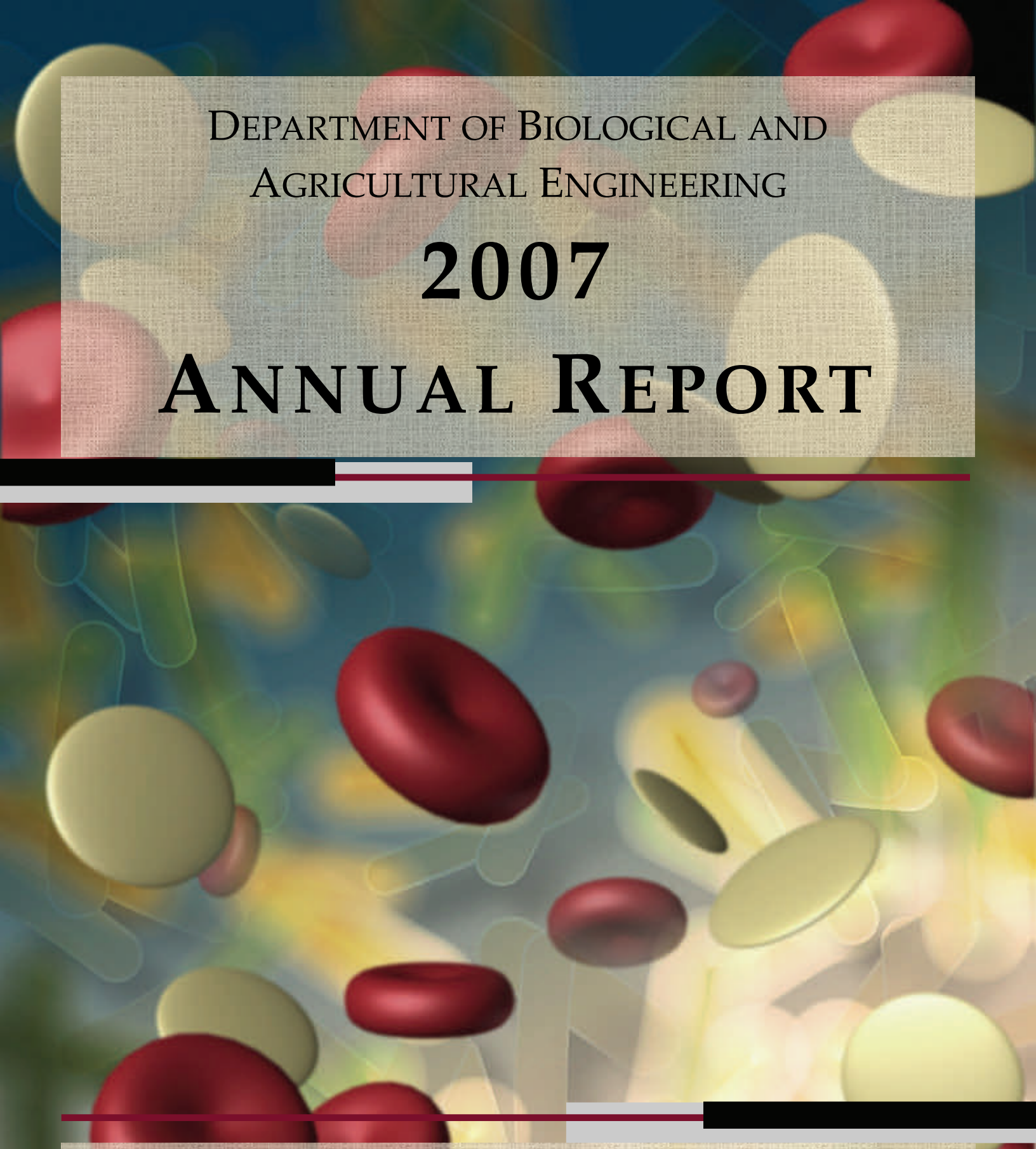
Department of Biological and Agricultural Engineering

2007 Annual Report



UofA
UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE

Dale Bumpers College of Agricultural, Food and Life Sciences

College of Engineering

University of Arkansas
1871

2007 Annual Report

Department of Biological and Agricultural Engineering

Lalit R. Verma
Department Head

Arkansas Agricultural Experiment Station
Mark J. Cochran
Associate Vice President for Agriculture Research

Cooperative Extension Service
Ivory W. Lyles
Associate Vice President for Agriculture Extension

University of Arkansas
Division of Agriculture
Milo J. Shult
Vice President for Agriculture

Dale Bumpers College of Agricultural, Food & Life Sciences
Gregory J. Weidemann
Dean

College of Engineering
Ashok Saxena
Dean

University of Arkansas
John A. White
Chancellor

Bob Smith
Vice Chancellor and Provost

Department of Biological & Agricultural Engineering

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FOREWORD

FROM THE DEPARTMENT HEAD

This annual report describes the outstanding accomplishments of the Department of Biological and Agricultural Engineering in 2007.

Our mission: *to develop and disseminate biological engineering knowledge through teaching, research, and technology -transfer that will maximize the professional value of biological engineers to the clients they serve in biological, agricultural, environmental, biomedical, or value-added bioprocess engineering enterprises whether in private practice, government service, industry, or education.*

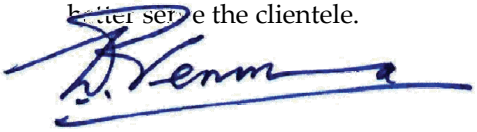
I am pleased to report that the department experienced growth in teaching, research, and service. With the addition of the Biomedical Engineering master's degree program in 2004, our graduate program increased to more than forty students. Over half of the undergraduate student body was enrolled in the Honor's College. The diversity of the undergraduates was also increased with a record forty percent female enrollment. The freshman class also had a good enrollment, bringing the total enrollment in the undergraduate program close to eighty students.

The research and extension program continued in Biomedical, Biotechnology, and Ecological Engineering. The department houses eighteen faculty members, five of which are located in the Cooperative Extension Service state office in Little Rock. The faculty strive to increase funding from outside sources and earn grants from the US Department of Agriculture, the Environmental Protection Agency, the National Science Fund, the National Institutes of Health, and the American Heart Association. The expenditures from external grant funding in 2007 was over one and half million. The total departmental expenditures totaled over four million.

The faculty and students have made significant accomplishments in 2007, such as the Tyson Endowed Chair in Biosensing Engineering. Young Researcher award by the Asian Association for Agricultural Engineering (AAAE). Arthur C Guyton award for excellence in integrative physiology and medicine .Top five, 2007 RESNA/NSF National Student Design Competition

The Academy of Biological Engineers also inducted three new members. John J. Classen, Bruce Netherton, and William K. Warnock joined the Academy in April 2007 and were officially inducted at the annual Academy Banquet.

It is great to have excellent faculty, staff, students, and friends who support the mission and goals of this department. Your comments and suggestions are always welcome to further improve our programs and better serve the clientele.



Lalit R. Verma
Professor and Department Head

SIGNIFICANT ACCOMPLISHMENTS IN 2007

- The Asian Association of Agricultural Engineers honored Dr. Sreekala Bajwa's research program by giving the ***AMA-SHIN NORINSHA-AAAE Young Researcher Award*** at its annual meeting in Bangkok in 2007.

- The Arthur C Guyton award for excellence in integrative physiology and medicine was given to Dr. Mahendra Kavdia. The award comes with $15000 for the research money

- The 2007 Tyson Endowed Chair in Biosensing Engineering, University of Arkansas (this is a 1.5 million dollars endowed chair supported by both Tyson and Walton foundations) was awarded to Dr. Yanbin Li.

- 2007 John W. White Outstanding Research Award, Dale Bumpers College of Agricultural, Food and Life Sciences, University of Arkansas was awarded to Dr. Yanbin Li

- Dr. Yanbin Li was awarded the 2007 Bao Yugang Visiting Professor Fellowship, Zhejiang University, China (the fellowship provides one month summer living expense for three years with international travels and funding for teaching and research at Zhejiang University, RMB¥60k per year. Zhejiang University is ranked #3 in China and offers this fellowship to only five internationally known foreign scientists in different areas each year).

- The research, teaching and service activities of the Department of Biological and Agricultural Engineering continue to grow. Our programs are developing and disseminating useful information to biological, agricultural, environmental, biomedical, or value-added bioprocess engineering enterprises in private practice, government service, industry, and education.
-
- The department's science-based undergraduate program in Biological Engineering has established a sound foundation and is attracting bright young minds interested in Ecological, Biotechnology, and Pre-Med/Biomedical Engineering areas of emphasis. The student enrollment is steadily increasing. There are presently twelve faculty members in research and teaching at Fayetteville, five faculty members in extension in Little Rock and one extension faculty in Fayetteville. Labs for Biomedical Engineering and Nano-bioengineering are completed and functioning at the Engineering Research Center. BAE shop and labs for Biotechnology and Ecological Engineering are at the Agricultural Experiment Station facilities near campus.

- G. Scott Osborn received the BAE Outstanding Faculty Award for Teaching, 2007.

- Tom Costello received the BAE Outstanding Faculty Award for Service to Students, 2007.

- Marty Matlock received the 2008 Institute Honor Awards for Regional and Urban Design from the American Institute of Architects (AIA). "Habitat Trails: from infill house to green neighborhood design", a collaboration among UACDC, the University of Arkansas Ecological Engineering Group, Department of Biological and Agricultural Engineering, Department of Landscape Architecture, Morrison Shipley Architects, and JKJ Architects in Rogers, AR

- Marty Matlock received the 2007 ACSA/AIA Housing Design Education Award for Excellence in a Housing Education Course. This inaugural award is jointly sponsored by ACSA and the American Institute of Architects, and has been established to recognize both the centrality and difficulty of housing design as a subject matter in curriculum development. The award was for the Habitat for Humanity/Rogers housing course involving UACDC, Marty Matlock in the Dept of Biological and Agricultural Engineering, and Mark Boyer in the Dept of Landscape Architecture.

SIGNIFICANT ACCOMPLISHMENTS IN 2007

- Marty Matlock received the 2007 Charter Design Award, Congress for New Urbanism, the leading organization promoting walk able, neighborhood-based development as an alternative to sprawl. The CNU Charter Awards were awarded internationally to twenty planning and architecture projects that manifest principles of exemplary urbanism as defined by the CNU.

- Marty Matlock received the 2007 National Council of Architectural Registration Boards NCARB Prize, awarded annually to six initiatives in architecture programs based on their "creative integration of practice and education in the academy".

- Marty Matlock received the 2007 Outstanding Mentor, University of Arkansas, and Recognized as one of two outstanding mentor teams for mentoring undergraduate students.

- Mahendra Kavdia received the BAE Outstanding Faculty Award for Research, 2007

- The Asian Association of Agricultural Engineers honored Dr. Sreekala Bajwa's research program by giving the ***AMA-SHIN NORINSHA-AAAE Young Researcher Award*** at its annual meeting in Bangkok in 2007.

- Dr. Danielle Julie Carrier was a member of NSF, DoE-USDA and USDA-SBIR panels.

- Dr. Danielle Julie Carrier research program is centered on understanding on how to extract valuable phytochemicals from biomass with subcritical water prior to the pretreatment step. She has five publications in peer-reviewed journals and participated in a biofuels grant.

- Dr. Brian Haggard had seven projects that were funded totaling $681,491, with ~42% ($287,176) directly supporting his research program over the next few years.

- The Arthur C Guyton award for excellence in integrative physiology and medicine was given to Dr. Mahendra Kavdia. The award comes with $15000 for the research money

- Dr. Yanbin Li's research led to the development of a portable impedance biosensor for rapid, sensitive, specific screening of avian influenza H5N1 in poultry swab samples for in-field use. This research was conducted in collaboration with Dr. Billy Hargis of Poultry Science Department, Dr. Steve Tung of Mechanical Engineering Department, and Dr. Luc Berghman of Texas A&M University. A USDA/NRI grant ($375,000) was obtained for further research of the AI biosensor.

- Dr. Yanbin Li's research led to the development of nanomaterials and microfluidics based biosensors coupled with magnetic nanobeads immunoseparation for rapid detection of foodborne pathogens, including L. monocytogenes, S. Typhimurium and E. coli O157:H7. This research was conducted in collaboration with Dr. John marcy of Poultry Science Department, Dr. Luc Berghman of Texas A&M University, Dr. Daniel Fung of Kansas State University, and Dr. Shu-I Tu of USDA/ARS ERRC.

- Dr. Yanbin Li's research led to the development of predictive models and risk assessment models for Listeria contamination of poultry products in processing. Both laboratory-scale and pilot plant-scale experiments were conducted for developing and validating the predictive microbial model and the risk assessment simulation model suing @Risk software.

DEPARTMENT FACULTY

SREEKALA G. BAJWA

Associate Professor
B.S. Ag.E. (1991) Kerala Agricultural University, India
M.S. Ag.E. (1993) Indian Institute of Technology, India
Ph.D.(2000) University of Illinois at Urbana-Champaign
Research Areas: Precision agricultural machinery and equipment, sensors, and controls, remote sensing for crop monitoring and soil characterization, GIS, GPS, and decision support systems.

D. JULIE CARRIER

Associate Professor
B.S.(1984) McGill University, Canada
M.S. (1986) McGill University, Canada
Ph.D. (1992) McGill University, Canada
Research Areas: Effect of agricultural production systems on phytonutrient or "health beneficial compounds" with emphasis on drying and extraction of vegetable and medicinal plant crops.

THOMAS A. COSTELLO, P.E.

Associate Professor
B.S. Ag.E. (1980) University of Missouri
M.S. Ag.E. (1982) University of Missouri
Ph.D. (1986) Louisiana State University
Research Areas: Plot and field scale studies to quantify impacts of land application of animal manure on surface water quality; broiler litter management and its effects on air quality (for birds and workers), building energy consumption, bird performance and the final value of the litter as a fertilizer, energy conservation and environmental control in poultry houses.

DENNIS GARDISSER, P.E.

Associate Head of Extension
B.S. Ag.E. (1979) University of Arkansas
M.S. Ag.E. (1981) University of Arkansas
Ph.D. Engineering (1992) University of Arkansas
Research Areas: Extension education programs related to engineering aspects of agricultural chemical applications (pesticides, plant nutrients, and other biological products), processing (including on farm storage, drying, and handling of grain), fencing and other aspects of animal confinement or movement control, educational leadership and coordination of precision agriculture, GPS, and GIS.

CARL L. GRIFFIS, P.E.

Professor
B.S. Ch.E. (1963) University of Arkansas
M.S. Ch.E. (1965) University of Arkansas
Ph.D. Engineering (1968) University of Arkansas
Research Areas: Applications of computers and microcircuitry for monitoring and control of biological processes in food processing, quality, and safety.

BRIAN E. HAGGARD

Associate Professor
B.S. Life Sciences (1994) University of Missouri
M.S. Environmental Soil & Water Science (1997) University of Arkansas
Ph.D. Biosystems Eng. (2000) Oklahoma State University
Research Areas: Ecological engineering including the evaluation of nitrogen, phosphorus, carbon and antibiotics transport and transformation through aquatic systems; the sorption and release of dissolved phosphorus to or from soils and sediments; the determination of factors limiting the growth of periphyton and phytoplankton in streams and reservoirs; and the use of aquatic and terrestrial ecosystems to provide wastewater treatment and nutrient retention.

MAHENDRA KAVDIA

Associate Professor
B. Tech Ch.E. (1992) Indian Institute of Technology
M. Tech Ch.E. (1995) Indian Institute of Technology
Ph.D. Ch.E. (2000) Oklahoma State University
Research Areas: Experimental and computational research of nitric oxide and reactive oxygen species specifically applied to endothelium function and diabetes research; *in vitro* drug delivery; *in vitro* experimental system design; statistical analysis; mammalian cell culture techniques; microscopy; spectrophotometry; radio-immuno assyas; enzyme-based assays; mathematical modeling of reaction and transportation; and biological control.

JIN-WOO KIM

Associate Professor
B.S. Ch.E. (1986) Seoul National University, Korea
B.S. Microbiology (1991) University of Iowa
M.S. Biology (1994) University of Wisconsin
Ph.D. Ag.E. (1998) Texas A&M University
Research Areas: Biotechnological/biochemical engineering, including process analysis and optimization, bioreactor design, biological remediation of environmental toxins, conversion of renewable biological wastes to high value products, and bio-catalytic potential microbes.

YANBIN LI, P.E.

Professor
B.S. Ag.E. (1978) Shenyang Agricultural University, China
M.S. Ag.E. (1985) University of Nebraska
Ph.D. Ag.E. (1989) Pennsylvania State University
Research Areas: Developing biosensors and engineering methods for food safety and sanitation, specifically, description of bacteria in poultry meat and processing water, and rapid detection of bacteria in food products.

YI LIANG

Associate Professor, Extension
B.S. Ag. E. (1990) China Agricultural University, China
M.S. Ag. E. (1995) China Agricultural University, China
Ph.D. (2000). University of Alberta, Canada
Research Areas: Air quality and energy efficiency with confined animal feeding operations, quantification of emission and transportation of air pollutants, development and evaluation of emission prevention and control technologies.

OTTO J. LOEWER, P.E.

Professor
Director, University of Arkansas Economic Development Institute
ASABE Fellow
B.S. Ag.E. (1968) Louisiana State University
M.S. Ag.E. (1970) Louisiana State University
M.S. Ag. Econ (1980) Michigan State University
Ph.D. Ag.E. (1973) Purdue University
Research Areas: Computer simulation of biological systems; grain drying, handling, and storage systems.

MARTY D. MATLOCK, P.E.

Associate Professor
B.S. Soil Chemistry (1984) Oklahoma State University
M.S. Plant Physiology (1989) Oklahoma State University
Ph.D. Biosystems Engineering (1996) Oklahoma State University
Research Areas: Nonpoint source nutrient loading effects on water bodies and developing engineering design parameters for using constructed ecosystems as treatment systems.

DEPARTMENTAL RESOURCES

FACULTY

G. SCOTT OSBRON, P.E.
Associate Professor
B.S. Ag.E. (1984) University of Kentucky
M.S. Ag.E. (1987) University of Kentucky
Ph.D. Bio & Ag.E. (1994) North Carolina State University
Research Areas: Heat and mass transfer coupled with kinetics of biological systems and modeling of biological processes.
Application Areas: Control of rice fissuring through genetic manipulation, ecological engineering, oxygenation of wastewater and natural water bodies, biomechanics, food engineering, and biomedical engineering.

DHARMENDRA SARASWAT
Assistant Professor, Extension
B.S. Ag.E. (1988) Allahabad University, India
M.S. Ag.E. (1990) Indian Agricultural Research Institute, India
Ph.D.(2007) Ohio State University
Research Areas: GeoSpatial technologies (Geographic Positioning Systems, Geographic Information Systems, remote sensing and sensor technology) in agricultural settings, and simulation modeling for watershed management and production agriculture.

SAMY SADAKA
Assistant Professor, Extension
B.S. (1982) Alexandria University, Egypt
M.S. (1988) Alexandria University, Egypt
Ph.D. (1995) Dalhousie University, Nova Scotia, Canada and Alexandria University, Egypt
Research Areas: Gasification and fast pyrolysis of biomass; biorenewables resources; biofuels and biopower; fluidized beds; energy conservation.

PHIL TACKER
Associate Professor, Extension
B.S. Ag.E. (1979) University of Arkansas
M.S. Ag.E. (1982) University of Arkansas
Research Areas: Development and management of soil and water resources for row crop and horticulture crop production in the state; work with drainage, irrigation, water resource development and management and water quality (domestic and irrigation), irrigation system design, selection and operation using soil and water management variables for determining drainage and irrigation requirements, determining proper irrigation scheduling, monitoring irrigation pumping, and controlling pumping costs; develop and maintain professional and cooperating relationship with agencies involved in soil an water resource development and management.

KARL VANDEVENDER, P.E.
Professor, Extension
B.S. Ag.E. (1985) Mississippi State University
M.S. Ag.E. (1987) Mississippi State University
Ph.D. Engineering (1992) University of Arkansas
Research Areas: Development and implementation of statewide Extension programs in livestock and poultry waste management, liquid and dry; develop curricula and training materials for educational programs in collection, storage, and land application of waste to prevent contamination of surface and groundwater; work with other UA personnel to develop and demonstrate manure storage, treatment, and utilization practices that address environmental, production, and economic considerations; develop and maintain positive working relationships with other government agencies and industries.

