367P SCREENING ASSAYS FOR G PROTEIN-COUPLED EVENTS

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High throughput screening for therapeutically active compounds initially focused on identifying ligands which interacted with receptor binding sites. This type of receptor binding assay gave information on binding but did not classify compounds as either agonists or antagonists. The use of an assay system to measure GTP binding in cell membranes enables those compounds which exert an agonist effect to be identified at the first screening step.

SPA is an homogeneous assay format which does not require separation of bound from free radioactivity. It can be used to measure GTP binding in cell membranes, containing G protein coupled receptors, by binding membrane fragments to wheat germ agglutinin-coated SPA beads. When the membranes are treated with an effector compound, in the presence of [^{35}S]GTPγS, a non-hydrolysable form of GTP, only the [^{35}S]GTPγS bound to the membrane, and hence, to the bead will be detected in the assay. The lack of a separation step makes this assay format ideally suited for high throughput applications.

A further refinement would be to look at a downstream event which is a result of G protein activation and which requires the use of intact and fully functioning cells. One example of this type of assay is the measurement of arachidonic acid release from the membranes of cells by phospholipase A2 which has been activated via a G protein.

This can also be done in a homogeneous assay format using Cytostar-T scintillating microplates. A cell monolayer is grown on the base of the 96 well microplate, labelled *in situ* with [^{14}C]arachidonic acid and then treated with an effector. Arachidonic acid release can then be measured directly, in real time, by the reduction in the microplate signal. This 'one plate' format of this assay also makes it more suited for higher throughput applications than conventional sampling assays.

368P TEACHING PHARMACOLOGY IN THE 21st CENTURY: WHAT WILL THE CUSTOMERS BE LIKE?

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The terms customer and higher education (HE) are not often associated but various groups might be considered as customers for HE.

One customer group is the students. Mature students who often pay their own way have always been vocal about the shortcomings of their HE experience and now Dearing has recommended a loan based HE including a contribution to fees "customer satisfaction" is likely to take a higher profile. "Branding", "packaging", "customer friendly service", "value for money" and "the sales environment" are terms common in the retail sector and have clear counterparts in HE. Competition for numbers of students and for quality of intake is already with us especially in the medical field. Dearing has recommended increasing participitation rates to 40% and this will further increase diversity of ability and motivation in pharmacology students which has implications for course design.

The government pays HE for educational provision. This customer is exerting a stronger influence on HE not only in numbers/price of students admitted but also in terms of the content, quality, style and objectives of the teaching which is acceptable. There is no question but that the unit of resource has dropped sharply over the last few years. There have been a number of initiatives, primarily through the Department for Education and Employment, changing the nature of the teaching in HE, the material taught and the emphasis on the purpose for which HE is provided. Enterprise in Higher Education, the Higher Education Discipline Networks and Teaching Quality Assessment all effectively represent customer pressure on HE.

Employers are customers who may choose to buy the products of HE. The majority of pharmacology student enter occupations involving the pharmaceutical industry or study for a higher degree but a substantial and increasing minority enter non-pharmacology areas. Both types of employer are quite clear that subject specific knowledge is of less importance that other generic skills and attitudes in graduates they choose to employ and this will continue to affected HE courses. Increasingly employers are obtaining input into the provision of HE through course committees, government initiatives, and the increasing emphasis placed on the importance of work experience.

Professional bodies could be seen as customers. Some have as yet little customer power, for example the BPS, while others, like the GMC, have a great deal. The latter has been a notable catalyst for change in medical pharmacology courses over the last 5 years.

A fifth customer is the institution in which the course is provided. Does the course break even financially or is it subsidised by other courses and to what extent? This question was never asked of the excellent pharmacology course which I and the other student (singular) in my year experienced.

As with any organisation trying to survive in a marketplace - and I am firmly convinced pharmacology providers are in a market place - the trick is to keep all the customers happy all the time. There is undoubtably a variety of disparate solutions to this aspiration and it seems likely that pharmacology courses across the UK will increasingly reflect a diversity of response to pressures from our different customers as we enter the millennium.

369P WHO WILL BE DOING THE TEACHING?

