Bio 21

Washington State's Initiative In 21st Century Health

Report to Governor Gary Locke from the
Bio 21 Steering Committee

Prepared by the Technology Alliance

January 2004

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REPORT OVERVIEW

The following report has been prepared through a multi-step process. Its genesis was the request of Governor Locke for an answer to the question: "Does Washington have unique assets at the intersection of biotechnology and information technology that may be exploited for the benefit of our economy and the health of our citizens?"

Beginning in mid-2002, Fred Morris, the Governor's science and technology advisor, and Chuck Hirsch, partner with Madrona Venture Group, co-led a year-long discernment process that included a pro bono consulting effort from the McKinsey Company and interviews and consultations with many of our state's scientific and business luminaries. The result of this effort was a resounding "yes" to the Governor's question. In short, they determined that Washington does have enormous assets and opportunities; Washington is not alone in pursuing these opportunities; Washington needs to play catch-up compared to other states; and Washington needs a coordinated plan backed by state resources.

As a next step, the Washington Technology Center (WTC) funded a market assessment prepared by Lynnor B. Stevenson, PhD, Managing Partner, Alta Biomedical Group to further define the opportunity. The executive summary of that study is included as Appendix A. The complete study is available through the WTC.

With planning funds provided by the Legislature in July 2003 at Governor Locke's request, the State entered into a contract with the Technology Alliance to lead a rapid, focused process to develop a program plan. A Steering Committee was formed in August 2003, chaired by Shan Mullin, partner with Perkins Coie and former chair of the board of the Fred Hutchinson Cancer Research Center (FHCRC), and co-chaired by Lura Powell, former director of Pacific Northwest National Laboratory (PNNL) and the Advanced Technology Program at the National Institute of Standards and Technology and now President and CEO of Advanced Imaging Technologies. The complete Steering Committee is listed in the acknowledgements.

An Executive Committee – which served as the ongoing working group – was comprised of the co-chairs and Chuck Hirsch; Ken Myer, President of the Technology Alliance board and CEO of Interval Systems; Bill Grinstein of PNNL; Paul Isaki and Fred Morris of the Governor's Office; and myself.

Using a request-for-proposal (RFP) process, the Technology Alliance hired the Washington Advisory Group (WAG) from Washington, DC to produce a draft strategy for Washington State based upon our core competencies to serve as the basis for the Bio 21 program plan. WAG interviewed dozens of scientific and business leaders and, using its experience from Michigan and other states, provided several working models for the Steering Committee to consider. Appendix B includes the last version of the draft plan provided by WAG along with a summary letter. Appendix C contains a complete list of those interviewed.

In addition, Lee Hartwell, President and Director of the FHCRC, assembled a group of scientific and industry experts to discuss what the most promising opportunities might be for Washington.

That group, identified in the acknowledgements, met in November 2003 and many of their suggestions have been incorporated into the plan.

The nine-page program plan is the heart of our recommendation to the Governor and to the state. It describes a bold program of strategic investment designed to expand our state's research capacity, leading to breakthrough discoveries with clinical application and exceptional commercial potential. It was prepared by the Technology Alliance staff with significant input by the Steering Committee, especially the Executive Committee.

It has been our very great honor to be involved in the preparation of this report and recommendations to Governor Locke for the future health of Washington State's economy and citizens. We look forward with great enthusiasm to its implementation.

Susannah Malarkey
Executive Director
Technology Alliance
January 2004

January 12, 2004

Honorable Gary Locke
Office of the Governor
#AS-13, Legislative Building
Olympia, Washington 98504

Dear Governor Locke:

As co-chairs of the Bio 21 Steering Committee and on behalf of the Bio 21 Executive Committee, it is our privilege to present to you the attached report, which is the product of careful deliberation and innovative brainstorming on how best to capitalize on Washington's assets in the fields of biological sciences, information technology and health care delivery for the benefit of the state's economy and citizens.

The Executive Committee, with the advice of the Steering Committee and assistance of the Technology Alliance, has put together an ambitious plan which would forge a new public-private partnership to leverage Washington's already considerable strengths in research and development to ensure our state's competitiveness in the economy of the future. Ours is a long-range vision that must evolve with the technology that is its object. As such, the report lays the foundation for a governance structure, funding mechanisms and focus areas while allowing for future flexibility. It also establishes a framework for a competitive, peer-review process for evaluating potential research grant recipients and an additional program component directed at support for technology transfer and commercialization. The projects to be funded in accordance with the strategy laid out in the report will have a tangible impact on not only our own citizens' health but that of the world through developments in preventive and personalized health care.

Bio 21, which seeks to advance research and commercialization within Washington State, should be viewed as one element of a complete, statewide strategy focused on growing our high technology sector. It is essential that we pursue a comprehensive strategy that creates a stable, supportive environment in which our research institutions and technology companies can operate. Therefore, the Steering Committee recommends that the state concurrently pursue extension of the research and development tax incentives and make a concerted effort to direct capital investment in early stage companies within Washington in conjunction with the Bio 21 program.

During our deliberations, several members of the Steering Committee identified access to early stage "seed" funding for emerging companies as an additional need that a comprehensive statewide strategy should address. Such funding serves as a bridge between the proof of concept funding for researchers recommended as part of the Bio 21 program in the attached report and later stage angel or venture funding. The need for greater access to seed funding is particularly acute for early stage companies in the life sciences. The Seattle-King County Economic Development Council is currently embarked on an effort to develop a statewide seed fund. Given the pressing nature of the need, the Executive Committee urges you to develop a proposal to establish a professionally managed seed fund for early stage companies as part of a broader strategy for capital formation.

As you recognized when you charged this committee with such an important task, Washington is at a crossroads. While we have always aspired to excellence in our high technology and health care sectors, and have met with many notable successes, we have reached a critical point at which we must recommit ourselves to positioning Washington State as a leader in these fields for the 21st Century. Washington is in competition with not only other states and regions, but other countries to attract and retain the brightest scientists, cutting-edge facilities and financial investment, and to reap the attendant economic benefits of a vibrant technology sector. We are confident that the plan submitted to you today, in conjunction with the aforementioned, complementary policy initiatives, will launch Washington down an exciting new path, with the state as a full partner, and consolidate our position at the forefront of innovative research and health care.