LALIT R. VERMA, P.E.
Professor
Department Head
B.Tech Ag.E. (1972) Agricultural University, India
M.S. Ag.E. (1973) Montana State University
Ph.D. Engineering (1976) University of Nebraska
Research Areas: Dr. Verma conducts the administration of the Department of Biological and Agricultural Engineering department, overseeing all components of the department including curriculum design, teaching, research, and extension.

KAIMING YE
Assistant Professor
B.S. Ch.E. (1985) East China University of Science and Technology
M.S. Ch.E. (1988) East China University of Science and Technology
Ph.D. Ch.E. (1991) East China University of Science and Technology
Research Areas: Stem cell engineering, high throughput screening platform for screening for breast cancer specific genes using siRNA library, Biosensing, and Bioimaging.

ADJUNCT FACULTY

SIMON ANG, PH.D.
Professor, Electrical Engineering
University of Arkansas

ROBERT R. BEITLE, P.E., PH.D.
Professor, Chemical Engineering
University of Arkansas

INDRAJEET CHAUBEY, PH.D.
Associate Professor, Earth and Atmospheric Sciences
Purdue University

EDGAR C. CLAUSEN, P.E., PH.D.
Professor, Chemical Engineering
University of Arkansas

RUSSELL J. DEATON, PH.D.
Professor, Computer Science Computer Engineering
University of Arkansas

CHRISTA HESTEKIN, PH.D.
Assistant Professor, Chemical Engineering
University of Arkansas

TERRY HOWELL, PH.D.
Assistant Professor
McKee Foods, Inc.

W. REED GREEN, PH.D.
Assistant Professor
USGS Arkansas Water Science Center

NEIL INGELS, PH.D.
Professor
Stanford University Medical Center

SHANNON SERVOSS, PH.D.
Assistant Professor, Chemical Engineering
University of Arkansas

GAL SHAFISTEIN, PH.D.
Assistant Professor
University of Arkansas for Medical Sciences

RYAN TIAN
Assistant Professor, Chemical Engineering
University of Arkansas

VIJAY VARADAN, PH.D.
Distinguished Professor, Electrical Engineering
University of Arkansas

JIM WIMBERLY
Assistant Professor
Organic Resources Management

ZHONGPING YANG, PH.D.
Assistant Professor
Medtronic

DEPARTMENTAL RESOURCES

PROFESSIONAL AND ADMINISTRATIVE STAFF

JULIAN ABRAM
Program Tech Lab Coordinator

JACKQUELYN ANDERSON-O'DONNELL
Secretary II, Extension

PAUL ALGEE
Technology Support Specialist

LESLIE BARTSCH
Program Associate

LYNN BAXTER
Technician, Extension

GLORIA BROWN
Administrative Secretary

ZARA CLAYTON-NIEDERMAN
Program Associate

BO COUNTS
Service Assistant

ERIC CUMMINGS
Program Technician

PAUL DELAUNE
Post Doctoral Associate

VIRGINIA GLASS
Accountant

CHASITY KNIGHT
Administrative Office Supervisor, Extension

SUBODH KULKARNI
Program Associate, Extension

KENTU LASSITER
Program Associate

SCOTT LONGING
Program Associate

BETTY MARTIN
Technical Assistant

JOHN MURDOCH
Program Technician

EYLEM MUTLU
Post Doctoral Associate

LINDA PATE
Administrative Manager

GURPAL SINGH-TOOR
Program Associate

LEE SCHRADER
Program Technician

SARA SEABOLT
Service Assistant

ELAINE SMILEY
Department Fiscal Manager

KATIE VAUGHN
Program Technician

RONGHUI WANG
Post Doctoral Associate

STEPHANIE WILLIAMSON
Program Technician

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UAMS

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Department of Physiology and Biophysics

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Tyson Foods, Inc.

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Riceland Foods, Inc.

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USDA

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Washington Regional Medical Center

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Riceland Foods, Inc.

WESLEY RITTER
Halliburton

GENE SULLIVAN

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Arkansas Soil and Water Conservation

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Baxter International Inc.

BOB MORGAN
Beaver Water District

TONI PEACOCK
BAEG Alumna

CHRISTOPHER PIXLEY
BAEG Alumnus

ACTIVE ACADEMY MEMBERS

DAVID ANDERSON
B.S. ('70)

STANLEY B. ANDREWS
B.S. ('90), M.S. ('93)
COE Young Alumni 2007

JOHN L. BOCKSNICK
B.S. ('76), M.S. ('78)

DAVID BEASLEY
B.S. ('71), M.S. ('73), Ph.D. ('77)

BILLY B. BRYAN
B.S. ('50)

WESLEY F. BUCHELE
M.S. ('51)
COE Distinguished Alumni 2005

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B.S. ('71)

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DAVID "GAIL" COWART
B.S. ('60)

STEVEN D. DANFORTH
B.S. ('80)

JOE D. FADDIS
B.S. ('67)

MICHAEL W. FREER
B.S. ('85), M.S. ('88)

ALAN D. FORTENBERRY
B.S. ('72), M.S. ('77)
COE Distinguished Alumni 2007

FRED G. FOWLKES
B.S. ('68), M.S. ('77)

DENNIS R. GARDISSER
B.S. ('79), M.S. ('81), Ph.D. ('92)

CARL L. GRIFFIS
B.S. ('63), M.S. ('65), Ph.D. ('68)

FLOYD R. GUNSAULIS
B.S. (88), M.S. (90)
COE Young Alumni 2006

DARRELL HOLMES
B.S. ('81)

JOHN P. HOSKYN
B.S. ('60), M.S. ('64)

MICHAEL D. JONES
B.S. ('67), M.S. ('68)

DAYNA KING-COOK
B.S. ('85), M.S. ('88)

JOHN L. LANGSTON
B.S. ('71), M.S. ('73)

OTTO J. LOEWER
B.S. ('68), M.S. ('70), Ph.D. ('73)

JEFFERY D. MADDEN
B.S. ('88)

RALPH A. MASHBURN
B.S. ('58)

STANLEY A. MATHIS
B.S. ('84)

BRUCE NETHERTON
B.S. ('60)

ROBERT W. NEWELL
B.S. ('54)

RICHARD PENN
B.S. ('82), M.S. ('92)

STANLEY E. REED
B.S. ('73)
BILL R. RIDGWAY
B.S. ('88)

DAVID WESLEY RITTER
B.S. ('79), M.S. ('81)

RICHARD M. ROREX
B.S. ('78), M.S. ('81)

TERRY SIEBENMORGEN
B.S. ('79), M.S. ('81), Ph.D. ('84)

MICHAEL D. SHOOK
B.S. ('82)

JAMAL SOLAIMANIAN
B.S. ('83), M.S. ('85), Ph.D. ('89)

EUGENE H. SNAWDER
B.S. ('69)

FREDDIE C. STRINGER
B.S. ('70)

ALBERT E. "GENE" SULLIVAN
B.S. ('59)
COE Distinguished Alumni 200'7

PHIL TACKER
B.S. ('79), M.S. ('82)

PAUL N. WALKER
B.S. ('70), M.S. ('71), Ph.D. ('74)

WILLIAM K. WARNOCK
B.S. ('72), M.S. ('75), Ph.D. ('77)

BRUCE E. WESTERMAN
B.S. ('90)
COE Young Alumni 2005

ROBERT W. WHITE
B.S. ('72), M.S. ('76)

J. RANDY YOUNG
B.S. ('71), M.S. ('75)
COE Distinguished Alumni 2006

HONORARY ACADEMY MEMBERS

HAROLD S. STANTON
B.S. ('50), M.S. (53)

H. FRANKLIN WATERS
B.S. ('55) Posthumously

ALBERT H. MILLER
Posthumously

2007 ACADEMY INDUCTEES

JOHN J. CLASSEN

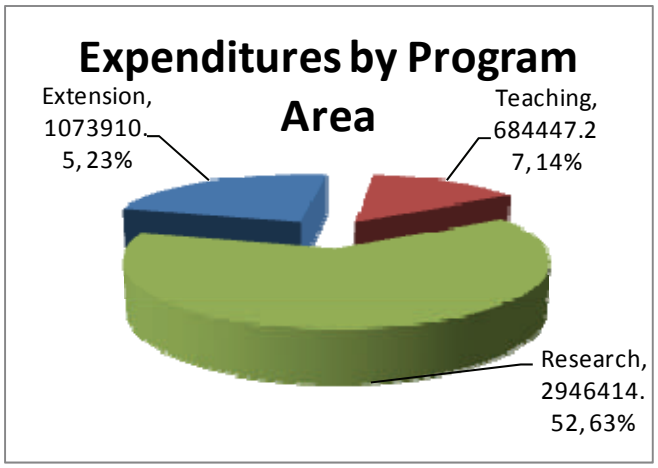
BRUCE NETHERTON

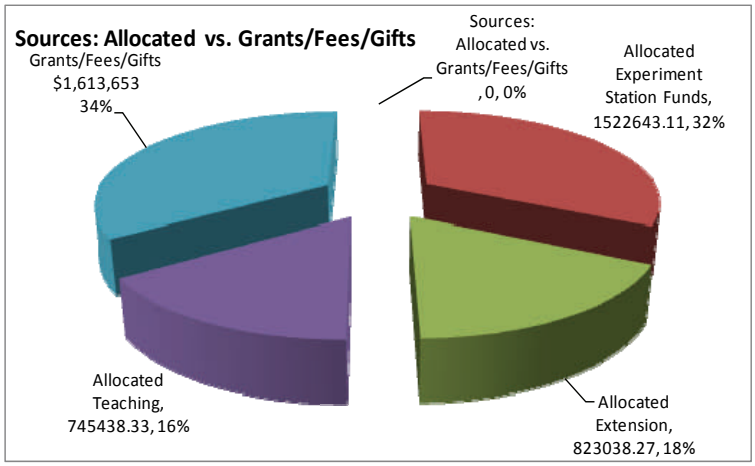
WILLIAM K. WARNOCK

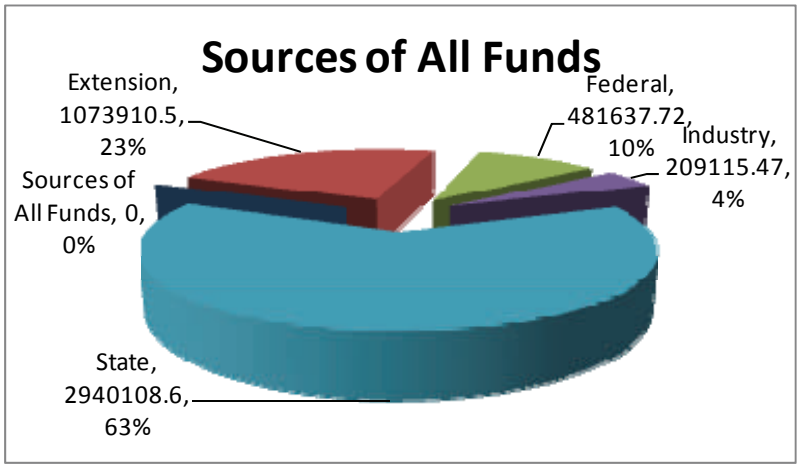
DEPARTMENTAL RESOURCES

FINANCIAL REPORT

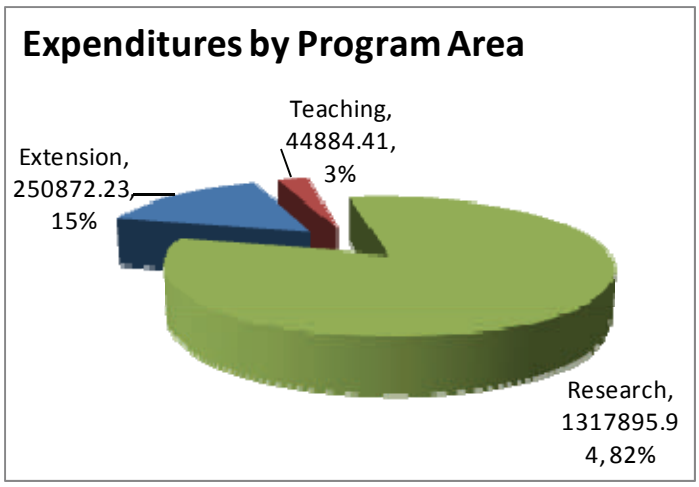
Total Expenditures, July 1, 2007 to June 30, 2008 - $4,704,773

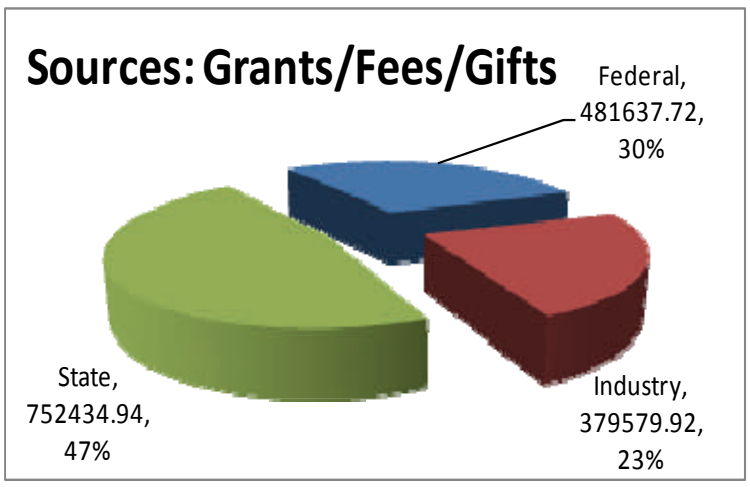






Grants/Fees/Gifts - $1,613,653





UNIVERSITY OF ARKANSAS

The University of Arkansas was founded in 1871 under the Morrill Land-Grant Colleges Act of 1862. Originally named Arkansas Industrial University, classes began in February of 1872.

Old Main was completed in 1875, and was the primary instructional and administrative building. The first class to graduate etched their names in the sidewalk in front of Old Main, starting Senior Walk and a tradition that is still going today.

The University of Arkansas became the first major Southern public university to admit African-American student without litigation when Silas Hunt of Texarkana, an African-American veteran of World War II, was admitted to the university's School of Law in 1948. Vitamin E was co-discovered by UA Agricultural Chemistry Professor Barnett Sure (1920-51). Sure, along with fellow professor Marinus C. Kik (1927-67), made major advances in nutrition science during their tenures at the university. Along with this discovery, Sure extended knowledge of how vitamin E, amino acids, and B-vitamins function on reproduction and lactation. Kik developed the process for parboiling rice to increase retention of vitamins and shorten cooking time. Kik also documented benefits of adding fish and chicken to rice and grain diets to provide adequate protein for a growing world population.

The university has many great traditions like Senior Walk. The *UA Alma Mater* was written in 1909 by Brodie Payne and was recognized in 1931 as one of the twenty-five best college songs by the University College Song Association in New York, and at the end of the song, students and alumni always point toward Old Main. The *Arkansas Fight Song* was written in the late 1920's and is still sung at every football game. The university received the Razorback mascot in 1909 during a speech by the current football coach, Hugo Bezdek, when he referred to the team as "a wild bang of Razorback hogs," and in 1910, the student body voted to change the mascot from the Cardinals to the Razorbacks. The "calling of the Hogs" began in the 1920's, when several local farmers attending a football game decided to try to help a lagging team and yelled "Woo, Pig Sooie!" The school colors are cardinal red and white.

DEPARTMENT OF BIOLOGICAL AND AGRICULTURAL ENGINEERING

In 1921, the University of Arkansas activated the Department of Agricultural Engineering to teach service courses and conduct applied research. The department was housed in Gray Hall, located where Mullins Library now stands. The department moved to the old campus infirmary, nicknamed "the old agriculture building" and now called the Agriculture Annex, in 1966, and finally to its current location in Engineering Hall in 1990 after a renovation of the building originally built in the early 1900's.

The first Bachelor of Science on Agricultural Engineering was conferred in 1950, with the first Master of Science in Agricultural Engineering following in 1952. The first Ph.D. degree was conferred in 1984.

To reflect the change in the Engineering field of study, the department's name was changed to Biological and Agricultural Engineering in 1988. In 1990, the B.S. and M.S. degrees were renamed to reflect the change in the curriculum and the new name of the department, and in 2002, were renamed again to Biological Engineering.

In 2003, the department received approval from the Arkansas Department of Higher Education to begin the M.S. in Biomedical Engineering program. This showed the department's continued goal of keeping up with the changes in the biological engineering research fields. The first M.S. in Biomedical Engineering was conferred in 2006.

The Biological and Agricultural Engineering Department is housed on the second floor of Engineering Hall. The main department office and all the faculty offices are located on the second floor. The department has use of two classrooms, two conference rooms, one computer lab, one student lab, and a study lounge. The department also has offices and labs at the Biological and Agricultural Lab, located on North Garland Avenue, and at the Engineering Research Center, located off South School Street.

DEPARTMENTAL RESOURCES

HISTORY

City of Fayetteville and Northwest Arkansas

The City of Fayetteville recently ranked eighth in the Best Metro on Forbes Magazines "Best Places for Business and Careers," boasting a ranking of 12 and 16 for cost of doing business and job growth for 2007. Kiplinger's 2008 "Best Cities to Work, Live and Play" list featured Fayetteville as its number seven choice.

According to the 2006 special census, Fayetteville has a population of 67,158 and is the third most populous city in Arkansas. It boasts a proud history, with several notable residents including authors Ellen Gilchrist (*In the Land of Dreamy Dreams*, 1981) and Donald Harrington (*The Cherry Pit*, 1965), Arkansas U.S. Senators J. William Fulbright and David Pryor, poet Miller Williams and his Grammy Award-winning songwriter daughter Lucinda, and noted architect E. Fay Jones.

The city of Fayetteville has many highlights, including the town square, where a farmer's market is held from April through November. Dickson Street is a main thoroughfare leading to the University of

Arkansas and is lined with shops and restaurants. The Walton Arts Center is a professional performing arts center and hosts many national and international fine art events throughout the year.

Many industry giants consider Northwest Arkansas home. Bentonville based Wal-Mart, is the world's largest public corporation by revenue, according to the 2008 Fortune Global 500. Founded by Sam M. Walton in 1962, it is the largest private employer in the world and the fourth largest utility or commercial employer. Lowell is the home for J.B. Hunt Transport Services, Inc., one of the largest truckload transportation companies in the United States, with annual revenues of over $2 billion. Tyson Foods, Inc. is based out of Springdale and is the world's largest processor and marketer of chicken, beef, and pork. With 2005 sales of $26 billion, Tyson Foods is the second-largest food production company in the Fortune 500, the largest meat producer in the world, and according to Forbes one of the 100 largest companies in the United States.

FOREWORD

Biological Engineers improve people's lives today and help assure a sustainable quality of life for tomorrow. They create solutions to problems by coupling living systems (human, plant, animal, environmental, food, and microbial) with the tools of engineering and biotechnology. Biological engineers improve human health through biomedical engineering; ensure a safe, nutritious food supply and create critical new medications through biotechnology engineering; secure a health, safe environment through ecological engineering. A bachelor or science in biological engineering is excellent preparation for medical school.

Biological engineering is an ABET accredited program leading to a B.S. degree, M.S. degree, or Ph.D. degree offered through the department. The curriculum is under joint supervision of the dean of the College of Engineering and the dean of the Dale Bumpers College of Agricultural, Food and Life Sciences. The Bachelor of Science in Biological Engineering degree is conferred by the College of Engineering and is granted after the successful completion of 128 hours of approved course work.

The educational objectives of the Biological Engineering program are to produce graduates who:

- *Effectively apply engineering to biological systems and phenomena (plant, animal, human, microbial, and ecosystem) with demonstrated proficiency in basic professional and personal skills.*

- *Are well prepared for diverse careers in biological engineering, life-long learning, and professional and ethical contributions to society through sustained accomplishments in biomedical engineering, ecological and biotechnology.*

AREAS OF TECHNICAL EMPHASIS

The three areas of technical emphasis in biological engineering are as follows:

BIOMEDICAL ENGINEERING

This emphasis focuses on nanomedicine, tissue engineering, organ regeneration and its clinical application, bioinstrumentation, biosensing/medical imaging, medical electronics, physiological modeling, biomechanics, and rehabilitation engineering. This area provides exceptional preparation for medical, veterinary, or dental school as well as for graduate programs in biomedical engineering.

