REPORT
GOVERNOR'S TASK FORCE
ON BIOTECHNOLOGY

January 28, 1985

Prepared by
The Governor's Task Force on Biotechnology
and the
Minnesota Office of Biomedical/Health Systems

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EXECUTIVE SUMMARY

GOVERNOR'S TASK FORCE ON BIOTECHNOLOGY

THE CHALLENGE

Minnesota needs a strategy to assist the economic growth of a biotechnology-related industry. Such a strategy will create new jobs, attract new capital to the State and advance Minnesota's leadership position in industries such as agriculture, forestry, food processing, biomedical devices and computers. This report very briefly assesses Minnesota's current strengths and weaknesses and recommends steps that the State should consider to strengthen its competitive position.

THE OPPORTUNITY

While we may not have as many large biotechnology-oriented chemical and pharmaceutical companies as competing centers, we do have world-leading companies in medical devices, supercomputers, process control, agriculture and food processing. There are complementary programs in bioprocess technology, molecular biology, chemical engineering, biomedical engineering, surgery, computer science, agriculture, and food sciences at the University of Minnesota. Combination of these strengths, with the vigorous

interaction among researchers, manufacturers, and users that our geographical proximity and social mechanisms encourage, could lead to the rapid development of unique products and processes with great economic importance to the State.

MEASURING THE ECONOMIC IMPACT

A model does exist in Minnesota whereby we can evaluate the impact on jobs and new business development in a high technology field. A multibillion dollar medical device industry (over 150 medical device firms) grew largely from the founding of Medtronic, Inc., which had its origins from within the University's Department of Surgery.

Current and proposed University programs in modern biology can support leading researchers, attract new capital to the State, create jobs at the University and eventually spin off ideas, products and new businesses.

STATE OF THE ART

In Minnesota new biotechnology companies are springing up and established companies are slowly turning their interests toward biotechnology. Efforts are being directed toward designing new agricultural products, improving food and other fermentation processes and designing new related medical devices and computing capabilities.

Public/private linkage groups are presently very active in Minnesota. These groups have the potential, as yet not fully committed, of offering a very strong support system for networking and attracting community support.

Biotechnology efforts at the University of Minnesota are spread among many departments and graduate programs, rather than being primarily centralized in one building, center or institute. The lack of aggregation and related low visibility may be deceptive in judging the extent and quality of these efforts, because many of the biotechnology-related efforts are nationally and internationally recognized. Old programs are being restructured and new programs are taking shape in bioprocess technology, human genetics, plant molecular biology, cancer research and animal biology. New efforts promise to extend this knowledge to undergraduate and high school students.

RECOMMENDATIONS

This report has briefly surveyed the interests and strengths of current biotechnology-related university programs and state industries. The overview is encouraging; we have substantive programs in place or coming on board in the University, and the business of the State lends itself readily to the commercialization of modern biology. Yet we have noticeable

weaknesses. Many states have already addressed their weaknesses and it is time for Minnesota to take similar actions, particularly as they apply to the agricultural, biomedical and computer business sectors.

The following recommendations are directed toward correcting perceived weaknesses. Each recommendation needs to be studied and expanded further by government appointed commissions, legislative forums and private sector trade and community associations. Finally, the public must be educated as to the value of biotechnology to our State and the rationale for increasing our commitment to education, research and new business development.

RECOMMENDATION 1: Establish a permanent commission to develop a long-range biotechnology strategy for the State.

RECOMMENDATION 2: Initiate new K-12 programs of science education.

RECOMMENDATION 3: Encourage support for undergraduate programs in biotechnology.

RECOMMENDATION 4: Strengthen the University's infrastructure in biotechnology and in related technologies.

RECOMMENDATION 5: Encourage current and create new interfaces between the University and industry.

RECOMMENDATION 6: Develop incubator space for new biotechnology-related start-up companies near the University (incorporated into the Technology Corridor concept).

RECOMMENDATION 7: Explore legislative proposals to advance financing for incubator funding opportunities to University and industry entrepreneurs.

RECOMMENDATION 8: Provide tax incentives to young high technology companies in the more advanced development stage.

REPORT

GOVERNOR'S TASK FORCE ON BIOTECHNOLOGY

I. INTRODUCTION

A. The Challenge

Minnesota needs a strategy to assist the economic growth of a biotechnology-related industry. Such a strategy will create new jobs, attract new capital to the State and advance Minnesota's leadership position in industries such as agriculture, forestry, food processing, biomedical devices and computers. This report very briefly assesses Minnesota's current strengths and weaknesses and recommends steps that the State should consider to strengthen its competitive position.