We are grateful to you, Governor, and your staff, as well as the Steering Committee members and science and industry leaders who donated their time and expertise to this endeavor, and many other individuals who aided the Committee in its work. We look forward to working with you and other stakeholders in making this exciting vision a reality for the state of Washington.

Sincerely yours,

Shan Mullin

Lura Powell

ACKNOWLEDGEMENTS

A steering committee consisting of senior scientists and staff from large research organizations in Washington State, executives of biotech and technology companies, venture capitalists, lawyers specializing in bioscience issues and legislators collaborated with the Technology Alliance to create this report. An executive committee of this steering committee coordinated its work throughout the process. In addition, members of the Technology Alliance board and executive committee, a group of independent scientists, and others reviewed the report at various stages and provided comment. The many hours these individuals have contributed to the final product is gratefully acknowledged.

Bio 21 Steering Committee

Executive Committee Members:

Shan Mullin, Chair, *Partner, Perkins Coie LLP*

Lura Powell, Co-Chair, *President & Chief Executive Officer, Advanced Imaging Technologies*

Bill Grinstein, *Associate Director, Public Affairs, Battelle Pacific Northwest National Laboratory*

Chuck Hirsch, *Managing Director, Madrona Venture Group, LLC*

Paul Isaki, *Governor's Special Assistant for Business, Office of the Governor*

Susannah Malarkey, Ex Officio, *Executive Director, Technology Alliance*

Fred Morris, Ex Officio, *Executive Policy Advisor for Science and Technology, Governor's Executive Policy Office*

Ken Myer, *Founder, Interval Systems; President, Technology Alliance Board*

Steering Committee Members:

Dennis Adler, *Director, WAT Microsoft Research Management, Microsoft Corporation*

Tom Alberg, *Managing Director, Madrona Venture Group, LLC*

Rob Arnold, *President & Chief Operating Officer, Geospiza, Inc.*

Albert Berger, *Associate Dean, Department of Research and Graduate Education, University of Washington School of Medicine*

Lee Cheatham, *Executive Director, Washington Technology Center*

Martha Choe, *Director, Washington State Department of Community, Trade and Economic Development*

Senator Luke Esser, *Chair, Technology & Communications Committee, Washington State Senate*

Karen Glover, *Partner, Preston Gates & Ellis LLP*

Nat Goodman, *Senior Research Scientist, Institute for Systems Biology*

Deborah Knutson, *President, Economic Development Council of Snohomish County*

Karen Lane, *Consultant, Cedar River Group*

Ed Lazowska, *Bill & Melinda Gates Chair in Computer Science, University of Washington*

George Michaels, *Director of Bioinformatics, Biomolecular Systems Initiative, Pacific Northwest National Laboratory*

Peggy Means, *Senior Vice President, Strategic Development and Planning, Fred Hutchinson Cancer Research Center*

Representative Jeff Morris, *Chair, Technology Committee, Washington State House of Representatives*

Craig Mundie, *Chief Technology Officer, Microsoft*

Jim Petersen, *Vice Provost for Research, Washington State University*

Tom Ranken, *Chief Executive Officer, Vizx Labs, Inc.*

Norm Rice, *President & Chief Executive Officer, Federal Home Loan Bank of Seattle*

Senator Dino Rossi, *Chair, Ways & Means Committee, Washington State Senate*

Ruth Scott, *President, Washington Biotechnology & Biomedical Association*

Representative Helen Sommers, *Chair, Appropriations Committee, Washington State House of Representatives*

Patrick Tam, *Executive Director, Spokane Intercollegiate Research & Technology Institute*

Scientific Input:

Lee Hartwell, *President and Director, Fred Hutchinson Cancer Research Center,* assembled a prestigious group of scientists to provide scientific input on the Bio 21 report. Those who commented include:

Alan Aderem, *Co-Founder and Director, Institute for Systems Biology*

Mark Boguski, *Director, Allen Brain Atlas project*

Jim Cook, *Interim Dean, School of Agriculture, Washington State University*

Yongmin Kim, *Professor and Chair, Department of Bioengineering/Professor, Department of Electrical Engineering, University of Washington*

John King, *Senior Vice President & Chief Operating Officer, Rosetta Inpharmatics, Inc.*

Peter Morrissey, *Worldwide Life Sciences Executive, IBM*

John Nilson, *Director, School of Molecular Biosciences, Washington State University*

David Notkin, *Bradley Professor & Chair, Department of Computer Science and Engineering, University of Washington*

Karin Rodland, *Principal Investigator, Systems Biology, Pacific Northwest National Laboratory*

Ken Stuart, *Director & President, Seattle Biomedical Research Institute/Professor & Chair, Department of Pathobiology, University of Washington*

Diter Von Wettstein, *Professor, Department of Crop & Soil Sciences, Washington State University*

Robert Waterston, *Professor & Chair, Department of Genome Sciences, University of Washington*

Paul Yager, *Professor & Vice Chair, Bioengineering/Member, Adjunct Faculty in Chemical Engineering and Chemistry, University of Washington*

Technology Alliance Board

We would like to acknowledge all of the guidance and feedback we received from the Technology Alliance executive committee and board members who did not serve directly on the Bio 21 Steering Committee but provided valuable input to this effort:

Ed Fritzky, *Retired Chairman, Chief Executive Officer & President, Immunex Corporation*; **Steve Davis**, *President & Chief Executive Officer, Corbis;* **Chris Rice**, *Partner, KPMG;* **Dan Rosen**, *Managing Partner, Frazier Technology Ventures;* **Marty Smith**, *Partner, Preston Gates & Ellis LLP;* **Bill Baxter**, *Chairman, President & Chief Executive Officer, BSQUARE Corporation;* **Paul Clark,** *Chairman, President & Chief Executive Officer, ICOS Corporation;* **David Clarke,** *Partner, Perkins Coie LLP;* **Lee L. Huntsman**, *President, University of Washington;* **Richard D. Klausner**, *Executive Director, Global Health, Bill & Melinda Gates Foundation;* **Alan C. Nelson**, *Chairman & Chief Executive Officer, VisionGate, Inc.;* **Donald Pickering,** *President & Chief Executive Officer, Memetic Systems;* **V. Lane Rawlins**, *President, Washington State University;* **Vaho Rebassoo,** *Chief Technology Officer, Information Technology Services, The Boeing Company;* **Joseph Sasenick**, *Chairman & Chief Executive Officer, Alcide Corporation;* **Chad Waite**, *Partner, OVP Venture Partners;* **Kathleen Wilcox,** *President & Chief Executive Officer, WSA*