BIOTECHNOLOGY ENGINEERING

This emphasis entails biotechnology at the micro and nano scale, food processing, food safety and security, development of new products from biomaterials, and biotransformation to synthesize industrial and pharmaceutical products.

ECOLOGICAL ENGINEERING

The integration of ecological principles into the design of sustainable systems for treatment, remediation, and prevention of pollution to the environment are key components of this area of emphasis. Stream restoration, watershed management, water and wastewater treatment design, ecological services management, urban greenway design, and enclosed ecosystem design are several applications used in this emphasis.

Each student is required to complete eighteen semester hours of approved electives in his or her area of concentration. Six hours must be from the biological engineering design elective courses (listed below) from a single area of concentration. The remaining twelve hours are classified as technical electives and consist mainly of upper-level courses in engineering, mathematics, and the sciences as approved by the student's advisor. The selected technical electives must include at least sic hours of upper-level engineering courses, either within BENG or from other engineering departments. The department maintains a list of approved electives.

The areas of technical concentration and the recommended elective courses for each are listed beginning on page sixteen.

For more information, visit the website at http:// www.baeg.uark.edu or contact the Department of Biological and Agricultural Engineering office at (479) 575 -2351.

TEACHING PROGRAM

UNDERGRADUATE PROGRAM

BIOLOGICAL ENGINEERING CURRICULUM

2007-2008 COURSE CATALOG

The following is a list of courses required for the Bachelor of Science in Biological Engineering degree and a suggested course sequence. Some courses are not offered every semester, so students who deviate from the suggested sequence must pay close attention to course offerings each semester and the required pre-requisites for courses. Students are strongly encouraged to meet with their advisors on a regular basis.

Students with a Pre-medical focus area must see a faculty advisor for alternate scheduling and elective course requirements.

FRESHMAN YEAR

FIRST SEMESTER

ENGL 1013	Composition I
CHEM 1103	University Chemistry I
GNEG 1111	Introduction to Engineering I
MATH 2554	Calculus I
PHYS 2054	University Physics I

Total of 15 Semester Hours

SECOND SEMESTER

ENGL 1023	Technical Composition II
CHEM 1123/1121L	University Chemistry II and Lab
GNEG 1211	Introduction to Engineering II
HIST 2003, 2013 or PLSC 2003 *(choose one)*	
MATH 2564	Calculus II

Total of 15 Semester Hours

SOPHOMORE YEAR

FIRST SEMESTER

BENG 2612	Biological Engineering Design Studio II
CHEM 3603/3601L	Organic Chemistry I and Lab
GNEG 1122	Introduction to CAD
MATH 2574	Calculus III
PHYS 2074	University Physics II

Total of 16 Semester Hours

SECOND SEMESTER

BIOL 2013/2011L	General Microbiology and Lab
BENG 2622	Biological Engineering Design Studio III
CHEM 3613/3611L	Organic Chemistry II and Lab
MATH 3404	Differential Equations
MEEG 2003	Statics

Total of 17 Semester Hours

JUNIOR YEAR

FIRST SEMESTER

BENG 3712	Engineering Properties of Biological Materials
CHEM 3813	Introduction to Biochemistry
MEEG 3013	Mechanics of Materials
3 Hour Technical Elective *(see advisor)*	
Choose One:	
CHEG 2313	Thermodynamics of Single Component Systems
MEEG 2403	Thermodynamics
Choose One:	
CHEG 2133	Fluid Mechanics
CVEG 3213	Hydraulics
MEEG 3503	Mechanics of Fluids

Total of 17 Semester Hours

SECOND SEMESTER

BENG 3723	Unit Operations in Biological Engineering
BENG 3803	Mechanical Design in Biological Engineering
BENG 4104	Instrumentation in Biological Engineering
ENGL 2003	Advanced Composition or Exemption

BENG Design Elective *(see advisor)*
Humanities/Social Science Elective *(see advisor)*

Total of 16 Semester Hours

SENIOR YEAR

FIRST SEMESTER

BENG 4813	Senior Biological Engineering Design I
BENG 3733	Transport Phenomena in Biological Systems

BENG Design Elective *(see advisor)*
3 Hour Technical Elective *(see advisor)*
6 Humanities/Social Science Elective *(see advisor)*

Total of 18 Semester Hours

SECOND SEMESTER

BENG 4822	Senior Biological Engineering Design II

6 Hours of Humanities/Social Science Elective *(see advisor)*
6 Hours of Technical Elective *(see advisor)*

Total of 14 Semester Hours

128 TOTAL HOURS REQUIRED

AREAS OF TECHNICAL EMPHASIS

The Biological Engineering curriculum has a choice of three areas of technical emphasis for students. The areas of technical emphasis and the recommended elective courses for each emphasis are listed below. This list contains courses required for the Bachelor of Science in Biological Engineering degree and a suggested course sequence. Some courses are not offered every semester, so students who deviate from the suggested sequence must pay close attention to course offerings each semester and the required pre-requisites for courses. Students are strongly encouraged to meet with their advisors on a regular basis.

BIOMEDICAL ENGINEERING/PRE-MEDICAL

DESIGN ELECTIVES

BENG	3213	Biomedical Engineering: Emerging Methods & Applications*
BENG	4203	Biomedical Engineering Principles*

TECHNICAL ELECTIVES

BENG	4113	Risk Analysis for Biomedical Systems
BENG	4123	Biosensors and Bioinstrumentation
BENG	4623	Biological Reactor Systems Design
BENG	451VH	Honors Thesis
BIOL	2533/2531L	Cell Biology
BIOL	4233	Microbial Genetics
ELEG	2903	Digital Systems
HESC	3204	Nutrition
KINS	3353	Mechanics of Human Movement

CHOOSE ONE:

BIOL	2404	Comparative Vertebrate Morphology*
BIOL	2443/2441L	Human Anatomy*

CHOOSE ONE:

BIOL	4234	Comparative Physiology
BIOL	2443/2441L	Human Physiology

*Students in the Pre-Medical Concentration **must** see a faculty advisor for alternate scheduling and elective course requirements. Pre-Medical students must take CHEM 3613/3611L (Organic Chemistry I) and CHEM 3603/3601L (Organic Chemistry II). This requires special scheduling of courses beginning in the first semester of the Sophomore year. Consultation with faculty advisors are greatly encouraged.*

* Elective course strongly recommended by the faculty for a particular area of emphasis.

BIOTECHNOLOGY ENGINEERING

DESIGN ELECTIVES

BENG	4623	Biological Reactor Systems Design
BENG	4703	Biotechnology Engineering

TECHNICAL ELECTIVES

BENG	4113	Risk Analysis for Biomedical Systems
BENG	4123	Biosensors and Bioinstrumentation
BENG	451VH	Honors Thesis
BIOL	4233	Microbial Genetics
BIOL	4313	Physiology of Microorganisms
CHEG	3153	Non-equilibrium Mass Transfer
CHEG	4423	Automatic Process Control
CHEM	3453/3451L	Elements of Physical Chemistry
FDSC	3103	Principles of Food Processing
FDSC	4124	Food Microbiology
FDSC	4304	Food Chemistry
HESC	3204	Nutrition
MEEG	4413	Heat Transfer

ECOLOGICAL ENGINEERING

DESIGN ELECTIVES

BENG	4903	Ecological Engineering Principles
BENG	4923	Ecological Engineering Design

TECHNICAL ELECTIVES

BENG	4113	Risk Analysis for Biological Systems
BENG	4123	Digital Remote Sensing and GIS
BENG	4403	Enclosed Ecosystems Design
BENG	451VH	Honors Thesis
BENG	4623	Biological Reactor Systems Design
BENG	4803	Precision Agriculture
BIOL	3863/3861L	General Ecology
CSES	2203	Soil Science
CSES	4043	Environmental Impact and Fate of Pesticides
CVEG	3223	Hydrology
CVEG	3243	Environmental Engineering
CVEG	4243	Environmental Engineering Design
ENSC	4034	Analysis of Environmental Contaminants
GEOG	4543	Geographic Information Systems

TEACHING PROGRAM

UNDERGRADUATE PROGRAM

GRADUATES FOR 2007

BACHELOR OF SCIENCE IN BIOLOGICAL ENGINEERING

Divakar K. Arora
Nupura Sudhir-Rohita Bhise
Rachel Carlisle
Rebecca Carlisle
Catherine Irene Erikson
Luke James Hall
Sarah Elizabeth Huber
Adrian Joseph Kaufman
Scott Bradford Moore
William James Richardson
Jessica Rene Temple
Krystal Arington Utubor
Freddie L. Walker
Jonathan Clark Watson

BIOLOGICAL ENGINEERING STUDENT CLUB

2007-2008 OFFICERS

Ben Kennedy
President

Nathan Baltz
Vice President

Rebecca Logsdon
Social Chair

Ben Holden
Treasurer

Kris Bunnell
Community Service Chair

Andrew Ellenburg
Secretary

Tanushree Thote
Student Faculty Correspondent

Advisors: Dr. Carl L. Griffis and Dr. Lalit R. Verma

ALPHA EPSILON

2007-2008 OFFICERS

Venkata Venkatakrishnan
President

Thomas F. Garrison
Vice President

Leslie Bartsh
Secretary

Prabhakar Deonikar
Treasurer

Sunny Wallace
Past President

Advisors: Dr. Sreekala Bajwa and Dr. Thomas A. Costello

SCOLARSHIP RECIPIENTS FOR 2007

ARKANSAS ACADEMY OF BIOLOGICAL & AGRICULTUREAL ENGINEERING SCHOLARSHIP

Jennifer Jannings
Garrett Franklin Kever
Tanya Ann Pereira

BIOLOGICAL & AGRICULTURAL ENGINEERING GERNERAL SCHOLARSHIP

Rhys Moore
Tanushree Thote

BILLY BRYAN SCHOLARSHIP

Tai-Wan Debby Chou
Molly K. Steen
Dabney Thomas
Casey Vickerson
Summer Wilkie

XZIN MCNEAL SCHOLARSHIP

Marie Dai
Tai-Wan Debby Chou
Randall Turner Hall, Jr.
Samantha Carol Hovis
Garrett Franklin Kever, Jr.
Aung Myat Khaing
Tanya Ann Pereira
Nelia Sandoval
William Timothy Scott, Jr.
Tanushree Thote

J.A. RIGGS TRACTOR COMPANY SCHOLARSHIP

Linda Tarantino
Russell Tate

STAPLCOTN ANNUAL SCHOLARSHIP

William Timothy Scott, Jr.

JOHN W. & TRANNYE ODOM WHITE SCHOLARSHIP

Jennifer Jannings

MASTER OF SCIENCE IN BIOLOGICAL ENGINEERING

FOREWORD

The Department of Biological and Agricultural Engineering desires that each graduate student receives a broad and comprehensive educational experience. This experience includes social as well as intellectual development to lead students to an increased level of maturity. Certainly, coursework is primary, but social activities—the exploration of the unknown and the exchange of ideas with fellow students and faculty—are also part of the total educational experience.

An additional part of this development process occurs through service to others. Students are encouraged to become involved in all departmental functions including teaching, research, extension, and social activities so that they may obtain the best possible education.

The core of graduate education lies in obtaining technical expertise in an area of specialization. Specifically, the objectives of the Master's and PhD engineering graduate program are for students to:

- Develop the ability to comprehend and apply engineering principles in order to solve problems in research, development and design.
- Obtain sufficient understanding of the mathematical, physical and biological sciences for comprehension of literature in these and related fields.
- Acquire the skills required to use appropriate equipment, including instruments and computers, in solving problems in their areas of interest.
- Achieve the technical competence necessary to teach college-level courses and conduct an adult education program (such as in Cooperative Extension).

In the attainment of the above objectives, graduate students will combine biological or biomedical engineering courses with other engineering fields, the physical sciences, mathematics, statistics and the biological sciences in developing their program of study. The advanced degrees are primarily research degrees awarded for significant creative research or design accomplishment, and not for the completion of a specified number of courses. Therefore, a student's program concentration is on a significant thesis or dissertation problem completed under the supervision of members of the graduate faculty. This complements a program of strong course support to properly address the thesis or dissertation problem.

ADMISSION REQUIREMENTS

Admission to the M.S.B.E. program is a three-step process. First, the prospective student must be granted admission to the University of Arkansas Graduate School. Second, the prospective student must be accepted into the department's program which depends on transcripts, recommendations, a statement of purpose, and the following additional requirements:

- A cumulative GPA in the last sixty hours of course work of 3.0.
- A cumulative GRE score of 1100 or higher (verbal and quantitative combined).
- A TOEFL score of at least 550 (paper-based), 213 (computer-based), or 80 (internet-based). This requirement is waived for applicants whose native language is English or earned a bachelor's or master's degree from a U.S. institution.
- An eligible member of the faculty (graduate status of group II or higher) must agree to serve as the major advisor to the prospective student.

Third, the prospective student will only be admitted to the M.S. program provided engineering competence can be demonstrated by satisfying one of the following criteria:

- Receipt of a B.S. degree in engineering from a program accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET) or equivalent.
- Completion of 18 hours of additional undergraduate course work (deficiency courses) in addition to the Master's program requirements (additional hours may be required for course pre-requisites).

More detail on admission requirements may be found at http://catalogofstudies.uark.edu/.

TEACHING PROGRAM

GRADUATE PROGRAM

MASTER OF SCIENCE IN BIOMEDICAL ENGINEERING

FOREWARD

The Master of Science in Biomedical Engineering is a multidisciplinary degree program designed for students from a multitude of academic areas. The objectives of the M.S.B.M.E. program are to prepare graduates for careers in biomedical engineering practice with government agencies, engineering firms, or industries and to provide a foundation for continued study at the past-masters level. This program focuses on Bioimaging and Biosensing; Bioinformatics and Computational Biology; Tissue Engineering and Biomaterials; and Bio-MEMS/ Nanotechnology.

ADMISSION REQUIREMENTS

Admission to the M.S.B.E. program is a three-step process. First, the prospective student must be granted admission to the University of Arkansas Graduate School. Second, the prospective student must be accepted into the department's program which depends on transcripts, recommendations, a statement of purpose, and the following additional requirements:

- A cumulative GPA in the last sixty hours of course work of 3.0.
- A cumulative GRE score of 1100 or higher (verbal and quantitative combined).
- A TOEFL score of at least 550 (paper-based), 213 (computer-based), or 80 (internet-based). This requirement is waived for applicants whose native language is English or earned a bachelor's or master's degree from a U.S. institution.
- An eligible member of the faculty (graduate status of group II or higher) must agree to serve as the major advisor to the prospective student.

Third, the prospective student will only be admitted to the M.S. program provided engineering competence can be demonstrated by satisfying one of the following criteria:

- Receipt of a B.S. degree in engineering from a program accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET) or equivalent.
- Completion of 18 hours of additional undergraduate course work (deficiency courses) in addition to the Master's program requirements (additional hours may be required for course pre-requisites).

More detail on admission requirements may be found at http:// catalogofstudies.uark.edu/.

DOCTOR OF PHILOSOPHY IN BIOLOGICAL ENGINEERING

ADMISSION REQUIREMENTS

In addition to the requirements of the University of Arkansas Graduate School, admission to the departmental aspect of the PhD program depends strongly on the judgment of the individual professor who will serve as the graduate advisor. The minimal admission criteria are as follows:

- A GRE score of 1100 or above (verbal and quantitative).
- A TOEFL score of at least 550 (paper-based), 213 (computer-based), or 80 (internet-based). This requirement is waived for applicants whose native language is English or who earn a bachelor's or master's degree from a U.S. institution.
- A member of the faculty who is eligible (graduate status of group II or higher) must agree to serve as major advisor to the prospective student.
- A Master of Science degree in Engineering with a thesis.

Prospective PhD students may decide to go directly from a bachelor's degree to the PhD program if the following criteria are met:

- A cumulative GPA in the last sixty hours of 3.5.
- A minimum GRE score of 1200.
- A Bachelor of Science in Engineering from an ABET accredited program.

Students wishing to enter the PhD program with both a bachelor's and master's degree in a non-engineering science will be required to demonstrate engineering competence by one of the following:

- Pass all deficiency courses detailed by student's advisor.
- Pass a qualifying examination constructed and administered by the Graduate Committee.

Students with a non-engineering bachelor's degree will not be considered for direct admission to the PhD program. Students will be advised to begin the Master's program first. Exceptions must be approved by the Departmental Graduate Review Committee and the Department Head.

More detail on admission requirements may be found at http:// catalogofstudies.uark.edu/.

GRADUATE STUDENTS

The following students were part of the Graduate program during 2007. Several students cannot be listed due to limitations of the Family Educational Rights and Privacy Act (FERPA). Faculty advisors provided support and planning to the students throughout their career in the Department of Biological and Agricultural Engineering.

MASTER OF SCIENCE IN BIOLOGICAL ENGINEERING

STUDENT	*ADVISOR*
Prathamesh Bandekar	Dr. Sreekala Bajwa
Amber Gosnell	Dr. Carl Griffis
Haibo Huang	Dr. Yanbin Li
Shichuang Liu	Dr. Yanbin Li
Sathya Vandhana Ravindranath	Dr. D. Julie Carrier
Juhi Srivastava	Dr. Carl Griffis
Nirmal Uppugundla	Dr. D. Julie Carrier
Yun Wang	Dr. Yanbin Li

MASTER OF SCIENCE IN ENVIRONMENTAL ENGINEERING

STUDENT	*ADVISOR*
Leslie Bartsch	Dr. Brian E. Haggard
Eric Cummings	Dr. Marty Matlock
Morgan David	Dr. Brian E. Haggard
Kyle Kruger	Dr. Marty Matlock
Ruth Zeledón-Kelly	Dr. Marty Matlock

MASTER OF SCIENCE IN BIOMEDICAL ENGINEERING

STUDENT	*ADVISOR*
Charles Darr	Dr. Jin-Woo Kim
Jared Garrett	Dr. Kaiming Ye
John Judkins	Dr. Jin-Woo Kim
Venkata Kolipaka	Dr. Mahendra Kavdia
Sowmya Krothapalli	Dr. Christa Hestekin
John Leach	Dr. Kaiming Ye
Pratyush Rai	Dr. Vijay Varadan
Vasuda Ramachandran	Dr. Vijay Varadan
Siddhant Ramaswamy	Dr. Simon Ang
Venkatasubraman Venkatakrishnan	Dr. Mahendra Kavdia

DOCTOR OF PHILOSOPHY IN BIOLOGICAL ENGINEERING

STUDENT	*ADVISOR*
Zara Clayton-Niederman	Dr. Marty Matlock
Prabhakar Deonikar	Dr. Mahendra Kavdia
Jeong-Hwan Kim	Dr. Jin-Woo Kim
Subodh Kulkarni	Dr. Sreekala Bajwa
Nisha Lakshmanan	Dr. Mahendra Kavdia
Mansoor Leh	Dr. Indrajeet Chaubey
Naresh Pai	Dr. Dharmendra Saraswat
Jithesh Velichamthotu-Veetil	Dr. Kaiming Ye
Sunny Wallace	Dr. D. Julie Carrier
Xinxin Wu	Dr. Kaiming Ye

TEACHING PROGRAM

GRADUATE PROGRAMS

GRADUATE STUDENT ADVISEES IN OTHER AREAS

The following students are participating in other programs across the university with a member of the department's faculty serving in an advising role. Several students cannot be listed due to limitations of the Family Educational Rights and Privacy Act (FERPA).