B. Definition

Prior to assessing Minnesota's position in biotechnology, the Task Force deemed it necessary to agree on an operational definition of biotechnology as a starting point for discussion. The operational definition agreed to is the following:

> "The application of knowledge and techniques of advanced biological sciences. This includes such techniques as recombinant DNA, genetic engineering, monoclonal antibodies, cell fusion,

tissue culture, cloning, new embryo technology, and related areas of biology. It also involves advanced biomedical engineering, biomaterial science, and the interface between computers and biology for the design or production of commercial products and processes."

It is important to recognize that the "bio" in biotechnology refers to the modern day capability of altering living cells (plant, animal or bacterial) to make novel products. The "technology" refers to the enabling aspects of engineering, material sciences, computers and agricultural production.

C. The Opportunity

Biotechnology in Minnesota is developing in a unique environment. While we may not have as many large chemical and pharmaceutical companies as competing centers, we have world-leading companies in medical devices, supercomputers, process control, agriculture, and food processing. There are complementary programs in bioprocess

technology, molecular biology, chemical engineering, biomedical engineering, medicine and surgery, computer science, agriculture, forestry and food sciences at the Univeristy of Minnesota. Combination of these strengths, with the vigorous interaction among researchers, manufacturers, and users that our geographical proximity and social mechanisms encourage, could lead to the rapid development of unique products and processes with great economic importance to the State. Some examples:

Medical: New biosensors are needed both in implantable biological drug delivery systems and in large-scale production bioreactors. The scientific expertise to devise such sensors can be brought together from a number of University departments; the results can be tested, refined, and brought to commercial utilization in a variety of local companies.

Process control: Several Minnesota companies are leaders in process control and should be attracted by the opportunity to expand their markets to bioprocess technology.

Computer: The computer technology and supercomputer power provided by local companies will be essential to meet the computational demands of protein and drug design, biomolecular graphics and complex bioprocess control. Interactions between genetic engineering firms, University researchers and the Minnesota computer industry should develop some unique computing strategies. One day the computer may depend upon a "biochip" and have a biological (DNA) memory.

Agriculture: Agricultural applications of biotechnology, in such areas as animal health products, animal and plant breeding, and pesticide and herbicide resistance, are among the most promising and most likely to come to early fruition.

Food Processing: Minnesota has the largest collection of food processing firms in the country, along with related distinguished University programs in food science and nutrition, chemical engineering and biochemistry. This may mean the eventual commercialization of new products, e.g., starches, flavors, sugars or as an example, a high protein, nutritionally enhanced cereal.

The committee perceives that a great deal of the early innovation in biotechnology will come in the agricultural sector. This makes it particularly relevant and urgent that the Minnesota agribusiness community, in order to sustain its current prominence, be urged to focus upon these opportunities. Also, an increasing proportion of State agricultural research dollars should be directed at the emerging technologies. We must also be particularly alert to opportunities in the biomedical and computer industries, where the State's current business strength can most easily capture new markets.

D. Overview

Businesses likely to be affected by biotechnology (plant and animal agriculture, agricultural processing, mineral and petroleum extraction and processing, forestry products, manufacturing of pharmaceuticals and medical devices, and the computer industry) currently represent 15% of the GNP. While the large-scale impact is yet to be felt, plausible forecasts are impressive. By the year 2000, the worldwide market for products of biotechnology

is projected at nearly $65 billion. (This forecast considers only the newly designed products of living cells and not the hardware or equipment needed to manufacture or deliver the products.) (Sheets T.A. (1982) Eur. Chem. News/March 15, p.17):

Application	$ Billion
Energy	16.35
Foods	12.66
Health Care	9.08
Chemicals	10.55
Agriculture	8.55
Others	7.67

This estimate does not include the value of capital investments, building and leasehold improvements, etc., which would be required to support this industry.

The significance of the new opportunities, as perceived by existing industrial firms, may be assessed by noting that in 1982, all but one of the top ten chemical companies had a commitment to genetic engineering (Donnelly

L.W. (1982) Chem. Eng. Progr. 78 #11). Over $500 million has been invested in new biotechnology companies by chemical and pharmaceutical firms, by venture capital, and by public stock offerings (Chemical and Engineering News, March 29, 1982, p. 11).

