REPORT ON
THE BIOTECHNOLOGY SYMPOSIUM:
AN INDUSTRY-UNIVERSITY DIALOGUE

Report prepared by the
Office for Partnerships for Advanced Skills
and the
Biotechnology Human Resource Council

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Office for Partnerships for Advanced Skills
180 Dundas Street West, 11th Floor, Toronto, Ontario M5G 1Z8
Phone: (416) 979-2165   Web Site: http://www.cou.on.ca/opas.htm

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REPORT ON THE BIOTECHNOLOGY SYMPOSIUM: AN INDUSTRY-UNIVERSITY DIALOGUE

I. INTRODUCTION

On January 21, 1999, the Office for Partnerships for Advanced Skills (OPAS) and the Biotechnology Human Resource Council (BHRC) hosted a Biotechnology Symposium at the Ontario Science Centre in Toronto. The one-day session was co-chaired by Dr. William C. Leggett, Principal and Vice-Chancellor of Queen's University, and Graham Strachan, President and Chief Executive Officer of Allelix Biopharmaceuticals Inc.

OBJECTIVE OF THE SYMPOSIUM

The symposium provided a forum for effective dialogue between the biotechnology sector and universities on three issues: **research, curriculum development** and **workforce training.**

The importance of this dialogue was identified by the Council of Ontario Universities' Task Force on Labour Market Issues report entitled *Sectoral Skill Needs: The Role of Universities*, and by the Paget report on the biotechnology sector, *Building Long-Term Capability Now*, which consequently led to the establishment of the BHRC. Both reports called for increased dialogue and closer working relations between industry and academia.

Since opportunities for this kind of exchange are rare, the symposium was seen as a significant occasion. Most sharing of views takes place in the context of a specific project, or between one university and a single corporation. The concept of bringing Ontario universities and biotechnology companies together as a group to discuss issues of common concern was seen as overdue by many observers.

The symposium provided an opportunity to examine a series of important issues. The biotechnology industry was born through the commercialization of academic research. New companies are often "spun-off" from university research labs and built around an idea and a talented individual. A founding scientist in a particular company may also be director of research in a hospital and a professor at a university. But the drive to bring the fruits of research to market can make the distinction between what is an academic and what is an industry activity somewhat hazy.

The symposium began with a background paper that set out and examined in detail the **three** issues. Each issue began with remarks from an industry and a university representative, followed by a general discussion. The focus then shifted to finding solutions or actions to address priorities identified in the dialogue.

PARTICIPANTS

OPAS and BHRC were pleased that so many senior representatives of the biotechnology industry and the university community agreed to participate in this event. A listing of participants is provided in Annex 1.

OVERVIEW OF ISSUES -- BACKGROUND PAPER

Prepared by John R. Clement, PhD

1. INTRODUCTION

Availability of employees with the necessary skills sets is a key factor in the continued growth of a successful biotechnology sector.

Both the Biotechnology Human Resource Council (BHRC) and the Office for Partnerships for Advanced Skills (OPAS) seek to promote increased dialogue and understanding between the biotechnology industry and universities with the intent of finding ways to work more effectively together to identify and provide the skills needed by industry.

This paper was prepared as a backgrounder for the Biotechnology Symposium, which was held on January 21, 1999, and co-ordinated by BHRC and OPAS. It provided a framework for the dialogue at the symposium.

BACKGROUND

Biotechnology is emerging as a major industrial discipline with an impact in numerous areas of life, from medicinal diagnosis and treatment, to agriculture and food production, to mining and forestry. Because biotechnology is an enabling technology, a strong national biotechnology industry will create spin-off advantages in other sectors. Biotechnology jobs require high-level skills and add high value to employment.

As a company develops, different skills sets are required at different stages of growth. For early-stage R&D companies, skills are more closely linked to traditional research knowledge and capabilities in the specific field. In the normal process of development a potential product is chosen and developed toward commercialization. Increasingly rigorous analytical and investigative studies are required under defined levels of discipline as the product moves down the regulatory path toward licensing. In addition to research competence, skills and knowledge are required in pre-clinical trials in design of an optimal regulatory path, in quality assurance (QA) and quality control (QC) and in process engineering as production methods are scaled up. Once the product is fully developed and has received any necessary approvals, marketing, manufacturing and production management become important.

In addition to the skills of a biotechnology nature, growing companies need skill and experience in a variety of other disciplines, for example, financing, management, marketing and sales, and human resources. These subjects are not covered in the normal science curriculum; nevertheless, some understanding of each is important.

Availability of employees with the necessary skills sets is a key factor in the continued growth of a successful biotechnology sector.

THE PAGET REPORT

An extensive 1996 study of Canadian Human Resources in Biotechnology (*Building Long-Term Capability Now*, otherwise known as the Paget report) was commissioned by Human Resources Development Canada. It provides an overview of the human resource requirements of the biotechnology sector and of the current mechanisms for developing skills relevant to biotechnology.

The biotechnology sector is a small but strategic employer, offering high value-added employment and facilitating growth in other sectors. In 1996, there were more than 8,000 people employed in biotechnology in Canada. Under a moderate growth scenario of 8% per annum, there would be sector employment of 11,970 by the year 2000 while, under 12% annual growth, sector employment would be 14,076. The largest categories of employment growth were forecast to be scientific research, product development, scientific support activities, operations and technical research. Need was seen for multidisciplinary skills and for significant applied (on-the-job) experience.

Among its recommendations, the Paget report called for:

> Stronger strategic and operational relationships between the biotechnology industry and academic and research organizations.
>
> Partnerships with the educational system to improve the general awareness of biotechnology and to increase the level of academic attention to the field in the school system.

The Paget report also called for "expanded and more effective working relationships between business and the educational system at all levels," to clarify the needs for people with multidisciplinary backgrounds combining several scientific specialities, such as molecular biology and bioinformatics. The report noted that universities cannot be expected to provide the specialized expertise that biotechnology companies will need as they move toward commercialization, as much of this can only be obtained through experience.

As a means to advance the recommendations, the Paget report proposed the creation of a Biotechnology Human Resource Council to develop and implement the recommendations.

BHRC'S INVENTORY OF BIOTECHNOLOGY EDUCATION IN CANADA

The Biotechnology Human Resource Council sought in 1998 to build on the Paget study by developing an inventory of educational programs in biotechnology in Canadian universities and colleges. To this end, the course content and program materials from approximately 120 colleges and 60 universities across Canada were reviewed with the goal of identifying those programs offering education and training applicable to the biotechnology industry.

To determine industry relevance, 50 companies were surveyed to indicate their preferences for training and experience in new hires. From this feedback, the **human resource requirements of the biotechnology sector index** of between 0 to 3 was calculated for each program. A high value of the index (>2) indicated that a program had courses that were more closely aligned with the needs of the biotechnology industry. A low value of the index (<1) indicated that there were few courses perceived as relevant by the industry.

In the survey of industry preferences regarding new hires, **work experience/co-op experience** was rated highly, as was **general biochemistry training** and **knowledge of QA and QC**. Some educational programs offer co-op, almost all offer biochemistry, and some cover QA and QC.

In the category of "knowledge preferences," higher relevance was seen for **depth of knowledge in (their) biotechnology specialization**, coupled with a **solid foundation in the core sciences** (chemistry, biology). These preferences were followed by **breadth of knowledge in biotechnology in general**.

