Editor's LETTER

ACS chemical biology

Chemistry or biology? The debate continues...

Where exactly on the continuum between *absolute* biology and *pure* chemistry do areas of study such as biochemistry and chemical biology lie? This seemingly straightforward question continues to inspire vigorous debate from both sides of the aisle these days.

Ever since October, when the Royal Swedish Academy of Sciences awarded the 2009 Nobel Prize in Chemistry to Venkatraman Ramakrishnan of the MRC Laboratory of Molecular Biology at Cambridge, Thomas A. Steitz of Yale University, and Ada E. Yonath of the Weizmann Institute "for studies of the structure and function of the ribosome", there has been a firestorm of commentary on whether this research is within the realm of chemistry (*1*). In the process, there has been considerable discussion on what exactly defines chemistry. This discussion has ranged from the opinion expressed in the Terra Sigillata blog that if electrons are "being pushed around, it is chemistry" (*2*) to the viewpoint in *Nature Chemistry* discussing differences between "traditional chemistry" and biology (*3*).

A logical consequence of the current debate is the question of whether to consider fields such as biochemistry and chemical biology as part of biology or as part of chemistry for purposes of classification. This should not be considered merely a speculative exercise. Hinging on this question is public perception, power, and financial resources. For years now, academic departments have been morphing and changing names with the result that many chemistry departments have become "chemistry and biochemistry" or "chemistry and chemical biology" departments. Similarly, medical schools and biological science divisions have introduced "biochemistry and molecular biology" and "biochemistry, molecular, and cell biology" departments and interdisciplinary programs.

Of course, those of us interested in chemically inclined biology and biologically relevant or inspired chemistry have our own ideas of what to consider biochemistry and chemical biology, but finding formalized definitions that do not embrace platitudes is another matter altogether. If we start by looking through textbooks and reviews, or typing in "biochemistry" or "chemical biology" in major Internet search engines, we get inundated with results attempting to describe these fields. If, however, we carefully scrutinize these results, we find that we are left with essentially little more than the notion that biochemistry and chemical biology are "something chemical" associated with "something biological".

This dichotomy often has peculiar consequences. The journal *U.S. News & World Report* publishes a ranking of the "best" graduate academic programs in the United States every few years. Highly rated programs proudly display their rankings on their web sites in order to recruit the best prospective students. Interestingly, "Biochemistry/Biophysics/Structural Biology" is considered a specialty area under the "Top Biological Sciences Programs", whereas "Biochemistry" finds mention in the "Top Chemistry Programs." Both rankings are different. The biochemistry program at the University of Wisconsin-Madison is in the top 10 in the specialty area under chemistry for 2007 (the last year for which data is available) but not in biological sciences; conversely, Johns Hopkins University has a top-10 biochemistry program for the same year classified in the biological sciences but not in chemistry (*4*). Paradoxically, many

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ranked institutions offer advanced biochemistry courses that can serve toward fulfilling requirements for degrees in both chemistry and biology academic units.

The confusion does not end there. Just last month the National Science Foundation published the preliminary results of the Survey of Earned Doctorates (SED) for the 2008 academic year (*5*). The survey concluded that 2,247 doctorates were awarded in 2008 in the chemistry "field of study"; however, this number did not include those with newly minted biochemistry Ph.D. degrees, which the SED counts as part of the biological sciences. For comparison, the SED reported 7793 doctorates awarded in biological sciences in the same period. In a separate report, the Committee on Professional Training (CPT) of the American Chemical Society noted that roughly two-thirds of Ph.D. programs in chemistry in the U.S. had a biochemistry (or similar) division (*6*). Incidentally, the CPT reported 2,362 chemistry doctorates from ACS-approved Ph.D. programs in 2008 (*7*).

Are the scientists working at the interface of biology and chemistry equally polarized? The Division of Biological Chemistry of the ACS has around 6,000 members, and the American Society for Biochemistry and Molecular Biology (ASBMB) has over 10,000. This would seem to support the thesis that fields such as biochemistry are either part of chemistry or biology, but for a simple inconvenient fact: many scientists who consider themselves biological chemists or chemical biologists belong to the ACS, while also retaining membership in more biologically oriented scientific societies such as ASBMB.

So are biochemists and chemical biologists leaning more toward biology or chemistry? Increasingly, the answer depends on what day of the week you ask the question. A lab that successfully resolves the crystal structure of a protein will often consider the option of probing activity by synthesizing organic small molecules that interact with it. Similarly, a lab adept at synthesizing organic small molecules might try to tweak the function of a biological target not amenable to genetic approaches. Laboratories without the required skill set will consider collaborating or hiring extra hands. As a result, these days we all know someone who was trained as a chemist who went on to do a more "biological" postdoctoral stint (and *vice versa*). It may be that scientists from different backgrounds bring different perspectives, but in the final equation, there are so many important scientific questions to be answered along the biology–chemistry continuum that pragmatic scientists will try to find the most efficient ways to answer them.

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