The biotechnology industry will provide new employment opportunities. This means jobs not only for highly trained personnel, but also for less skilled workers. For example, the projected employment profile (1987) of Molecular Genetics, Inc., a Minnesota-based biotechnology company, is as follows:

30	Ph.D. or equivalent
100	college education
170	2 years college or high school
300	Total Employees

Biotechnology holds enormous economic potential for the United States, but other countries are vigorously exploiting it as well. Japan is particularly noteworthy (Business Week, February 23, 1981, p.46H). "...it could

mount the same challenge to the U.S. in biotechnology markets in the 1980s as it did in the automotive, steel, and microelectronics markets in the 1970s."

Within the United States, several states have established a high profile in biotechnology development. California, Massachusetts and North Carolina are particularly recognized as leaders. Many other states, including Virginia, Maryland and New Jersey (a recent bond issue will build centers at Rutgers and Princeton) are launching state financed development programs to support biotechnology research and training.

Thus, to develop new products and exploit new markets, to make existing products more cheaply and efficiently, to anticipate inevitable changes in agriculture, food processing, medicine and other industries, and to strengthen its position in a highly competitive international economy, Minnesota must vigorously pursue new opportunities in biotechnology.

E. The Economic Impact

1. An Industrial Model

A model does exist in Minnesota whereby we can evaluate the impact on jobs and new business development in a high technology field. A multibillion dollar medical device industry (over 150 medical device firms) grew largely from the original founding of Medtronic, Inc. and from the University's Department of Surgery's Ph.D. program. We wish to briefly review this flow of intellectual property from the University to the private sector, which can serve as a paradigm for biotechnology development in our State.

MEDTRONIC AS A MODEL

Cooperative efforts between Dr. C. Walton Lillehei, a distinguished Minnesota academic surgeon, and Earl Bakken, co-founder of Medtronic, Inc., led to the development of the first wearable cardiac pacemaker in 1958. In 1960 its implantable counterpart was introduced. Since 1949, when Medtronic was established, many large and small companies producing medical devices have

been founded in Minnesota. New companies are continuing to "spin off" from large established firms and as a result of related biomedical research at the University of Minnesota.

In 1984 Medtronic, Inc. sales were reported at $422.7 million. Medtronic employs 5000 people world-wide and does business in more than 75 countries. (Approximately 50% of Medtronic's personnel are employed within Minnesota.) Today Medtronic is the world's leading maker of implantable medical devices, including designing, manufacturing and marketing cardiovascular systems, neurological systems and mechanical heart valves.

Roots of the state's multi-billion dollar medical device industry can be traced directly to spin-offs (which includes over 150 medical device firms) from Medtronic, Inc. Some Minnesota-based Medtronic spin-off firms include:

Cardiac Pacemakers, Inc.

Renal Systems

St. Jude

Stimulation Technology

EMPI

Aequitron Medical

Cardio-Pace Medical

Med Tel

Medical Devices, Inc.

Pharmadyne Corp.

Vivatron, Inc.

WR Medical Electronics Company

Population Research

Angiocor

Biomedicus Inc.

Sci Med Life Systems

Mentor

These businesses have attracted new capital to Minnesota from around the world. Furthermore, the profits from these corporations have provided venture capital to many new Minnesota businesses in totally unrelated markets.

2. An Academic Model

A review of the current University programs in modern

biology reveals data very similar to the industrial model, i.e., leading researchers attract new capital to the State, create jobs at the University and eventually spin off ideas, products and new businesses. A mature investigator at the professorial level brings to the State about $150,000 in direct annual grant support from federal programs and private foundations. Federal grants account for roughly two-thirds of the monies and attract an additional 50% indirect cost reimbursement. Each research professor is likely to attract, or train and retain, given adequate support of salaries and space by the University, an additional four faculty. The younger investigators are likely to average about $75,000 in direct grant support.

If the State were to commit $12 million (packaged as start-up monies for salaries, supplies and equipment) to specifically attract 12 new senior faculty in biotechnology-related sciences, the impact might be estimated to create as many as 200 new jobs and attract $8.0 million of new capital to the University annually.