Consultants to the Project:

Washington Advisory Group LLC – please see Appendix B

Other Contributors:

Jay Reich, *Partner, Preston Gates & Ellis LLP*, provided consultation and advice regarding governance structure; **Leroy Hood**, *President, Institute for Systems Biology;* **Jack Faris**, *Vice President for University Relations, University of Washington;* **Alan Frazier**, *Founder & Managing Partner, Frazier Healthcare Ventures/Co-Founder & Managing Partner, Frazier Technology Ventures;* and **Gretchen Sorensen**, *Senior Director, External Affairs & Development, Institute for Systems Biology*

Funding of this project was provided by:

The State of Washington Department of Community, Trade and Economic Development

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Susannah Malarkey, *Executive Director*

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Ann O'Donnell Bury, *Program Coordinator*

BIO 21: WASHINGTON STATE'S INITIATIVE IN 21ST CENTURY HEALTH
Leveraging Washington's research excellence for a stronger statewide economy and a healthier population

Vision

Catalyze a revolution in global health while advancing the 21st century economy in Washington State through a partnership of the public and private sectors.

Mission

Advance Washington's position as a world leader in the application of information technology to the biological sciences and health care through a bold program of strategic investment to expand research capacity, leading to breakthrough discoveries with clinical application and exceptional commercial potential.

Strategies

Building on Washington's leadership in both computer and biological sciences, Bio 21 will leverage these assets to grow our economy and lead a revolution in global health through the power of preventive and personalized medicine and other breakthrough advances.

Bio 21 calls for a highly-leveraged, public-private program over a 10 to 15-year period to fuel this revolution through execution of the following set of strategies:

Leverage Federal Funding:

Each year, Washington's universities, non-profit research institutions and federal laboratories, which are highly-ranked nationally, attract well over one billion dollars in federal funding for biological and related research. This funding base represents an enormous regional asset which has yet to be fully exploited, and one which we are at risk of losing to other states that provide the matching dollars increasingly expected by the Federal Government as a condition for funding. Bio 21 will ensure that Washington continues to be highly competitive in attracting federal research dollars by providing matching funds to selected projects. These will be in core areas for which private funds or other match is available, and where leveraging such funds can advance both health care and our economy.

Build on Our Strengths:

Washington boasts unique assets in the biological sciences, bioengineering, and health care delivery. The state also enjoys complementary strengths in computer science and software. As a result, Washington is a recognized leader in research and technology development at the convergence of information technology and the biological sciences, occupying a very strong position in such critical new fields as genomics, proteomics, systems biology, nanotechnology,

computational biology, bioinformatics and medical information systems, as well as plant, animal and microbial biotechnology as applied to human health. Bio 21 will take full advantage of our unique, world-leading assets at the intersection of information technology and the biological sciences while filling strategic gaps to enhance the research and development (R&D) and commercialization potential within the state.

Accelerate Commercialization:

Washington's research institutions are already major drivers of economic development. Of the approximately 190 biotechnology and medical device companies in Washington, more than half are based on technologies developed at the University of Washington (UW), the Fred Hutchinson Cancer Research Center (FHCRC), Washington State University (WSU) and Pacific Northwest National Laboratory (PNNL). By providing researchers with proof of concept (validation) funding and by encouraging closer industry collaboration with research institutions, Bio 21 will create a rich pipeline of innovations commercialized in Washington and spur the creation and growth of emerging companies and major economic development.

Improve Health Care:

The Human Genome Project and other biological research have opened doors to the treatment of such previously intractable diseases as cancer, cystic fibrosis and heart disease. Further advances on the horizon promise to enable medicine to anticipate disease through early diagnosis and intervention, superseding later, less effective and more costly treatment. The power of early detection through advanced diagnostic techniques has the potential to revolutionize our health care system both here in Washington and around the world by moving those systems to a preventive model. Bio 21 will facilitate rapid translation of new discoveries into clinical practice to improve the health of Washington's citizens and lower health care costs.

Maintain a Research-Friendly Business Climate:

Washington's universities, non-profit research institutions and federal laboratories are precious assets. As illustrated by the recent recruitment of the Scripps Research Institute to Florida, they operate in an increasingly competitive environment. The state needs to ensure that they grow and thrive in Washington. A complementary resource, relatively untapped here, is the potential contribution of major pharmaceutical research facilities. The presence of Merck (through the acquisition of Rosetta) and Amgen (through its merger with Immunex) suggests this potential, but Washington would benefit considerably from a far greater pharmaceutical research presence. Accordingly, in collaboration with other state and private efforts, Bio 21 will work to create a business climate that encourages research institutions of all types to remain in or expand into Washington.

Bio 21 in the Context of a Broader Statewide Strategy

Bio 21 will function in concert with other state policy initiatives focused on growing Washington's biotechnology sector. The program is intended to be one element of a complete, statewide strategy that will encourage commercialization and job creation, and foster an overall stable, supportive environment in which our research institutions and biotechnology companies

can operate and collaborate. Specifically, Bio 21 supports the extension of the research and development tax incentives and a targeted effort to direct capital investment in early stage companies within Washington State.

Situation Analysis

Washington has achieved an enviable position of strength in the convergence of the biological and information sciences, on both the research and industry sides, without any organized effort and with no directed state investment. However, the competitive landscape is changing dramatically. If Washington is to retain, much less advance, its leadership position, state commitment and action is required.