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As defined recently by Laurence (1) the pharmacological sciences cover an extremely wide and heterogeneous field with numerous subdisciplines. Accordingly, teaching in pharmacology also in the new millenium will require a variety of educational activities and qualified teachers, involving for instance: basic and molecular pharmacology/biology, clinical pharmacology, clinical medicine (drug therapy), epidemiology (clinical trials), and to a modest degree moral philosophy (ethics) and law. Furthermore it should be realized that teaching is required in academia, in academic and peripheral hospitals, and also in pharmaceutical industry.
In academic life pharmacology is taught predominantly to students of pharmacy, medicine, and in those countries where a distinct degree in pharmacology can be obtained (mostly the U.K., hardly in continental Europe), pharmacology. Those who do the teaching have been appointed, at least in part, for this purpose as professors, lecturers and tutors.
Clinical teaching of drug therapy is and will be predominantly performed by experienced and specialized clinicians such as internists, cardiologists, nephrologists, etc., and not so much (in spite of repeated recommendations in this sense) by clinical, let be fundamental pharmacologists.
Peer teaching has been proposed repeatedly as a desirable development, but still remains to be realised. Academic teachers continue to be selected mainly on the basis of research abilities and less so because of their didactic potency. It is my personal opinion that in academic life a strict separation between education and research will not be fruitful on long term. Furthermore, it draws the attention that pharmacology and therapeutics are usually not much appreciated disciplines by medical students, in contrast to the pharmacy students who appear to enjoy these subjects.
Clinical trials and outcome research (evidence based medicine) are predominantly planned and performed by epidemiologists, and the same holds for the teaching of these subjects. I consider it regrettable and disadvantageous to our discipline (pharmacology) that pharmacologists play at best a meagre, and most of the time no role at all in clinical trials and the presentation of their results - this development has been clearly missed by pharmacology and pharmacologists. Teaching of pharmacological subjects in pharmaceutical industry, including medicinal chemistry, is part of the system of continuing education in research-oriented companies. In addition teaching activities in industry usually include guest speakers from academia. This holds in particular for extramural clinical experts. Teaching on the job is a current and regular phenomenon in industry, but less so (at least in an organized form) in an academic setting.
Recommendations: 1) Basic pharmacology should involve molecular biology, but continue to be aimed at research on potential and existing therapeutics; 2) Drug therapy should be taught by experienced clinicians of various disciplines together with expert pharmacologists; 3) In the design, performance and teaching of the outcome of clinical trials pharmacologists should play a much more active role than realised so far.

1.Laurence D.Tr.Pharmac.Sci.1997;18:153-155.

370P TEACHING PHARMACOLOGY IN THE 21st CENTURY: WHAT WILL WE BE TEACHING?

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The Dearing report (National Committee of Inquiry into Higher Education, 1997) states that Programme specifications should be developed for courses, clearly indicating outcomes for students. Several questions follow in relation to BSc Pharmacology courses.
What is pharmacology? A pharmacologist can be defined as a person who "starts with the phenomena of drug actions" (Black, 1996). Currently students are taught phenomena, mechanisms, kinetics and therapeutic uses of small organic molecules, often those related to endogenous molecules. However, boundaries with other disciplines are now more blurred, for example, are the substances involved in gene therapy to be included?
How is the knowledge base changing? In recent decades the number of drugs has increased as has understanding of their mechanism of action and the techniques used to elucidate mechanisms. Such trends will continue, especially the application of molecular biology methods. An inevitable conclusion is that principles should be taught, illustrated with examples, rather than attempt an encyclopaedic coverage.
Who are we teaching pharmacology to? Historically, science pharmacology was aimed at a small number of students, the majority of whom were likely to pursue a related career. Now, with increased entrants and modularisation only a minority will specialise in the discipline. Such pressures can lead to changes in emphasis but also expose pharmacology to a wider range of students. The proposal to increase intake to >40% of young adults will led to further moves in that direction.
What other skills should be taught? The Dearing Report emphasises the importance of skills development. These skills include key skills (communication, numeracy, use of information technology and learning to learn), cognitive and analytical skills and subject-specific skills (laboratory skills). The latter were not in the top quartile of skills required by pharmacology graduates in first employment, even by those entering the pharmaceutical industry (Hughes *et al.*, 1997). Perhaps in future students should be exposed to a wide variety of laboratory methods but expertise development should be in work placement or post graduation? Training in key skills will be increasing important but should be embedded in pharmacology courses.
What are the implications for medical and related courses? The ever increasing knowledge base (including pharmacology) underpinning medicine and the recognition of the importance of key skills has led the General Medical Council (1993) to promote major changes in medical education. Problem-based learning, with emphasis on student-led learning, principles not detail and incorporation of key skills, is now the norm in many Universities such as Manchester (Burdett, 1995).
Should courses be externally regulated and, if yes, by whom? Traditionally universities devised their courses in isolation. As a result of pressures from various customers, external validation is increasing (Hughes, 1997). Quality Assessment by the Higher Education Funding Councils measures general provision, development of generic skills and, to some extent, subject specific content. This assessment is set to grow. Should other agencies, such as the BPS, set minimum standards and content by accreditation?