II. STATE OF THE ART ASSESSMENT

A. Industry

In Minnesota new biotechnology companies are springing up and established companies are slowly turning their interest toward this area. Several industrial sectors are involved:

1. Agriculture related efforts

   a) Plant growth regulation and modifications related to improving yields, nutritional value, winter hardiness, disease and insect resistance, and efficiency of converting nutrients into plant materials are examples of work that show promise. For example, the development of cereal grains with a more correct balance of essential amino acids are being developed.

   b) Biotechnology techniques are being used to understand and manipulate animal bioregulation for purposes of improving growth rate and efficiency of growth, milk yield and

reproductive efficiency through increased twinning. Research on embryo splitting and cloning of animals to more rapidly propagate genetically superior animals is an example of such work.

c) The control of plant and animal diseases through improved diagnostic techniques and biologicals to control losses from disease is an area where biotechnology has already had an impact. New animal vaccines and cereals resistant to fungus have been developed.

2. Fermentation related efforts

a) Modification of non-pathogenic organisms is in progress to improve certain food processes, convert biomass into more useful products and to produce biologically active compounds. Three examples are:

i) Modified fermentation organisms for the improved production of cheese and sausage have been produced.

ii) Genetically engineered organisms are used in the production of a growth hormone which in recent tests caused greater than a 30% increase in milk production.

iii) Organisms are being developed to convert cellulose and lignin into digestible nutrients for ruminant livestock and remove toxic materials (e.g., PCB's) from waste disposal sites.

3. Medical device and computer related efforts

a) Implanted capsules acting as artificial pancreases capable of secreting insulin when a recipient's blood sugar falls are being designed.

b) Computers are being modified to design new proteins and genes.

Many industrial corporations both large and small within the State have committed to biotechnology research and new product development. A partial list includes:

1. Agriculture related efforts

   Molecular Genetics, Inc.

   Cargill

   Genesis Labs, Inc.

   Northrup King (Sandoz)

   Keltgen Seeds (United Agriseeds)

2. Fermentation related efforts

   Endotronics

   Economics Laboratories

   Cargill

3. Biomedical related efforts

   Medtronic, Inc.

   CPI

   St. Jude Medical

   3M

   Maico, Inc.

   LecTec

   Kallestad

   Immunonuclear

   Diagnostics, Inc.

B. Public/Private Partnerships

Public/private linkage groups are presently very active in Minnesota. These groups have the potential, as yet not fully committed, of offering a very strong support system for networking and attracting community support.

1. Minnesota High Technology Council (MHTC)

MHTC is an organization of more than 150 leading technology oriented corporations in Minnesota. It was formed in 1982, and is committed to preserving an environment in Minnesota that is favorable to the creation and growth of technology-intensive industry. The Council is focusing its efforts on increasing state funding for a number of science and engineering education programs and facilities. The Council's major interest is to improve the quality of education and thus increase the quantity and preparedness of scientists, engineers and technicians for Minnesota industry. The Council supports key technology-related legislation and conducts numerous programs to educate the public on the value of technology.

2. Minnesota Wellspring

Twenty-eight leaders in labor, business, agriculture, education and government created Minnesota Wellspring in 1981 as an active alliance of leaders in labor, business, agriculture, education and government to strengthen technology-powered job creation and economic vitality. Serving as a Board of Directors, these leaders govern this non-profit corporation with the guidance of the Governor as honorary chair and with one representative of labor and of business serving as co-chairs. Minnesota Wellspring was designed to work for the expansion of technological innovation and the increased generation of new jobs. Its goal is to mobilize Minnesota-based support for job creation by encouraging creative thinking, scientific discovery, technological innovation, business growth, and the development of public policy. It operates with a task force design, with many in operation, including one titled, "Technology and Expansion of Employment", chaired by William C. Norris.

The staff of Wellspring is located in the State Planning Agency, where it carries out studies and makes recommendations for activities designed to improve Minnesota's economy.

3. Minnesota Business Partnership, Inc.

The chief executive officers of 60 of Minnesota's largest corporations formed an alliance in 1978 that is known as the Minnesota Business Partnership. The Partnership is organized into five task forces for Small Business and Job Creation, Competitive Environment, Communications, Education and Transportation.

A number of specific initiatives of importance to high technology growth and development in Minnesota have been created by these task forces, including the Minnesota Seed Capital Fund, a for-profit venture specializing in providing early stage, start-up financing for new firms; Mid-American International Trading, an entity created to assist both small and medium-sized businesses in the Midwest in marketing

their products and services; the Help Start a Company Program, where participating larger companies each make a commitment to help start at least one new company through the assignment of a high-level executive to work as an in-house promoter of the program.

4. Medical Alley Association

The Medical Alley Association was established in November 1984 to act as the trade organization for all firms and institutions making up Minnesota's medical and healthcare industry. The purpose of the organization is to build and promote Minnesota's "World Health Technology Center".

