Questioning 'chemistry'

The Nobel Prize in Chemistry for 2009 was awarded for research into the structure and function of the ribosome, sparking debate about its significance to chemists.

Chemistry is often referred to as 'the central science' and its associations to all fields are clearly there to behold, but to some these links may stretch too far. Some purists have had their chemical noses put of joint with the recent awarding of the Nobel Prize in Chemistry for 'studies of the structure and function of the ribosome' — apparently a topic that, for some, is not chemistry but biology. The arguments over the undeniable biological bent of the Nobel Prize in Chemistry are not new[1,2], but they seem to have reached a new level of intensity (or at least visibility) this year with various blogs[3] and tweets[4] doubting its current relevance to chemists. The award certainly leads to questions over the definition of chemistry and whether such 'structural biology' can indeed be classified as chemistry.

Chemistry, in the most concise but broadest sense, is the study of matter and its transformations. Its established definition can be traced back to its birth out of the philosophical discussions on the nature of matter and the vain efforts of alchemists to transform all kinds of starting materials into gold. The way in which chemistry is studied now would be unimaginable to the chemists of this bygone era, but what has remained is the ethos of empirically studying the basic questions: 'what is it?', 'what is its structure?' and 'how/why does it do that?' So by these criteria, how can chemists have any problem with the awarding of their Nobel Prize to those who elucidated the structure of the ribosome and shed light on how it works? A quick interrogation of chemists in laboratories across the world, however, would most probably reveal many with concerns.

The prize-winning work on the ribosome is undoubtedly tour-de-force science that both used and improved a number of chemical techniques. The crystallization of a ribosome was thought of as "outrageous" before 1980 (ref. 5) and the advances in X-ray crystallography techniques are certainly notable. They have, however, been used to work out the structure and function of a large cell component; not a molecule, but a collection of molecular constituents with a function that lies at the heart of molecular biology.

Defenders of the award will use the logic of Nobel Prize Laureates James Watson and Roger Kornberg who said that "life is simply a matter of chemistry" and "the answers to the questions we have about biology all lie at the level of chemistry"[6]. That biology can be thought of as 'life chemistry' is a very strong argument. It is one that has been strengthened over the past century as the study of biology has evolved, edging further and further into the molecular world of the chemist as chemical techniques improve and enable the investigation of systems in ever-increasing detail.

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If this is indeed the case then it begs the question: when does chemistry actually become biology? Is it merely a case of scale? The flight of a bird is only possible because of various chemical processes. The internal structure of the wing, the complex nature of the feathers and the power supplied by the muscles all derive from intricate chemical processes, but most would argue that the study of bird flight is more biology than chemistry. At the other end of the scale is the design and synthesis of pharmaceuticals, certainly of biological interest, but inarguably the domain of the chemist. The ribosome, however, falls in the grey and 'fuzzy' area in the middle: too large for every chemist to see its relevance, but too small to be classified purely as biology.

The indifference of the traditional chemistry community to the award may have roots in the fact that the structure, function and mechanism of the ribosome are far more likely to be taught in a biology, rather than chemistry, classroom. Thus many of the intricacies of the system will be lost on a large section of chemists. The research is also still at the stage of discovering and understanding phenomena, rather than adapting and controlling it. Chemistry remains a very creative discipline — as Marcellin Berthelot once observed "chemistry creates its own object" — and the community as a whole may not stand up and take notice until the system can be manipulated through, and used to help, their creative endeavours.

There is, however, a precedent for structural biology studies nudging chemists into action. The structure of DNA may have excited more biologists than chemists at the time of its discovery, but as more chemical techniques for its manipulation have become available, more chemists have taken an interest in its structural and functional properties (for example as molecular scaffolds and machines[7,8]). Maybe we will say the same about the ribosome in 60 years time, but for now some will question its worthiness for a prize in chemistry.

Classifying scientific research topics is becoming increasingly difficult and pigeonholing is now impossible, and perhaps even counter-productive. Definitions are, however, an important method by which to guide the interest of others — we know to pick up a copy of *Nature Chemistry* if we want to see some interesting breakthroughs in chemistry and we know to peruse *The Economist* for the latest in international affairs. This idea of interest is at the heart of the debate over the awarding of the Nobel Prize in Chemistry. An easy gauge of a community's interest is to look at where the majority of the related research has been performed and published. It is, unsurprisingly, to be found in biology rather than chemistry departments and journals[3]. Although the award-winning research on the ribosome is 'chemistry' by definition, considering its previous exposure to many chemists, it is not difficult to understand their apathy. ❒

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