When industry was asked about general attributes sought in new hires, in addition to the obvious **technical knowledge** and **theoretical knowledge**, companies were clear in their preference for **flexibility** to react to changing needs, **listening and communications skills**, **perseverance**, **objective-driven** character and **realistic expectations**.

Large well-established companies with well-established internal training resources seemed to have a preference for a solid theoretical background, stating that they preferred to teach their own way of doing the practical tasks required. In contrast, smaller growing companies were more apt to look for new hires with hands-on practical training who could make a useful contribution relatively soon after hire.

This information will be used by BHRC to find ways to foster communication between industry and educators, with the end of making biotechnology education as relevant as possible to the needs of Canadian industry.

COU TASK FORCE REPORT ON SECTORAL SKILL NEEDS

The 1998 report of the COU Task Force on Labour Market Issues, *Sectoral Skill Needs: The Role of Universities*, recognized the importance of biotechnology as a driver of technology transformations in other sectors, the importance of the industry as an employer of university graduates, and the sector's potential for significant growth in skilled, well-paid jobs. The task force noted that, due to the sector's high level of leading-edge research, the lines between education and training and research activities become blurred. Industry relies on the results of research to expand knowledge; so do universities. Thus, the sector offers an intriguing partnership prospect for both industry and universities.

The COU report noted that BHRC, using different definitions than those found in the Paget report, put job creation at 6,000 between 1995 and 2000, predicting a shortage of 8,000 to 10,000 people by the year 2000, with a general shortage of experienced technical and scientific personnel. (Experienced leadership is critical. To address this particular need, BHRC has successfully pursued the development of a strategic immigration policy to alleviate specific high-skill shortages.) At the same time, both BHRC and COU are working to support Canada's postsecondary sector in filling the demand for postdoctoral fellows, postgraduates, university graduates and technicians.

Universities and colleges have a generally adequate capacity to supply the number of graduates needed by the biotechnology sector. However, employers in the biotechnology sector state that it can be difficult to find new employees with sufficient training and experience. This suggests that current graduates need additional training or experience to meet industry's needs. The biotechnology industry appears to want to be actively engaged in the development of curriculum, rather than be passive consultants in its design.

Employers perceive a lack of nontechnical skills (such as skills related to the business aspects of the sector) in new graduates. Firms in the industry tend to start as scientific enterprises; however, to succeed as business enterprises, they require entrepreneurial and management/business skills not usually found in the university departments of chemistry, physics or biology.

Ongoing workforce training is an important need of all companies, and one where universities should be well-positioned to assist. Given the nature of the biotechnology sector's activities, scientific and technical skills must be constantly refreshed. The sector also has a need for non-scientific training for its employees. The small size of many firms in the sector does not allow them to have specialized internal departments to handle the business functions of the enterprise. Thus, industry's scientists and managers require entrepreneurial and management skills if they are to be successful. There is also a need for training in regulatory and intellectual property issues. Although some needs may be met by conventional full-time courses, it is likely that workforce training will need to be based on alternative delivery methods, including short-term, seminar-based training.

2. RESEARCH

Canada has a tradition of excellent basic research; however, it has not historically been strong at developing new discoveries to the stage of commercial success. The volume of new technologies developed has, to date, far surpassed the country's capacity for up-scaling and commercial development. The result has been that promising technology developed with Canadian public funding has been lost to the country and developed elsewhere, most frequently in the U.S.

The challenge is to maintain, enhance and focus research capabilities currently in the system, while building a greater sensitivity to potential commercialization.

Maintaining current competence requires investment; however, sources of research funding are becoming more limited. The issue of research funding is important for all interested parties, and is discussed below.

Transferring technology to a Canadian company for commercialization assumes that such receiver companies exist and have the capacity to accept new technologies for development. At present, the capacity of Canadian companies to accept and develop new technology is far less than the volume of new technology being developed. An alternative is for the researchers to raise funds and form an enterprise to commercialize their work. This approach is becoming more common.

RESEARCH FUNDING

Potential sources of funding include:

- governments
- university funds
- industry
- private funds

Should more $ be available for basic research? Where should this come from?

Do funders feel that they get value for money when supporting university research? How can (the perception of) the value for this money be increased?

What are the key elements in determining the amount of funding available?

What can and should be done to increase the total funding available?

Who should receive funding; that is, how should funding be directed?

Should funds be re-directed from general research support toward those areas seen as more relevant by industry? (This could be argued as directing funds *toward those areas where the taxpayer is more likely to receive a fiscal dividend from the research investment). If so, then how should the selection process be set up?*

Do the present levels of university overhead allocations present a barrier to industry participating in funding? (Are present overhead allocations fair and realistic?)

CONFIDENTIALITY AND OWNERSHIP

A. Publication vs. Confidentiality

A key reason for industry to carry out or fund research is to gain a competitive advantage in the form of new or improved products. Industry research dollars need to justify themselves in terms of expected payback.

In contrast:

One of the main determinants of progress in the university research system is the number and quality of publications. Further, graduate students need to be able to publish the results of their work in thesis form as one of the requirements for graduation.

How can industry and universities co-operate to resolve these conflicting needs?

Should universities and granting agencies develop/emphasize alternative measures for establishing seniority, other than peer-reviewed publications?

An allied topic is the ownership of the results of research.

B. Rights to Ownership of Intellectual Property Arising from Research

Who will be the owner of any intellectual property arising from industry-funded research? If industry is paying it will expect some rights to ensuing patents.

With industry having ownership or part ownership of patent rights, there is an obligation on the laboratory to protect information gained during the course of the work. Investigators may need to restrict access to areas where industry work is being done, and will need to refrain from publishing, at least until after any patent applications have been filed. (This is in direct contrast to the traditional investigator's drive to publish as soon as possible.) Additionally there may be a need for only certain members of a research group to be informed about a particular project. Maintenance of confidentiality may become an issue.

Is “Publish vs. Patent” an issue requiring clarification or guidelines?

Are both universities and industry representatives generally satisfied with the current mechanisms for negotiating rights to ownership of intellectual property arising from industry-funded research?

Is the negotiation process seen as efficient, time-sensitive and effective?

REGULATORY ISSUES

Industrial research is normally directed toward gaining regulatory approval for the end product in the shortest possible time. An important element is that the work is carried out under rigorously defined codes such as good manufacturing practice (GMP) and good laboratory practice (GLP), where procedures, conditions and methods of documentation are often more highly formalized than in many university laboratories. These codes build regulatory credibility into the research process, allowing much more rapid acceptance of work performed according to their disciplines. If these disciplines are not followed sufficiently rigorously, otherwise excellent research may have to be repeated to allow inclusion in a regulatory dossier. This leads to delays in commercialization and reduces the commercial value of the original research.

There appears to be a general feeling among industry representatives that the commercial importance of GMP and GLP is not fully understood within universities. Certainly graduates of most university science programs appear to have very little knowledge of GMP or GLP, yet within industry knowledge of these subjects is a fundamental requirement.

There are two specific areas for consideration regarding regulatory-based quality issues:

- Inclusion of GMP and GLP as components of the curriculum. This will be addressed in the next section.
- Quality assurance with respect to laboratories wishing to perform industrially relevant research.