Assets:

Washington has much of the foundation to be a leader in 21st century health, based on our distinctive capabilities in the biological sciences and information technology:

- UW has led the nation's public universities in competing for federal research and training grants since 1974. The University's Medical School as a whole and its Genome Sciences, Bioengineering, and Computer Science departments are among the strongest and most respected in the nation.

- Microsoft is the largest software company in the world, and Microsoft Research is ranked among the top computer science research organizations in the world.

- Leading-edge biotechnology, pharmaceutical and information technology companies already located in Washington include Amgen, Merck, Intel, Microsoft, GE Medical Systems, Siemens, Philips, Cray, Hollister-Stier, and IBM Life Sciences. Each is active in our state and is eager to partner with our research institutions on new ventures.

- WSU is home to one of the nation's leading plant biochemistry and biotechnology programs.

- In less than four years, the Institute for Systems Biology has attracted more than $140 million in funding and become internationally renowned for pioneering the new field of systems biology, the key to predictive, preventive and personalized medicine.

- The U.S. Department of Energy's PNNL has the nation's most advanced cellular and molecular imaging instruments and the fastest civilian supercomputer in the U.S.

- The FHCRC, world-renowned for its pioneering research in the understanding, prevention, and treatment of cancer and related diseases, is the largest recipient of federal funding among the nation's independent comprehensive cancer research institutes.

- The Bill and Melinda Gates Foundation is the world's largest foundation, and the research and clinical networks being created by this remarkable organization is helping Washington to earn a reputation as the "new Geneva" in global health. The Program for Appropriate

Technology in Health (PATH) and the Seattle Biomedical Research Institute (SBRI) are just two complementary local examples.

- The new Allen Institute for Brain Science in Seattle, endowed with $100 million in philanthropic funds from Paul G. Allen, has embarked on an ambitious program with its inaugural project, the Allen Brain Atlas, to achieve new understanding of brain function and brain-related disorders and to support third-party research into the treatment and prevention of diseases such as Alzheimer's and autism.

- Washington has a uniquely innovative and entrepreneurial culture yielding a high rate of invention, technology transfer, and business startups.

With so many assets, what is the problem?

The short answer is that Washington lacks both the significant state financial commitment and an organized public-private partnership to remain competitive with other states and regions around the nation, and countries around the world, that are moving aggressively on both fronts.

Challenges

Washington's primary challenge lies in the historical fact that our excellence in research has been achieved with little direct support by state government. We currently rank 46th among all states in per capita spending on R&D. Three key trends render this relative neglect a luxury the state can no longer afford:

- Federal agencies are increasingly requiring "hard match" of state dollars as a prerequisite for receipt of federal research funding.

- After a period of explosive growth, federal research budgets in the biological sciences are expected to increase much more modestly for the foreseeable future.

- Other states are investing heavily in their R&D sector in order to compete for federal support and attract the most talented scientists and pharmaceutical R&D facilities.

In short, the competition for research leadership is becoming more intensive every day. If Washington fails to step up, we risk squandering a substantial lead built up in the days when state expenditure was less essential.

A second challenge lies in the need to more fully exploit our research assets for commercial advantage. Although Washington's public and non-profit research institutions bring in more than $1 billion annually in federal R&D funding, we are not fully translating that research into commercial opportunities for our state. For example, over the period 1963-2001, Washington ranked 25th among all states in per capita patents issued.

The Threat:

Other states and nations are making major investments in R&D, particularly in the biosciences, and we are losing ground to them. To cite just a few examples, Michigan, Georgia, California, New York, Florida, Arizona, Singapore, Australia, Malaysia and Sweden have all launched major government-funded research initiatives, and sustained them even during tough economic times.

The Opportunity:

As they dramatically change the face of medicine and improve human health, advances at the intersection of the biological sciences and information technology are creating huge new markets. By 2005, global demand for bio-based diagnostics and therapeutics, medical devices and imaging, and health care informatics is expected to reach $230 billion. This revolution represents a unique economic opportunity for those regions that are able to excel in these fields, while changing the face of medicine here in Washington and around the world.

There is already a strong tendency for biopharmaceutical and medical device companies to cluster such functions as product development, marketing and manufacturing in geographic proximity to the research centers that make the discoveries on which their businesses are based. With focused state investment, we can capitalize on our strengths and bring more of these innovative companies, high-paying jobs and tax revenues to Washington State. At the same time, we have an opportunity to also bring the benefits of preventive and personalized health care to our own citizens and to people around the world.

Program Elements

Expanding Research Capacity:

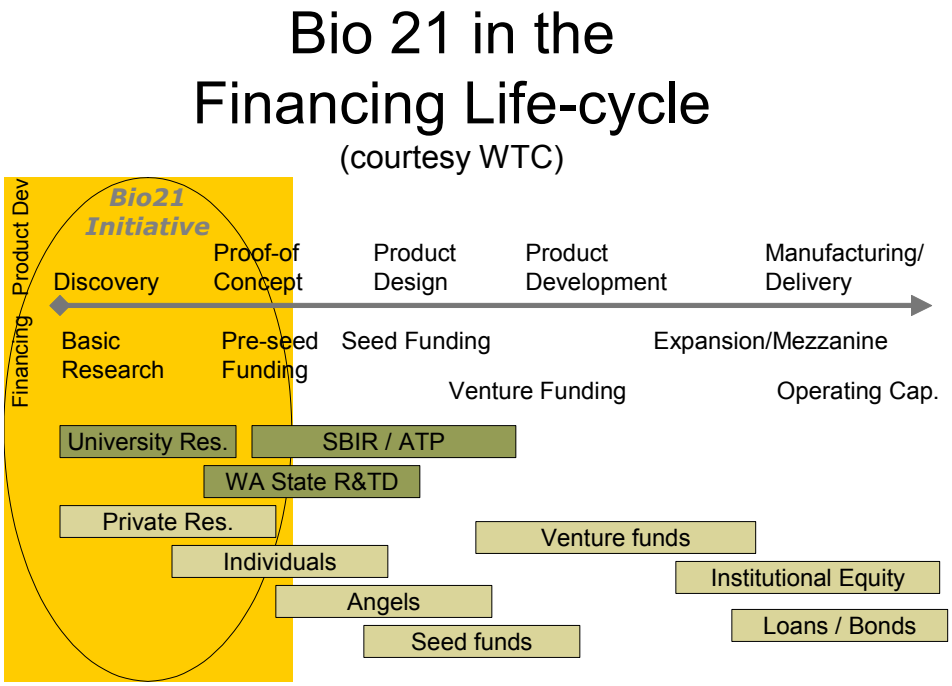
Bio 21 will assemble a substantial non-profit fund to make strategic research capacity investments in Washington's universities, non-profit research institutions, health care organizations and/or companies. Grants will be made to reinforce strengths, fill strategic gaps and stimulate collaboration across disciplines and institutions, all to advance the competitive position of Washington's research enterprise and build the economy of the future while realizing real benefits to human health.

