The UNIVERSITY of OKLAHOMA

Department of Chemistry and Biochemistry

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OKLAHOMA REVAMPS GRADUATE PROGRAM

Chemistry department takes **MODULAR APPROACH** to coursework and puts research up front

CELIA HENRY ARNAUD, CHEMICAL & ENGINEERING WASHINGTON

THE 28 STUDENTS who entered the University of Oklahoma's chemistry graduate program this fall are "newbies" in more ways than one: Not only are they beginners at the school, but they're also the first to experience a completely revamped curriculum. That curriculum—more than a decade in the making—was inspired by the chemistry department's participation in the Carnegie Initiative on the Doctorate and by the American Chemical Society's 2012 report " Advancing Graduate Education in the Chemical Sciences," two efforts to modernize Ph.D. education and training.

Over the years, "we had experimented piecemeal with changing our curriculum, but it was basically putting Band-Aids on what we already had," says Michael T. Ashby , the professor who spearheaded the revamp. "Last year, we decided basically to burn everything to the ground and start from scratch."

As part of the overhaul, the department switched to a so-called modular approach composed of shorter, more focused classes and eliminated chemistry

Continues on pg. 2

OKLAHOMA REVAMPS GRADUATE PROGRAM

continued

divisions—such as organic or physical—at the graduate level. (It still has divisions at the undergraduate level to help organize the curriculum and manage teaching loads.)

"The chemical sciences have become very interdisciplinary," says Ashby, who studies the mechanisms and kinetics of inorganic antimicrobials and antioxidants. "Although I'm in the inorganic division, half my group are microbiologists and half are chemists. My actual research doesn't have much inorganic chemistry at all. That's part of the issue with having formal divisions at the graduate level. It doesn't make a lot of sense anymore."

Because the chemistry department has such a biological bent, some students entering the grad program have gaps in their chemistry backgrounds. The new curriculum has the flexibility to bridge those gaps up front. For example, during the first five weeks of this semester, seven students took an accelerated program in physical chemistry to bring them up to speed to join their fellow students when regular introductory graduate classes began in the sixth week.

The flexibility comes from the modular approach that the department has adopted. Instead of teaching three-credit, semesterlong classes organized by division—the older, more traditional approach—the department has broken the coursework into one-credit, 12.5-hour modules. Students take 16 credits of coursework, down from the 21 credits required by the old curriculum. They will finish those classes in three semesters, rather than the traditional four. In their first semester, students take modular classes that fulfill their "breadth" requirement. For example, students planning to focus on inorganic chemistry might fulfill their breadth requirements with modules in organic or physical chemistry. After that, they focus exclusively on their own program of study, following an individual development plan crafted with the help of their advisory committee. The chemistry department uses these plans to know which courses it needs to offer in any given semester.

One point of the modules is to minimize repetition of material among different classes. Ashby has been teaching kinetics in a modular format for more than five years. Students take the first module on kinetic theory and then choose two more from chemical kinetics, biological kinetics, and a laboratory. As a result, kinetics is now taught in one place instead of being distributed among the different subdisciplines that use it.

THE MODULES also make more efficient scheduling possible. No graduate classes meet on Fridays, so students have a three-day block in which to do research. Even more important, students get into the lab faster in Oklahoma's new curriculum. "Research is now front and center in the first semester with laboratory rotations," Ashby says. "Rotations are not typical in a chemistry department. That's more of a biology thing."

During their first semester, students do two seven-week rotations. Most students join a lab in December of their first year. Convincing chemistry professors, most of whom didn't go through rotations themselves, of the value of rotations was a challenge, Ashby says. But "because the students now have this intimate experience of research in their first semester, they're in a more informed position in selecting a research director."

"The big news is that here's an institution that has really taken on in a big way the reconception of graduate education," says Larry Faulkner , president emeritus of the University of Texas, Austin, and head of the commission that produced the 2012 ACS report. "Much of what Oklahoma has done is worthy of note by other people."

Bassam Shakhashiri , who commissioned the report when he was ACS president, finds it "gratifying that the ACS report helped to a certain extent in making all this happen."