C. University of Minnesota

Biotechnology efforts at the University of Minnesota are spread among many departments and graduate programs, rather than being primarily centralized in one building, center or institute. This structure is not atypical but the lack of aggregation and related low visibility may be

deceptive in judging the extent and quality of these programs. Many of the biotechnology-related efforts are nationally and internationally recognized even though the effort is sometimes centered around very few people.

A survey of faculty in 1983 indicated that 175 biotechnology-related projects in 20 departments brought in $15.6 million from federal and private funding sources. Research efforts at the Twin Cities campus include:

1. Biotechnology Research Center

The Biotechnology Research Center (BRC) is an all-University organizational construct intended to coordinate and foster UM programs in biotechnology. The Center has currently identified ten multi-disciplinary biotechnology programs throughout the University. They are biological process technology, biomass technology, biomedical engineering, clinical diagnostics, environmental biotechnology, food processing biotechnology, human genetics, plant molecular biology, pharmaceutical and immunological technology, and reproductive biology.

As individual biotechnology programs have developed within individual colleges and departments, the fostering and coordinating functions of the Biotechnology Research Center have given way to the information-gathering and disseminating function of the Biotechnology Information Office.

2. Biotechnology Information Office

The Biotechnology Information Office is being established to serve as a central reference and referral agency for biotechnology research activities at the University of Minnesota. It will maintain a data base on research projects, compile statistics on biotechnology activity at the University, and refer inquiries to the appropriate faculty member or special research facility.

3. Biological Process Technology Programs

Biological Process Technology was early recognized as a special priority because of its importance in bringing the promise of genetic engineering to practical fruition and because of the University's

strengths in many of the key academic departments such as Chemical Engineering, Biochemistry and Microbiology. There are three related components to the University's efforts in this area:

a. Institute for Advanced Studies in Biological Process Technology: The Institute is a unique interdisciplinary academic program whose goal is stimulating graduate training and advanced research into the biological and engineering problems fundamental to scale-up of industrial bioprocesses. Its new director will be Biochemistry Professor Michael Flickinger, currently Director of Fermentation Reserach at the National Cancer Institute. This facility is designed for investigation of contemporary problems in biological processes and incorporates new and development technologies in its pilot-scale equipment. The research interests of the faculty are generic but with a strong appreciation for industrial application.

b. Industry-University Cooperative Research Center: The Center, formed under the auspices of the National Science Foundation, performs industry-funded research on biological process technology. It is directed by Professor Victor Bloomfield, Professor and Head of the Department of Biochemistry in the College of Biological Sciences. There are currently about 40 participating faculty, from 15 departments in seven colleges of the University, associated with the Center. Starting with about ten industrial members in 1985, the Center membership is expected to grow to about 30 in a few years, with each company contributing $30,000 annually. Research priorities of the Center are determined in consultation with the industrial members.

c. Microbial Engineering MS Program: Suitably trained personnel are in short supply for industrial work in biological process technology. The Department of Microbiology at the University,

in cooperation with the Department of Chemical Engineering, has instituted a new MS program. The program, under the direction of Microbiology Professor Palmer Rogers, educates students who have a BS in Chemical Engineering in the fundamentals of the genetics, physiology and biochemistry of industrially important microorganisms. Conversely, students with a basic degree in modern biology receive training in the core curriculum of chemical engineering. Both groups obtain practical experience through preceptorships with local biotechnology companies.

4. Institute of Human Genetics

The Institute of Human Genetics was inaugurated in 1984 as an effort to aggregate and develop programs in modern biology within the University's biomedical complex. Old genetics programs will be revitalized and new programs will be funded and staffed. This includes the disciplines of: 1) molecular genetics, 2) behavioral genetics, 3) clinical genetics and 4)

genetic services. Clinical programs cover much of the state including St. Cloud, Duluth and Mankato. New laboratory programs are directed toward understanding the genetic basis of Alzheimer's disease and the fundamental condition of gene damage and repair.

5. Plant Molecular Biology

Research and graduate education in Plant Molecular Biology at the University is primarily carried out in two colleges on the St. Paul campus--the College of Biological Sciences (CBS) and the College of Agriculture. Six departments are represented (Biochemistry, Botany, and Genetics and Cell Biology in CBS; Agronomy and Plant Genetics, Horticultural Science and Landscape Architecture, and Plant Pathology in the College of Agriculture).