Proposed that a joint industry-university task force consider how best to improve the standards of GMP and GLP in university labs. This could, for example, include a voluntary program of quality assurance audits of university labs, conducted by industry QA representatives.

If confidentiality concerns can be addressed, it may also be instructive for selected university representatives to have the opportunity to sit in on internal industry GMP training programs and/or to accompany an internal QA audit of an industry research lab.

CHOOSING TOPICS FOR RESEARCH

Universities have traditionally defended the concept of academic freedom. University-based research has thus been primarily guided, in the past, by the interests of the faculty. In recent years, as research funds have become less plentiful, the relevance of research programs to funding agencies has become more of a factor in obtaining funding.

Industry normally has an expected end point, time line and cost envelope for a given program of research. Given the current funding climate, many researchers are becoming more interested in fee-for-research studies. Funding mechanisms are thus acting as a *de facto* selection mechanisms, influencing which studies are carried out.

A. Should Selected Research Areas Be Promoted?

Is there a need for a combined industry-university mechanism for guiding the areas where universities focus their research efforts, to make research more industrially relevant?

How effective are the Networks of Centres of Excellence, as a model for industry-university co-operation?

How can industry most effectively communicate their needs regarding research directions?

What will be the consequences over time if basic research (not directly related to industry needs) is not supported?

3. CURRICULUM DEVELOPMENT

SCIENCE COURSES

BHRC has taken an inventory of Canada's university and college courses during 1998. There is a large selection of courses seen as having differing level of relevance to industry. Universities, in particular, offered a high level of flexibility and choice for students in selecting optional courses toward a degree. The 1998 BHRC survey found high levels of support for basic broad knowledge in biology, chemistry and related areas. Specific subjects that were seen as important in driving the future of biotechnology include bioinformatics, biomaterials, molecular modelling, molecular biology and medicinal chemistry.

While universities in general provide excellent education in the specific fields of study they offer, there are some disciplines needed in industry that have traditionally not been included in university curricula.

Is the current selection of science courses sufficient in both variety and quality to serve the needs of Canada's bioscience industry?

Are there any scientific subjects or disciplines not adequately covered by current program offerings?

How much of the additional subject matter is properly the work of universities?

How would additional content be fitted into available time?

OTHER TOPICS

A. Quality Operations

GMP, GLP, validation, the writing of standard operating procedures, and the writing and use of batch production records are necessary disciplines for most industry positions. These are not regarded as being addressed adequately, if at all, in most university programs.

Likewise, the path to regulatory approval is important background knowledge for anyone entering industry. The future survival of the company may well depend on the speed and efficiency of the regulatory development process. The need for specialist training in regulatory affairs is being addressed at the postgraduate, post-diploma level by programs such as the advanced postgraduate program at Queen's University, and by Seneca College's one year post-degree, post-diploma program in pharmaceutical regulatory affairs and quality operations that began in January 1999.

What priority should universities give to training in quality operations?

How conversant should graduates be in these disciplines?

Do all universities have the in-house expertise to give such programs? If not, how should training in these areas be best addressed?

B. Business and Management Skills

University graduates often have little understanding of how industry works. The adjustment to industry may be more efficient if a basic level of understanding in corporate ways of thinking was provided.

Possible topics could include:

Overview and understanding of corporate structure and language. How are companies organized, who makes what sorts of decisions, and how are these made?
Accounting, budgeting and finance for the nonfinancial person. Graduates may often be asked to participate in the budgeting process or in variance analysis.

Project management. This is a key discipline. It should at least be covered at an elementary level and possibly as an in-depth subject option.

What priority should universities give to the inclusion of management subjects in the curriculum? To what depth and level of detail should these be taught?

C. Leadership Skills

For example:

- How to manage a team and/or a diverse workforce.
- How to manage change.
- How to foster a positive group/corporate culture.

What priority should universities give to the inclusion of leadership training in the curriculum? Should this be part of the regular curriculum or a separate course of study?

D. Communications and Technical Writing

In the survey of industry conducted as part of the BHRC Inventory of University and College Training in Biotechnology (1998), both communications and technical writing received very high support as disciplines industry seeks in new hires. These do not appear to be covered in a formal sense in university programs, although graduates are normally exposed to these subjects incidentally during their normal course of study.

Should universities give greater formal emphasis to communications in general and technical writing in particular? Should these topics be part of the normal curriculum or addressed in some separate manner?

E. Co-op Studies

In the 1998 BHRC industry survey of preferred attributes of new hires, co-op experience was rated very highly by respondent companies.

How valuable is the co-op training as part of a university education in biotechnology?

How can co-op training be structured (for example, scheduling and duration of work terms) for the best advantage of the student and the industry?

What can be done to promote co-op positions within industry?

4. WORKFORCE TRAINING

With new research discoveries, new ways of doing things and developments in technology, there is an increasing need for the principle of lifelong learning as critical skill requirements keep changing. Examples of such developments include new methods of production (for example, the movement of insulin production from extracting pancreas glands to genetic engineering), and the rise of computerized process control. The Paget report detailed how new skills are required as biotechnology enterprises develop. Yet, employees do not have the time to go back to school to take conventional full-time courses. A number of different approaches are being tried.

Companies can offer workforce training by sending employees out to existing courses or by contracting the provision of an internal course. Internal courses offer the advantages of being tailored more to the company's specific requirements, can be of any length and level of detail, and offer greater scheduling efficiency. They are generally, however, costly to develop. For a larger workforce, where the costs of content development can be spread over a number of employees, a customized internal course is often preferable. In this case, companies tend to identify external competence and negotiate a program to be delivered. Individual university faculty may be used as resources, with the relationship being a direct one between the faculty member and the company.

Should universities seek to build and/or offer programs of study amenable to the needs of multiple companies, and promote these for industry in-house training purposes?

How can OPAS most effectively assist industry to help maintain the skill level of the workforce, and how can industry be a more effective partner of OPAS?

Industry has a number of challenges regarding workforce training:

> Sometimes existing staff need to be trained in new concepts/methods to bring this knowledge into the company. These people need a concentrated, rapid, efficient training experience for the company to begin taking advantage of the new technology/approach.
>
> At other times, while there may be those within a company knowledgeable in the new areas, these persons may be too busy or may lack appropriate skills in training to provide an effective internal training program.
>
> The existing workforce may not contain many suitable candidates for training in the new disciplines. The example has been given of "filling and packaging," traditionally an area requiring a number of staff capable of reliable, repetitive actions but without any significant educational background. The area of filling

and packaging is increasingly moving to emphasize computer skills and engineering, concentrating much more on analytical thought than on repetitive action.

Within the scientific and research side of a company, workplace training is likely to be of two types:

- continued refresher courses in the area of specialization
- cross-functional training in areas beyond the particular specialization

Appropriate levels for such training needs could be either a graduate-level lecture series of, for example, 15 hours total duration as refresher courses for specialists, or full advanced undergraduate-level courses for cross-functional training. These courses need to be scheduled to minimize the time away from the workplace.

ISSUES REGARDING WORKFORCE TRAINING

Universities offer a useful mechanism for addressing some workforce training needs; however, there is potential for this contribution to be increased. Issues include access, scheduling and motivation.

