

Everything to play for

Opportunities abound in chemistry research, but if the US is to maintain its dominance in the field, there is plenty of work to be done. **Randy Wedin** reports

Chemists know that it usually takes more than just combining two reactant substances to make a successful chemical reaction. Other factors – including the solvent and the reaction conditions of temperature and pressure – can make a big difference.

Similarly, to chart a successful career in chemistry, you'll need to consider more than just your specific educational training and work experience. First, take a look at the economic and scientific health of an industry sector, a specific field or the regional and national economy. Then, find out what fields are hot and where the hiring pressure is greatest.

A recent study gave a comprehensive overview of chemistry research in the US. The National Research Council convened panels of academic, industrial and governmental leaders to assess the current and future US position relative to other regions and countries.

The Future of US Chemistry Research: Benchmarks and Challenges concludes that “chemistry research in the US is stronger than in any other single country, but competition from Europe and Asia is rapidly increasing”.

The chair of the study, Dr. Charles Casey of the University of Wisconsin-Madison, says: “I believe the funding agencies can use the report to make a case that increased funding of chemistry will be needed to keep us competitive. It will also be useful in targeting important areas of chemistry in need of added support.”

The report reviews the relative strength of all the major subfields, highlighting areas where jobseekers will find plenty of opportunities. In chemistry, particular strengths are found in emerging areas, such as nanoscience, biological chemistry and materials chemistry.

Another report by the National Research Council found that the emerging areas in chemical engineering are cellular and metabolic engineering; biocatalysis and protein engineering; systems, computational, and synthetic biology; nanostructured materials; non-fossil energy; and green engineering.

Both reports warn, however, that the country's leadership is jeopardized by recent trends in education and training. Casey says: “We're wondering whether we'll be able to continue to fulfill our personnel needs for chemistry PhDs in the US, because we're not attracting enough American students and the supply of international students is not secure. International students and postdocs have more and more opportunities in their own countries.”

While this projection worries industrial and academic leaders, it suggests that jobseekers, especially those who are already US citizens, will be in increasing demand in the future.

Here, we look at three emerging fields of chemistry that show good potential for employment opportunities.

Chemical biology

Chemical biologists apply chemical principles and techniques to the investigation and modulation of biological systems. For example, small molecules are used to probe signal transduction, metabolic pathways, gene regulation, angiogenesis and other biological processes. This emerging field, which could revolutionize the way chemists and biologists study cells and manage disease, is attracting heavy investment from funding agencies and companies.

One way to spot a rapidly emerging scientific field is to look for the establishment of new

The US is the world leader in chemistry research and it needs huge amounts of new talent to maintain its position

journals. In the field of chemical biology, two high-visibility journals have sprung up in the past two years – *Nature Chemical Biology* from the Nature Publishing Group and *ACS Chemical Biology* from the American Chemical Society.

Leading institutions that have recently launched programs in chemical biology include Harvard University, Johns Hopkins University, Massachusetts Institute of Technology, Scripps Research Institute, the University of California at Berkeley, the University of California at San Francisco, the University of Michigan and Vanderbilt University.

Energy

In the past few years, the public's awareness of climate change and energy has grown. Carbon footprints and greenhouse gases are now discussed in coffeshops, churches and community meetings. As a result, chemists' work has been thrust into the spotlight.

Accompanying this growth in public attention is a flurry of research investment by both industry and government. For example, BP selected the University of California at Berkeley, in partnership with Lawrence Berkeley National Laboratory and the University of Illinois at Urbana-Champaign, to lead an unprecedented \$500 million research effort to develop new sources of energy and reduce the impact of

“Students in research groups specializing in green chemistry are being scooped up”

\$500m

Funding from BP for a research effort to develop new sources of energy



energy consumption on the environment. The funding will create the Energy Biosciences Institute (EBI), which initially will focus its research on biotechnology to produce biofuels.

ConocoPhillips has established an eight-year, \$22.5 million research program at Iowa State University for developing bio-renewable fuel technologies. And the US Department of Energy (DOE) has invested \$375 million in three Bioenergy Research Centers aimed at accelerating basic research in the development of cellulosic ethanol and other biofuels: DOE's Lawrence Berkeley National Laboratory, DOE's Oak Ridge National Laboratory and the University of Wisconsin-Madison.

Green chemistry

"The students in the big research groups specializing in green chemistry are being scooped up," says Dr. Paul Anastas, director of the Center for Green Chemistry and Green Engineering at Yale University. "They're receiving multiple job offers before graduation."

Green chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances.

Evidence of strong industrial interest can be seen by the activities of organizations such as the Green Chemistry Institute's (GCI) Pharmaceutical Roundtable, a working group of pharmaceutical

industry representatives. It has identified a number of challenges, such as chemical reactions and processes in drug discovery and process chemistry that need cost and environmental improvements. So far, GCI has awarded research grants that address two of these challenges, and there are more to come in 2008.

The government is getting into the act, too. The Green Chemistry Research and Development Act of 2007, with an authorization of \$58 million for fiscal year 2008, has been recently re-introduced in the House of Representatives after receiving favorable House action in the 2006 House session.

To maintain its dominance in the field of chemistry, the US will have to focus not only on providing sufficient support to the industry, but also on encouraging both citizens and foreign students to enter – and stick with – chemistry education and training.

In the meantime, Casey believes two things should drive jobseekers – the first of which is passion. The second, he says, is that "they should be looking to address major problems that the US and the whole world faces".

Pointing to emerging areas such as sustainable energy, the pharmaceutical industry and materials science, he says: "These are areas where there's a great need for chemists and where they can make important contributions to society." ■

Where are the strongest chemistry programs?

Rankings of universities and individual departments tend to be controversial. Some look at the number of citations in peer-reviewed publications, and others the amount of federal funding received by each department. More comprehensive rankings consider a range of factors. The same departments, however, tend to rise to the top in almost all of these lists.

Below is the most recent ranking (in part) of US chemistry departments' PhD programs from *US News & World Report's* 'America's Best Graduate Schools 2008'. It asked deans, program directors and senior faculty to judge the academic quality of programs in their field on a scale of 1 ("marginal") to 5 ("outstanding").

Chemistry (PhD)

Rank/School	Average assessment score (5.0 = highest)
1 California Institute of Technology	4.9
= Massachusetts Institute of Technology	4.9
= Stanford University (CA)	4.9
= University of California, Berkeley	4.9
5 Harvard University (MA)	4.8
6 Scripps Research Institute (CA)	4.6
7 University of Illinois, Urbana-Champaign	4.5
= University of Wisconsin, Madison	4.5
9 Cornell University (NY)	4.4
= Northwestern University (IL)	4.4
11 Columbia University (NY)	4.3
12 University of California, LA	4.3
= University of Chicago	4.2

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» **MIT**
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» **Stanford University**
www.stanford.edu/dept/chemistry

» **Scripps Research Institute**
www.scripps.edu/chem