Program funds could be used to attract and retain star scientists, their research teams and pledged funding streams; build key facilities; purchase critical equipment; provide hard match for federal funding; shore up competitively important areas of weakness; and provide proof of concept funding to break into new fields. Bio 21 will not serve as a "mini-National Institutes of Health" or "mini-National Science Foundation," funding the types of research projects that would otherwise be suitable for federal support; rather, the program will position qualifying institutions to be highly successful competitors for federal and industrial research funding in an increasingly competitive environment.

Awards will be made through a rigorous and independent peer review process, taking into account such factors as:

- Short-term and long-term potential for clinical and commercial application;
- Commitment of matching funds from federal, corporate and/or philanthropic resources;
- Strategic importance to the institutions and the state;
- Involvement of small and emerging companies;
- Impact on recruiting and retaining "star" scientific talent, which brings with it significant outside funding support; and
- Potential health care cost savings.

The locus of Bio 21's investments in the R&D lifecycle is depicted in the following diagram:



Accelerating Technology Transfer and Commercialization:

Throughout, Bio 21 will look for strategic opportunities that have significant commercial potential and where Bio 21 funds can be most highly leveraged. In addition to research capacity investment, Bio 21 will provide proof of concept funding (sometimes referred to as validation

funding) to Washington's universities, non-profit research institutions, health care organizations and/or companies. These grants will be used to enable those institutions to develop research results with clinical or commercial promise to the point of technology transfer and suitability for seed, angel or early stage venture investment.

Promoting Collaboration:

Bio 21 will work closely with the state's science and technology organizations and with the private sector, to ensure that the discoveries made with the assistance of Bio 21 funding will find commercial application in Washington and thus create companies, jobs and improved health outcomes for the state's citizens. In particular, Bio 21 anticipates that the Washington Technology Center (WTC) through its Research and Technology Development Program will help develop partnerships between researchers and companies to spur commercial application. WTC may also provide advice and counsel to Bio 21 on areas of research focus through the strategic assessment process established under recent legislation, and potentially complementary investment in commercialization through the accompanying Investing in Innovation account. Similarly, Bio 21 will work closely with new and proposed investment vehicles, such as the UW's Office of Intellectual Property and Technology Transfer, WSU's Office of Intellectual Property Administration and the WSU Research Foundation, the loan program administered by the Spokane Intercollegiate Research and Technology Institute (SIRTI) and the seed fund under development by the Seattle-King County Economic Development Council.

Measures of Success:

The impact of Bio 21's investments will be measured and tracked over the short, medium, and long terms. Ultimately, Bio 21's efforts will help create high-growth companies and thousands of well-paying jobs in both the research and commercial sectors, and lead to a transformation of health care delivery. Bio 21's immediate outcomes include measurably increased research volume, improved levels of collaboration, and substantial industry involvement in participating institutions. Bio 21's efforts will also increase the number of breakthrough discoveries with clinical utility and high commercial potential.

The anticipated progress over a 10 to 15-year timeline relies on an accepted cycle for projects funded through the Bio 21 program from the point of inception. Initiatives further along in the development cycle that qualify for funding under the Bio 21 program can be expected to yield more immediate economic and health benefits.

Because Bio 21 will be focusing many of its grants in the area of preventive medicine, there are significant cost savings to be realized. For example, breast cancer is the most common form of cancer in women and the second leading cause of cancer death for women in the United States. Early detection of breast cancer currently saves $40,000 per patient and increases survival rates to 96 percent. Breakthrough technologies now being developed in Washington and elsewhere could allow savings related to the prevention and treatment of this and other life-threatening diseases to be significantly higher.

Focus Areas:

The following areas of advanced and applied research and development have been identified as those where the potential markets are substantial; where Washington has considerable expertise and comparative advantage; and where applied research can quickly lead to commercial applications.

- **Diagnosing and treating disease:** This area will focus on the application of the biological sciences to the creation of new drugs and diagnostics, including plant and animal research with human health implications.

- **Medical devices & imaging:** This area includes bioengineering, nanotechnology, and the application of computer and information technology to biological research.

- **Software used in clinical settings:** This area will focus on advanced informatics systems which increase efficiencies, lower health care costs, and rapidly translate new discoveries into clinical practice.

Illustrative Projects Suggested by Science and Industry Leaders:

- Shared centers for applied chemistry and technology to facilitate translation of academic research into commercial products.

- Genomes to Life Production Proteomics Facility at PNNL to facilitate the discovery of key biomarkers and attract researchers from around the world.

- Development of strategically important programs at UW's South Lake Union campus.

- Biomedical computing grid for virtual statewide collaboration between industry and research institutions.

- New directions in agriculture, including using plants for the production of medicines and to enhance global nutrition.

- Collaboration with Spokane's clinical research capabilities and the Inland Northwest Health System, including their four-state regional medical information program.

- Establishment of an Ultranet hub in Seattle to provide increased bandwidth for research computing.

Resources:

Bio 21 intends to secure state and private resources, which have the potential for great leverage, to fund this effort over roughly a 15-year period. The target is to ramp up to a fund that by year five makes grants totaling approximately $50 million annually (less administrative expenses of approximately 5 %), and to maintain that level of annual grant funding for another ten years. All grant recipients will be required to obtain matching resources, in cash or in kind, from outside

sources on at least a one to one basis and, in the aggregate, total grants from the fund each year must yield a match from outside sources of two to one (two dollars of outside match, in cash or in kind, per dollar of grant funding).