A. Access to Classes

Employees may not have the formal educational background normally expected of university entrants. This is often offset by significant on-the-job knowledge and experience. Companies report that it can be a cumbersome process to obtain the necessary waivers to allow some employees entry to university courses to take training they require.

Do university-entry requirements pose a significant obstacle to employees seeking upgrading training? How complex is the process of gaining exceptions? What should be done?

B. Scheduling

University classes are normally scheduled for the timetables of full-time students. Classes are held several times a week for a limited time each class, and the duration of each course covers several months. When travel time and ongoing work obligations are considered, such a schedule is not particularly accessible for those in the workforce.

There are a number of efforts being made by universities to address the scheduling issue. For example, the Faculty of Applied Science and Engineering at the University of Toronto offers a range of evening and semester courses directed to engineers and related professionals, as well as a short seminar series that provides an initial introduction to a selection of topics including “Design, Validation and Regulatory Compliance of Pharmaceutical Processes and Facilities.” Short courses and evening courses such as these are easier to schedule than full-day courses as a part of workplace training.

Other alternative forms of delivery may also be more amenable:

- distance learning
- alternative class schedules, such as accelerated summer programs
- programs brought to the employer's site

How much would alternative scheduling options increase the attractiveness of universities as workplace training resources?

C. Progress Toward Degree or Certificate

Both companies and employees report that there is a higher interest in courses that lead to some form of certificate of ***achievement***, not just of attendance. If a course is opened for audit only, it should be considered whether to require auditing students to complete all assignments and projects, and to take tests.

Should workforce training lead to a formal qualification?

How much of a motivator is a certificate, degree or other formal qualification to:

- *Company? (proof of performance not just attendance)*
- *Employee? (proof of training/skill in that discipline)*

5. RELATIONSHIP WITH COLLEGES

University programs in the biosciences provide an excellent grounding in theoretical understanding, concepts, methods and research. In contrast, the emphasis of college training is on practical application, with relatively high laboratory content, including analytical procedures and the operation of equipment. College programs also tend to have higher emphasis in areas such as GMP and GLP, validation and the writing of standard operating procedures.

A developing trend is for university graduates to attend college after completing their degrees. (In fact, the University of Toronto is described by one college as being its "largest feeder school.") Some universities and colleges are developing joint programs to try to provide a seamless, co-operative approach to provide both theoretical and practical education.

For example, the University of Guelph and Seneca College are co-operating on a joint program, where students will spend part of the program at the University of Guelph and part at Seneca. Additionally, these two institutions have established an articulation agreement whereby selected Seneca graduates are given advanced standing toward a degree at Guelph, allowing them to complete both a diploma and a degree in four years.

Is there an advantage to include colleges as partners in these industry-university training considerations?

PRESENTATIONS AND DISCUSSION OF ISSUES

With the background paper as context, the symposium turned to a discussion of the three key issues: **research**, **curriculum development** and **workforce training**. Each topic began with a presentation by an industry representative, followed by remarks from a representative from the university community. The following summarizes the remarks of the speakers and the discussion that ensued.

1. RESEARCH

INDUSTRY PERSPECTIVE

Dr. George Jackowski*, Vice-Chairman and Chief Scientific Officer, Skye Pharmatech Inc. Dr. Jackowski is a past winner of the Medical Devices Canada Award. He served as President and Chief Technical Officer of Spectral Diagnostics.*

Goals of Industry

- gain a competitive advantage with new or improved products; or access to new technology
- return on investment
- research directed towards possible commercialization.

Figure 1: Biotechnology Company

Phase 1	**Phase 2**	**Phase 3**	**Phase 4**	**Phase 5**
Need: • Discovery Scientists	Recruit: • Development • Manufacturing • Regulatory • Marketing • Trainees	Additional: • Manufacturing • Regulatory • Marketing/ Sales/ Tech Support/ Distribution • Trainees (as needed)	Supplement: • Marketing/ Sales/ Distribution • Managers Streamlining/ Optimizing Profits • Trainees (as needed)	Expand: • Strategic Planners (to expand market segments/ niches) • Trainees (as needed)

Human Resources

Sources of Funding

- some public support, but primarily venture capital
- venture capitalists require revenue within three years. The revenue curve is a basic reality for industry.
- time is critical for industry; money is expended with usually no return in the "early-stage" companies. An "incubator" facility would make start-ups easier.

Issues Associated with Industry Research

- industry research concerns change according to the stage of development of the particular research company
- there are five phases of development; companies at each stage have distinct research concerns, as shown in Figure 1.
- currently, 90% of the companies in the Canadian biotechnology sector are in Phase 1 -- which means they are involved in basic research and they need discovery scientists.
- few companies are able to focus on research concerns beyond their basic need to achieve discoveries with market potential
- in Phase 2, companies require development scientists, and also begin to have a need for people with expertise in business, regulatory affairs, marketing and small-scale manufacturing. They may also begin to bring on co-op trainees at this stage.
- as companies move into Phase 3, they need to scale up manufacturing and begin to bring on marketing, sales and technical support people.
- by Phase 4 a company has achieved full-scale manufacturing. Operations managers and others with expertise in streamlining processes and optimizing profits become valuable.
- Phase 5 companies seek to expand and capture global business. Very few Canadian biotech companies exist at this level..
- big pharmaceutical companies may not have the skills to pass on to early-stage companies; they are too different in their scope and structure.

UNIVERSITY PERSPECTIVE

***Dr. Eleanor Fish**, Associate Professor, Department of Medical Genetics and Microbiology, University of Toronto. Her research focus involves an investigation of the mechanisms of action of and the potential therapeutic indications for cytokinins. Dr. Fish has extensive interactions with the biotechnology industry in Canada, the U.S. and Europe, serving as a consultant and on scientific advisory boards.*

Mandate of Universities:

- Institutions of higher learning and research
- Knowledge base grows with advances in research
- Requirement therefore for ACADEMIC FREEDOM... **research directed by the interests of faculty**

Research Funding:

Reality of limited funds and funding sources:

- government
- university
- industry / private

Issues Associated with Industry Support:

- Ownership of intellectual property and patent rights:
- Materials transferred?
- GLP documentation requirements?
- Reporting process?
- Publication vs. confidentiality
- 30-day policy

Partnerships:

- Graduate programs
- Internships
- Shared funding of stipends
- Placement opportunities

University researchers undertake basic research with applications in biotechnology. There is an absolute requirement on the part of university researchers for academic freedom, since basic research is fundamental to the biotechnology industry. However, industry has a need for directed research and universities should also be able to undertake this. Faculty interests guide research directions.

Intellectual property is important. There is a need to protect the interests of basic scientists, while ensuring industry can benefit from the research that it has funded.

New university researchers initially receive funding from government or charities. Once they have established some credibility, they can seek research funding from industry, which assumes the financial risk in the partnership.

There is no conflict between the drive to publish and confidentiality sought by industry (see the background paper); publication and patenting are not mutually exclusive.

Industry placements and internships are useful interactions between industry and academia and should be encouraged.

DISCUSSION

The Ontario government has undertaken some important initiatives such as the R&D Challenge Fund to enhance business-university partnerships, the Ontario Business-Research Institute Tax Credit and Ontario New Technology Tax Incentive, but more is needed. So too is more extensive co-ordination between the initiatives of the provincial and federal governments.