Student	*Program*	*Advisor*
Tatsuya Aikyama	MS Environmental Soil and Water	Dr. Brian Haggard
Dilek Austin	MS Food Science	Dr. G. Scott Osborn
Li Bai	PhD Environmental Dynamics	Dr. Sreekala Bajwa
Joyce Berger	PhD Crop Soil and Environmental Sciences	Dr. Yanbin Li
Barbara Boland	MA Geography	Dr. Sreekala Bajwa
Geneva Brion	MS Environmental Soil and Water	Dr. Brian Haggard
Payel Chaudhuri	PhD Cell and Molecular Biology	Dr. Mahendra Kavdia
Feng Chen	PhD Chemistry	Dr. Yanbin Li
Anh Chu	PhD Electrical Engineering	Dr. Yanbin Li
Lisa Cooney	MS Food Science	Dr. Yanbin Li
JianJin Du	PhD Chemical Engineering	Dr. D. Julie Carrier
Abigail Engelberth	PhD Chemical Engineering	D. Julie Carrier
Dustin Freyaldenhoven	MS Chemical Engineering	Dr. G. Scott Osborn
Rebecca Gill	MS Cell and Molecular Biology	Dr. Yanbin Li
Jonathon Gillup	MS Geosciences	Dr. Brian Haggard
Irene Hanning	PhD Cell and Molecular Biology	Dr. Yanbin Li
Thang Ho	MS Chemical Engineering	Dr. D. Julie Carrier
Xiaoyan Hu	MS Crop Soil and Environmental Sciences	Dr. Sreekala Bajwa
Brad Hufhines	MS Environmental Soil and Water	Dr. Brian Haggard
Damira Kanayeva	PhD Cell and Molecular Biology	Dr. Yanbin Li
Nalini Kotagiri	PhD Chemical Engineering	Dr. Jin-Woo Kim
Ju-Seok Lee	PhD Cell and Molecular Biology	Dr. Jin-Woo Kim
Sarah Lewis	PhD Environmental Dynamics	Dr. Marty Matlock
Min Li	PhD Food Science	Dr. Yanbin Li
Justin Lovelady	PhD Chemical Engineering	D. Julie Carrier
David Lyons	PhD Environmental Dynamics	Dr. Brian Haggard
Yue Ma	MS Cell and Molecular Biology	Dr. Yanbin Li
Michelle McDonald	MS Crop Soil and Environmental Sciences	Dr. Yanbin Li
Brie Menjolet	MS Environmental Soil and Water	Dr. Brian Haggard
Jason Patton	PhD Environmental Dynamics	Dr. Brian Haggard
Jeffrey Prichard	MS Cell and Molecular Biology	Dr. Mahendra Kavdia
Daniel Ruiz	MS Electrical Engineering	Dr. Mahendra Kavdia
Balaji Srinivasan	PhD Mechanical Engineering	Dr. Yanbin Li
Ryan Stoner	MS Environmental Soil and Water	Dr. Brian Haggard
Mayen Udoetuk	MS Microelectronics-Photonics	Dr. Mahendra Kavdia
Leisha Vance	PhD Environmental Dynamics	Dr. Marty Matlock
Raharamesh Varakala	PhD Chemical Engineering	Dr. Mahendra Kavdia
XinXin Wu	PhD Cell and Molecular Biology	Dr. Mahendra Kavdia, Dr. Jin-Woo Kim
Jon Zawislak	MS Entomology	Dr. D. Julie Carrier

GRADUATE DEGREES EARNED

The following students completed all requirements for their degree program and were awarded a degree from the University of Arkansas.

RAYMOND SCOTT AVERY
M.S., Biological Engineering
Dr. Brian Haggard
Dissertation: "Evaluating the Impact of Nutrient Input Reductions on Chlorophyll A Concentrations Using CE-QUAL-W2 at Lake Eucha, Oklahoma"

VIJAY GARG
Ph.D., Biological Engineering
Dr. Indrajeet Chaubey
Dissertation: "Development and Evaluation of a Physical Hyperspectral Optical– Monte Carlo Model for an Aquatic Medium Reflectance Simulation"

THOMAS FREDERICK GARRISON
M.S.., Biological Engineering
Dr. Jin-Woo Kim
Dissertation: "Kinetic Modeling and Experimental Analysis of Gold-Coated Carbon Nanotube (gCNT) Synthesis Through AU^{3+} Reduction"

SUBODH SHAMRAO KULKARNI
Ph.D., Biological Engineering
Dr. Sreekala Bajwa
Dissertation: "Spatial Analysis of Soybean Canopy Response to Soybean Cyst Nematodes (*Heterodera glycines*) in Eastern Arkansas: An Approach to Future Precision Agriculture Technology Application"

ZHIHUI LIU
Ph.D., Biological Engineering
Dr. Yanbin Li
Dissertation: "Disinfection of Recirculated Chilling Brine Using Flow-Through Electrolyzing Treatment Chambers and Acidification"

JOSHUA J. GIOVANNETTI
M.S., Environmental Engineering
Dr. Brian Haggard
Dissertation: "Land Use Effects on Ozark Stream Organic Carbon and Nutrient Concentrations"

ROBERT ALLEN MORGAN
Ph.D., Biological Engineering
Dr. Marty Matlock
Dissertation: "A Hierarchical Watershed Assessment and Resource Prioritization Protocol for Stream Pollution Control and Restoration"

SUNIL SURESH POTDAR
M.S., Biomedical Engineering
Dr. Mahendra Kavdia
Dissertation: "Role of Cardiovascular Risk Factors on Endothelial Cell Function"

NITIN KUMAR SINGH
M.S., Biological Engineering
Dr. Sreekala Bajwa
Dissertation: "Estimation of Correction Factor for Water Surface Reflections Under Lab and Field Conditions"

KATHERINE PAGE SHURGAR
M.S., Biological Engineering
Dr. Marty Matlock
Dissertation: "Stressor-Response Relationships Between Landscape Features and Benthic Macroinvertebrate Indices Using the USEPA Wadeable Stream Assessment Program Data"

ANDREA LORENE LUDWIG
M.S., Environmental Engineering
Dr. Marty Matlock
Dissertation: "Periphytic Algae Nutrient Limitation in Streams Draining the Beaver Reservoir Basin, Northwest Arkansas, USA, 2005-2006"

MONICA A. KOLLER-IRIARTE
M.S., Environmental Engineering
Dr. Marty Matlock
Dissertation: "Trophic Conditions and Nutrient Limitations in the Headwaters of Beaver Lake, Arkansas, During a Dry Hydrologic Year, 2005-2006"

The following courses are taught as part of the Biological and Agricultural Engineering curriculum for the Undergraduate, Master's, and Ph.D. programs.

BENG1012 BIOLOGICAL ENGINEERING DESIGN FUNDAMENTALS
Introduction to the profession of Biological Engineering including a definition, and demonstration through field trips, guest speakers, examples of job opportunities and internships. Basic engineering methodologies, including analysis and design, as applied to biological systems. Introduction to problem solving, data analysis, report writing, presentations, and engineering record keeping. Group activities and team design efforts. Lecture 1 hour, laboratory 3 hours per week. Co-requisite: Lab component.

BENG1022 BIOLOGICAL ENGINEERING DESIGN STUDIO I
Practice of biological engineering design in the Biological Engineering Design Studio. Design projects explore the unique problems associated with engineering applied to biological systems. Group activities to teach teamwork skills in the context of engineering practice, including reporting, project management, time management, communication and balancing individual and team accountability. Introduction and application to a computer aided graphics package. Lecture 1 hour, laboratory 3 hours per week. Prerequisite: BENG 1012 or GNEG 1103. Co-requisite: Lab component.

BENG2103 ELECTRONIC APPLICATIONS IN BIOLOGICAL SYSTEMS
Basic circuit theory and introductory applications of DC circuits, AC circuits and electro-mechanical components in actuating, monitoring and controlling processes involving biological materials. Lecture 2 hours, laboratory 3 hours per week. Co-requisite: Lab component.

BENG2612 BIOLOGICAL ENGINEERING DESIGN STUDIO II
Applications of biology, chemistry and physics to the design of life support for enclosed biological systems involving people, animals, plants and microbes. Design process will be based upon engineering analyses such as quantifying bio-energetics and growth, energy and mass balances, solar energy and use of watershed modeling tools. Student teams will be presented multiple design modules that include literature/experimental discovery, open-ended design and prototype testing. 4 hours of design studio per week. Prerequisite: GNEG 1121. Pre- or Co-requisite: PHYS 2054, BIOL 1543/1541L.

BENG2622 BIOLOGICAL ENGINEERING DESIGN STUDIO III
Continuation of BENG 2612. Design Studio experience includes additional life support system design modules. Design process will include discussion of social issues and ethics, use of engineering economics as a tool to evaluate design alternatives. Use of descriptive statistics and regression to analyze experimental data. Improve written and oral communication skills through presentation of design project results. 4 hours of design studio per week. Prerequisite: BENG 2612.

BENG3213 BIOMEDICAL ENGINEERING: EMERGING METHODS AND APPLICATIONS
Introductory course for undergraduate biomedical engineering students. Emerging biomedical engineering topics including: tissue engineering, stem cell engineering, biomedical nanotechnology, medical imaging and biosensing, single molecule imaging, biomarker discovery and proteomics, gene therapy, drug delivery, and protein engineering. Design of components for tissue engineering processes, nanodrug delivery and nanotechnology based disease detection. Lecture 3 hours per week. Prerequisite: BIOL 2533. Pre- or Co-requisite: BENG 3723.

BENG3712 ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS
Measuring and predicting the physical, chemical, and biological properties of biological materials necessary for the analysis and design of production and processing systems. Lecture 2 hours per week. Prerequisite: BENG 2622.

BENG3723 UNIT OPERATIONS IN BIOLOGICAL ENGINEERING
Design of basic unit operations typical of biological engineering practice; unit operations include pump-pipe, fan-duct, moist air (psychrometric) processes (cool/heater/humidifier/dryer), air mixing, aeration, and refrigeration; unit operations design will account for unique constraints imposed by biological systems. Lecture 2 hours and lab 3 hours per week. Co-requisite: Lab component. Prerequisite: (MEEG 2403 or CHEG 2313) and (CVEG 3213 or CHEG 2133 or MEEG 3503).

BENG3733 TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEMS
Applications of the principles of kinetics and heat and mass transfer to the analysis and design of biological engineering processes. Biological engineering processes will encompass examples in the realms of biotechnology, ecological, and biomedical engineering. Lecture 3 hours per week. Prerequisite: MATH 3404 and BENG 3723. Pre- or Co-requisite: CHEM 3813.

BENG3803 MECHANICAL DESIGN IN BIOLOGICAL ENGINEERING
Introduction to the mechanical design process applied to biological engineering, with examples of mechanical components interfacing with biological systems. Engineering properties of materials, loading, combined stress analysis, theories of failure. Systems approach in design, including safety, reliability and cost. Lecture 2 hours, laboratory 3 hours per week. Co-requisite: Lab component. Prerequisite: MEEG 3013.

BENG4104 ELECTRONIC INSTRUMENTATION FOR BIOLOGICAL SYSTEMS
Theory and advanced applications of analog circuits, digital circuits, and commercial instruments involving biological materials and systems. Lecture 3 hours, laboratory 3 hours per week. Prerequisite: PHYS 2074.

BENG4104H HONORS ELECTRONIC INSTRUMENTATION FOR BIOLOGICAL SYSTEMS
Theory and advanced applications of analog circuits, digital circuits, and commercial instruments involving biological materials and systems. Lecture 3 hours, laboratory 3 hours per week. Prerequisite: PHYS 2074.

BENG4113 RISK ANALYSIS FOR BIOLOGICAL SYSTEMS
Principles of risk assessment including exposure assessment, dose response, and risk management. Methods of risk analysis modeling and simulation with computer software. Applications of risk analysis in medical, animal, food and environmental systems. Prerequisite: MATH 2564 and BIOL 2013.

BENG4123 BIOSENSORS & BIOINSTRUMENTATION
Principles of biologically based sensing elements and interfacing techniques. Design and analysis methods of biosensing and transducing components in bioinstrumentation. Applications of biosensors and bioinstrumentation in bioprocessing, bioenvironmental, biomechanical and biomedical engineering. Lecture 2 hours, laboratory 3 hours per week. Co-requisite: Lab component. Prerequisite: BIOL 2013 and BENG 4103.

BENG4133 DIGITAL REMOTE SENSING AND GIS
Basic digital image processing techniques and geo-spatial analysis applied to monitoring of natural processes and resources. Course topics include introduction to electromagnetic radiation, concept of color, remote sensing systems, and light attenuation by atmosphere, objects and sensors. Advanced topics include data models, spectral transforms, spatial transforms, correction and calibration, geo-rectification, and image classification with hyperspectral and multi-spectral images acquired with aerial and satellite sensors. Raster GIS is integrated into the course throughout the semester. Will use software such as ENVI, ArcGIS and ArcView. Lecture 2 hours, lab 3 hours per week.

BENG4203 BIOMEDICAL ENGINEERING PRINCIPLES
Engineering principles applied to the design and analysis of systems affecting human health. This is an introductory course focusing on fundamentals of physiological systems and modeling and how this relates to analysis and equipment design. Topics include: brief overview of anatomy and physiology; bioelectric phenomena, physiological modeling, cardiovascular system, biomechanics, computational biology. Requires a background in circuits, fluid dynamics, mechanics, biology, and chemistry. Lecture 3 hours per week. Prerequisite: MEEG 2013, (MEEG 2403 or CHEG 2313), ELEG 2103, (MEEG 3503 or CVEG 3213 or CHEG 2133), MEEG 3013, BIOL 1543 or equivalents.

BENG4223 NUMERICAL METHODS IN BIOMEDICAL ENGINEERING
Application of mathematical techniques and numerical methods for analyzing biological data and solving biological problems. The emphasis will be computer simulation and mathematical modeling applications in biomedical engineering. Prerequisite: MATH 3404.

BENG4403 DESIGN OF ENCLOSED ECOSYSTEMS (IRREGULAR)
Environmental and functional design of buildings, chambers, rooms and habitats to house/exhibit animals and plants. Advanced analytical techniques which incorporate physiological considerations. Psychometrics, solar and alternate energy principles. Design of ventilation, heating and cooling systems and controls. Design considerations include animal behavior, stress and welfare. Lecture 2 hours, lab 3 hours per week. Co-requisite: Lab component. Prerequisite: BENG 2622.

BENG450V SPECIAL PROBLEMS (I-V)
Selected problems in biological engineering are pursued in detail. Prerequisite: senior standing. May be repeated for 4 hours.

BENG451VH HONORS THESIS (1-6)
Prerequisite: Honors candidacy.

BENG452V SPECIAL TOPICS IN BIOLOGICAL ENGINEERING (1-6)
Special topics in biological engineering not covered in other courses. May be repeated. May be repeated for 8 hours.

BENG4623 BIOLOGICAL REACTOR SYSTEMS DESIGN
Extension of principles of microbial growth kinetics and transport phenomena to the design of biological reactor systems used in biological engineering. Reactor systems using specialty microbial biomass (activated sludge) for substrate utilization as well as biomass and product formation. Application areas such as bio-remediation, bioprocessing and organic (food/animal) waste treatment. Co-requisite: Lab component. Prerequisite: MATH 3404. Pre- or Co-requisite: BENG 3733

BENG4703 BIOTECHNOLOGY ENGINEERING
Introduction to biotechnology topics ranging from molecular biological engineering, bioprocess engineering, biopharmaceutical manufacturing and biosensors to FDA regulations, as well as engineering principles in the design of the systems in the aforementioned topic areas. Lecture 3 hour per week. Prerequisite: BIOL 2013, (CHEM 2613 or CHEM 3603) and (MEEG 2403 or CHEG 2313).

BENG4803 PRECISION AGRICULTURE
Introduction to precision agriculture, benefits, spatial variability within a field, zone concept, and site-specific management. Spatial data collection: sensors, GPS, yield monitoring, and remote sensing. Knowledge discovery from data: data processing, neural networks, genetic algorithms, and use of GIS. Decision support systems. Variable-rate technology: real-time and map-based systems, variable-rate machinery, and smart controls. Evaluation: Yield mapping and economic analysis. Students are expected to have basic computer skills and statistics knowledge. (same as CSES 4803). Co-requisite: Lab component. Prerequisite: MATH 1213 and junior standing.

BENG4813 SENIOR BIOLOGICAL ENGINEERING DESIGN I
Design concepts for equipment and processes used in biological, food and agricultural industries. Initiation of comprehensive two -semester team-design projects; defining design objectives, developing functional/mechanical criteria, standards, reliability, safety, ethics and professionalism issues. Lecture 2 hours, laboratory 3 hours per week. Co-requisite: Lab component. Prerequisite: consent of instructor. Prerequisite: BENG 3723. Pre- or Co-requisite: BENG 3733.

BENG4822 SENIOR BIOLOGICAL ENGINEERING DESIGN II
Continuation of BENG 4813. Design concepts for equipment and processes used in biological and agricultural industries.

Completion of 2-semester team design projects. Construction, testing, and evaluation of prototypes. Written and oral design reports. Discussion of manufacturing methods, safety, ergonomics, analysis/synthesis/design methods as appropriate for particular design projects. Laboratory/design 4 hours per week. Prerequisite: BENG 4813.

BENG4903 WATERSHED ECO-HYDROLOGY
Engineering principles involved in assessment and management of surface water flow and hydrologic processes within ecosystems. Includes frequency analysis of rainfall, infiltration, runoff, evapotranspiration. Use of GIS/mathematical models to quantify hydrologic processes at the watershed landscape scale. Design/implementation of best management practices and ecological engineering principles and processes for advanced ecological services. Lecture 3 hours per week. Prerequisite: CVEG 3213.

BENG4923 ECOLOGICAL ENGINEERING DESIGN
Design of low impact development techniques to enhance ecological services, reduce peak runoff, and capture sediments, nutrients and other pollutants resulting from urban development. Techniques may include: bio-swales, retention basins, and filter strips. Design of sustainable ecological processes for the treatment and utilization of wastes/residues. Techniques may include: direct land application to soils/crops, composting systems, lagoons and constructed wetlands. Design goals include optimization of ecological services to maintain designated uses of land, water and air, including enhancement of habitat for wildlife and recreation, and the discovery of economically viable methods for coexistence of urban and agricultural land uses. Lecture 3 hours per week. Prerequisite: BENG4903.

BENG500V ADVANCED TOPICS IN BIOLOGICAL ENGINEERING (1-6)
Special problems in fundamental and applied research. Prerequisite: graduate standing. May be repeated for 6 hours.

BENG5103 ADVANCED INSTRUMENTATION IN BIOLOGICAL ENGINEERING
Applications of advanced instrumentation in biological systems. Emphasis on updated sensing and transducing technologies, data acquisition and analytical instruments. Lecture 2 hours, lab 3 hours per week. Co-requisite: Lab component. Prerequisite: BENG 4103.

BENG5113 DIGITAL REMOTE SENSING AND GIS
Basic digital image processing techniques and geo-spatial analysis applied to monitoring of natural processes and resources. Course topics include introduction to electromagnetic radiation, concept of color, remote sensing systems, and light attenuation by atmosphere, objects and sensors. Advanced topics include data models, spectral transforms, spatial transforms, correction and calibration, geo-rectification, and image classification with hyperspectral and multi-spectral images acquired with aerial and satellite sensors. Raster GIS is integrated into course throughout the semester. Will use software such as ENVI, ArcGIS and ArcView. Requires a class project in the student's area of interest. Lecture 2 hours, lab 3 hours per week. Students may not earn credit for both BENG 5113 and BENG 4133. Co-requisite: Lab component. Prerequisite: MATH 3404.

BENG5123 IMAGING AND RAPID ANALYSIS OF BIOLOGICAL AND AGRICULTURAL MATERIALS
Techniques of imaging and non-invasive analyses of biological and agricultural materials. Covering spectral sensing (x-ray, UV, VS, IR), optics, image processing, recognition, on-line monitoring and vision-based controls. Applications to automated food/fruit inspections, defect/contaminant detection, and characterization of food non-food materials in real-time on processing lines. Prerequisite: BENG 4103

BENG5203 MATHEMATICAL MODELING OF PHYSIOLOGICAL SYSTEMS
Application of mathematical techniques to physiological systems. The emphasis will be on cellular physiology and cardiovascular system. Cellular physiology topics include models of cellular metabolism, membrane dynamics, membrane potential, excitability, wave propagation and cellular function regulation. Cardiovascular system topics include models of blood cells, oxygen transport, cardiac output, cardiac regulation, and circulation. Background in biology and physiology highly recommended. Lecture 3 hours per week. Prerequisite: MATH 3404.