Governance and Organizational Structure:

Bio 21 is envisioned as a publicly chartered, independent entity governed by a board of trustees comprised of highly-respected and recognized individuals appointed by the Governor. This entity will administer public and private funds allocated to this effort, with an emphasis on leveraging incoming federal grants to our institutions and fueling competitive research, development, demonstration and commercialization. The organization will work closely with other state entities, such as the WTC, SIRTI and others, who may be asked to administer portions of the program in accordance with their distinctive competencies and statutory authorities to further ensure statewide engagement and most effective use of resources.

Complementary policy initiatives at the state and regional levels, such as extension of R&D tax incentives, expanded sources of seed and venture capital, the UW's South Lake Union medical campus in Seattle, the Genomes to Life program at PNNL in the Tri-Cities, the Center for Integrated Biotechnology at WSU, the Spokane Alliance for Medical Research (SAMR), Explore Life, and the Innovation Corridor, will also help to ensure that the rich pipeline of intellectual property created through this initiative leads to the creation, attraction and retention of companies and jobs in Washington.

APPENDIX A
EXECUTIVE SUMMARY, BIOINFORMATION MARKET STUDY

Prepared by Lynnor B. Stevenson, PhD, Managing Partner, Alta Biomedical Group

Executive Summary

Business, academic and governmental leaders in the State of Washington have concluded that the region has strengths in the application of computer science and technology to biology and medicine, a field that includes a number of technologies, products and markets collectively called "Bioinformation". In order to accurately assess the opportunity, market information was gathered from publicly available sources for potential markets in the near term (2005) and longer term (2010), and relevant Washington strengths were reviewed.

Conclusions

While other states will be competitive, Washington appears well positioned to compete successfully to develop this industry, which is projected to grow to a worldwide market size of $176 Billion by 2005, and $243 Billion by 2010.

Global Market Estimates

Total Market Estimates($million)	2005	2010
Medical Information Systems	25,000	32,000
Contract Clinical Research	11,000	20,000
Medical Artificial Intelligence	4,200	7,500
Medical Therapy	3,980	7,500
Value-added Medical Devices	125,000	160,000
Biological Research	6,800	16,000
Total	**175,980**	**243,000**

Market Drivers

The market drivers for the expansion of bioinformation markets include

- Cost of health care
- Regulation
- Consumer demand for information
- Data management in biology, and
- Efficiency of drug development

Policy Issues

National and state policy issues affecting the growth of the bioinformation industry include the Food and Drug Administration approval process, the ramifications of the Health Insurance Portability and Accountability Act regarding patient privacy and medical records, improving the technology transfer process from universities to the private sector, and the evolution of patent and copyrights law as it relates to inventions in bioinformation fields.

Market Sectors

Four major market sectors were identified, each with several segments. Market data for each segment and extrapolated to provide global estimates for 2005 and 2010.

Medical Information Management

This field includes all of the information that might be gathered about patients under hospital care or ambulatory care (e.g., outpatient offices, primary care physicians). The market is currently over $20 billion.

Medical Informatics enables the organization, analysis, management and use of information in health care by sharing of information between professional groups. Research centers can be linked to healthcare providers; physicians share information across networks; area wide databases are being deployed.

Computerized Physician Order Entry (CPOE) is seen as a major factor in reducing medical error. CPOE streamlines the management of workflow within healthcare delivery organizations. While adoption has been slow (3% of US urban hospitals), health care professionals are gradually accepting the utility of hand held devices and analysts expect growth of over 100% per year.

Clinical Trial Management

This market aims to solve the two major bottlenecks in the clinical trials process - the recruitment of investigators and patients and the transfer of data from the investigator into the clinical data system. The market is estimated at between $6 and $9 billion.

Artificial Intelligence

AI's role in medicine has grown substantially in the last decade and expected to further grow given the pressure on health care organizations to ensure efficiency and cost-effectiveness. The total AI market in 2002 was $11.9 billion and it is expected to grow at an average annual growth rate (AAGR) of 12.2 %, reaching $21.2 billion by 2007. The insurance industry is an early adopter of artificial intelligence given its interest in having predictive tools to understand claims and make reimbursement decisions.

Therapy Planning, Implementation and Outcome Evaluation

Therapy planning includes three main tasks in reference to effective knowledge-based data analysis: selecting which therapeutic actions may improve the patient's condition, predicting short- and long-term outcomes of therapeutic actions, and adopting a therapeutic plan according to some explicitly defined preferences on the predicted condition of the patient. This is a growing market that should expand significantly to over $1.6 billion in 2009.

Telemedicine

Telemedicine is a means of transmitting medical images and other medical information. Picture Archiving and Communication Systems (PACS) are a major growth area in this market with expenditures of over $600 million.

Medical Devices and Diagnostics

The world medical device market in 2000 exceeded $170 billion; the United States portion alone constituted approximately $70 billion, and is projected to grow at 5% per year over at least the next five years. New generations of "value-added" products, which comprise approximately $100 billion of the global market, are being developed at a rapid rate in areas such as imaging, computer assisted surgery, wireless communication, and miniaturization, utilizing developments in electronics, software and biology.

Biological Research and Drug Discovery

The major market segments are genomics, proteomics and high throughput drug screening. These segments include gene sequencing, gene expression using microarrays, protein separation and identification, biological assays and bioinformatics. The combined market totals $2.7 billion in 2002. Pharmacogenomics is a newer and rapidly growing market. Laboratory automation is driven by the pharmaceutical and biotechnology industries needs to streamline high throughput screening and combinatorial chemistry.

Bio-Nanotechnology

Nanotechnology today is a young industry that falls into two distinct categories: materials science products and basic research. The bio-nanotechnology market is $930 million in 2003 for the three existing market segments (drug delivery, imaging agents, and biosensors), growing to $1.5 billion in 2005.