Both industry and academia need to engage people with the importance of biotechnology. The biotechnology sector could market biotechnology as being important to the economy, to achieve more government buy-in. The sector should have "hot buttons" to engage the public's support. Universities can educate the public on biotechnology -- which scientists do not do well -- to set up a stronger case to government.

Using Quebec as a model, federal and provincial governments could work together to provide cash and tax incentives for developing biotechnology in the province.

The sector as a whole could involve various associations to convince government that biotechnology is a priority for everyone. There needs to be recognition at all levels that universities cannot achieve world-class research at current low-funding levels.

There is currently a disconnection between research, which is the main focus of the university community, and commercialization, which is the main concern of industry. From an industry perspective, there needs to be a more accurate assessment of the commercial value of new discoveries and technologies. Technology transfer/ commercialization centres are working, but the research base is not yet robust enough.

If universities wish to ensure that their research is as robust as possible, they must retain the brightest researchers. Successful researchers need to be competitive internationally and this usually requires a staff of 20 to 30 people. Only the very best people who have ideas and who are well funded, succeed. Even the brightest can be distracted and fail, if constantly looking for funding.

If there is no industry-university dialogue, no amount of funding will help. Universities need to seek out industrial partners early on and plan together. Scientific management is critical, so is interaction with finance and legal personnel to give workshops. However, not all universities have the infrastructure to support industrial partnerships. There is a need to interface science and business for proof-of-concept studies. Scientists often cannot see business success potential. Industry may see the potential but may not understand technology; academics may not have a realistic view of the value of a given technology. Therefore:

- Need interdisciplinary skilled person or panel-review process.
- Need a more accurate assessment at an early stage; companies are too quick to rush to clinical trials (it's much better to fail early than late).

A "Biotechnology" Centre of Excellence would be a vital step forward. Although there are four Centres of Excellence, none of them is linked to biotechnology, especially in Ontario. This creates a significant gap and hinders progress. (The "incubator" at Queen's University would be one possible resource to fix this, but unfortunately it is full.) The cost for such a centre would have to be shared among the local community, industry and academic institutions.

It is necessary to build on networks that have already been developed. All that is needed is a virtual network; there is no need for a "bricks and mortar" Biotechnology Centre, although the latter would be useful. The physical condition of facilities at universities is becoming an important issue. It cannot be disassociated from the capacity of universities to provide training to a global standard.

It was proposed that a joint industry-university task force consider how best to improve the standards of GMP and GLP in university labs. This could, for example, include a voluntary program of quality assurance audits of university labs, conducted by industry QA representatives.

If confidentiality concerns can be addressed, it may also be instructive for selected university representatives to have the opportunity to sit in on internal industry GMP training programs and/or to accompany an internal QA audit of an industry research lab.

Internships and other industry-university exchanges need to be strongly promoted. The faculty of universities can increase work with industry more closely; for example, a professor's sabbaticals could be taken in industry and industry representatives could become professors. It is difficult, however, to get academics to take sabbaticals in industry due to a feeling that their research will become "tainted" and that they will no longer be seen as a pure science researcher. Generally, academics have *not* been receptive to working with industry

To improve the status of research in the Province of Ontario, the following issues were identified:

A need to align Ontario initiatives more closely with federal funding programs to increase leverage.

A need for recognition of the high cost of research overhead and infrastructure

-- and, consequently, for funding of universities to increase.

A need for a dedicated biotechnology commercialization centre to provide ‘critical mass’ and incubation of research.

A need for scientific evaluation of technology to be built into commercialization facilities to determine the viability of proceeding in a company. (For example, Canadian scientists have been very successful in gene discovery yet, ironically, there is no genomics company in Canada.)

A need for more highly visible successes. It is easier to lobby government when the sector can point to success stories. (For example, universities are doing a tremendous job training for discovery science.)

A need for postgraduate/faculty internships and secondments. Industry placements and internships are useful interactions between industry and academia and should be developed further. More industry involvement in graduate programs and perhaps a share in funding stipends are other possibilities.

2. CURRICULUM DEVELOPMENT

INDUSTRY PERSPECTIVE

***Dr. Brian Underdown**, Vice-President of Science and Technology, MDS Capital Corp. and University Medical Discoveries Inc. His experience includes senior academic posts as Associate Dean Research (Health Sciences) at the University of Toronto and McMaster University; and as Assistant Vice-President, Research, at Pasteur Merieux Connaught.*

It is difficult for Phase 2 (see Figure 1) companies to recruit the needed skills. Employees with the required experience seek the security of larger, better established firms.

Significant amounts of money are needed to kick-start the commercialization of research. However, the growth of the biotechnology sector is largely due to the formation of small businesses that depend mainly on people, *not money.*

Emerging companies are science-driven; there is some requirement for management skills but mostly on a part-time basis. The typical structure of emerging companies involves scientists who act as part-time CEOs, business development specialists and/or financial controllers. The need for management skills can be satisfied by hiring “retired” consultants or by recruiting from the U.S. or elsewhere. University people tend not to have these skills.

Growing companies, on the other hand, need *full-tim*e CEOs and vice-presidents of business development -- individuals with industry experience. From industry’s perspective, the best solution is not necessarily having the Medical Research Council (MRC) and the Natural Sciences and Engineering Research Council (NSERC) fund research. What is needed are innovative people -- which is why MDS Capital focuses on intellectual assets when deciding where to invest its funds.

The shortfall in skills may lie in quality, not in quantity. BSC graduates, for example, do not appreciate the basics of business. The quality of graduates, *not the quantity,* needs to be more keenly matched to the needs of industry.

Industry needs graduates with **essential skills** -- individuals who:
1. are knowledgeable
2. are entrepreneurial problem-solvers
3. are team players
4. possess communications skills and
5. have “the ability to wear several hats”

Universities should highlight these essential skills and, while more emphasis on them would require less focus on science knowledge, the upside is that these skills have a longer shelf life.

The ideal scientist has a strong scientific culture, significant integrity and a strong background in a specific field but with a multidisciplinary perspective. While “dreamers” (innovators) are needed, universities should encourage more objective-oriented thinking.

Students themselves should become skilled and knowledgeable in areas of demand such as molecular biology, bioinformatics and chemical synthesis. Experience and training in team-based problem-solving and communications skills are not add-ons -- these skills are essential for career success.

The role of universities and colleges is to facilitate learning and instill the five characteristics of a desired employee (see the previous page). Specifically, industry needs employees with entrepreneurship skills, an understanding of patents and licensing agreements, and knowledge of development science and regulatory affairs. These skills would most likely come from business schools (entrepreneurship); universities and patent firms (patents and licensing); university and college science and engineering faculties (development scientists) and graduate schools (regulatory affairs).