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371P HOW WILL WE BE TEACHING PHARMACOLOGY?

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Traditionally, pharmacology is taught as a combination of theoretical (lectures) and practical courses, where the two types of courses were synchronized for optimal integration. There are at least three developments that force us to reflect on both feasibility and desirability of this sort of organization, and on possibilities for future developments. The first reason for such reflection derives from the way in which medical curricula are organized. Many curricula are constructed around problem-based learning. They depend upon students selecting their own learning-goals from patient cases. Almost by definition, this implies a de-synchronization of the total student population, which makes it hard, if not impossible, to offer them a comprehensive, structured program. Lectures are no longer introductory, but aim at integration of knowledge the students have gathered. Although one can plan such lectures based on the probability when the majority of students will have studied the subject, this situation does not hold for the practical courses. Ideally the students should have access to any practical at any time in the curriculum. Obviously, this makes practicals that use biological materials impossible to organize, and alternatives have to be sought. This development is reinforced by social resistance towards the use of biological materials for experimentation as well as teaching, which has often resulted in prohibitive legislature. For these reasons, computer simulation programs have been developed to mimic laboratory experiments, providing students a chance to apply their theoretical knowledge without the necessity of the use of biological materials. For many years, such simulations were hampered by relatively primitive computer technology, resulting in slow and unattractive programs. Experience teaches that this results in poor usage of such programs. Modern technology, which combines increased speed of calculations with the use of multimedia techniques, seems to have solved this problem. Another problem may, however, persist, and that is the fact that student-appreciation, and, therefore, the learning effect of such simulations depend upon the presence or accessibility of teachers to answer questions the moment they arise. The de-synchronized use of the practicals may thus result in an increased teaching load, because teachers have to be available at all times.

A third development may, theoretically, help overcome this problem. That is the introduction of the Internet-technology. Not only does this technology provide more widespread access to the programs, but it also allows independent interaction of teachers with many different students at a time, providing an opportunity to optimize teacher's efforts. Although Internet technology has been and is hailed at many occasions, it does re-introduce one of the problems that we thought solved. Typically, data-traffic on the Internet slows down programs and communication to an extent that they lose their attraction. We shall have to await the solution of this problem before the Internet becomes really usable for teaching.

In conclusion, there will be changes in the nature of the classes that we teach and in the way practicals are organized. For the near future there will, however, be a continued, if not increased need for personal interactions between students and teachers.

372P CLINICAL PHARMACOLOGY TEACHING IN BELGIUM AND THE NETHERLANDS

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Belgium and The Netherlands have 7 and 8 medical schools, respectively. Except for 1 medical school in Belgium all schools have courses in clinical pharmacology. In the majority of medical schools clinical pharmacology teaching is provided by the department of pharmacology. Some medical schools in The Netherlands have a well identified department or section of clinical pharmacology. In the two countries teaching methods and contents of courses vary largely between medical schools.