BENG5213 INTRODUCTION TO BIOINFORMATICS
Application of algorithmic techniques to the analysis and solution of biological problems. Topics include an introduction to molecular biology and recombinant DNA technology, biological sequence comparison, and phylogenetics, as well as topics of current interest. (Same as CSCE 5213)

BENG5223 BIOMEDICAL ENGINEERING RESEARCH INTERNSHIP
Minimum six-week program (possibly up to several months) in a medical research environment working on an original engineering research project. Possible specialty areas include Anesthesiology, Cardiology, Informatics, Opthalmology, Orthopedic Surgery, and Radiology. Prerequisite: graduate standing and approval of coordinator.

BENG5233 TISSUE AND CELL ENGINEERING
This course introduces students to biological, engineering and clinical aspects of tissue and cell engineering. The introduction to stem cells and histology are reinforced with a concomitant lab that introduces cell culture techniques and illustrates functional and structural aspects of various biological tissues. Topics include Cell Signaling, Transport and Kinetics, Scaffolds, Surface Interactions, Drug Delivery, and Clinical, Ethical and Regulatory Considerations. Two to three lecture hours per week plus three lab hours per week. Co-requisite: lab component. Prerequisite: MATH 3404 and CHEM 3813.

BENG5243 BIOMATERIALS
A graduate course on molecular structure-property relationships in biomaterials. Special focus is given to polymers, metals, ceramics, composites, and biodegradable materials. The design of

artificial biomaterials for biosensors, drug delivery and medical implants is considered. Host response and biocompatibility factors are introduced. Previous course in materials desirable.

BENG5253 BIO-MEMS
Topics include the fundamental principles of microfluidics, Navier-Stokes Equation, bio/abio interfacing technology, bio/abio hybrid integration of microfabrication technology, and various biomedical and biological problems that can be addressed with microfabrication technology and the engineering challenges associated with it. Lecture 3 hour per week. Prerequisites: MEEG 3503 or CVEG 3213 or CHEG 2133. (Same as MEEG 5253)

BENG5263 BIOMEDICAL ENGINEERING PRINCIPLES
Engineering principles applied to the design and analysis of systems affecting human health. This is a course focusing on fundamentals of physiological systems and modeling. Topics include: brief overview of anatomy and physiology, bioelectric phenomena and neuronal model, compartmental modeling, cardiovascular system and blood flow, biomechanics, computational biology and signal transduction. Requires a background in circuits, fluid dynamics, mechanics, biology, and/or biochemistry. Lecture 3 hours per week. Students may not earn credit for both BENG 5263 and BENG 4203. Prerequisites: MATH 3404 or equivalent and graduate standing.

BENG5273 NUMERICAL METHODS IN BIOMEDICAL ENGINEERING
Application of mathematical techniques and numerical methods for analyzing biological data and solving biological problems. The emphasis will be computer simulation and mathematical modeling applications in biomedical engineering. Lecture 3 hours per week. Students may not earn credit for both BENG 5273 and BENG 4223. Prerequisite: MATH 3404.

BENG5613 SIMULATION MODELING OF BIOLOGICAL SYSTEMS
Application of computer modeling and simulation of discrete-event and continuous-time systems to solve biological and agricultural engineering problems. Philosophy and ethics of representing complex processes in simplified form. Deterministic and stochastic modeling of complex systems, algorithm development, application limits, and simulation interpretation. Emphasis on calibration, validation and testing of biological systems models for the purposes of system optimization, resource allocation, real-time control and/or conceptual understanding. Prerequisite: AGST 4023 or STAT 4003 or INEG 3333.

BENG5703 DESIGN AND ANALYSIS OF EXPERIMENTS FOR ENGINEERING RESEARCH
Principles of planning and design of experiments for engineering research. Propagation of experimental error. Improving precision of experiments. Analysis of experimental data for optimal design and control of engineering systems using computer techniques. Students must have an introductory background in statistics. Lecture 2 hours, laboratory 3 hours per week. Co-requisite: Lab component.

BENG5713 FOOD PRODUCT AND PROCESS DEVELOPMENT
Multidisciplinary approaches for developing new food products and processes in the context of an industry-sponsored project. Group dynamics and interpersonal skills. Factors that influence product and process development. Analysis and modeling applied to food process design. Lecture 1 hour, laboratory 6 hours per week. Co-requisite: Lab component. Prerequisite: BENG 4703.

BENG5723 FOOD SAFETY ENGINEERING
Principles of engineering methods applied to food and safety and sanitation. Principles of engineering methods applied to food safety and security. Discussion of thermal, chemical and electrical pasteurization or sterilization in food processing. Demonstration of monitoring and detecting techniques for food safety, including image analysis, biosensors and modeling. Lecture 3 hours per week. Prerequisite: BENG 4103 and FDSC 4124 (or equivalent).

BENG5733 ADVANCED BIOTECHNOLOGY ENGINEERING
Applications of the principles of bioprocess/biochemical engineering to microbiological and biomedical problems. Topics include applied enzymology, metabolic engineering, molecular genetics and control, and bioinformatics and nanobiotechnology in addition to classical applied enzyme and cell-growth kinetics and advanced bioreactor design. Prerequisite: BENG 3733 or CHEG 5531.

BENG5743 BIOTECHNOLOGY ENGINEERING
Introduction to biotechnology topics ranging from molecular biological engineering, bioprocess engineering, biopharmaceutical manufacturing and biosensors to FDA regulations, as well as engineering principles in the design of the systems in the aforementioned topic areas. Requires background in microbiology, organic chemistry and thermodynamics. Lecture 3 hour per week. Students may not earn credit for both BENG 5743 and BENG 4703

BENG5801 GRADUATE SEMINAR
Reports presented by graduate students on topics dealing with current research in agricultural engineering. Prerequisite: graduate standing.

BENG5903 WATER QUALITY MODELING AND MANAGEMENT
Processes and methodologies associated with surface water quality modeling, investigation of management processes based on modeling results. Process from simple steady-state spreadsheet models (to understand aquatic biosystems modeling) to complex GIS-based dynamic models. Develop calibration and validation statistics for model applications. Students will develop a semester project that integrates their skills and knowledge in parameterizing, calibrating, and validating water quality models for environmental applications. Prerequisite: BENG 5613.

BENG5913 BIOREMEDIATION AND BIODEGRADATION
Environmentally-relevant biotechnology using organisms to remove or metabolize environmental pollutants through microbial degradation and phytoremediation of recalcitrant

compounds. Benefits as well as potential costs of environmental applications of biotechnology will be evaluated.

BENG5923 NONPOINT SOURCE POLLUTION CONTROL AND MODELING
Control of hydrologic, meteorologic, and land use factors on nonpoint source (NPS) pollution in urban and agricultural watersheds. Discussion of water quality models to develop NPS pollution control plans and total maximum daily loads (TMDLs), with consideration of model calibration, validation, and uncertainty analysis. Prerequisite: BENG 4903 or CVEG 3223.

BENG5933 ENVIRONMENTAL AND ECOLOGICAL RISK ASSESSMENT
Process and methodologies associated with human-environmental and ecological risk assessments. Environmental risk assessments based on human receptors as endpoints, addressing predominantly abiotic processes. Ecological risk assessments based on non-human receptors as endpoints. Approach using hazard definition, effects assessment, risk estimation, and risk management. Application of methods to student projects to gain experience in defining and quantifying uncertainty associated with human perturbation, management and restoration of environmental and ecological processes.

BENG5943 WATERSHED ECO-HYDROLOGY
Engineering principles involved in assessment and management of surface water flow and hydrologic processes within ecosystems. Includes frequency analysis of rainfall, infiltration, runoff, evapotranspiration. Use of GIS/mathematical models to quantify hydrologic processes at the watershed landscape scale. Design/implementation of best management practices and ecological engineering principles and processes for advanced ecological services. Lecture 3 hours per week. Students may not earn credit for both BENG 5943 and BENG 4903. Prerequisites: CVEG 3213 or equivalent.

BENG5953 ECOLOGICAL ENGINEERING DESIGN
Design of low impact development techniques to enhance ecological services, reduce peak runoff, and capture sediments, nutrients and other pollutants resulting from urban development. Techniques may include: bio-swales, retention basins, filter strips. Design of sustainable ecological processes for the treatment and utilization of wastes/residues. Techniques may include: direct land application to soils/crops, composting systems, lagoons and constructed wetlands. Design goals include optimization of ecological services to maintain designated uses of land, water and air; including enhancement of habitat for wildlife and recreation, and the discovery of economically viable methods for co-existence of urban and agricultural land uses. Lecture 3 hours per week. Students may not earn credit for both BENG 5953 and BENG 4923. Prerequisite: BENG 4903 or equivalent.

BENG600V MASTER'S THESIS (1-6)
Prerequisite: graduate standing.

BENG700V DOCTORAL DISSERTATION (1- 18)
Prerequisite: candidacy.

RESEARCH PROJECTS

BIOMEDICAL ENGINEERING

NON-CROSSHYBRIDIZING DNA OLIGONUCLEOTIDES FOR DNA-BASED NANOTECHNOLOGY AND DNA COMPUTING

JIN-WOO KIM, *Associate Professor*

Issue:

When used to self-assemble nanostructures for biological, medical and electronic applications, if DNA oligonucleotides can form unplanned duplexes (crosshybridizations), defects might result. Likewise, crosshybridizations can produce errors in the results of DNA computations. Thus, there is a need for libraries of oligonucleotides that minimize crosshybridization.

Action:

In my laboratory, in vitro methods have been developed and verified to produce large libraries with thousands of DNA oligonucleotides that interfere minimally with each other. These libraries are being used to self-assemble complicated nanostructures, for molecular electronic, medical and sensor applications, with greater control of component location to overcome the fundamental physical limits.

Impact:

The libraries of DNA oligonucleotides produced in our laboratory should be useful for a variety of biological, biomedical, and other applications, particularly as DNA oligonucleotide building blocks for DNA-based computers and nanotechnology. The research has generated over 12 publications and presentations during the year 2005.

Funding:

- National Science Foundation
- Arkansas Bioscience Institute

Cooperating Scientist or Institution:

- Dr. Russell Deaton, UA Department of Computer Science and Computer Engineering

BIOLOGICAL ENGINEERING STUDENTS DESIGN PROSTHETICS FOR THE DEVELOPING WORLD

THOMAS A. COSTELLO

Associate Professor

Issue:

In developing countries, there are many people who have suffered amputation of limbs due to trauma (from war and motor vehicle accidents) along with complications from diabetes and other vascular diseases. Physicians in many countries are less able to save threatened limbs due to poor emergency health care and almost non-existent follow-up care in the home. Prosthetic limbs typical in the U.S. are much too expensive for amputees in developing countries. Most patients either suffer without an artificial limb, or they rely on donated prosthetics (e.g., discarded by patients in the U.S.) imported to the country by international medical missions. In order for the medical systems in developing countries to meet needs of their patients in a sustainable way, there is a need for prosthetic components which can be manufactured locally in developing countries

Action:

Two UA biological engineering senior design teams focused in 2006-2007 on the design of low-cost prosthetic devices for use in developing countries. One team designed and implemented modifications to the International Red Cross arm to make it a more functional upper extremity prosthesis. They added body-powered motion (shoulder flex, biscapular abduction) to flex the forearm. They designed a cable operated locking mechanism for the elbow which is activated by a shoulder drop movement. Both of these are simple mechanisms which can improve quality of life for the patient. A second team designed a low cost, adjustable lower-limb prosthesis for children in developing countries. The two main portions of the prosthesis were the socket and pylon. The socket was created using a composite material constructed of sawdust and recycled high density polyethylene, which are locally available world-wide. The pylon was constructed using two pieces of standard sized structural aluminum tubing selected for a telescoping fit to allow easy adjustment of length as the child grows. Students did the research, considered multiple alternatives, and used engineering methods to optimize the best solutions. The second semester of the course sequence allowed students to build and test prototypes of their designs. A team of 5 students and 1 faculty presented ideas to a prosthetic clinic in the Dominican Republic.

Impact:

Biological engineering students are learning to incorporate biology and engineering to solve problems in the medical field. Prototypes designed, fabricated and tested by student design teams in their senior design course provide evidence that graduates of the program will make contributions to improve medicine, health and quality of life as professional engineers. One student project from the 2006-2007 academic year took top honors in the 2007 RESNA National Student Design Competition. The competition, sponsored by NSF, is intended to promote new technology to assist disabled persons. Students in Arkansas--who have an interest in engineering, biology, and serving people--have an accredited engineering program at the UA that will help them to develop into important players in the world-wide health care system. Graduates can go on to medical school, do graduate work in biomedical engineering or seek industry jobs at the bachelor's level.

Funding:

- College of Engineering, University of Arkansas
- UA Division of Agriculture
- Dale Bumpers College of Agricultural Food and Life Sciences

THERMAL PROCESSING OF READY-TO-EAT MEAT PRODUCTS

CARL L. GRIFFIS

Professor

Issue:

Approximately 76 million cases of illness are caused every year due to food-borne pathogens, according to the Center for Disease Control and Prevention. Many of these illnesses result from improper cooking of food products by the consumer, but some arise from improper thermal processing of ready-to-eat meat products by the food industry. The food processing industry needs tools to help them determine appropriate processing conditions to guarantee the safety of ready-to-eat products.

Action:

Experiments in the Bio-Safety Level 2 laboratory in the Biological & Agricultural Engineering Research Laboratory are being conducted to determine basic parameters for thermal destruction of a variety of pathogens in combination with a variety of ready-to-eat food products.

Impact:

The studies will enable food processors to develop antimicrobials that can be applied to the ready-to-eat product just before packaging, thus, producing a safe ready-to-eat product.

Funding:

- Industry Grants

RESEARCH PROJECTS

BIOTECHNOLOGY ENGINEERING

MICRO/NANOSCALE BIO/ABIO INTERFACING TECHNOLOGY

JIN-WOO KIM, *Associate Professor*

Issue:

The biomaterials, including DNA, proteins, and cells, are well optimized through evolution, exhibiting unique recognition, transport, catalytic, and replication properties. In stead of reinventing the wheels, the integration of such pre-engineered biomaterials into nano systems would lead to the realization of the next generation bio/abio hybrid engineered systems for applications raging from MEMS/NEMS-based micro/nano fluidic systems to bioelectronic and biosensing systems. However, the major challenges for making this merger feasible are integration and interfacing of the micro- and nano-scale biological and abiological materials at similar scales. The successful development of interfacing techniques for their integration is imperative to overcome the challenges.

Action:

Currently, we are in the process of developing a series of nano hybrid devices through stable and 'controllable' interfaces between bio and abio materials at the nanoscale. These devices under investigation in my laboratory include (a) a nano flagellar motor based AC dynamo (nFMD), (b) a nano flagellar motor based TNT detection system (nFMTNT), (c) a DNA-based CNT wire (DNA/NTW) nanosensor, and (d) a photothermal diagnostic and therapeutic system using near-infrared responsive nanoparticles.

Impact:

These projects are important steps towards realization of the bio/abio nanotechnology that bridges the sciences of biology, medicine, nano-materials, and MEMS/NEMS by pairing their advantages. The research has generated over 14 publications and presentations during 2007.

Funding:

- National Science Foundation
- National Research
- Arkansas Bioscience Institute

NANOPARTICLES BASED FLUORESCENT BIOSENSOR FOR RAPID DETECTION OF *LISTERIA MONOCYTOGENES* IN FOODS

YANBIN LI, *Professor*

Issue:

Listeria monocytogenes is one of the major foodborne pathogens. It has relatively high heat resistance, salt tolerance, has the ability to grow at refrigeration temperatures, and survives over a wide range of pH. CDC estimates that 2,500 cases of human listeriosis occur annually in the US. It has a case fatality rate of 20% that leads to an estimated 500 deaths per year with a projected cost of $233 million. USDA/FSIS issued a "zero" tolerance policy for *L. monocytogenes* in ready-to-eat foods. To control *L. monocytogenes* in foods and to meet the federal regulations, food industries need a rapid, sensitive, specific and inexpensive method to detect *L. monocytogenes* in food products on line or even in real time.

Action:

The objective of this project is to develop a nanoparticle-based fluorescent biosensor for rapid detection of *L. monocytogenes* in foods. The biosensor system consists of a novel nanobeads bioseparator, novel quantum dots biolabels, and a fluorescent detector. The nanotechnology based biosensor is evaluated for the food industry to screen *L. monocytogenes* in poultry, meat and vegetables, specifically ready-to-eat food products. The result showed that magnetic immuno-nanobeads could capture target pathogenic bacteria in foods with more than 90% capture efficiency in fifteen minutes, which is advantageous over magnetic immuno-microbeads as well as centrifuge and filtration. Quantum dots nanoparticals were coated with anti-*Listeria* antibody and used as fluorescence labels in the immunosensor, which gave more than 100 times fluorescence emission compared to common fluorescent materials used in immunoassays. The fluorescent intensity measured is proportional to the concentration of *Listeria* cells in a range of 1 to 10^6 cfu/ml. A totally automated instrument (which consists of a nano-bioseparator, a flow-through microfluidics chip and an optical detector) has been designed and fabricated for this biosensing technology. Anti-*L. monocytogenes* monoclonal antibodies and rapid growth medium are being developed to make the required specificity (strain level), sensitivity (1 cfu/ml), and time (less than 2 hrs). This biosensing method is also able to simultaneously detect multiple pathogens in a food sample.

Impact:

The food industry and federal regulatory agencies can apply this novel biosensing method to food safety inspection and quality control to ensure food safety and security. Our society could benefit from this technology in terms of reducing foodborne diseases and consequently related medical costs. Application of the new nanotechnology-based biosensor would enable the food industry to be benefited economically in terms of prevention of product recalls and international embargo associated with the microbial contamination of food products.

Cooperating Scientist or Institutions:

- Luc Berghman, Texas A&M University
- Daniel Fung, Kansas State University
- John Marcy, University of Arkansas
- Shu-I Tu, USDA/ARS ERRC

Funding:

- USDA/ARS and NAFSS

BIOTECHNOLOGY ENGINEERING

NANOBEAD/NANOFIBER BASED IMPEDANCE BIOSENSOR FOR RAPID DETECTION OF FOODBORNE PATHOGENS

YANBIN LI, *Professor*

Issue:

Foodborne diseases cause approximately 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths in the U.S. each year at an estimated cost of $7.7-8.4 billion. Conventional microbial detection methods for food inspection are time consuming and expensive. It cannot match rapid food processing and distribution systems. To minimize product recalls, clear international trade barriers, and prevent foodborne diseases due to microbial contamination, the food industry needs more rapid, sensitive, specific and inexpensive methods to detect pathogens in food products on line or even in real time. A rapid biodetection method is also urgently needed for monitoring our food supply system for its safety and security in anti-bioterrorism.

Action:

The biosensor consists of a sampler, multiple-section microfluidic cartridges, a pumping unit, an impedance detector, a microprocessor, a display, a key panel, and a USB connector to a laptop or PC. First, a food sample containing various biological and chemical components and different bacteria is mixed with magnetic nanobeads coated with specific antibodies under a rotating magnetic field to separate and concentrate target pathogens. The pathogens captured on nanobeads flow through a microfluidic channel and are captured by the antibodies immobilized on the nanofibers connected to the embedded microelectrodes. The key part of the biosensor is TiO_2 nanowire/nanotube bundles that are immobilized with antibodies through covalent bonding. The change in dielectric properties of the nanofibers (i.e., the impedance change caused by captured target bacteria) can be measured and correlated to the cell number of *Listeria, Salmonella* or *E. coli* O157:H7. Multiple bacteria may be simultaneously detected by placing multiple electrodes in the microfluidic channel and coating them with different antibodies. An invention disclosure has been filed.

Impact:

The results of this project could provide the food industry with new technology to detect pathogens in foods in less than 1.5 hours with acceptable detection limits (less than 10 cells/ml or cells/g). The biosensor could be designed as a portable, hand-held instrument for use in a food processing plant or a food market. The food industry could save millions of dollars annually by avoiding product recalls since this biosensor technology could reduce the microbial detection time from more than 24 hours down to 1-2 hours. Consumers could benefit from reduced foodborne sickness and associated medical costs. This technology will also help our society reduce foodborne diseases and strengthen the safety and security of our food supply system.

