish and Fish Products", *the 24th Annual Conference of the Federation of Analytical Chemistry and Spectroscopy Societies*, Providence, RI, **October 1997**.

Cavinato, A.G., Mayes, D.M., Aldridge P.K. "Non-Invasive Determination of Tablet Formulation Through a Plastic Bottle Using Short Wavelength Near Infrared Spectroscopy", *Pittsburgh Conference*, Chicago, **March 1994**.

A.G. Cavinato, B. A. Rasco, "Development of a Non-Invasive Method for Measuring the Crude Lipid Content in Whole Fish and Fish Products", *106th AOAC Annual Meeting*, Cincinnati, **August 1992**.

Cavinato, A.G. "Non-Invasive spectroscopic techniques for monitoring bioprocesses", *AAPS Midwest Regional Meeting*, Chicago, **May 1992**.

Cavinato, A.G. "New Developments in non-invasive monitoring of biological systems", *Anatech '92*, Atlanta, **April 1992**.

Cavinato, A.G. "Non-invasive Spectroscopic Techniques for Monitoring Bioprocesses", *3rd Int'l Bioanalytical Workshop*, Lawrence, KS, **May 1991**.

Cavinato, A.G. "Non-invasive Bioprocess Monitoring and Control (Lehigh TIE Grant)", *Chemical Process Modeling and Control Research Center*, Lehigh University, Bethlehem, PA, **April 1991**.

Cavinato, A.G., Ge, Z., Callis, J.B., Finger, R.E. "Real-Time Measurement of Microbial Metabolism in Activated Sludge Samples", *201st Nat'l ACS Meeting*, Atlanta, GA, **April 1991**.

Cavinato, A.G. "On-line Monitoring of Cell Metabolism in Bioreactors", *Biotech USA*, Washington, D.C., **November 1990**.

Cavinato, A.G., Ge, Z., Mayes, D.M., Callis, J.B. "A Biosensor Based on Visible and Short Wavelength Near Infrared Spectroscopy", *Anabiotech '90*, San Francisco, CA, **October 1990**.

Cavinato, A.G. "Near-Infrared Spectroscopy and Process Analytical Chemistry", *University of Bari, Department of Chemistry*, Bari, Italy, **September 1990**.

Cavinato, A.G. Ge, Z., Mayes, D.M., Callis, J.B. "On-line Monitoring of Fermentation Processes by Non-Invasive Spectroscopy", *47th Annual Meeting of the Society for Industrial Microbiology*, Orlando, FL, **July 1990**.

Cavinato, A.G. Ge.,Z., Mayes, D.M, Callis, J.B. "Non-Invasive Spectroscopic Monitoring of a Bioprocess", *Frontiers in Bioprocessing II*, Boulder, CO, **June 1990**.

Cavinato, A.G. Ge.,Z., Mayes, D.M, Callis, J.B. "A Non-Invasive Sensor for On-line Monitoring of Fermentation Processes", *199th Nat'l ACS Meeting*, Boston, MA, **April 1990**.

Callis, J.B., Cavinato, A.G., Dahlberg D.B. "Non-Invasive Optical Sensors for Process Monitoring", *The 1989 Int'l Chemical Congress of Pacific Basin Societies*, Honolulu, HI, **December 1989**.

Contributed Presentations:

Servid, S.A., Cavinato, A.G. "Noninvasive characterization of maturity status to optimize caviar yield and quality in white sturgeon". 235th American Chemical Society National Meeting, New Orleans, LA, **April 2008**.

Troutman, K., Boethin, T., Hammers, M.M., Twombly, L.R., Servid, S.A., Cavinato, A.G. "Rapid screening method for nonlethal detection of bacterial kidney disease in Pacific salmon". 235th American Chemical Society National Meeting, New Orleans, LA, **April 2008**.

Troutman, K., Hoffnagle, T., Greenlee, A., Cavinato, A.G., "Nonlethal detection of bacterial kidney disease in Pacific salmon by near infrared spectroscopy". 234th American Chemical Society National Meeting, Boston, MA, **August 2007**.

Hammers, M.M, Lin, M., Mayes, D.M., Rasco, B.A., Cavinato, A.G., "Nondestructive detection of deep muscle bruising in salmon by near infrared spectroscopy". 234th American Chemical Society National Meeting, Boston, MA, **August 2007**.

Taisacan, D.L., Lee, Y.H., Mitchell, K., Cavinato, A.G., "Chlorinated pesticides and other water quality measurements at End Creek: an environmental stewardship project at Eastern Oregon University". 62nd Northwest Regional Meeting of the American Chemical Society, Boise, ID, **June 2007**.