In Belgium clinical pharmacolgy teaching is well developed at the University of Ghent. The teaching program consists of lectures and patient case discussions. Lectures are given in the 5th year of the curriculum and deal with basic principles of clinical pharmacology and pharmacotherapy. In addition, items of pharmacotherapy, not extensively covered by other courses - in regard to acute drug intoxications, pain management, insomnia, ... - are taught in more depth. Patient case discussions are held in the 7th year of the curriculum. These discussions deal with cases seen in general practice and mainly aim to train students in pharmacotherapeutic skills like stepwise solving therapeutic problems and use of adequate reference sources. Students have to pass exams on these items.

In The Netherlands medical curricula have undergone major changes in the past decade. The number of curricula using problem based teaching as originally developed at Maastricht University is increasing. In these curricula clinical pharmacology and therapeutics teaching is integrated in problem oriented modules. Although these problem oriented curricula may have major advantages over classical curricula, they also may hide some pitfalls. Therapy is mostly the end of solving a patient problem. As a consequence, it has to be watched carefully that the end of the module is reached in due time and that therapy is sufficiently discussed. In addition, module exams have to contain a substantial number of questions on clinical pharmacology and pharmacotherapy. Not only a minimal total exam score but also a minimal score for therapy items should be defined for students to pass. Besides clinical pharmacology and therapeutics teaching integrated in the problem oriented modules of the main curriculum some additional courses are given. For example, in Maastricht, facultative courses in clinical pharmacology and pharmacotherapy exist. In the preclinical phase a 6 week course aims to train students in choosing a drug for a disease. Basics of pharmacokinetics and biopharmacy, management of intoxications, therapy in children and elderly are also discussed. In the clinical phase of the curriculum, a 2 week course trains students in basic principles of therapy: stepwise solution of the therapeutic problem, making a personal formulary, good drug prescribing ...

In the Netherlands teachers in pharmacotherapeutics are meeting regularly. The aim of the meetings is to exchange ideas and experience and to develop teaching programs and tools for pharmacotherapy teaching such as patient cases. Last 2 years, 2 chairs for pharmacotherapy teaching have been installed and several books on pharmacotherapy have been published. The intensive contact in the past years of clinical pharmacology teachers from the different universities has greatly enhanced the effective training of medical students.

373P CLINICAL PHARMACOLOGY - A UK PERSPECTIVE

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There has been much criticism of medical undergraduate education, that it is excessively overloaded with factual knowledge, and poorly integrated, emphasing teaching rather than learning, to the detriment of students' abilities to apply their knowledge and to continue learning after qualification. The General Medical Council has required changes in undergraduate courses to create a core curriculum which all students must follow occupying about two thirds of the students' time, and special study modules occupying about one third, for which the student may select from a range of options. Such new curricula are now coming into place in many UK medical schools, and some schools have taken the opportunity to introduce methods such as problem based learning.

Problem based courses have no specific subject headings, and may appear fragmented and lacking in cohesion. Their introduction may cause anxiety and defensive attitudes among those accustomed to more traditional didactic teaching. It is important to define the core curriculum in each subject for both educational and managerial purposes to establish for students and teachers what knowledge, skills and attitudes the students should possess on completing the course, i.e. what a newly qualified doctor needs to know and to be able to do. These now become the criteria for core course content, and not as in the past, what the "subject experts", with departmental establishments to maintain, thought that students need to know and who inevitably feel that their subject is underemphasised.

Many departments of clinical pharmacology have struggled within their universities to maintain the profile of their subject within these new curricula. One department has published its approach which will be discussed (1). The clinical section of the BPS commissioned the development of a core curriculum for undergraduates, which could then be adopted by any medical school, with appropriate local modifications. The core was defined as "the knowledge, skills and attitudes that medical students should learn in order to become competent to prescribe drugs safely and effectively and to maintain this competence throughout their professional lives" (2). The core course includes limited amounts of basic pharmacology, recognising the practical needs of the medical student. It does not include detailed training in specific therapeutic areas, since in some schools this will be the responsibility of subject experts. This core course will need to be modified in the light of future experience.

The remaining one third of the course is the student options, and here is the opportunity to develop a particular interest in pharmacology in students. it is importatn therefore that pharmacologists are active in providing such options for students. It is also an opportunity to tempt students into intercalated BSc courses.