Cooperating Scientist or Institution:

- Ryan Tian, UA Chemistry/Biochemistry Department
- Michael Slavik, UA Poultry Science Department

Funding:

- BioDetection Instruments, LLC

PREDICTIVE MODELS AND QUANTITATIVE RISK ASSESSMENT MODELS FOR *SALMONELLA* TYPHIMURIUM AND *CAMPYLOBACTER JEJUNI* IN POULTRY PRODUCTS

YANBIN LI, *Professor*

Issue:

Salmonella Typhimurium and *Campylobacter jejuni* are two of the major human pathogens associated with poultry products, mainly due to microbial contamination, recontamination, or cross-contamination during production and processing. Each year in the US, an estimated $12 billion is lost in medical costs, lost productivity, recalls, legal fees, and loss of business due to the microbial contamination of meat and poultry products. The poultry industry needs more effective methods to determine microbial hazards, assess the risk in their HACCP programs and risk management, and evaluate intervention technologies applied to poultry production, processing, and handling systems.

Action:

Experiments have been conducted to collect the data for *S.* Ttyphimurium and *C. jejuni* on chicken skins and in processing water with various conditions (temperature, time, age of water, chlorine level, chemical spray and initial cell concentration). Predictive models have been developed for survival/growth/destruction of *S.* Typhimurium and *C. jejuni* on chicken carcasses and in processing water. Experiments were also conducted for the hatching process, providing the data on *Salmonella* contamination of eggs and chicks. A cross-contamination model for poultry chilling process was also investigated. A quantitative risk assessment model has been developed for poultry production, processing, and distribution based on both collected and reported data using the Monte Carlo simulation with @RISK software. The risk model can present the probability of microbial hazards in terms of percentage of contaminated carcasses or the pathogen level of each carcass for given processing conditions. Sensitive analysis can also rank the major sources of microbial contamination or the critical control points in poultry production, processing, and distribution. Interventions can be evaluated using the risk assessment simulation model coupled with predicted microbial models. A website is available for the introduction of the risk assessment model developed in this research (www.uark.edu/ua/biorisk).

Impact:

The predictive microbial models will provide poultry processors with a powerful tool to analyze the survival/growth/death and cross-contamination of pathogenic bacteria on poultry carcasses and in processing water under various processing conditions. The microbial risk assessment model will assist the poultry processor in their HACCP programs and risk management in a quantitative way. In combination with on-line or real-time microbial detection technologies, the predictive model and quantitative risk assessment model could make on-line risk analysis available, which would greatly help the poultry industry in their decision-making for food safety. Consumers will benefit from safer poultry products, and society will benefit from reduced foodborne diseases and related medical costs.

Cooperating Scientist or Institution:

- John Marcy, Poultry Science Department, University of Arkansas
- Andy Mauromoustakos, Ag. Statistics Lab, University of Arkansas

Funding:

- USDA/CSREES (Food Safety Consortium)

RESEARCH PROJECTS

BIOTECHNOLOGY ENGINEERING

A MICROFLUIDIC IMMUNOSENSOR FOR RAPID DETECTION OF MULTIPLE FOODBORNE PATHOGENIC BACTERIA IN POULTRY PRODUCTS

YANBIN LI, *Professor*

Issue:

Contaminated food, mainly by pathogenic microorganisms, is estimated to cause 76 million illnesses, 325,000 serious illnesses resulting in hospitalization, and 5,000 deaths in the US each year. USDA/ERS estimates the medical costs and productivity losses associated with *E. coli* O157, *Salmonella*, *Listeria monocytogenes* and *Campylobacter* alone amount to at least $6.9 billion annually. Current methods for detection of bacteria rely upon culture plating, ELISA, and PCR. However, these methods are time consuming, expensive, or not specific, and require trained operators with laboratory facilities. There is an urgent need for a rapid method in detection of major foodborne pathogens.

Action:

An immuno-electrochemical biosensor system coupled with immuno-magnetic separation was first developed for detection of *S.* Typhimurium in poultry products. The biosensor can enumerate *Salmonella* as low as 1 x 10^2 cell/ml in 2 h. A bienzyme electrode was developed for the biosensor to improve sensitivity. A capillary bioseparator/bioreactor was then studied to enhance the binding efficacy of antibodies/antigens and enzymatic reaction, and to design an automated instrument. Microfluidic channels were also applied to replace capillary columns to further improve the biosensor performance. The immunosensor has been evaluated for the detection of *S.* Typhimurium, *L. monocytogenes,* and *E. coli* O157:H7 in raw and cooked poultry products. Results showed the detection limit and time were 10 cells/ml and less than 1.5 h. The immunosensor showed its great potential to detect three target pathogens simultaneously. This biosensor has been further developed and commercialized by BioDetection Instruments (BDI) based on three patents filed by the University of Arkansas.

Impact:

The results of this project could provide the food industry with new technology to detect pathogens in foods in less than 1.5 hours with acceptable detection limits (less than 10 cells/ml or cells/g). The biosensor could be designed as a portable, hand-held instrument for use in a food processing plant or a food market. The food industry could save millions of dollars annually by avoiding product recalls since this biosensor technology could reduce the microbial detection time from more than 24 hours down to 1-2 hours. Consumers could benefit from reduced foodborne sickness and associated medical costs. This technology will also help our society reduce foodborne diseases and strengthen the safety and security of our food supply system.

Cooperating Scientist or Institutions:

- Steve Tung, UA Mechanical Engineering Department
- Michael Johnson, UA Food Science Department

Funding:

- USDA/CSREES (Food Safety Consortium), USDA/FAS

PORTABLE IMPEDANCE BIOSENSOR FOR IN-FIELD DETECTION OF AVIAN INFLUENZA H5N1

YANBIN LI, *Professor*

Issue:

Avian influenza (AI) virus H5N1 was discovered in the late 1990s. It has been reported by the W.H.O. in more than 46 countries for animal cases and in 14 countries for human cases. 349 people have been infected and 216 have died since 2003. In the US, a recent outbreak of low pathogenic AI in 2001 and 2002 resulted in the depopulation of over 4.5 million chickens and turkeys and cost the poultry industry approximately $125 million. World Bank estimated that more than 140 million birds have died or have been destroyed due to AI H5N1, and losses to the poultry industry are in excess of $10 billion worldwide. A key to controlling the spread of AI is the rapid detection of the disease, and then the quarantine, vaccination or eradication of infected animals. The technology for detection of AI H5N1 is mature, but many tests are complex, with some liable to error, and some can be performed safely only in BSL3 facilities. A simple, rapid, robust and reliable AI test, suitable for use in the field, is urgently needed.

Action:

A portable biosensor has been developed for in-field sensitive and specific detection of AI virus H5N1 in poultry swab samples. Magnetic nanobeads are coated with specific antibodies to target the virus and then used in the sampler to separate and concentrate the target virus from a poultry swab sample. Red blood cells, as biolabels, are mixed with the captured target virus to form the bio-nanobead-virus-red blood cell complex. A microfluidic biochip is designed and fabricated as a flow-through device to deliver the complex to an embedded interdigitated array microelectrode for impedance measurement. The change in impedance of the bionanobead-virus-red blood cell complex is correlated to the concentration of AI virus H5N1 in the original swab sample. Our results showed that a positive signal was clearly obtained when the concentration of AI virus H5N1 in cloacal swabs was equal to or more than 100 EID_{50}/mL. At 10 kHz frequency, the impedance of AI virus H5N1 significantly increased compared to either no any viruses or only Newcastle and Infectious Bronchitis viruses. A US patent has been filed. A research prototype of this biosensor has been designed and fabricated and is being evaluated with viable AI H5N1 in a BSL-3 lab and field tests.

Impact:

Since there are no in-field AI test instruments available currently, this biosensor would provide the poultry industry with a much needed technology for rapid, sensitive and specific screening of AI H5N1 in poultry. This will help the poultry industry be better prepared for AI H5N1, ensure poultry product safety and security, and minimize the testing cost.

Cooperating Scientist or Institutions:

- Billy Hargis, Poultry Science Department
  University of Arkansas
- Steve Tung, Mechanical Engineering Department
  Unversity of Arknasas
- Luc Berghman
  Texas A&M University

Funding:

- USDA/NRI, Arkansas Biosciences Institute
- UA Center of Excellence for Poultry Science
- UA Division of Agriculture

BIOTECHNOLOGY ENGINEERING

ELIMINATION OF *LISTERIA MONOCYTOGENES* DURING THERMAL PROCESSING OF READY-TO-EAT POULTRY PRODUCTS

YANBIN LI, *Professor*

Issue:

Listeria monocytogenes is a major foodborne pathogen associated with poultry products. The USDA Economic Research Service (ERS) estimates a $6.9 billion loss per year in the U.S. for medical costs, productivity losses, recalls, legal fees, and loss of business for diseases caused by five foodborne pathogens. The projected cost for *L. monocytogenes* alone was estimated at $233 million each year. The elimination of pathogens in meat and poultry products could save up to $12 billion annually in all associated costs. The USDA/FSIS regulations indicate a zero tolerance to *L. monocytogenes* in ready-to-eat (RTE) food products. Therefore, the poultry processing industry needs more effective technologies to ensure the elimination of *L. monocytogenes* during thermal processing.

Action:

The goal of this project is to evaluate the thermal processing conditions in an air-steam impingement oven to eliminate *L. monocytogenes* from different shapes and sizes of RTE poultry products and to provide the poultry processing industry and regulatory agencies with microbial kinetics and risk assessment models for pathogen lethality validation of the commercial thermal process. Treatment schedules were designed to achieve the targeted pathogen reduction on various shapes and sizes of RTE poultry products including chicken breasts, wings, nuggets, strips. The process lethality was evaluated at different time-temperature combinations in an air-steam impingement oven without compromising product quality and yield. A heat/mass transfer model coupled with pathogen kinetics has been developed to predict *L. monocytogenes* inactivation in RTE poultry products in an air-steam impingement oven as a function of time, temperature, pH, and moisture content. Computer simulation software is ready for use on the Internet. The predictive model will be further validated for thermal processing of RTE poultry products by conducting tests in commercial poultry processing plants.

Impact:

This research will help the poultry processing industry in eliminating *L. monocytogenes* while minimizing the detrimental effect to the product quality. With the optimized temperature-time combination for thermal processing of RTE products, the temperature to destroy *L. monocytogenes* could be guaranteed while the flavor and weight could be maintained. Therefore, the poultry processor would obtain the pathogens-free products with the maximum yield for more profits. The predictive models will be able to assist the poultry processors in design of the cost-effective treatment schedule for complete elimination of *L. monocytogenes* in RTE poultry products to ensure food safety and security.

Cooperating Scientist or Institution:

- John Marcy (Poultry Science Dept), Mark Tamplin (USDA/ARS ERRC)

Funding:

- USDA/ARS and NAFSS

RESEARCH PROJECTS

ECOLOGICAL ENGINEERING

MITIGATION OF AIR POLLUTION FROM CONCENTRATED ANIMAL FEEDING OPERATIONS

SREEKALA BAJWA, *Associate Professor*

Issue:

Air quality from confined animal feeding operations (CAFO) is an emerging issue, which will affect the economic viability of animal agriculture all over the US. As a top poultry state, and home to several poultry integrators, Arkansas would be a benchmark state for conducting research on air quality issues from poultry operations. Currently, the science behind CAFO emissions and mitigation is not completely understood. There are information gaps in methods used for estimating emissions, monitoring devices, models for house emissions, dispersion and fate, and mitigation strategies.

Action:

My research group is developing affordable and effective at-source mitigation strategies for controlling ammonia and particulate matter emitted from commercial broiler houses. We are focusing on those mitigation strategies that are non-hazardous to the birds and workers, easily disposable and have minimal impact on water and air quality after disposal. Additionally, we will also focus on developing baseline emission data for various weather conditions, bird age and bedding conditions.

Impact:

As the number two poultry state in the US, Arkansas could be seriously impacted by the evolving air quality issues, if not addressed immediately. The financial liability of animal feeding operations that were either sued or fined by EPA has been huge. If we do not develop economically viable mitigation techniques, anticipated changed in air quality regulations could lead to the demise of poultry operations in Arkansas. Our research is expected to develop affordable mitigation strategies for ammonia emissions from broiler operations.

Cooperating Scientists or Institutions:

- Tom Costello, Associate Professor, BAEG, University of Arkansas
- Yi Liang, Assistant Professor, BAEG, University of Arkansas

Funding Sources:

- Arkansas Agricultural Experiment Station

APPLICATION OF COTTON GIN WASTE AND RECYCLED COTTON BALE WRAP IN LIGNO-CELLULOSIC COMPOSITES (LCC)

SREEKALA BAJWA, *Associate Professor*

Issue:

Two of the major waste streams of cotton cultivation include the ginning waste that comes from cotton gins, and the plastic film used for wrapping the cotton bales in the new cotton module builder. Both of these waste streams do not have any other significant application at present. They pose serious environmental issues such as the fire hazard of gin waste piles, if merely discarded. Therefore, it is necessary to find alternate uses or disposal strategies for these waste materials without adding additional cost to the producers.

Action:

My research focus is to generate value added products from the two waste streams of cotton agriculture, the gin waste and bale wraps. Cotton gin waste is rich in natural ligno-cellulosic fibers, which may be used to replace the more expensive wood fiber in composite boards. Similarly, cotton bale wraps may be able to replace part of the high-density polyethylene in composite boards, without compromising the mechanical and physical properties of the end products. Therefore, the objective of this project was to evaluate the two waste materials for potential application in ligno-cellulosic composite (LCC) boards. We plan to characterize the burr and linters fraction of the cotton gin trash for chemical and physical properties, manufacture LCC boards with various amount of these waste materials as ingredients, test them for relevant physical and mechanical properties, and compare them to commercial composites to analyze their suitability in those applications.

Impact:

It is important to protect our environment for future generations, and to help rural communities by making agriculture more profitable. The new composites made with cotton gin waste and recycled bale wrap will add value to two of the otherwise waste materials, and reduce the environmental impact by removing them from the environment. This new composite will have lower costs as the raw materials are inexpensive. The cotton farmers will benefit from this product by selling the cotton gin waste for a price instead of paying for its disposal. The many wood-plastic composite industries situated in the cotton belt will benefit from this product by substituting the scarce and expensive raw materials with inexpensive and abundant raw materials that are locally available.

Cooperating Scientists or Institutions:

- Greg Holt, USDA-ARS, Lubbock, TX

Funding Sources:

- Cotton, Inc.

REMOTE SENSING OF NATURAL PROCESSES AND ENVIRONMENTAL QUALITY

SREEKALA BAJWA, *Associate Professor*

Issue: Water is a natural resource that is seriously impacted by anthropogenic factors such as urbanization and agriculture, and natural processes such as soil erosion, among other things. Although there has been significant research into the processes that affect water quality, a lot of it is still unknown. A true evaluation of the effect of natural processes and anthropogenic factors on water quality will require monitoring of these processes and the changes they cause in the landscape.

Action: My research focus on combining remote sensing techniques with transport models to capture the dynamic processes that affect water quality. One of the major research focuses is on modeling pesticide transport from agricultural land to surface water in L'Anguille River watershed. We are also studying remote sensing method to quantify stream bank erosion process, and to understand the relative contribution of sediments from stream banks and upstream areas within the Beaver Lake watershed.

Impact: It is important to protect our natural resources for future generations. A clear understanding of the various sources of pollution of surface waters, and the mode of action of these pollution sources is critical to develop remediation techniques or best management practices that would either control the pollution at the source or minimize the contribution from various sources.

Cooperating Scientists or Institutions:

- Indrajeet Chaubey, Associate Professor, Purdue University
- Marty Matlock, Associate Professor, BAEG, University of Arkansas

Funding Sources:

- EPA Region 6

TOWARDS CELLULOSIC DERIVED BIO-FUELS

Issue:

Although there are roughly 150 corn to ethanol plants, with a production capacity of 9 billion gallons, there is a need for additional bio-based liquid fuels. The next generation of bio-fuels centers on the transformation of cellulosic biomass to liquid fuels, such as ethanol or butanol. The objectives of this study are to determine conditions in which cellulosic biomass can be pretreated before being converted to bio-fuels. This pretreatment step includes the insertion of an extraction operation aimed at extracting valuable phytochemicals from the biomass prior to conversion.

Action:

Producing biofuels in the saccharification platform implies the release of cellulose and hemicellulose from the biomass by pretreatment with dilute acid or hot water. As a source of cellulosic biomass, this project focused on *Albizia julibrissin* and on switchgrass, namely with a hot water pretreatment at 60 and 120°C. Switchgrass 60°C hot water extracts displayed interesting anti-oxidant properties, indicating that it could be possible to obtain a high value phytochemical stream prior to the 120°C pretreatment. Obtaining such stream could bring additional value to the biorefinery. Similar work is currently under way with *A. julibrissin* biomass. ot water pre-treatments are currently being examined. This project is on going.

Cooperating Scientists or Institutions:

- Ed Clausen, Associate Professor, Chemical Engineering, University of Arkansas

Funding Sources:

- Division of Agriculture
- Ralph E. Martin Department of Chemical Engineering

RESEARCH PROJECTS

ECOLOGICAL ENGINEERING

POULTRY MANURE AS RENEWABLE ENERGY RESOURCE

THOMAS A. COSTELLO, *Associate Professor*

Issue:

Fuel for space-heating is the single largest operating expense for most poultry growers. Costs for propane continue to escalate and threaten profitability of many operations. Poultry litter can be viewed as a renewable biomass energy resource that is generated on the farm. Broiler litter has about 60-70% of the energy content of wood or sawdust. Combustion of poultry litter is being considered as a way to utilize this resource in an environmentally friendly way to reduce consumption of fossil fuels, propane and natural gas.

Action:

Biological engineers and poultry scientists at UA tested a broiler litter -fired furnace in a recent demonstration project. The prototype furnace was provided by an Arkansas company (Lynndale Systems of Harrison). The demonstration was conducted at the UA Applied Broiler Research Farm, near Savoy. The furnace was operated during the grow-out of two flocks of broilers from August 1, 2006 to November 24, 2006. A follow up test in April 2007 provided performance data for an improved furnace prototype. A tractor front -end loader was used to move litter from an adjacent outdoor, covered stockpile to the fuel hopper which automatically fed the furnace. The furnace sustained burns of 100% raw broiler litter. Combustion chamber temperatures were in the range from 600 to 1000 ^{o}F. The improved furnace model delivered a peak heat output 250,000 btu/h, consumed litter at a rate of 145 lb per hour, and exhibited a system efficiency of 30-33%. The manufacturer has planned further design improvements so that a future commercial furnace should save enough natural gas or propane to pay for the biomass energy system.

Impact:

The poultry industry has a need for multiple technologies to help respond to escalating fuel costs and continued environmental concerns. Litter to energy conversion is one idea that has great promise. The recent demonstration has shown that poultry manure can be combusted on-farm at rates over 1.5 tons per day to provide thermal energy needed for space-heating. Additional work is needed to test air emissions and find markets for litter ash. If successful, adoption of this technology would not only decrease litter application in sensitive watersheds, but it would displace expensive fossil fuels (propane and natural gas) with a renewable biomass energy source found right on the farm.

Cooperating Scientists or Institutions:

- Tom Tabler, , Center of Excellence for Poultry Science, University of Arkansas
- Susan Watkins, Center of Excellence for Poultry Science, University of Arkansas
- Jim Raley, Lynndale Systems, Harrison, AR

Funding:

- Division of Agriculture, University of Arkansas
- Arkansas Natural Resources Commission
- Arkansas Department of Environmental Quality
- U. S. Environmental Protection Agency

LAND USE EFFECTS ON STREAM WATER QUALITY

BRIAN E. HAGGARD, *Associate Professor*

Issue:

The degradation of water resources throughout Arkansas is a critical environmental concern, as the quality of our streams, rivers, and reservoirs are vital to the natural beauty and tourism of our state, as well as, ultimately, the health of the Gulf of Mexico. The input of nutrients from anthropogenic sources into streams, rivers, and reservoirs can accelerate the natural process of eutrophication and impair water quality and the water bodies designated beneficial uses. These issues must be addressed at the larger watershed scale, and require evaluation across defined land use gradients.