Under the Competitive Grants Program of the USDA, 21 grants totalling about $1.7 million have been awarded to the University faculty in this program. These faculty recently received a McKnight Foundation Grant ($750,000) to fund the training of students in plant

molecular biology. Finally, the University successfully competed to be a training center for a new USDA National Needs Graduate Fellowships Grant program.

One program--The Molecular Biology of Economic Plants with Applications to Agriculture--has received worldwide recognition for studies of the expression of corn (maize) genes and the synthesis of corn storage proteins.

6. Cancer Research

Cancer research at the University of Minnesota is performed in many different departments. One highly visible effort is that of Drs. Daniel Vallera and John Kersey to use monoclonal antibodies--the so-called "guided missiles" of medicine combined with the plant toxin ricin to prevent the sometimes fatal complications of bone marrow transplantation--initially in mouse experiments and now extending to clinical trials in humans. Transplantation of bone marrow is used to treat various forms of acute leukemia, aplastic anemia and some disorders of the

disease-fighting immune system. Another important program headed by Dr. Jorge Yunis has identified chromosomal defects in cancer patients.

7. Food Fermentation Organisms

Work in this area in the College of Agriculture is concerned with the application of genetic engineering for improving starter cultures for cheese, yogurt, buttermilk and fermented sausage. Organisms modified to stabilize lactose metabolizing ability, to be phage resistant and to produce inhibitory substances against other organisms that decrease product shelf life have been developed.

8. Animal Disease Resistance

This is an area where a number of new diagnostic techniques are being developed through monoclonal antibodies and other biotechnologies. In addition, work is underway to improve resistance to disease in certain animals utilizing genetic engineering.

9. Reproductive Biology

The biotechnology aspects concerned with this area are

directed toward in vitro fertilization which is a joint effort between individuals in the Colleges of Agriculture and Medicine. Other work is concerned with embryo splitting in cattle and improved techniques to make this more commercially feasible.

D. State University System

1. Mankato State

a. Undergraduate biotechnology program:

Mankato State University has proposed that there be added to the Department of Biology curriculum an emphasis in biotechnology at the undergraduate level. Graduates of this program would be awarded the degree of Bachelor of Science in Biotechnology and would be prepared for employment as biotechnicians in industries involving microbial or biochemical production processes, or for continued study at a graduate level.

b. Honors workshop (NSF Grant):

The purpose of this funded grant is to use biotech-

nology as a vehicle to engage qualified high school biology teachers in applied research so that they can better teach biology. The workshop will involve 20 participants for each of two years. The participants will be involved in actual biotechnology research during a nine-week summer program where they will be working with University faculty as research associates. Once the participants leave the workshop, they then will spend the year working this knowledge into their classroom curricula and finally return to Mankato State to summarize the benefits of this experience.

III. ECONOMIC CONSIDERATIONS

A. Current Government Incentives

Certain Minnesota tax provisions may benefit new and existing biotechnology companies. The following is a list of select provisions that may be useful. Many of the provisions are relatively new and in somewhat of a state of flux.

1. Research and Development Credit: A research and development credit similar to the federal credit has been established. Qualifying expenditures are the same as for federal purposes except that they must be made within Minnesota. Contributions to a nonprofit organization established to provide funds for establishing small, high technology businesses in Minnesota qualify. The credit is 12.5% of the first two million dollars of qualified expenses which are in excess of the average expenses for the preceding three years and 6.25% of qualified expenses in excess of two million dollars. The credit is nonrefundable but a carryback and carry-forward of any unused credit is allowed. An additional credit applies with respect to qualified expenditures relating to certain subsidiaries operating in Puerto Rico. (Mn. Statute 290.068)

2. Small Business Investment Credits: Several tax credits, with very complex requirements, have been established to encourage small business. Briefly, the credits are:

a) A credit to corporations of 30% of the value of technology transferred to a qualifying small business. The value of technology cannot exceed $1 million in any year. The transferor must have exclusive rights to the technology and must not retain a proprietary or financial interest after the transfer. The transferee cannot be an affiliate or subsidiary and must make an investment in developing technology.

b) Contributions to a qualified small business assistance office or innovation center by a corporation qualify for a 50% credit on the first $50,000 of such contributions.

c) A credit equal to 30% of the net investment in excess of $25,000 in the equity stock of a qualified small business is allowed up to $75,000 per year. The credit cannot exceed 75% of the tax liability after subtracting other credits. Additional credit applies if the small business is in an enterprise zone. The basis of stock is

decreased by the amount of the credit. This credit also applies to individuals.