The ultimate hope is that the new program will help students graduate faster. "The key is to ramp up the students' ability to do original research," Ashby says. "That means getting out of the classroom. This curriculum allows us to do that." ■

SOURCE: American Chemical Society "Starting Salaries of Chemists And Chemical Engineers: 2015"

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$50,000 for a M.S. degree

$75,000 for a Ph.D. degree

Median ages of the 2015 survey takers

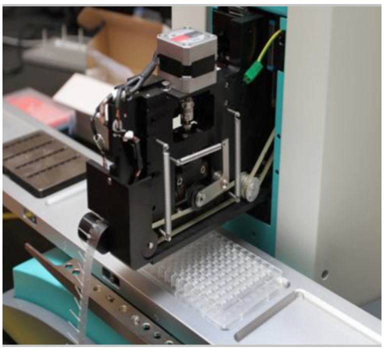
23 for B.S. degree

27 for M.S. degree

30 for Ph.D. degree

SOURCE: American Chemical Society "Starting Salaries of Chemists And Chemical Engineers: 2015"

COLLABORATIVE RESEARCH CENTERS



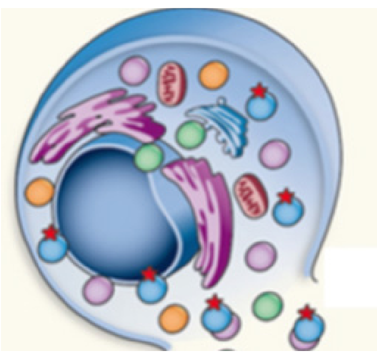
Center of Biomedical Research Excellence

The NIH-funded COBRE comprises an active team of researchers who use the three-dimensional structures of biological macromolecules to shed light on their physiological functions. The central theme is focused on X-ray.

Crystallographic and computational approaches to understand the important relationship between structure and biological activity. The research has direct relevance to human diseases and conditions associated with aging, cancer, host-pathogen interactions, bacterial infections and immunity.

Institute for Natural Products Applications and Research Technologies

The Institute for Natural Products Applications and Research Technologies (INPART) has established itself as one of the largest teams of researchers in the central United States that is dedicated to the development and understanding of natural product based medicines. INPART functions as an alliance of collaborating scientists focused on the innovative use of secondary metabolites to generate new products for improving the human condition. The purpose of INPART is to find creative solutions that harness the power of natural products chemistry for generating new medicines that will improve human health and wellbeing.



Center for Bioanalysis

The Center for Bioanalysis (CBA) CBA develops the cutting-edge protein and small molecule-oriented analytical methods and provides novel and conventional analysis platforms allowing for understanding and solving important issues in the biosciences.

Bioanalysis plays a critical role in life science research. Advanced bioanalytical methods and tools have facilitated and accelerated the understanding of life processes, evolution of diseases, diagnosis of diseases, improvement of therapies, development of drugs, etc.

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Our Graduate Students Come From Across the US