Changes in medical undergraduate education may seem to pose threats to clincial pharmacology, but can also be opportunities to ensure that all students can prescribe drugs effectively and safely, and to go on doing so for the rest of his professional life, despite the likelihood of rapid changes in drug therapy in the future; and to encourage interested studets to take their studies in this area further.

1. Lloyd Jones G et al BJCP1997; 43: 15-19
2. Walley & Webb BJCP 1997; 44: 167-170 and BJCP 1997; 44: 171-174

374P POSTGRADUATE EDUCATION - AN EMPLOYER'S EYE VIEW

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Students with postgraduate qualifications are specifically recruited by industry, commerce, government and educational establishment. Frequently, this recruitment is into jobs carrying strategically important responsibilities. Often, postgraduates are recruited by employers over and above their existing graduate employees who have had a similar period of experience post graduation. Why is this group specifically recruited? What qualities are instilled by the final phase of the educational process that makes this relatively small group of individuals attractive to employers?

To keep this report brief I've concentrated upon PhDs as representative sub-population of postgraduates. To keep it topical for the BPS, I've gathered data where possible on Biology students. Almost 70% of Biology PhDs are employed in scientific endeavour, with a further 10% entering the teaching professions. The remaining 20% find their way into financial, administrative and management posts. In a recent survey of employers(Connor et al, 1994), over 50% reported that they employed PhDs because of their specialist knowledge or experience, indicating that the topic of their thesis conferred a specific advantage. The remainder responded in terms of technical skills, training and analytical ability, indicating that the training aspect of the PhD was most important.

Within my own industrial environment PhDs are hired for their grounding in scientific process, analytical ability, problem solving ability and creativity. Most important however, is their potential as leaders of science and strategy. Thus, although the PhD provides advanced training in a science, the student is expected to posses additional qualities; communication skills, persistence, commitment and team management abilities for example.

How does the current training address the need for these skills? There is a belief that the act of choosing to undertake a PhD marks out a particular type of personality. Someone prepared to devote themselves to a further period of study clearly demonstrates a commitment, either to their subject, or to advancing their career, marking them out as being prepared to take a long term view and work towards a predetermined goal (how long will this remain as students find themselves at the end of undergraduate courses with substantial loans needing to be repaid?). Once in place, the key facets of the training relate to the degree of independence and support given to the student. Ideally this is a time for the student to demonstrate and practice their creativity and problem solving skills, supported by a knowledgeable supervisor to keep his/her enthusiasm within bounds of realism. In practice, work has to be funded, and grants obtained. In extremes we find that this leads to PhDs becoming "super-technicians" generating data to be fed into the paper generating machine for their Department, often having little appreciation of their contribution to the whole. This leads to the phenomenon of the highly rated Department turning out poor quality students, often in quantity. Quality therefore, not quantity should be our goal. Postgraduate training, particularly at the PhD level should provide a firm grounding in science, an understanding in the progression of scientific logic and foster good scientific judgement. Students should be urged to think for themselves, communicate their ideas and learn by experience. Most importantly, postgraduate training should not be about short term success (numbers of papers), but sound training for the future.

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375P TRAINING PHARMACOLOGISTS FOR THE 21st CENTURY: WHAT IS THE ROLE OF THE LEARNED SOCIETIES AND THEIR JOURNALS?

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There is increasing, and justified, pressure to provide vocationally skilled pharmacologists for the 21st century. Future generations of pharmacology graduates need not only a thorough understanding of the scientific foundations and principles of pharmacology, but also to be equipped with the specialist technical and professional skills required by employers, whether in the academic or industrial sector.

Individual departments have always met the requirements in producing graduates with a high level of scientific knowledge and appreciation of the subject, but as student numbers rise and resources – both human and financial – become increasingly stretched, this seems threatened.

In this climate, the enhancement of courses to provide more experimental training is unlikely. One option is to provide comprehensive careers advice early in the undergraduate course, and to tailor vocational courses around career choice – preferably supported by work-experience (i.e. sandwich courses). Students could opt for appropriate experimental work, which could be structured as 'modules' in specialist areas such as, for example, *in vivo* techniques, radio-ligand binding, molecular biology techniques, microelectrode techniques, etc. Also, in collaboration with clinical pharmacologists, more human experimental pharmacology could be incorporated. Those students having decided not to pursue a career in research could be given options in, for example, drug regulation, and clinical trial management.