Other State Activities

A number of states and municipalities across the nation are considering technology-based economic development strategies based on bioinformation industries. Characteristics common to communities with thriving biotechnology industries were identified to include strong research institutions, access to early stage capital, a highly skilled workforce, and successful transfer of research results to commercialization. The Seattle area is considered to be one of the nine leading biotechnology centers in the nation, which include Boston, San Francisco, San Diego, and Raleigh – Durham among others. Assuming similar characteristics will be necessary to foster successful bioinformation industries, Seattle appears to be well positioned to develop this industry. Competition comes in the form of several leading states that are making significant investments to foster indigenous bioinformation industries.

To read the full report of the "Bioinformation Market Study for Washington Technology Center," please go to: http://www.watechcenter.org/pubs/other/BioinformationStudy.pdf.

APPENDIX B
RECOMMENDATIONS OF WASHINGTON ADVISORY GROUP LLC

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December 2, 2003

Ms. Susannah Malarkey
Executive Director
Technology Alliance
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The Washington Advisory Group LLC

Dear Susannah,

This final letter report and attachments describe the work we've done with you, the Executive Committee, the Steering Committee, and the Technology Alliance over the course of the last 4 months. It has been a pleasure working with you and your colleagues on this project and we wish you great success in getting a strong, effective program launched in the State of Washington.

The Project

As you know, we were engaged to perform three tasks:

- Perform a rapid assessment of opportunity areas for new or newly programmed investment of resources to make the State competitive in bioinformation research and commercialization.

- Prepare a draft program plan focusing on activities and goals in the broad area of bioinformation most suited to Washington's needs.

- Use meetings and/or interviews with individuals from health care, research, corporate, public, economic development, and venture enterprises in the State of Washington to vet and refine the draft program plan, and then develop and provide one full revision of the plan.

The goal of our engagement was to develop—as quickly as possible—a sound and targeted working draft program plan that could be used to generate constructive discussion among the involved and interested parties in the State of Washington. As such, the assessment work we performed had two primary components. First,

we reviewed a limited set of published and publicly available material for analysis and insights that could help support the program design process. In doing this work our team – Gil Omenn, Maxine Savitz and I – drew heavily on the Washington Advisory Group's experience in other states and with federal and foundation biomedical funding and commercialization enterprises. A list of the material reviewed—published reports, information generated from web research and telephone research—and notes on activities in five other states are contained in Attachment 1. This material was the basis of my presentation on September 8, the opening night of the Alliance's 2003 Technology Institute at the Sleeping Lady conference center.

Second, Gil Omenn, Maxine Savitz and I conducted 44 interviews with individuals in the State of Washington or individuals with relevant experience with the State's biomedical institutions. Notes of the majority of those interviews were provided to the Executive Committee in advance of the Sleeping Lady Conference. An initial set of notes/questions for the interviews and a complete list of individuals interviewed appear in Attachment 2.

Core Competence, Economic Impact and Program Design

Our approach did not include an in depth assessment of the State's capabilities (or core competencies). That work would require much more time and budget than you or we had available. Rather our approach was to learn enough about the State's strengths and gaps in capability to design a robust and productive program. As you and I have discussed, a comprehensive assessment of core competencies would also require a good deal more specificity regarding what is meant by the words "core competence." Is core competence:

1. Capability in biomedical research and attracting research funding (high in Washington);
2. Demonstrated ability to create new life sciences companies with staying power (lower in Washington than some competitor states);
3. Demonstrated ability to attract corporate research funding and interest to match non-profit research (high in Washington);
4. Demonstrated ability for the State to attract corporate R&D facilities for life sciences companies (lower in Washington than some competitor states); or
5. The ability to continuously improve the health of, and reduce the cost of health care for, citizens of the State using science and technology developed in the State?

Presumably the State wants all of these things from its investments and our focus (as a group engaged in program design) was on areas of opportunity in research, development and commercialization where plausible scale incremental investments might make a difference in the State's ability in any and all of the above functions. The logic was that a State investment program should make investments that can make a difference.

Similarly, while the draft program designs were explicitly focused by the desire for a positive economic and health impact for the people of the State of Washington, our approach did not include any attempt to estimate the economic impact of the program. The program design was informed by our experience with high-value public and private R&D investments in other settings (and by the experience of other state, federal and private programs) but we made no attempt to estimate the relationship between levels and types of funding and the number and types of jobs created, or the overall economic welfare of the citizens of Washington.

While we have tremendous confidence that the draft program we provided—if implemented—would generate substantial economic benefits and jobs to the State, there are insurmountable difficulties in producing any specific estimates of economic benefits. First, the reliability of analytical approaches to estimating the economic impact of specific public or private R&D investments is very low. While it is possible to estimate direct economic impact of research spending (using input-output methodologies and software), the direct economic impact is a small part of the story. The application of research results in the creation of new enterprises, and in the expansion and growth of existing enterprises, is the goal of most economic-development focused research investments. These impacts cannot reliably be estimated, especially if a substantial portion of the work being supported is basic research; if you can be certain of the outcomes—technical or economic—and the timing of those outcomes, you are not supporting research and development.

Second, during the program design phase there is a high degree of variability in the design over the course of a week or even a couple of days. Shifting even ten percent of possible program funding from one category to another, or adding or deleting a type or focus of funding, inevitably has a material impact on any estimate of economic impact. This is uncertainty piled on uncertainty. During an R&D program design phase the most reliable approach is to stay focused on identifiable areas of opportunity—strengths that can generate economic growth or health benefits, or gaps that need to be filled. Again, the logic behind our efforts was that a State investment program should make investments that can make a difference.

The Program Designs

The iterative results of our program design efforts are illustrated in Attachments 3, 4 and 5 which represent three progressively honed versions of a draft program plan. The first (Attachment 3) was created, almost in real time, during the Sleeping Lady conference and presented to Governor Locke and others at the conference as the initial roll-out of the draft plan. The second (Attachment 4) was the first full draft of the plan and reflects inputs from the Executive Committee, the Steering Committee and individuals interviewed, many of them from industry, after the Sleeping Lady conference.