UNIVERSITY PERSPECTIVE

***Dr. William Bridger**, Vice-President (Research), The University of Western Ontario. Prior to his current appointment, he was Associate Vice-President (Research) and Chair of the Department of Biochemistry at the University of Alberta. Dr. Bridger has also conducted research at UCLA and at the Rockefeller University.*

Some Assumptions:

- Biotechnologists require a deep understanding of relevant science (for example, biochemistry, genetics, molecular biology, microbiology, cell biology)
- Expectations of BSC and PhD graduates are different
- Industry requires employees who are adaptable, articulate and conversant with business tools, practices and language
- Universities are not vocational schools

Typical Honours Biochemistry Program:

- Challenging program with little room for add-ons
- Foundation is physical and organic chemistry, physics, mathematics, biology
- Require some arts and social science courses:
- for example, English, history, economics
- Rapidly expanding biosciences have substantial advanced course requirements: protein chemistry, proteomics, molecular biology, membrane

biology, metabolic controls and signal transduction
Laboratory project in senior year(s)

UWO Combined Engineering and Business Administration Program:

Two years in a regular engineering program (for example, chemical and biochemical engineering)
One year in a regular honours business administration program (finance, marketing, management)
Two years with a mixture of senior engineering courses plus core senior business courses (for example, business policy, industrial relations, corporate strategy)
Five years to BESc/HBA degrees (instead of six outside of combined program)

Undergrad Co-op Programs (e.g., UVic Biology Co-op):

YEAR	*SEPT-DEC*	*JAN-APR*	*MAY-AUG*
1	Campus	Campus	Free
2	Campus	Campus	Work 1
3	Campus	Work 11	Campus
4	Work III	Campus	Work IV
5	Campus	Graduation	

After or During a PhD?

Short intensive “boot camp” entrepreneurial courses:
for example, Ivey/CMDF/MDS initiative
Travelling project management courses (University of Waterloo/OCCUR)
Regulatory Affairs: Universities not generally equipped to teach GMP or GLP (Seneca College’s one-year program)
Full-blown MBA (Queen's MBA for science and technology)

Dr. Bridger expressed his disappointment with low industry turnout and encouraged industry representatives to pass on the message that universities are ready to work with industry.

Universities have a mandate and responsibility to educate people *for life*, not just for a career. In that regard, universities are not vocational schools.

For a BSC graduate, a fundamental understanding of science is essential, and the curriculum focus has traditionally been on this requirement only. The language of business, including its tools and practices, has not been incorporated.

A three-year undergraduate program is not much use compared to an honours program, and there is no practical way to introduce business knowledge into an honours program other than for the student to continue on to a BComm or MBA program, or to combine majors (for example, English and business administration). Co-op programs enable students to acquire business exposure and experience and, for these reasons, are increasing in popularity.

For postdoctorates, there are often short secondments on projects supported by industry.
Other possibilities include short “boot camp”courses for business skills such as project management, distance education, GMP/GLP and regulatory affairs training through a combined college MBA program.

The speed of scientific advances in biotechnology makes it difficult to maintain the lifelong learning needed to stay current with the science. Undoubtedly, there is a need for sustained two-way communication between business and industry.

DISCUSSION

Industry funds research in order to recruit employees and gain access to new technologies and expertise that it does not have in-house. Companies can and do seek solutions worldwide. These kinds of industry placements are already taking place; for example, the University of Ottawa’s “Bridge to Success” program.

Funding of curriculum development is an issue for universities. McMaster University has completed an analysis of why integrated (essential) skills are not being delivered, and the conclusion was that there are no available resources, which means that partnerships with industry must extend beyond research.

The essential skills needed by the biotechnology industry are the same as those needed in any other field. Are universities producing the right sort of graduates?

In pursuing the goal of building essential skills into the curriculum, it would also be beneficial to add general management skills and ethics.

An analysis of industry needs, when compared to university goals for education, revealed that they are almost identical. Universities are doing what they can but they simply do not have the capacity nor resources to bring this training more fully to all undergraduates.

Universities recognize the need for skills training. However, many university courses are offered through distance learning; naturally, that makes it difficult to teach team-building skills. Universities need to form partnerships with industry to implement the required training programs.

While industry seeks out a course or program to develop essential skills, it is important to note that these same skills can be developed in other circumstances (for example, through sports). Ultimately, if there is a larger pool of potential employees in Canada with the appropriate skills sets to draw from, this will mean that the movement of individuals within the biotechnology sector will be contained in Canada and we will be less likely to hire from outside the country.

The University of Waterloo has created a program that addresses industry needs by combining science and management skills. These skills are taught through workshops, presentations, projects (such as technology transfer) that emphasize teamwork and co-operative placements. It was initially difficult to persuade university departments to co-operate in developing new curriculum (combined degree requires co-operation between faculties). But the Waterloo program, which is now in its third year, is popular with the students, and the interaction with the business community, which helps to ensure the integrity of the program, is ongoing.

It might be helpful to have internships, of perhaps nine-months duration, in industrial setting for professors. It would be relatively easy to accommodate on the part of the universities and would promote more interest in industrial projects.

There is a need for self-reproduction, for example, chemistry professors creating more chemistry professors, is what drives academics.

There is a need for a change in the reward system of universities: reward patenting instead of publishing, moving away from pure public funding to include patents, licences and so on. There is a need to protect the intellectual property coming out of universities, and these might be different approaches.

Joint science and management programs are a response to the needs of industry. Engineering graduates have higher placement rates, which may be due to business skills being easier to incorporate into an applied science curriculum than into a basic science program.

3. WORKFORCE TRAINING

INDUSTRY PERSPECTIVE

***Mr. Craig Anhorn**, Director, Organizational Transformation, Pasteur Merieux Connaught - Canada. He has 20 years experience in operations, marketing and human resources management in the health care and biotechnology industries. Recently, Mr. Anhorn was appointed to lead the redesign and implementation of Pasteur Merieux Connaught's global executive succession planning and strategic human resource planning process.*

Management Skills of Scientific Staff:

Need to deliver projects "on time, on budget"
Need to apply project management: leadership, facilitation, teamwork and planning
Need to learn proposal writing and finance
Most learn by reading -- they want the 20-minute version
Resist the in-house efforts, but need the skills

Research Staff:

How do we keep the skills of technical staff current?
Send scientists to symposia, but what about the other staff who are closer to the work

Regulatory Affairs:

Not the same as the pharmaceutical industry
In fact a newly hired senior RA person commented that she was amazed by the science required at Pasteur Merieux Connaught (PMC), since in the pharmaceutical industry she spent more time with legal and finance

Quality Assurance and Quality Control:

GMP
New test development -- demands of new technology on testing
System validation
Team Biologics U.S. FDA

Manufacturing:

Retraining of older staff in new techniques
Basic training of new staff -- the older staff tend to understand the practical aspects of manufacturing but not the technology, while the new staff understand the technology but cannot apply it
Co-op works well for providing the practical, but it must extend to at least one year -- anything less is not worthwhile to the company since it takes at least three months of training before a student is of benefit in a manufacturing environment
Question: how do we upgrade the skills of older staff?... we cannot afford to

pay two people for the same job
Many staff are not interested in pursuing evening courses at colleges
Need to bring the skills-upgrading opportunities on site

All industries need the same essential skills.

Many research scientists lack management skills, which is understandable since there is virtually no value attached to management or teamwork skills in the university environment they come from.

For industry, the key to reducing the time it takes to bring a product to market is more effective project management. In some instances, project management can reduce the delivery time from 10 to six years. Companies must deliver projects “on time, on budget.” A large company can address this by bringing functions such as project management or technical writing in-house.

Keeping research staff current is also a key issue. However, since there are so many significant scientific developments regularly unfolding, only a critical mass of employees would make regular updates an affordable proposition for a company. PMC is fortunately large enough to develop and deliver seminars for its research staff and to bring in college workshops for its technical staff.