The small business, the small business assistance office and the innovation center must be located in Minnesota. The credits become effective for years beginning after December 31, 1983 and expire, except for possible carryovers, for transactions or contributions made in years beginning after December 31, 1985. The credits cannot exceed tax liability. There is no carryback available but a 15-year carry-forward applies. (Mn. Statute 290.069)

3. Enterprise Zone: A designated enterprise zone may provide for exemption from sales tax, income credit based on number of employees and debt financing cost for new facilities and special property tax credit. The availability of such zones are extremely limited with broadened application for certain cities bordering states where tax policies hamper business development. The credits cannot last more than five years and are

effective June 15, 1983 with a sunset clause of December 31, 1996 (1983 Session Laws, Chapter 342, Article 8).

IV. RECOMMENDATIONS

This report has briefly surveyed the interests and strengths of current biotechnology-related university programs and state industries. The overview is encouraging; we have substantive programs in place or coming on board in the University, and the business of the State lends itself readily to the commercialization of modern biology. Yet we have noticeable weaknesses. Many states have already addressed their weaknesses, and it is time for Minnesota to take similar actions.

The following recommendations are directed toward correcting perceived weaknesses. Each recommendation needs to be studied and expanded further by government appointed commissions, legislative forums and private sector trade and community associations. Finally, the public must be educated as to the value of biotechnology

to our State and the rationale for increasing our commitment to education, research and new business development.

...

The weakness: This task force worked for less than six weeks without a budget or staff. There was no time to survey in depth the initiatives already implemented by other states, nor were we able to adequately address the feasibility and costs involved in implementing our recommendations.

RECOMMENDATION 1: Establish a permanent, appropriately funded, commission to develop a long-range biotechnology strategy for the state. This body must carefully survey the current climate for biotechnology within the State, track activities of other states and countries and formulate viable legislative programs.

...

The weakness: Many of our state high school graduates have not received up-to-date education in modern biology, chemistry, physics and mathematics.

RECOMMENDATION 2: Initiate new K-12 programs of science education.

a. The Mankato State workshop for science teachers should be expanded to include some other state university campuses.

b. The State should review K-12 science requirements with the intention of upgrading and modernizing science programs.

c. A high school for science should be created to serve gifted students. This may best be accomplished in concert with a high school for the arts.

...

The weakness: Very little educational opportunity in modern biology is available at an undergraduate university level. For instance, fewer children of farmers will be returning to the family farm, yet many have an interest in biology and attend state universities. All students with an interest in biology should be greatly encouraged to pursue careers in biotechnology.

RECOMMENDATION 3: Encourage support for undergraduate programs in biotechnology with particular emphasis on some major campuses besides the University of Minnesota Twin Cities campus.

...

The weakness: Measures to strengthen graduate training and research programs in biotechnology-related disciplines at the Univeristy of Minnesota are largely in a stage of planning or early implementation. Furthermore, we are developing so slowly that we are in danger of losing current faculty. For example, our leading plant molecular biologist has been recruited to lead a New Jersey program. Our biotechnology programs require additional organization and a great deal of additional financial support.

RECOMMENDATION 4: Strengthen the University's infrastructure in biotechnology and in related technologies.

a. Support current legislative proposals in biotechnology.

i) Human Genetics special

ii) Biotechnology special

b. Target new programs for molecular and cell biology, agricultural genetics and animal health care, neuro-sciences and human genetics.

i) Pursue new research funding by State biotechnology-related industries and interested foundations.

ii) Reallocate additional State research dollars toward emerging biotechnologies with emphasis on agriculture, medicine and computer sciences.

c. Create and finance programs to attract new faculty to the University and retain current faculty.

i) Indirect cost reimbursement may provide much needed funds.

ii) Support the use of endowment income from the Permanent University Fund to support endowed professorships.

iii) Additional legislative support and money from local foundations and companies will be needed.

...

The weakness: There is a need to better facilitate the flow of intellectual property from the University to the private sector.

RECOMMENDATION 5: Encourage current and create new interfaces between the University and industry.

a. Work collaboratively with the Health Sciences staff of the newly established University Office of Research and Technology Transfer Administration.

b. Endorse the establishment of the University of Minnesota's Health Sciences Center-Industry Clinical Studies Center now being studied by the Medical School in collaboration with Medtronic, Inc.

...

The weakness: It remains difficult for the biotechnology entrepreneur to start a new business. If he or she is a University scientist, often this means leaving the University. Small capital needs cannot be adquately met without sacrificing a great deal of equity in a new concept or invention.