Action:

In order to properly manage and protect our water resources, we need to know where these nutrients come from, how they get to streams and lakes, and when most of these losses occur. It is also vital to know what happens to these nutrients once they leave the edge of a field and enter a stream or river, in order to determine or even predict how receiving water bodies will be influenced. This will require a multidisciplinary understanding soil–water–nutrient interactions, fluvial channel processes, and internal lake or reservoir mechanisms that can influence water quality. Several projects are evaluating the changes in physical, chemical and biological conditions of streams draining catchments across a gradient of land uses (e.g., forest, pasture and urban).

Impact:

These multidisciplinary approaches have been applied in targeted watersheds across northwest Arkansas (i.e., the Eucha–Spavinaw Basin, Illinois River Basin and White River Basin). The contributions from nonpoint sources and municipal wastewater treatment plants to annual nutrient loads have been identified, and this allows farmers, cities, and watershed managers to better focus efforts to reduce nutrient inputs from the landscape and critical effluent discharges. Furthermore, we have an increased understanding of how fluvial channel and reservoir processes influence nutrient transport and can act as nutrient sources or sinks, which allows us to communicate to stakeholders the importance of these processes and potential nutrient sources when considering watershed management strategies that will influence a diverse and wide range of stakeholders within the watershed.

Cooperating Scientists or Institutions:

- Marty Matlock, Biological and Agricultural Engineering Department, University of Arkansas
- Andrew N. Sharpley, Crops, Soils and Environmental Sciences Department, University of Arkansas

Funding:

- UA Division of Agriculture
- USDA Agricultural Research Service
- USDA CSREES Nutrient Science for Improved Watershed Management Program
- US Geological Survey State Water Resources Institute Research Program
- Cities of Fayetteville, Springdale and Rogers, AR

ADAPTIVE MANAGEMENT OF THE STATEWIDE NONPOINT SOURCE POLLUTION PLAN FOR ARKANSAS

MARTY D. MATLOCK, *Associate Professor*

Issue:

Section 319 of the Clean Water Act requires that each state:

- Assess the waters of the state for impacts from nonpoint source pollution
- Develop a management program outlining how the State intends to address the categorical sources of pollution and the impaired waters identified in the assessment
- Report annually to the Environmental Protection agency progress made in implementation of the program.

Arkansas's management program expired at the end of 2004. New State and Federal regulations along with ever changing environmental conditions in the State make it necessary to develop a major update of the current management program.

Action:

The Ecological Engineering Group developed an updated State Management Plan for 2005 through 2010, and used stakeholder-driven adaptive management strategies to revise and update the plan for 2008. The plan was approved in October 2006; it considers the impact of new regulations regarding urban and agricultural runoff, updated water quality information, and improved management measures developed over the last decade. The EEG used the Soil and Water Assessment Tool (SWAT) and ArcView GIS to model impaired watersheds in the state and to target specific nonpoint source problem areas. An extensive consensus building effort was conducted including facilitated meetings with all State and Federal resource management agencies, local watershed action teams, agricultural commodity groups and other non-government organizations. The results of the modeling and consensus building will be compiled into a single document which will be submitted by the Governor to the EPA on behalf of the State of Arkansas.

Impact:

The Nonpoint Source Management Plan establishes priorities for implementation of the section 319(H) Grant program and gives guidance to all State and Federal agencies in development of their environmental protection actions. In 2004, the section 319(h) program alone expended over 6 million dollars on nonpoint source management. The consensus building program being conducted as an element of this project has brought together over 60 individuals representing 51 different agencies, NGOs, or watershed teams to discuss workable management actions concerning categorical and watershed based programs. These management measures will be implemented in the State over the next five years.

Funding Sources:

- U. S. Environmental Protection Agency and Arkansas Soil and Water Conservation Commission

DEMONSTRATION OF A GREENWAY DEVELOPMENT TO PROTECT ECOLOGICAL SERVICES IN SMALL URBAN STREAMS

MARTY D. MATLOCK, *Associate Professor*

Issue:

The city of Rogers, Arkansas is part of the rapidly growing metropolitan area of Northwest Arkansas. In 2003, this area was determined by the Milken Institute to be the best performing metropolitan area in terms of business development. The urbanization of historically agricultural land has stressed infrastructure to the limit. Alternatives to the current practices are needed to maintain more natural conditions in the streams.

Action:

A demonstration project on use of riparian corridors as greenway parks is being conducted by the City of Rogers, the Biological and Agricultural Engineering Department (BAEG), the Arkansas Water Resource Center, and Rogers Public Schools. A natural design is being provided to maintain ecological services in 4,900 feet of the Blossom Branch Creek. The BAEG conducted analysis of the ecological services, hydrology, and geomorphology, designed a greenway park, supervised construction of the project and is evaluating the results. Local and National technology transfer workshops have been held at the site for city planners, city engineers and developers to adopt more sensitive drainage practices in their development plans.

Impact:

The City of Rogers, Arkansas has adopted the Urban Greenway into its comprehensive growth master plan for the city. The first phase of the greenway was dedicated in August, 2006. Phase 2 of the project is under design by the EEG. Plans are currently underway to connect this demonstration with an additional 23 miles of greenway virtually encircling the city, and connecting with the trail system of the City of Bentonville, Arkansas. As a result, ecological services of the headwater streams draining this rapidly expanding town will be retained and the impacts of the development will be significantly lessened.

Funding Sources:

- U. S. Environmental Protection Agency and Arkansas Soil and Water Conservation Commission

RESEARCH PROJECTS

ECOLOGICAL ENGINEERING

USE ATTAINABILITY AND WATER QUALITY ASSESSMENT OF COFFEE CREEK, MOSSY LAKE, AND THE OUACHITA RIVER, SOUTHERN ARKANSAS

MARTY D. MATLOCK, *Associate Professor*

Issue:

Arkansas and Louisiana Departments of Environmental Quality have designated the Ouachita River to support the propagation of fish and wildlife, primary and secondary contact recreation, perennial Gulf Coast fisheries, public, industrial, and agriculture water supply. Previous assessments in Southeastern Arkansas have shown that water quality standards are not being met and have called for additional study in order to more accurately maintain these uses. Mossy Lake and Coffee Creek are used to treat effluent from Georgia-Pacific and the City of Crossett, Arkansas, before entering the Ouachita River. They flood approximately 60 percent of the year. It is unknown if Mossy lake and Coffee Creek can support additional uses other than its designated industrial water supply.

Action:

The goal of this project is to perform a water quality assessment of the Ouachita River and to determine if aquatic life uses are attainable in Coffee Creek and Mossy Lake. In order to address previous data gaps, more complete assessment methods will be used. Data to be collected include: water quality field measurements, physical water conditions, analytical water analysis, sediment analysis, habitat assessment, fish and macroinvertebrate community assessment. All sampling protocols will meet ADEQ requirements and ultra clean metal sampling methods will be employed.

Impact:

This project evaluated the current water quality status of the Ouachita River, Coffee Creek and Mossy Lake. This information will be used in better management practices in Southeast Arkansas and Northeastern Louisiana. The final report was submitted in January 2007.

Funding Sources:

- U. S. Environmental Protection Agency and Parsons Engineering

A WATERSHED NUTRIENT MANAGEMENT DECISION SUPPORT SYSTEM FOR THE EUCHA BASIN

MARTY D. MATLOCK, *Associate Professor*

Issue:

A team of scientists in Arkansas and Oklahoma developed a watershed nutrient management decision support system (DSS) to improve land use and water resource management decision-making. The project efforts focused on the Eucha Basin, with results applicable to similar watersheds across the U.S. The Eucha basin was selected because nutrient management issues in this basin are representative of the political, economic, and ecological challenges facing resource managers across the US. The Eucha Basin includes Spavinaw Creek in northwestern Arkansas and drains into Lake Eucha in northeastern Oklahoma, a water supply reservoir for the city of Tulsa, Oklahoma. Water quality in the reservoir has been declining for several years in part due to increased algal growth resulting from increased phosphorus loads from point and nonpoint sources, including the land application of poultry litter. However, there is no clear threshold for managing water quality for algal growth, so there is no clear management endpoint for phosphorus loading to the reservoir.

Action:

The goal of this project was to develop a nutrient management decision and education support system (NMDESS) for developing comprehensive watershed nutrient management strategies for both agricultural and urban landscapes. The process of Analysis and Deliberation was used to develop this DSS. This process involves intensive discourse, both in public education sessions and private interviews, between the scientific community, watershed managers, and other stakeholders within the basin. NMDESS provides a risk-based approach to identifying substantial nutrient sources within watersheds based on site-specific terrestrial, atmospheric, and hydrologic components of nitrogen and phosphorus nutrient cycles. NMDESS integrates risk-based decision-making theory with geographic information system (GIS)-based watershed modeling (Soil and Water Assessment Tool, or SWAT) and reservoir modeling (CE-QUAL-W2) to create a decision support system that links land use practices with reservoir water quality.

Impact – Outcomes:

This project engages community members, educators, policy makers and scientists from two states to develop NMDESS, a watershed-based ecosystem management framework. The NMDESS framework is unique in its integration of chemical and biological measurements, *in situ* algal growth bioassessments, complex watershed and reservoir models, and stakeholder-developed scenario analyses. Land owners, policy makers and other stakeholders will be able to analyze the impacts of a wide range of land management scenarios on water quality in the Eucha Basin using this on-line tool. The methods and tools for implementing NMDESS are applicable nation-wide.

Funding Sources:

- USDA-CSREES Watersheds Science Program

THE SUPERSATURATED DISSOLVED OXYGEN (SDOX) AND OZONE (HYDOZ) INJECTOR

G. SCOTT OSBORN, *Associate Professor*

Issue:

Proper treatment to remove pollutants from water affects all people of the world as well as many different industries. Humans require clean water to live and enjoy a quality of life. Accordingly, governments regulate industries to ensure clean water in our shared environment is maintained. An indicator of the societal impact of wastewater treatment is that the US market for bioremediation and wastewater treatment was $9 billion in 2002. The predominant treatment of organic wastewater is biological where bacteria digest organic matter through their respiration cycle. Efficient and effective biological wastewater treatment occurs under aerobic conditions (in the presence of oxygen) and therefore requires that oxygen be delivered to the water to meet the biochemical demands of the bacteria. If sufficient rates of oxygen delivery are not provided, the rate of treatment is greatly reduced and undesirable byproducts (such as odors) are produced. Another important tool for removing pollutants from water is the application of dissolved ozone. Ozone is a powerful oxidant that can kill bacteria, spores, cysts, and viruses. Ozone can also be used to oxidize chemical to less harmful states. The use of ozone is becoming more and more important as the byproducts from chlorine disinfection (a competing technology) are becoming regulated as more is learned about their harmful effects on humans. Ozone also has potential as a technique for removing drug and antibiotic residuals from wastewater streams being released from hospitals. This treatment can reduce the occurrence of drug resistant strains of bacteria that form because of exposure to residuals in the environment. Specific problems being addressed in this work include: stream restoration, animal waste lagoon odor prevention, removal of antibiotic residuals from hospital wastewater, drinking water treatment, municipal wastewater treatment, aquaculture, and food processing wastewater treatment.

Action:

The device developed utilizes a new technology that allows for the efficient oxygenation and ozonation of a wide variety of water bodies, both natural and manmade. This new technology is much less expensive to operate than existing technology for several key applications. Operating cost savings of 80% have been demonstrated on-site at commercial operations. The patented and patent pending technology delivers a stream of water that has been supersaturated with a gas (such as oxygen, air or ozone). Once this supersaturated stream is released to a water body, the dissolved gas is blended with environmental waters and does not exit solution. The delivery of dissolved oxygen can be used to enhance the treatment of organic waste from a variety of sources (municipal and industrial wastewater treatment facilities, animal waste lagoons, aquaculture facilities, food processing plants and more) and quickly increases the dissolved oxygen (DO) content of the water body and will enhance any process that requires aerobic bacterial digestion of organic waste.

The intellectual property for this invention is owned by the University of Arkansas and licensed to BlueinGreen, LLC, a start-up company created as a partnership between the inventors, U of A, and a private Fayetteville-based company, Virtual Incubation, Inc.

Impact:

The use of the SDOX technology for delivery of dissolved oxygen for a variety of applications has been studied in detail. Commercial demonstrations of the technology have been conducted at Noland Wastewater Treatment Plant in Fayetteville, AR, Rogers Pollution Control Facility, Lake Brittany in Bella Vista, AR, Norfork National Trout Hatchery at Norfork Lake, AR. Operating cost savings of 80% have been achieved at the commercial scale. The first commercial sale of the unit was made to the City of Fayetteville in 2007. Since the SDOX delivers oxygen in the dissolved state, a substantial cost savings is realized because none of the oxygen is lost due to bubbling out of the top of the water column as is seen with fine-bubble diffusers that deliver oxygen in the gaseous state. The impact of this result is that wastewater treatment facilities may be able to increase their processing capacity without increasing costs or adding significant additional infrastructure. The SDOX may also be able to replace existing technology and provide substantial operating cost savings to wastewater treatment plants.

Funding:

- National Science Foundation,
- National Institutes of Health,
- Beaver Water District.
- Tulsa Water Utilities
- Private Investors

EXTENSION PROJECTS

EXTENSION AND OUTREACH PROGRAMS

IDENTIFICATION AND PRIORITIZATION OF SUB-WATERSHEDS IN L'ANGUILLE RIVER WATERSHED

DHARMENDRA SARASWAT, *Assistant Professor, Extension*

Issue:

Water quality is becoming an increasing concern not only in the United States but around the globe as well. Arkansas has made substantial progress to protect water quality by continuously addressing point sources of pollution. However, determination of specific sources and causes of non point source pollution remains an issue of special concern because management practices are mostly "voluntary" in nature and limited funding forbids a holistic approach in tackling the water quality problems. Therefore, concerned state agencies have focused their educational and research efforts on those watersheds where there are known impairments or significant threats to water quality from present and future activities.

Action:

The efforts to identify sources and causes of non point sources solution have been fueled by the availability of spatial data which is collected by both the federal and state agencies. Therefore, the use of latest spatial data is required to ensure that watershed management plans are commensurate with dynamic ground realities. One approach to designate watershed of concern is to rank the priority watersheds based on a percentile scale, with those falling in the 80-100th percentile being designated as priority sub watersheds. It is also important to understand the role of best management practices (BMPs) in evaluating their effectiveness for reducing sediments and nutrients loadings in Arkansas rivers. This is being addressed through simulation modeling.

Impact:

The critical knowledge about the prioritized sub watersheds will help in determining those watersheds where more monitoring efforts are required. It may also guide both the funding agencies and concerned producers in devising/adopting effective mitigation strategies for the local ecosystem preservation.

Funding:

- Arkansas Natural Resources Commission

RESEARCH GRANTS

GRANTS

The following grants have been awarded to the faculty during 2007 to fund research in specific areas.

A DISTRIBUTED ARTIFICIAL NEURAL NETWORK MODEL FOR HYDROLIC MODELING
Dr. Sreekala Bajwa
SURF
2007-08
$1,000

APPLICATION OF COTTON GIN WASTE AND RECYCLED COTTON BALE WRAP IN LIGNOCELLULOSIC COMPOSITES
Dr. Sreekala Bajwa
Cotton, Inc.
2007
$5,299

ENVIRONMENTAL RESOURCE MANAGEMENT TO DEVELOP WATERSHED TECHNOLOGIES AND MANAGEMENT TOOLS
Dr. Sreekala Bajwa
US EPA Region 6
2006-09
$55,000

MID-SEASON NITROGEN APPLICATION AIDED BY REMOTE SENSING TECHNOLOGY
Dr. Sreekala Bajwa
Rice Foundation
2007-10
$3,500

SPRAY EQUIPMENT
Dr. Carl L. Griffis
AutoJet
2007
$5,500

DEVELOPMENT OF NORTH CAROLINA WATERSHED MANAGEMENT PLAN
Dr. Brian E. Haggard
Environmental Protection Agency
2006-07
$4,000

HYDROPORUA SULPHURIUS (COLEPTERA: DYTISCIDAE) CURRENT DISTRIBUTION
Dr. Brian E. Haggard
Arkansas Game and Fish Commission State Wildlife Grant
2007-08
$39,370

OSAGE AND SPRING CREEKS WATER QUALITY ASSESSMENT
Dr. Brian E. Haggard
Cities of Rogers and Springdale, AR
2007-09
$114,991

POTENTIAL PHOSPHORUS SOURCE ID WITH OXYGEN ISOTOPES
Dr. Brian E. Haggard
USGS 104b
2007-08
$6,815

UA DIVISION & ARS SPECIFIC COOPERATIVE AGREEMENT
Dr. Brian Haggard
EPA
2007-08
$72,000

WATERSHED INVESTIGATIVE SUPPORT TO THE BEAVER WATER DISTRICT
Dr. Brian E. Haggard
Beaver Water District
2006-07
$25,000

WATERSHED INVESTIGATIVE SUPPORT TO THE BEAVER WATER DISTRICT
Dr. Brian E. Haggard
Beaver Water District
2007-2008
$25,000

RESEARCH GRANTS

HONORS COLLEGE UNDERGRADUATE RESEARCH GRANT FOR AUDREY BEARDEN
Dr. Mahendra Kavdia
Honors College
2007
$1,000

NITRIC OXIDE TRANSPORT IN THE MICROCIRCULATION
Dr. Mahendra Kavdia
American Heart Association
2005-08
$260,000

DESIGN AND FABRICATION OF MICRO FLAGELLAR MOTOR BASED DYNAMO
Dr. Jin-Woo Kim
National Science Foundation
Since 2004
$34,500 per year

EXPLORATION OF A NANO-ENGINEERED FLAGELLAR MOTOR BASED TNT DETECTION SYSTEM
Dr. Jin-Woo Kim
National Science Foundation
Since 2005
$23,000 per year

EXPLORATION OF DNA-BASED NANOSCALE BUILDING BLOCK (DNANBLOCK) FOR CONTROLLABLE AND SCALEABLE FABRICATION OF ACTIVE NANOSTRUCTURES
Dr. Jin-Woo Kim
National Science Foundation
Since 2007
$100,000 per year

INTEGRATING NANOSCALE SCIENCE AND TECHNOLOGY INTO INTRODUCTORY COMPUTER SCIENCE COURSES
Dr. Jin-Woo Kim
National Science Foundation
2007
$9,335

LARGE-SCALE DNA ASSOCIATIVE MEMORIES
Dr. Jin-Woo Kim
National Science Foundation
Since 2005
$41, 000 per year

NANOPARTICLE SYSTEMS FOR DELIVERY OF BIOLOGICAL ANTIMICROBIAL COMPOUNDS TO LIMIT MICROBIAL CONTAMINATION IN INDUSTRIAL YEAST FERMENTATION
Dr. Jin-Woo Kim
Sun Grant Initiative– South Central Region
2007
$10,000 per year

BIOSENSOR FOR RAPID SCREENING OF AVIAN INFLUENZA VIRUSES
Dr. Yanbin Li
ABI
2007-09
$75,000

BIOSENSOR FOR RAPID, SENSATIVE, AND SPECIFIC DETECTION OF AVIAN INFLUENCE VIRUS H5N1
Dr. Yanbin Li
EPA
2007-08
$150,000

ENHANCING THE SAFETY OF POULTRY PRODUCTS
Dr. Yanbin Li
FSC
2007-10
$100,000

NANOWIRE BASED BIOSENSOR FOR DETECTION OF FOODBORNE PATHOGENS
Dr. Yanbin Li
BDI
2007-2011
$10,000

RESEARCH GRANTS

VEGETATIVE SHELTERBEDS AND WINDBREAK WALLS TO MITIGATE DUST AND ODOR EMISSIONS DOWNWIND FROM POULTRY FARMS
Dr. Yi Liang
UA Division of Agriculture– CSES
2007-10
$20,553

PRIVATE INVESTMENT AS MATCH FOR SBIR PHASE IB OXYGEN
Dr. G. Scott Osborn
Private
2007
$100,000

PRIVATE INVESTMENT AS MATCH FOR SBIR PHASE IB OZONE
Dr. G. Scott Osborn
Private
2007
$50,000

SBIR PHASE IB: A PORTABLE DISSOLVED OXYGEN DELIVERY SYSTEM FOR RAPID TREATMENT OF ORGANIC SPILLS
Dr. G. Scott Osborn
National Science Foundation
2007
$50,000

SBIR PHASE IB: DELIVERY OF HYPER-CONCENTRATED DISSOLVED OZONE FOR MORE EFFECTIVE TREATMENT OF DRINKING WATER
Dr. G. Scott Osborn
National Science Foundation
2007
$25,000