Regulatory affairs is another major concern. BSC-level students should consider this a career option; it enables them to develop in business instead of being confined to a lab bench. There are also big gaps in systems validation and, unfortunately, not many people are familiar with the its principles. In biotechnology, more so than in the pharmaceutical industry, a strong scientific background is required. BSC students can also concentrate in quality assurance and quality control, where many opportunities exist.

Co-op programs are great, but three to four months is not long enough to properly train and assess an individual’s skills. The length of the program should be extended to one year.

Older staff who need training often cannot attend night courses due to family and other concerns; they must be able to take courses during the day. However, manufacturing schedules and shareholder concerns do not allow for prolonged absences, and productivity cannot be adversely affected.

University graduates are seen to be a well-rounded “product” of an education, equipped with excellent theoretical understanding (not necessarily achievable at a vocational school). But how can a university add skills training without becoming a vocational school and at a minimum cost? The quick answer: *it’s not cheap.* PMC spent $1.5 million in Toronto on education, $600,000 on computer training alone.

It can be difficult to draw the line between knowledge of a subject and mastery of essential skills, but this is a major issue now because of the ever-increasing amount of information that must be absorbed in a small amount of time.

UNIVERSITY PERSPECTIVE

Dr. Norm Shulman*, Executive Director, Office for Partnerships for Advanced Skills. OPAS brings together the intellectual assets of the universities and advanced training needs of the private sector to foster continuous skill upgrading and lifelong learning.*

Biotechnology is a dynamic changing field -- driven by its inherent nature of moving from research to a finished product. With new research discoveries, new ways of doing things and developments in technology, there is an increasing need for the principle of lifelong learning as critical skill requirements keep changing. Examples of such developments include new methods of production (for example, the movement of insulin production from extracting pancreas glands to genetic engineering), and the rise of computerized process control. Consequently, the skills of workers are dynamic and changing; they need to be constantly fine-tuned.

The demand for continued learning is not unique to the biotechnology sector; the same issue has been heard from IT and telecommunications sectors. Employees do not have the time to go back to school to take conventional full-time courses. Should the Individual – already working long hours and with little time for family and personal pursuits -- take some responsibility to remain employable? Or does the Employer take prime responsibility? Many do, although some equate continued learning with a cost rather than an investment. Perhaps government should assume the responsibility since it means less unemployment and a broader tax base.

A number of different approaches are being tried.

Companies can offer workforce training by sending employees out to existing courses or by contracting the provision of an internal course. Internal courses offer the advantages of being tailored more to the company's specific requirements, can be of any length and level of detail, and offer greater scheduling efficiency. They are generally, however, costly to develop. For a larger workforce, where the costs of content development can be spread over a number of employees, a customized internal course is often preferable. In this case, companies tend to identify external competence and negotiate a program to be delivered. Individual university faculty may be used as resources, with the relationship being a direct one between the faculty member and the company.

Keeping research staff current is also a key issue. However, since there are so many significant scientific developments regularly unfolding, only a critical mass of employees would make regular updates an affordable proposition for a company. Very few Canadian companies are large enough to develop and deliver seminars for their research staff and to bring in college workshops for their technical staff.

Universities offer a useful mechanism for addressing some workforce training needs; however, there is potential for this contribution to be increased. Issues include access, scheduling and motivation.

Finally, the growing need for university-based upgrading of skills comes at a time when universities have limited resources due to a serious decrease in public funding. Since 1992, Ontario universities have endured a 25% decrease in financial support and now rank 10th of the 10 provinces on the basis of per capita funding. This means that Ontario universities are not well positioned to invest money in new ventures. Contrast this with the high demand from industry in Ontario for suitable graduates.

DISCUSSION

While larger companies can afford to recruit people with specific skills and provide training where required, small companies are often unable to do so and rely on generalists with various skills.

Focused expertise is an acceptable hiring criterion for an established company but, for start-up companies that do not generally have adequate financing and infrastructure in place, a diversity of skills is also needed. The problem is a discovery scientist generally does not want to work for a large company. There are tradeoffs to consider between training for in-depth knowledge and a broader education.

There is a need to increase curriculum development funding. The corporate community can help universities by targeting government and delivering this message. The problem exists because the sector as a whole has not convinced government that funding for university needs to be restored and increased.

More focused and up-to-date curriculum will help drive the expansion of the biotechnology sector and individual companies. The industry representatives at the symposium could assist in the expansion drive by providing lectures as part of a course on the business world without expending much in resources in terms of time and money.

Successful training must accommodate work schedules and business demand.

Industry has found it difficult to work with universities on professional development for their workforce. OPAS provides a solution to this problem and some work has already been done in this new context.

From the preceding discussion, a number of solutions were proposed in each area of discussion.

CONCLUSIONS AND RECOMMENDATIONS
(loud and clear request for action to government)

RESEARCH

While some important government initiatives have been undertaken such as the R&D Challenge Fund, Ontario Business-Research Institute Tax Credit (CRI), much more is needed. More extensive co-ordination between the provincial and federal governments is vital.

The high cost of research overhead and infrastructure must be recognized and supported if Ontario is to sustain a world-class research capability.

Successes need to be made more visible to help garner the support needed for a strong biotechnology presence in Ontario; and both industry and academia need to engage customers.

A program(s) of postgraduate and Faculty Internships and secondments would advance biotechnology a good deal.

Scientific evaluation of technology should be ‘built into’ commercialization.

Closer interface between science and business is needed for proof of concept studies.

Technology transfer/commercialization centres are working, but the research base/strength is not robust enough. A “Biotechnology” Centre of Excellence would be a vital step forward.

Internships and other industry-university exchanges need to be strongly promoted.

While research is the main focus for universities, the commercialization of research is the prime concern of industry. It is therefore important to find ways to bring the two groups together and create continuity between the two priorities.

Universities must retain their brightest researchers--for the sake of pure research and for commercialization. This requires adequate funding to provide staff and other support for these researchers.

The existing Centres of Excellence do not include a Biotechnology component. Establishing Biotechnology Centre of Excellence, which would not necessarily be a bricks and mortar centre, would be a major step forward for biotechnology. A Centre would necessarily build on existing networks to achieve the ‘critical mass’ needed for success.

One way of bringing university researchers and industry closer would be via exchanges that would bring faculty to industry settings for sabbaticals and at other times, while those working in industry could become involved with the universities, for example as adjunct faculty.

Biotechnology must be more effectively marketed; that is, the importance of the sector to the economy must be emphasized in order to obtain more government support, along the lines of the Quebec model.

Industry and universities can work together to educate the public on what biotechnology involves and its importance.

Follow-up:

To pursue these issues, a working group was struck: Dr. Eleanor Fish, Associate Professor, Department of Medical Genetics and Microbiology, University of Toronto; Ms. Eleanore Rupprechte, Manager, Biotechnology Secretariat, Ministry of Energy, Science and Technology; and Dr. Brian Underdown, Vice-President of Science and Technology, MDS Capital Corp. and University Medical Discoveries Inc.

CURRICULUM DEVELOPMENT

Universities should:

- Pay more attention to **essential skills.**
- **Extend co-op placements and internships** up to one year in length and expand their horizons to include international placements (with government and industry support).
- Increase the **quality of technical skills** being taught (for example, lab/bench skills).