RECOMMENDATION 6: Develop incubator space for new biotechnology-related start-up companies near the University (incorporated into the Technology Corridor concept).

RECOMMENDATION 7: Explore legislative proposals to advance incubator funding opportunities to University and industry entrepreneurs.

a. Promote the concept advanced by the Office of Science and Technology's pending legislative package for an "innovation fund" for new start-up companies.

b. Develop new tax incentives for venture capitalists to invest in biotechnology start-up companies.

...

The weakness: Young high technology companies need special nurturing. Often they might benefit from clustering around a technology corridor but the incentives to draw them together do not exist.

RECOMMENDATION 8: Provide tax incentives to young high technology companies in the more advanced development stage.

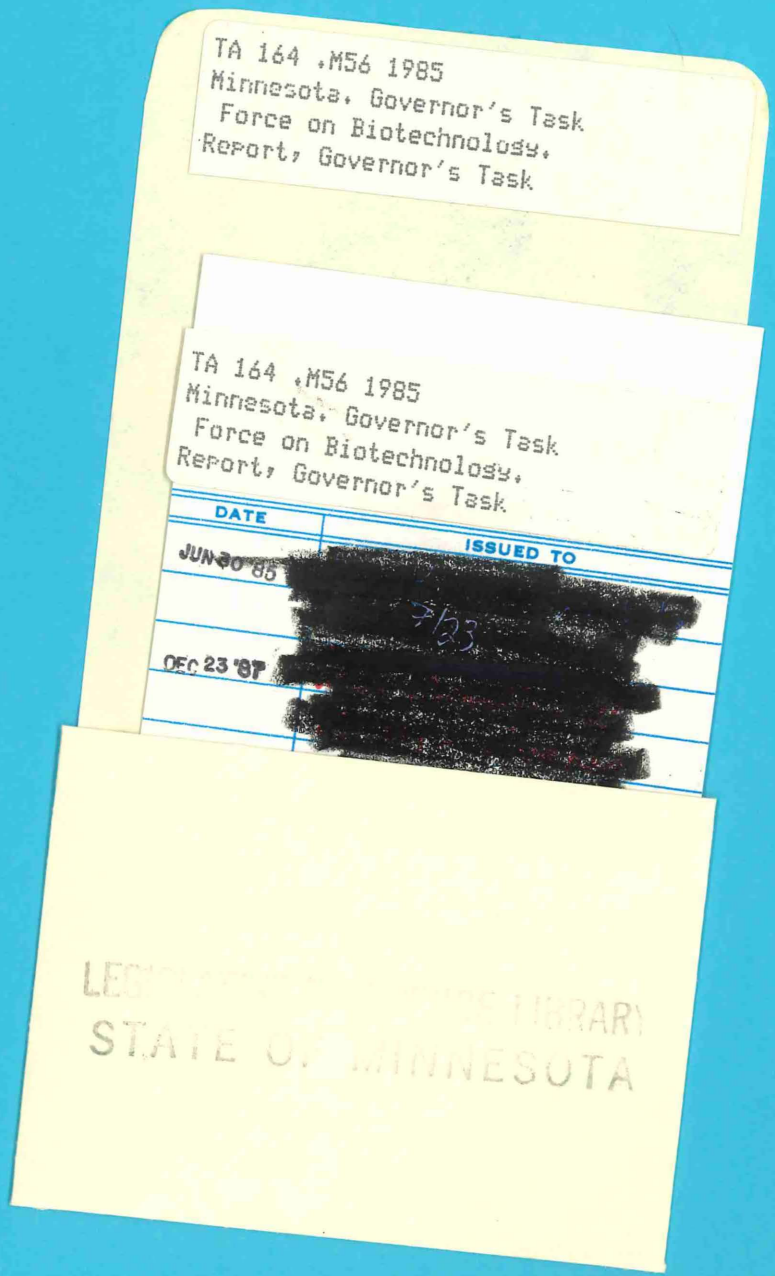
a. Industrial revenue bonds.

b. R & D tax credits.

c. Property tax relief

V. SUMMARY

This Task Force has attempted in an abbreviated time frame to address the challenges and opportunities for the State in a new and rapidly growing economic marketplace. Although the State is uniquely positioned to take advantage of many opportunities in biotechnology, much planning is still needed. Eventually, the community must make a substantial commitment of capital to strengthen the University infrastructure and assure the development of private biotechnology-related businesses.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