DEVELOPMENT OF NORTH CAROLINA WATERSHED MANAGEMENT PLAN
Dr. Brian E. Haggard
Environmental Protection Agency
2006-07
$4,000

BIO-OIL PRODUCTION FROM BIO-DRIED ANIMAL MANURE
Dr. Samy Sadaka
USDA (Subcontact by Iowa State University)
2007
$91,446

FAST PYROLYSIS OF COTTON GIN WASTE TO PRODUCE LIQUID FUEL
Dr. Samy Sadaka
Arkansas State Support Committee
2007
$30,872

PRODUCTION OF BIOFUELS FROM CROP RESIDUES
Dr. Samy Sadaka
USDA Agriculture Knowledge
2007
$33,333

PRODUCTION OF ETHANOL VIA FERMENTATION OF BIOMASS PYROLYSIS OIL
Dr. Samy Sadaka
Internal Innovative Grant Application
2007-10
$20,000

THERMOCHEMICAL PROCESS PLATFORMS TO UTILIZE CRUDE GLYCERIN FOR HYDROGEN PRODUCTION AND ELECTRICITY GENERATION
Dr. Samy Sadaka
California Energy Commission
2007
$95,000

PRODUCTION OF BIOFUELS FROM CROP RESIDUES
Dr. Samy Sadaka
US-India Agriculture Knowledge
2007-2008
$50,000

WATERSHED RESPONSE MODELING (WARM) FOR 12 -DIGIT HYDROLIC UNIT CODE "HUC" IN L'ANGUILLE RIVER WATERSHED
Dr. Dharmendra Saraswat
Arkansas Natural Resources
2007-08
$35,000

INTEGRATED WATER QUALITY...
Phil Tacker
USDA CSREES

$175,000

RICE IRRIGATION
Phil Tacker
AR RRPB

$235,000

SOYBEAN IRRIGATION
Phil Tacker
AR SRPB

$245,000

SUSTAINABLE WATER RESOURCES...
Phil Tacker
Environmental Protection Agency

$125,000

WATER USE/RUNOFF IN LRWS...
Phil Tacker
ASWCC/EPA

$300,410

NUTRIENT MANAGEMENT PLANNER AND NUTRIENT APPLICATOR TRAINING FOR CERTIFICATION
Dr. Karl VanDevender
Environmental Protection Agency
2003, 2006, 2007
$214,600

ORGANIC DAIRY FARMING
Dr. Karl VanDevender
Extension internal grants funding
2006-2009
$14,375

USING PARASITIC WASPS AS AN IPM APPROACH TO MANAGE FILTH FLIES IN SOUTHERN DAIRIES
Dr. Karl VanDevender
Southern Region SARE On-Farm
2004-08
$288,000

A GLUCOSE NANOSENSOR FOR CONTINUING MONITORING OF GLUCOSE WITHIN LIVING CELLS
Dr. Kaiming Ye
National Institutes of Health
2006-08
$208,239

ENGINEERING BACTERIOPHAGE BASED ON BIOSENSOR FOR RAPID DETECTION VIABLE FOODBORNE PATHOGENS
Dr. Kaiming Ye
National Science Foundation
2007-08
$75,000

FLOURESENCE LIFETIME MICROSCOPY IMAGING (FILM) OF INTRACELLULAR GLUCOSE IN BLOOD GLUCOSE CONTROL RELATED CELLS
Dr. Kaiming Ye
ABI
2006-2007
$220,000

MATERNAL ENDOTHELIAL PROGENITOR CELLS AND PERRECLAMPSIA
Dr. Kaiming Ye
National Institutes of Health
2005-2007
$27,000

STUDIES ON SINGLE MOLECULE IMAGING
Dr. Kaiming Ye
ABI
2005-2007
$250,000

PUBLICATIONS

BOOKS

Haggard, **B.E.**, and A.N. Sharpley. "Phosphorus Transport in Streams: Processes and Modeling Considerations." In *Modeling Phosphorus in the Environment*, edited by D.E. Radcliffe and M.L. Cabrera, 105-130. Boca Raton, FL: CRC Press Taylor and Francis Group, 2007.

Harmel, R.D., and **B.E. Haggard**. "Small Watershed Data Collection to Support Phosphorus Modeling." In *Modeling Phosphorus in the Environment*, edited by D.E. Radcliffe and M.L. Cabrera, 383-402. Boca Raton, FL: CRC Press Taylor and Francis Group, 2007.

Carrier, D.J. "Liquid Fuel Production in Arkansas." Invited oral presentation presented at the Biofuels 101 In-Service Training, Dale Bumpers National Rice Research Center, Stuttgart, Arkansas, January 2007.

Carrier, D.J., and E. Clausen. "Les Plantes et Leurs Composés." Invited oral presentation presented at La Guilde des Herboristes du Québec, Montreal, Quebec, Canada, November 2007.

Carrier, D.J., and E. Clausen. "Novel Extraction Procedures for Medicinal Plants." Invited oral presentation presented at Phytopharm Annual Meeting, Leiden, The Netherlands, June 2007.

Carrier, D.J., E. Clausen, and J. King. "Subcritical Water for Phytochemical Extraction from Energy Corps." Invited oral presentation presented at American Oils Chemists Society (AOCS) Annual Meeting, Quebec City, Canada, May 2007.

Haggard, B.E., and J. Giovanetti. "Land Use Effects on Stream Water Quality in a Drinking Water Supply Watershed." Invited presentation presented at American Water Works Association Southwest Section 2007 Annual Conference, Springdale, Arkansas, October 2007.

Haggard, B.E., L.D. Bartsch, and J.M. Galloway. "Net Changes in Antibiotic Concentrations Downstream from Effluent Discharges." Invited presentation presented at AWRC Annual Research Conference, Fayetteville, Arkansas, 2007.

Kavdia, M. "Biochemical Interaction of NO and Reactive Oxygen Species in an Arteriole-Venule Pair." Invited presentation presented at Biomedical Engineering Society (BMES) Annual Fall Meeting, Los Angeles, California, September 26-29, 2007.

Kavdia, M. "Oxidative Stress and Nitric Oxide Transport: A Computational Model." Invited presentation presented at Mathematical Biosciences Institute Workshop, Columbus, Ohio, January 2007.

Kavdia, M. "Role of Reactive Oxygen Species in the Microcirculation." Invited presentation presented at Experimental Biology (FASEB), Washington, D.C., April 2007.

Kim, J.-W. "Challenge to Bio-Actuators: Hybrid Flagellar Motor/MEMS Based Systems." Invited paper presented at International Symposium on Neo-Robotics, Nagoya Institute of Technology, Nagoya, Japan, January 2007.

Maguire, R.O., G.H. Rubæk, **B.E. Haggard**, and B.H. Foy. "Critical Evaluation of Mitigation Options for Phosphorus from Field to Catchment Scales." Invited presentation presented at 5th International Phosphorus Workshop, Silkeborg, Denmark, September 3-7, 2007.

Osborn, G.S. "BlueInGreen Proposal for SDOX Technology for Paul R. Noland Wastewater Treatment Plant." Presentation made to Fayetteville City Council, Fayetteville, Arkansas 2007.

Osborn, G.S. "Design, Development and Technology Transfer of the Supersaturated Dissolved Oxygen Injector." Invited presentation presented at American Society of Biological and Agricultural Engineers-Arkansas State Section Meeting, Little Rock, Arkansas, October 2007.

Osborn, G.S. "Design, Development and Technology Transfer of the Supersaturated Dissolved Oxygen Injector." Invited presentation presented to BAEG Advisory Committee, Fayetteville, Arkansas, November 2007.

Osborn, G.S. "Design, Development and Testing of the Supersaturated Dissolved Oxygen Injector." Invited presentation presented at Northwest District of the Arkansas Water Works and Water Environment Association District Meeting, Fayetteville, Arkansas, December 2007.

Osborn, G.S. "Point Source Ozonation to Minimize Antibiotic Resistance." Presentation made to Arkansas Water Resource Center Conference, Fayetteville, Arkansas, April 2007.

Osborn, G.S. "Supersaturated Dissolved Oxygen Injector." Presentation presented to Bella Vista, Arkansas Property Owners Association Subcommittee for Water Quality in Bella Vista Lakes, Bella Vista, Arkansas, 2007.

Osborn, G.S. "Utilizing SDOX Technology for Cost Savings in Wastewater Effluent Oxygenation Applications." Invited presentation presented to McGoodwin, Williams and Yeats Engineering Design Firm, Fayetteville, Arkansas, November 2007.

PUBLICATIONS

INVITED LECTURES AND PRESENTATIONS

Osborn, G.S., A. McCain, and C. Thompson. "Phase II: A Portable Dissolved Oxygen Delivery System for Rapid Treatment of Organic Spills." Invited presentation presented to Program Director for National Science Foundation, 2007.

Bajwa, **S.G.**, and E.D. Vories. "Spatial Analysis of Cotton Canopy Response to Irrigation in a Moderately Humid." *Irrigation Science* 25, no. 4 (2007): 429-441.

Bajwa, **S.G.**, and M. Mozaffari. "Effect of N Treatments on Vegetative Index of Cotton Canopy-A Spatial Regression Approach." *Transactions of the ASABE* 50, no. 5 (2007): 1883-1892.

Bhise, N., and **M. Kavdia**. "Design of a Bioreactor to Study the Role of Red Blood Cells in the Transport of Nitric Oxide in the Microcirculation." *Discovery* 8, no. 2 (2007): 29-40.

Bourne, P.J., **S.G. Bajwa**, and D.S. Bajwa. "Evaluation of Cotton Gin Waste as a Ligno-Cellulosic Substitute in Wood Plastic Composites." *Forest Products Journal* 57, no. 1/2 (2007): 127-131.

Bruner, D., **D.J. Carrier**, D. Belesky, D. Pote, and A. Ares. "Yield Components and Nutritive Value of Robinia pseudoacacia and Albizia julibrissin in Arkansas, USA." *Agroforestry Systems* 72 (2007): 51-62.

Cai, L., A. Koziel, **Y. Liang**, A.T. Nguyen, and H. Xin. "Evaluation of Zeolite for Control of Odorants Emissions from Simulated Poultry Manure Storage." *Journal of Environmental Quality* 36, no. 1 (2007): 184-193.

Chaubey, I., D. Sahoo, **B.E. Haggard**, M.D. Matlock, and T.A. Costello. "Nutrient-Retention, Nutrient-Limitation, and Sediment-Nutrient Interactions in a Pasture Dominated Stream." *Transactions of American Society of Agricultural and Biological Engineers* 50, no. 1 (2007): 35-44.

Chávez M.D., N. Lakshmanan, and **M. Kavdia**. "Impact of Superoxide Dismutase on Nitric Oxide and Peroxynitrite Levels in the Microcirculation - A Computational Model." *Proceeding of the 29th Annual International Conference of the IEEE Engineering in Medicine and Biology* 29 (2007): 1022-26.

Clendenin, J., S. Tung, and **J.-W. Kim**. "An Aligned Carbon Nanotube Biosensor for DNA Detection." *2nd IEEE International Conference on Nano/Micro Engineered and Molecular Systems* (2007): 1028-33.

Dong, W., T. Zhang, J. Epstein, L. Cooney, H. Wang, **Y. Li**, Y. Jiang, A. Cogbill, V. Varadan, and Z.R. Tian. "Multifunctional Nanowire Bioscaffolds on Titanium." *Chemistry of Materials* 19, no. 18 (2007): 4454-59.

Enns, D.K., P.G. Crandall, C.A. O'Bryan, **C.L. Griffis**, and E.M. Martin. "A 2-Step Cooking Method of Searing and Hot Water Pasteurization to Maximize the Safety of Refrigerated, Vacuum Packaged, Chicken Breast Meat." *Journal of Food Science* 72, no. 4 (2007): 35-44.

Garrett, J.R., X. Wu, S. Jin, and **K. Ye**. "Development of pH-Insensitive Glucose Indicator for Continuous Glucose Monitoring." *Proceedings of IEEE Region 5 Technical Conference* (2007): 171-74.

Griffis, **C.L.**, T.A. Costello, and L.R. Verma. "A Unified, Interactive Approach to Degree Programme Accreditation and Quality Assurance." *International Journal of Engineering Education* 23, no. 4 (2007): 1-5.

Haggard, **B.E.**, D.R. Smith, and K.R. Brye. "Variations in Stream Water and Sediment Phosphorus Among Select Ozark Catchments." *Journal of Environmental Quality* 36 (2007): 1725-34.

Jiang, X., J. Wang, Y. Yibin, and **Y. Li.** "Recent Advances in Biosensors for Food Safety Detection." *Transactions of the CSAE* 23, no. 5 (2007): 272-77.

Jin, S., and **K. Ye**. "Nanoparticle-Mediated Drug Delivery and Gene Therapy." *Biotechnology Progress* 23 (2007): 32-41.

Jithesh, V.V., and **K. Ye**. "Development of Immunosensors Using Carbon Nanotubes." *Biotechnology Progress* 23 (2007): 517-531.

PUBLICATIONS

REFEREED PUBLICATIONS

Kavdia, **M.**, and W.J. Richardson. "A Computational Model of Biochemical Interaction of NO and Reactive Oxygen Species in the Microcirculation." *8th World Congress for Microcirculation* (2007): 95-100.

Kim, **J.-W.**, E.V. Shashkov, E.I. Galanzha, N. Kotagiri, and V.P. Zharov. "Photothermal Antimicrobial Nanotherapy and Nanodiagnostics with Self-Assembling Carbon Nanotube Cluster." *Lasers in Surgery and Medicine* 39 (2007): 622-34.

Kim, **J.-W.**, N Kotagiri, R. Deaton, and S. Tung. "DNA-Directed Self-Assembly of Microscopic 1-D Carbon Nanotube Wire." *2nd IEEE International Conference on Nano/Micro Engineered and Molecular Systems* (2007): 1044-47.

Li, M., M. J. Hanford, **J.-W. Kim**, and T.L. Peeples. "Amyloglucosidase Enzymatic Reactivity Inside Lipid Vesicles." Journal *of Biological Engineering* 1, no. 4 (2007), http://www.jbioleng.org/content/1/1/4.

Liu, F., **Y. Li**, X. Su, M. Slavik, Y. Ying, and J. Wang. "Nanoparticles Labeled QCM Biosensor for Rapid Detection of E. coli O157:H7." *Journal of Sensing and Instrumentation for Food Safety and Quality* 1, no. 4 (2007): 164-168.

Martin, E., T. Osaili, **C.L. Griffis**, B. Beard, A. Keener, J. Marcy. "Thermal Inactivation Studies (D and Z Values) of Escherichia coli O157:H7, Salmonella, and Listeria Monocytogenes in Formulated Ready-to Eat, Breaded Pork Patties." *Journal of Food Science* 72, no. 2 (2007): 433-9.

Marwali, M.R., C.P. Hu, B. Mohandas, A. Dandapat, P. Deonikar, J. Chen, I. Cawich, T. Sawamura, **M. Kavdia**, and J.L. Mehta. "Modulation of ADP-Induced Platelet Activation by Aspirin and Pravastatin-Role of LOX-1, Nitric Oxide, Oxidative Stress and Inside-Out Integrin Signaling." *Journal of Pharmacology and Experimental Therapeutics* 322, no. 3 (2007): 1324-32.

Migliaccia, K.W., **B.E. Haggard**, I. Chaubey, and M.D. Matlock. "Linking Watershed Subbasin Characteristics to Water Quality Parameters in War Eagle Creek Watershed." *Transactions of American Society of Agricultural and Biological Engineers* 50, no. 6 (2007): 2007-16.

Migliaccio, K.W., I. Chaubey, and **B.E. Haggard**. "Evaluation of Landscape and Instream Modeling to Predict Watershed Yields." *Environmental Modeling and Software* 22 (2007): 987-99.

Pradhan, A., **Y. Li**, J. Marcy, M. Johnson, and M. Tamplin. "Pathogen Kinetics and Heat/Mass Transfer-Based Predictive Models for Listeria in Irregular-Shape Poultry Products During Thermal Processing." *Journal of Food Protection* 70, no. 3 (2007): 607-615.

Richardson, W.J., and **M. Kavdia**. "A Computational Model for Analysis of Uncouple NO Synthase on Nitric Oxide and Superoxide Interaction in Microcirculation." *Discovery* 8, no. 3 (2007): 67-76.

Sen, S., **B.E. Haggard**, I. Chaubey, K.R. Brye, T.A. Costello, and M.D. Matlock. "Sediment Phosphorus Release at Beaver Reservoir, Northwest Arkansas, 2002-3." *Water, Air, and Soil Pollution* 179 (2007): 69-77.

Sharpley, A.N., T. Krogstad, P.J.A. Kleinman, **B.E. Haggard**, F. Shigaki, and L. Saporito. "Managing natural processes in drainage ditches for nonpoint source phosphorus control." Journal *of Soil and Water Conservation* 62, no. 4 (2007): 197-206.

Toor, G.S., **B.E. Haggard**, and A.M. Donoghue. "Water Extractable Trace Elements in Poultry Litters and Granulated Products." *Journal of Applied Poultry Research* 16 (2007): 351-60.

Toor, G.S., **B.E. Haggard**, M.S. Reiter, T.C. Daniel, and A.M. Donoghue. "Phosphorus Solubility in Poultry Litter and Granulates: Influence of Litter Treatments and Extraction Ratios." *Transactions American Society of Agricultural and Biological Engineers* 50, no. 2 (2007): 533-42.

Varshney, M., and **Y. Li**. "Double Interdigitated Array Microelectrodes Based Impedence Biosensor

for Detection of Viable Escherichia coli O157:H7 in Growth Medium." *Talanta* 74, no. 4 (2007): 518-25.

Varshney, M., and **Y. Li**. "Interdigitated Array Microelectrode Based Impedence Biosensor Coupled with Magnetic Nanoparticle-Antibody Conjugates for Detection of Escherichia coli O157:H7 in Food Samples." *Biosensors & Bioelectronics* 22, no. 11 (2007): 2408-24.

Varshney, M., **Y. Li**, B. Vekatesh, and S. Tung. "A Label Free, Microfluidics and Interdigitated Array Microelectrode Based Biosensor in Combination with Nanoparticle Immunoseparation for Detection of Escherichia coli O157:H7 in Food Samples." *Sensors and Actuators B: Chemical* 128, no. 1 (2007): 99 -107.

Vaughn, K., C. McClain, **D.J. Carrier**, S. Wallace, J. King, S. Nagarajan, and E. Clausen. "The Effect of Albizia julibrissin Water Extracts on Low Density Lipoprotein Oxidization." *Journal of Agricultural Food Chemistry* 55 (2007): 4704-4709.

Veetil, J.V., M. Mehta, A. Wang, and **K. Ye**. "Quantum-Dot Based Lateral Flow Strip Assays for Biomedical Applications." *Proceedings of IEEE Region 5 Technical Conference* (2007): 309-313.

Wallace, S., J. Raible, **D.J. Carrier**, K. Vaughn, C.L. Griffis, E. Clausen, and S. Nagarajan. "Pressurized Water Rivals Ethanol as a Silybum marianum Extraction Solvent for the Initiation of Copper and Cell Mediated Low-Density Lipoprotein Oxidation." *Canadian Journal of Physiology and Pharmacology* 85 (2007): 894-902.

Wang, H., **Y. Li**, and M. Slavik. "Rapid Detection of Listeria monocytogenes Using Quantum Dots and Nanobeads Based on Optical Biosensor." *Journal of Rapid Methods and Automation in Microbiology* 15 (2007): 67-76.

Zharov, V.P., E.I. Galanzha, E.V. Shashkov, **J.-W. Kim**, N.G. Khlebtsov, and V.V. Tuchin. "Photoacoustic Flow Cytometry: Principle and Application for Real-Time Detection of Circulating Single Nanoparticle, Pathogens, Contrast Dyes in vivo." *Journal of Biomedical Optics* 12 (2007): 501-503.

PUBLICATIONS

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Bajwa, **S.G.**, and J. Rupe. "Soybean Disease Discrimination with Canopy Reflectance." Paper presented at ASABE Annual International Meeting and Conference, Minneapolis, Minnesota, July 17-21, 2007.

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