FACULTY AND RESEARCH AREAS

Michael T. Ashby	Inorganic | *chemistry and biology of reactive intermediates; STEM; transferable skills; mentoring models*
Robyn A. Biggs	Organic, Chemical Education | *chemical education; organic chemistry; mechanistic organization; curriculum development; laboratory development*
Christina R. Bourne	Biochemistry, Structural Biology | *structural biology; anti-bacterial; microbiology*
Anthony W.G. Burgett	Bioorganic, Organic | *natural products; molecular pharmacology; total synthesis; chemical biology*
Robert H. Cichewicz	Natural Products, Organic | *antibiotics; cancer; drug discovery; fungi; infectious disease; natural products*
Adam S. Duerfeldt	Bioorganic, Medicinal, Natural Products, Organic |*medicinal chemistry; synthesis; chemical biology*
Daniel T. Glatzhofer	Biomaterials, Organic | *energy conversion and storage; polymer chemistry; electrochemistry*
Ronald L. Halterman	Nanomaterials, Organic, Organometallics | *organic synthesis; nanotechnology; non-covalent self-assembly*
Ulrich H.E. Hansmann	Computational, Nanomaterials, Physical, Structural Biology | *protein folding; aggregation; enhanced sampling techniques*
Jun Li	Biochemistry | *malaria and mosquito; genetic variations; genomics*
Shaorong Liu	Analytical, Bioanalytical | *development and application of microfluidic systems; bio-separation and bio-analysis; analytical Instrumentation*
Chuanbin Mao	Biomaterials, Nanomaterials | *nanotechnology; nanomedicine; biomaterials*
Donna J. Nelson	Organic, Chemical Education, Diversity in Science, Public Perception of Science, Nanomaterials | *organic mechanisms and education; science policy; organic chemistry of single walled carbon nanotubes*
Rakhi Rajan	Biochemistry, Structural Biology | *Protein-Nucleic acid interactions; CRISPR; structural biology*
Charles V. Rice	Biophysical | *MRSA, antibiotics, beta-lactams, drug development*
George B. Richter-Addo	Bioinorganic, Inorganic, Structural Biology | *biological inorganic chemistry; heme proteins; nitric oxide*
Valentin Rybenkov	Biochemistry, Biophysics, Physical, Nanomaterials | *chromatin structure; single DNA nanomanipulations; drug design and discovery*
Bayrammurad Saparov	Inorganic, Solid State, Materials | *solid state chemistry, materials chemistry, hybrid organic-inorganic materials, chalcogenides, photovoltaics, thermoelectrics, magnetism, superconductivity*
Susan J. Schroeder	Biochemistry, Physical, Structural Biology | *RNA structure, function and energetics relationships; RNA structure prediction; RNA thermodynamics*
Yihan Shao	Computational, Physical, Biochemistry | *enzymatic reactions, bioluminescence, chemiluminescence, multi-scale modeling algorithms; quantum chemistry methods*
Indrajeet Sharma	Organic, Organomettalic, Drug Discovery | *synergistic catalysis; diazo chemistry; biomimetic synthesis*
Paul A. Sims	Biochemistry, Chemical Education | *enzymology; biocatalysis; biochemical education*
Shanteri Singh	Natural Product Biosynthesis, Structural Biology, Biochemistry | *chemoenzymatic, chemical biology, enzymes, X-ray, NMR*
Robert Thomson	Inorganic, Organometallic, Catalysis | *organometallic synthesis; catalysis; polymerization; tungsten; molybdenum; separations; energy; actinides; uranium; thorium*
Ann H. West	Biochemistry, Structural Biology | *signal transduction; structural biology; protein phosphorylation*
Robert L. White	Analytical | *infrared and mass spectrometric analysis; environmental chemistry*
Si Wu	Analytical, Bioanalytical | *proteomics; top-down MS; histone; PTM*
Zhibo Yang	Analytical, Bioanalytical, Physical | *mass spectrometry; live single cell analysis; mass spectrometry imaging; instrumentation; metabolomics; fundamental ion chemistry*
Wai Tak Yip	Nanomaterials, Physical | *sensor development; solar energy harvesting; single-molecule photophysics*
Helen I. Zgurskaya	Biochemistry | *cell membrane biochemistry*

SCHOOL SPENDING ON CHEMICAL R&D

INSTITUTION	SPENDING[a]	Faculty Members[b]	Spending per Faculty
Texas A&M	$22,378,000	41	$545,805
Texas	$24,649,000	48	$513,521
Kansas	$13,444,000	27	$497,926
Colorado	$20,668,000	47	$439,745
Purdue	$17,286,000	41	$421,610
Arizona	$17,255,000	42	$410,833
UCLA	$18,486,000	48	$385,125
Arizona State	$16,048,000	44	$364,727
Utah	$11,570,000	32	$361,563
UC Davis	$13,923,000	39	$357,000
Oklahoma	**$8,831,000**	**28**	**$315,393**
Colorado State	$9,744,000	32[c]	$304,500
Michigan State	$13,213,000	45	$293,622
Ohio State	$12,816,000	47	$272,681
Iowa State University	$7,836,000	29[c]	$270,207
Texas Tech	$7,017,000	28[c]	$250,607
North Texas	$6,219,000	25[c]	$248,760
New Mexico State	$7,084,000	29[c]	$244,276
Texas at El Paso	$5,037,000	21[c]	$239,857
Iowa	$6,254,000	30[c]	$208,467
University of Houston	$6,767,000	33[c]	$205,061

a SOURCE: National Science Foundation, WebCASPAR database
b SOURCE: OXIDE survey, http://oxide.jhu.edu/2/urm2015
c SOURCE: data not in the OXIDE survey, rather obtained from department website

RESEARCH FUNDING

Comparable to Leading Universities

28
faculty members

$8.8 MILLION
in funding

$315,393
per faculty member

Compare with:

- $385,125 per faculty at UCLA
- $364,727 per faculty at Arizona State
- $293,622 per faculty at Michigan State
- $272,681 per faculty at Ohio State

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