Boethin, T., Hammers, M.M., Troutman, K., Hoffnagle, T., Mayes, D.M., Cavinato, A.G., "Nonlethal detection of bacterial kidney disease in Pacific salmon by near infrared spectroscopy". 62nd Northwest Regional Meeting of the American Chemical Society, Boise, ID, **June 2007**.

Hammers, M.M, Cavinato, A.G., Mayes, D.M., Lin, M. Rasco, B.A.. "Nondestructive detection of deep muscle bruising in salmon by near infrared spectroscopy". 62nd Northwest Regional Meeting of the American Chemical Society, Boise, ID, **June 2007**.

Cavinato, A.G., Hammers, M.M, Mayes, D.M., Lin, M. Rasco, B.A.. "Nondestructive detection of deep muscle bruising in salmon by near infrared spectroscopy". 233rd American Chemical Society National Meeting, Chicago, IL, **March 2007**.

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A.G. Cavinato, D.W. Hoyt, K.A. Keating, "eNMR: Remote 600 MHz experiment over the Internet for Undergraduate Students", 219th ACS National Meeting, San Francisco CA, **March 2000**.

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N.L. Flintoff, A.G. Cavinato, S.A. Bryan, C.M. King "Spectra Elucidation of Inorganic Species Commonly Found in Hanford Radioactive Waste", 219th ACS National Meeting, San Francisco CA, **March 2000**.

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M.A. Wenz, A.G. Cavinato, P.T. Lofy, S.J. Boe "Near Infrared Spectrophotometric Determination of Maturity Status and Gender in Salmonids", 219th ACS National Meeting, San Francisco CA, **March 2000**.

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A.G. Cavinato, S.I. Bottoms, "Involving K-12 In-Service Teachers in the Science Preparation of Future Teachers", 54th Regional Meeting of the American Chemical Society, Portland, OR **June 1999**.

Panel presenter, "Spotlighting the Host: OCEPT Panel Presentation - Improving the Mathematics and Science Preparation of Future Teachers", PKAL Workshop on K-16 Connections: Designing K-12/Undergraduate Partnership to Enhance Science and Mathematics Learning of All Students" George Fox University, Newberg, OR, **May 1999**.

S. Lee, A.G. Cavinato, "Qualitative and Quantitative Analysis of Inorganic Compounds in Aqueous Waste by NIR", 217th ACS National Meeting, Anaheim, CA, **March 1999**.

C.D. Marks, T.M. Rogers, A.G. Cavinato, "Estimation of Photon Path Length in Fish Tissue", 217th ACS National Meeting, Anaheim, CA, **March 1999**.

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A.G. Cavinato, T.M. Rogers, M.A. Wenz, D.M. Mayes. B.A. Rasco. Y. Huang, " Predicting Sodium Chloride Concentration of Cured Salmon Muscle and Roe by Near Infrared Diffuse Reflectance Spectroscopy", 215th ACS National Meeting, Dallas, TX, **March 1998**.

A.G. Cavinato, "A Non-Destructive Method to Measure Lipid and Other Parameters in Fish", 19th *Smolt Workshop*, Hood River, OR, **November 1997**.

A.G. Cavinato and D. Camp, "Delivering Chemistry Education through the World Wide Web", *Distance Learning Oregon Connections*, Bend, OR, **October 1997**.

A.G. Cavinato, "New Strategies for Teaching and Learning Science at EOU", *NSF-UFE Dissemination Conference*, Forrest Park, WA, **July 1997**.

K.K.Hixson, A.G. Cavinato, and R. A. Hermens, "Bringing Process Analytical Chemistry to the Undergraduate Laboratory", 52nd *Northwest Regional Meeting of the American Chemical Society*, Moscow, ID, **June 1997**.

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A.G. Cavinato, N.Preyer, "Building a Home Page," *EOSC Brown Bag Seminar Series*, **February, April and September 1996**.

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A.G. Cavinato, D.M. Mayes, J.B. Callis, "A Non-Invasive Approach to Bioprocess Sensing", *46th Annual Meeting of the Society for Industrial Microbiology*, Seattle, WA, **August 1989**.

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M.S. Ahmed, A.G. Cavinato, L.W. Randall, D. Desiderio, B. Sibai, "The Opioid System in Human Placenta: Purification of the Receptor, Identification of the Endogenous Ligand and Relationship of the System to Labor and Delivery", *VII Annual Meeting of the Society of Perinatal Obstetricians*, Orlando, FL, **February 1987**.

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