research perspective, validation (or invalidation) is achieved by experimentally modulating the function of a putative target in a defined experimental system, then evaluating any effects on the disease-relevant phenotype (Box 1). As an example, antisense technology has become a popular tool for target validation, because the approach promises a high-throughput and a reliable means of inhibiting potential molecular targets in cell and animal models of disease[6].

As Sanseau related, the industry has developed technology to generate correlative genomics data and screen compounds against many classes of molecular targets. However, to develop innovative drugs, we need smarter and faster target validation, not more uHTS of increasing numbers of new targets. For the pharmaceutical industry, success in the clinic should be the ultimate criterion for target validation. The next challenge is therefore to develop robust tools to assess the disease-relevance of thousands of new gene products arising from the genome project, to select those few targets that are worthy of a full development effort.

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Education: the chemistry between academia and industry – Reply

Initial letter: Merritt, A. (2001) *Drug Discov. Today* 6, 287

Response from Jeremy Hinks

In a recent letter, Andrew Merritt raised the question of how industry and academia respond to the changing educational needs brought about by the development of new practices within the industry. In particular, he discussed this issue with respect to the rejuvenated interest in solid-phase chemistry and the development of combinatorial techniques, both in terms of the chemistry itself as well as the supporting technology.

Quite fairly, Dr Merritt comments that both communities have a training responsibility in this area: industry has a commitment to its staff in terms of providing opportunities for continuous professional development (CPD) whilst universities serve a student community that requires educationally sound courses that prepare them for employment. There is no question that universities take this issue seriously. However, there are difficulties in providing tuition in all the specialist areas that feature in the chemical industry as a whole. This highlights the need for CPD exercises put on by employers for employees to further support their development of specialist knowledge.

Courses for undergraduates

A chemistry undergraduate's teaching programme consists of two parts: core and specialist knowledge. Core chemistry makes up the courses attended by an entire undergraduate school. Their content excites significant debate amongst lecturers but their primary aim is to lay a firm foundation of chemical knowledge, the absence of which would compromise the learning experience in any concurrent or subsequent specialization. Specialist chemistries are discussed in advanced courses within the undergraduate school, the ultimate specialization being the choice of subject for a postgraduate study. The ideal educational programme is one in which all new topics of study are placed in context by analysis of previously studied course material.

The content of the core chemistry programme is particularly influenced by the knowledge base of incoming freshers. Their standard has changed over the years such that more theory and practical skills have to be covered in the early undergraduate programme. The core programme has also developed to incorporate key skills. The motivation for this has come from both government and industry and its uptake demonstrates higher education's recognition of the need to change in the face of mutable working practices.

The resulting pressures on the timetable mean that there is not enough time to cover as much specialist material as might once have been the case. Nonetheless, taking the University of Southampton (Southampton, UK) as an example, significant developments are recognized and courses are responsive to them. In terms of solid-phase/combinatorial synthesis, we have lectures and practical courses that develop knowledge by building on experiences gained in traditional chemistries. Particular effort is directed at covering the new technologies in 'appropriate context'. For instance, the very simplicity of much of this chemistry is only understood, and its significance appreciated, given a firm knowledge of the underlying science.

Enlightened collaborations of the type supported by the Industrial Consortium to support Combinatorial and Solid Phase Synthesis (ICCSP, see http://www.chemsoc.org/networks/ccn/index) have helped many institutions develop topical

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undergraduate courses in both the theory and the practice of the new technologies. This kind of support of undergraduate teaching (particularly the practical elements) is invaluable and, without it, demonstrating current practice will become increasing difficult.

Courses for employees

Even with this support there is no question that the employer will still need to develop CPD courses pertinent to the core skills required in any developing area. Taking combinatorial chemistry as a case in point, this is partially required because each employer uses significantly different protocols and technology – differences that are not appropriate, nor possible, to cover in an undergraduate programme.

The education of an employee could be an area where industry and academia might collaborate more effectively. At this time, their roles might reverse; the responsibility falling to the employer to continue the education of their employees with input, where appropriate, from academia. There are some examples of courses where this is the case. For instance, the Summer School in Combinatorial Chemistry hosted at the University of Southampton has evolved from a need identified by the ICCSP (see the ICCSP website for further details). A further development is that the Royal Society of Chemistry (UK) has begun to provide accreditation for courses that aid the development of the scientific skills base of those in employment. Although nothing new, I would suggest that there could be more proactive development of course material of this nature by both communities.

Conclusions

In conclusion, universities take pains to ensure they balance the opposing forces of an increasingly diverse student base with pressure to cover each and every new development in some detail. Nonetheless, as Dr Merritt points out, it is not appropriate or reasonable to lose basic knowledge in the pursuit of specialist skills. To avoid the 'unnecessary surprises' that he mentions, it will be necessary to continue the dialogue concerning the development of educational packages applicable to undergraduate level through the whole working life of employees in the chemical industries.

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