Industry should:

- **Support co-op programs** including the cost of operating them.
- **Increase awareness of the job opportunities** in biotechnology.
- **Be aware that increasing the quality** of university graduates is a cost issue for universities and that they are already under financial constraints.
- Develop a roster of speeches through which to ‘market’ biotechnology and its importance.

Government should:

- Definitely **increase funding for innovative curriculum development** (eg. a Curriculum Challenge Fund) and facilities for updating.
- Target funding for biotechnology.
- Be aware industry will need managers as well as technicians in the future (Queen's University has established a Centre for Management in Biotechnology Industries).
- Support initiatives to increase awareness in high schools and with the general public through science fairs, lectures, etc.

A revised curriculum for Ontario universities might:

- Focus on the most promising areas of biotechnology: bioinformatics; biomaterials; molecular modelling; and medicinal chemistry with a strong emphasis on molecular biology.

- Favour more time spent on problem-solving, communications and teamwork at the expense of some rhetorical instruction. Because this shift in focus will require more faculty-intensive time in small groups, it may be necessary to divert some of the large number of undergraduates going into advanced detailed fourth-year course work toward more business-oriented education. The small but growing numbers of combined science and business programs are early examples of this trend.

Universities, industry and government should agree on:

- A strategy for increasing and improving biotechnology education capacity at all levels: high schools, community colleges, universities (both undergraduate and graduate levels) through to ongoing industry-university liaisons such as the internships so often mentioned. Global competition means Canada cannot risk being left behind because it has no cohesive skills strategy. Government (and BHRC and OPAS) can act as facilitators to increase co-operation and co-ordination between academic and research institutions and various industrial groups.

- A funding strategy for the new curricula. Perhaps this could entail the revival of the Premier's Council grants for industry-university research collaborations.

Follow-up:

To pursue these issues, a working group was struck: Dr. John R. Clement, President, J.R. Clement and Associates; Dr. Morton Globus, Professor of Biology, University of Waterloo; and Ms. Mary Kuzyk, Vice-President, Human Resources, Hemosol Inc.

WORKFORCE TRAINING

- Industry must decide whether it wants to make use of what is currently in place at universities or of the new initiatives such as OPAS that universities are offering.
- It is vital to bring professors into an industrial setting to train company staff instead of sending the staff to a university environment. Instructors, therefore, should be compensated accordingly.
- Training must be made easy for the company; it must fit into their schedule.
- Courses are needed in quality assurance and quality control, regulatory affairs and pharmacology, as well as project management and communications.
- The biotechnology sector should continue to build on the initiatives that have already started with universities and with OPAS.
- If Ontario (and Canada) want to compete on a global basis, there must be acknowledgment that training and education are lifelong activities, especially in a knowledge-based economy.

Follow-up:

To pursue these issues, a working group was struck: Mr. Craig Anhorn, Director of Organizational Transformation, Pasteur Merieux Connaught - Canada; Mr. Terrance M. Hunsley, Executive Director, BHRC; and Dr. Norm Shulman, Executive Director, OPAS.

ANNEX 1

Co-Chairs:

Dr. William C. Leggett, Principal and Vice-Chancellor, Queen's University. Dr. Leggett is one of Canada's leading experts in the dynamics of marine fish populations. His knowledge of biotechnology derives from its application to his own research, and from his leadership in developing and overseeing research centres and institutes focused on biotechnological research and its applications. Prior to his appointment at Queen’s, Dr. Leggett served as Vice-Principal (Academic) at McGill University.

Mr. Graham Strachan, President and CEO, Allelix Biopharmaceuticals Inc. Mr. Strachan is Director of BIOTECanada and Director (and Past President) of BIO, an international trade association for biotechnology companies in Washington, D.C. In 1992, he was appointed Chair of the National Biotechnology Advisory Committee, which advises the Minister of Industry on biotechnology in Canada. Mr. Strachan also serves as Chair of the Biotechnology Human Resource Council, and Director of Resolution Pharmaceuticals Inc. and Base4 Bioinformatics.

Industry Representatives:

- Mr. Craig Anhorn, Director, Organizational Transformation at Pasteur Merieux Connaught - Canada
- Dr. John R. Clement, President, J.R. Clement and Associates
- Mr. John F. Hill, Consultant, Grapevine Executive Recruiters Inc
- Dr. George Jackowski *(Member, Symposium Steering Committee)*, Vice-Chairman and Chief Scientific Officer, Skye Pharmatech Inc.
- Ms. Mary Kuzyk, Vice-President, Human Resources, Hemosol Inc.
- Dr. Gordon Surgeoner, President, Ontario Agri-Food Technologies
- Mr. Bruno Syfrig, President, Novartis Canada
- Mr. Graham Strachan *(Co-Chair),* President and CEO, Allelix Biopharmaceuticals
- Mr. Brian Underdown *(Member, Symposium Steering Committee)*, Vice-President of Science and Technology, MDS Capital Corp. and University Medical Discoveries Inc.
- Dr. J. R. (Jack) Wearing, President, Wearing Development Inc.
- Dr. Michael West, Vice-President, Clinical Research, GLYCODesign Inc.

University Representatives:

- Dr. Bill Cade, Dean, Faculty of Mathematics and Sciences, Brock University
- Dr. Iain Lambert, Associate Dean of Science and Director of the College of Natural Science, Department of Biology, Carleton University
- Dr. David Hume, Professor, Department of Plant Agriculture, University of Guelph
- Dr. John Phillips *(Member, Symposium Steering Committee)*, Professor, Department of Molecular Biology and Genetics, University of Guelph
- Dr. Harvey Weingarten, Provost and Vice-President, Academic, McMaster University
- Dr. John Capone, Professor and Chair, Department of Biochemistry, McMaster

University

- Dr. Howard Alper, Vice-Rector (Research) and Professor of Chemistry, University of Ottawa
- Dr. William C. Leggett *(Co-Chair),* Principal and Vice-Chancellor, Queen's University
- Dr. Steven Liss, Assistant Chair, Department of Applied Chemical and Biological Sciences, Ryerson Polytechnic University
- Dr. Cecil Yip, Vice-Dean, Research, Faculty of Medicine, University of Toronto
- Dr. Eleanor Fish *(Member, Symposium Steering Committee)*, Associate Professor, Department of Medical Genetics and Microbiology, University of Toronto
- Dr. Morton Globus, Professor of Biology, University of Waterloo
- Dr. William Bridger, Vice-President (Research), Department of Biochemistry, The University of Western Ontario
- Dr. Art Szabo, Director, Great Lakes Institute for Environmental Research, University of Windsor
- Prof. R.E. Pearlman, Director, Core Molecular Biology Facility, Department of Biology, York University

Government Representative:

- Ms. Eleanore Rupprechte, Manager, Biotechnology Secretariat, Ministry of Energy, Science and Technology

BHRC Representatives:

- Mr. Mark Feldbauer *(Member, Symposium Steering Committee)*, Senior Associate, Communications, Biotechnology Human Resource Council
- Mr. Terrance M. Hunsley, Executive Director, Biotechnology Human Resource Council
- Ms. Alice Kubicek, Skills Development Co-ordinator, Biotechnology Human Resource Council

OPAS Representative:

- Dr. Norm Shulman *(Member, Symposium Steering Committee)*, Executive Director, Office for Partnerships for Advanced Skills