The learned societies have a key role to play in training future pharmacologists – at both undergraduate and graduate levels. Societies are not only better placed than individual departments to assess the requirements of employers and survey student career paths — and to co-ordinate career advice and work-experience accordingly – but also to liaise with the government and funding bodies to ensure that the skill base is maintained – and therefore to influence course content.

Societies are also in an influential position regarding the setting of standards and harmonisation of teaching practices. Through the collation, review, and circulation of information on the best paper and electronic resources, societies, via their journals, can help maintain the quality of material in use and ease the burden for teachers and course organisers of selecting information from a vast range. In this, there is a strong case for a society pharmacology journal dedicated to teaching methods, to facilitate international exchange of tried and tested initiatives and materials.

At post-graduate level, by acting as a professional institution, with continuing professional qualifications, societies could help graduates enhance and adapt their professional and technical skills by running accredited courses.

Along these lines, one initiative from IUPHAR Media, is the provision of 'Basic Skills Workshops' run in conjunction with national pharmacological societies. General vocational skills such as scientific writing, presentation skills, and statistical analysis etc. would be run from within the profession and structured specifically to meet the needs of pharmacologists. Societies could extend such professional training to technical areas and here there is potential for the introduction of training videos.

Against this backdrop, it is also important to consider the value of collaboration between the national pharmacological societies in training future generations of pharmacologists who are competitive in a changing international workplace and can meet the demands of a thriving and complex discipline.

376P

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The workshop on 'Teaching Pharmacology in the 21st Century' highlighted a number of key areas and issues. Differences between UK and Continental Europe were noted, with distinct degrees in Pharmacology being associated mainly with the former. With respect to the latter, the discipline is normally found within medical and related programmes It was made clear that the future will continue to require pharmacology teaching in the spheres of academia, hospitals and the pharmaceutical industry. In terms of academia, evidence presented indicated that academic teachers are continually selected on the basis of their research background and not didactic potency, even though peer teaching was deemed desirable. In academia traditional teaching is still carried out by specialist professors, lecturers and tutors. This is in contrast to the clinical environment, which appears to utilise specialists (i.e. cardiologists) and not pharmacologists. It was essential that drug therapy should be taught by experienced clinicians of various disciplines together with expert pharmacologists. It was also thought regrettable that the area of clinical trials depends heavily on the expertise of epidemiologists and does not involve the active participation of pharmacologists.

In terms of traditional pharmacology teaching, the normal integrated/synchronised combination of theoretical and practical components was now being reviewed. This need for change is a direct result of the ever increasing level of factual knowledge, making the above more difficult to achieve and resulting in poor integration and the emphasis being placed on teaching and not learning. These factors are believed to be detrimental to the students' ability to apply knowledge and to continue to learn, one solution being the construction of more curricula around problem-based learning (PBL)

This method allows students to select their own learning goals, with lectures being designed to integrate knowledge. A number of problems were identified with the delivery of PBL, especially the organization of practicals involving biological materials, resulting from de-synchronisation and potential increases in teaching loads. Other influencing factors identified were increased numbers of entrants and modulisation. These combine to reduce the number of students that were likely to specialise in pharmacology and would undoubtedly lead to changes in emphasis and exposure of pharmacology to a wider range of students. The recommendation to increase participation rates to 40% would further encourage the above changes.

Dearing also recommended that programme specifications should be developed for courses indicating outcomes for students, while actual students' feedback recommended that emphasis should be given to communication, numeracy and IT skills, with subject specific skills being of less importance to successful employment. The student laboratory experience was also thought to need more breadth, with expertise being developed in placement or post-graduate training. The importance of the latter was confirmed, with the majority of employers/customers specifically recruiting students with postgraduate qualifications for jobs that often incorporated strategically important responsibilities. One of the most important characteristics sought by employers is the potential to be leaders of science and strategy

It was thought essential that future course developments should be externally regulated by their own professional bodies with respect to curriculum design, accreditation and the assessment of quality. The ability of learned societies to liaise with government bodies would also play a key role.