The third full draft (Attachment 5) contains substantial contributions from members of the Executive Committee and a second round of discussions with individuals from scientific or industrial enterprises in the State of Washington. This final draft program maintains the substantive foci of the first and second drafts but re-orders the presentation to highlight the concept and importance of creating or maintaining centers of excellence. It also includes a section on the desirable characteristics of program governance.

Thoughts on Core Competencies and Economic Impact

While we did not develop a list of the State's core competencies or attempt to estimate the economic impact of the program proposed, a reader will find, embedded in the attached program design documents, considerable information about the State's strengths and gaps and about the nature and scale of economic impact anticipated from the program.

With regard to strengths and gaps, the starting point is the nature of opportunities in biomedical or bioinformation markets. Several institutions in the State of Washington (in particular the University of Washington, Fred Hutchinson Cancer Research Center, and Institute for Systems Biology) are national leaders and have a demonstrated depth of competence in a broad range of basic scientific biomedical research (e.g., genomics, proteomics, structural biology, infectious disease). These areas of science hold great promise for the early stages of pharmaceutical R&D (e.g., identification of targets and mechanisms of action) but they are the earliest (and most unproven) part of the value chain in developing new pharmaceuticals.

Similarly, Washington State University's (WSU) traditional focus (and the traditional focus of most strong agricultural universities) on agriculture has a tremendous impact on human health through nutrition, but WSU is also a very credible force in bioagro-technology applied to human health through the development of biological processes supporting the biopharmaceutical or health care enterprises.

Pacific Northwest National Laboratory's focus on bio-computation and visualization at the molecular level have the same characteristics as the basic research focus at the institutions in Western Washington; the work could be of interest to companies in therapeutics but it is early stage work in a very long value chain. As such, the commercial potential of current Washington's basic bioscience research enterprise needs to be discounted for time-to-market and scientific/technological uncertainty. This is not different from the challenges facing basic biomedical research activity in other states and regions.

Further, the State of Washington is not home to a high concentration of activity in many downstream elements of the pharmaceutical value chain—medicinal chemistry, pre-clinical services, clinical therapeutics research services. If the State has a demonstrated competence in basic biomedical research it lacks depth and density when it comes to later stages of pharmaceutical R&D. Amgen's acquisition of Immunex and Merck's acquisition of Rosetta and the fact that both pharmaceutical "assets" are still in Washington are notable exceptions.

There is some promise that the demonstrated competence of the State's institutions in genomics and proteomics could be a foundation for Washington participating in an emerging industry—molecular diagnostics—which links advanced understanding of human biology at the molecular level to markets for early detection and predictive/preventive medicine. The size and characteristics of this industry are, however, unproven and may not materialize at the predicted scale.

These observations above about Washington's strengths and gaps in therapeutics, diagnostics, bioinformatics, molecular visualization, and plant and animal biology applied to human health are not intended to discourage or encourage State investment in these areas. The draft program designs are explicitly intended to solicit collaborative research and development proposals, with significant industrial interest and participation, from the State's research institutions and companies. A focused, high-quality proposal that is arguably linked to improving the State's competitive position in these areas—whether that is taking advantage of a strength in the State or filling a gap—should be favorably regarded.

Perhaps the most significant addition to the program design as a function of our rapid review of the State's strengths was the explicit inclusion of bioengineering research and development investments. Institutions and companies in the State of Washington have a long history of demonstrated research, development, and commercialization in a wide range of bioengineering. Imaging, clinical instruments, instrumentation for pharmaceutical research, and medical devices are all strong at both the University of Washington and in Western Washington in general. The bioengineering competence of the State's companies and institutions gives credibility to the argument that Washington may have a comparative advantage in developing the new industry of molecular diagnostics as translation of the science into a useful diagnostic requires first rank and cutting edge bioengineering.

Linked bio-research and clinical networks, clinical records networks, and related applications of telemedicine are another area that was added to the program design as a result of strengths and gaps. In this case the State's strengths in public health and software/information technology co-exist with the State's lack of a notable research and development center of excellence in clinical informatics, or in distributed clinical informatics linked to research informatics. This is also an area where the distributed character of the University of Washington's medical school (serving five states) and an Eastern Washington institution—Inland Northwest Health Services, reportedly in the top 100 health systems in the country in clinical informatics—brings a great deal to the table and broaden the program's impact beyond the Western portion of the State.

Finally, the promise of population based medicine and the State's current strength in public health and increasingly prominent role in world health creates certain opportunities in areas such as chronic care challenges, infectious diseases and bio-defense. While this is not an explicit focus area in any of the draft programs these State strengths—and the economic and health care opportunities created by incremental investments in these areas—are woven throughout the focus areas as program themes. Proposals with a programmatic focus in these areas should be regarded more favorably by reviewers than programs that are of equal quality but do not touch on these areas.

With regard to economic impact, the most succinct presentation is drawn almost directly from the program plans. The first and subsequent draft program plans recommend a program at the level of $50 million per year for 5 years, or $250 million matched to $500 million. While this is a challenging level of State investment in tough economic times, $100 million in new funds every year is about a 10 to 15 percent increase in biomedical research funding in the State. The total five year "leveraged" amount of $500 million is less than the State's premier non-profit research organizations win in competitions from the National Institute of Health in a single year. Further, the five-year $500 million is also about $100 million less than 2002 venture capital investments in Washington companies and pales in comparison to the private and public expense of health care in the State, which runs in the tens of billions of dollars annually. In sum, the program is scaled to have a material impact on a large and complex research, development and health care enterprise in the State, which in turn has an impact on the $220 billion economy of the State.

The economic logic is that targeted State investments of $50 million per year—in centers of excellence, in the types of activities that cannot be funded from other sources, and in programmatic areas with direct relevance to the State's strengths and gaps—will create a

compelling reason for the State's research institutions, and for companies and philanthropic organizations inside and outside the State, to participate with funds and intellectual commitment to the development of the State of Washington. Further, the requirement that State funds be matched one-to-one by corporate or other private funds builds in an important economic development focus. The requirement for matching funds—especially in those program areas of interest to industry—assures that State investments will be targeted and managed to make a material difference in economic and/or health care outcomes.

Conclusion

Personally, and on behalf of my colleagues Maxine Savitz and Gil Omenn, I want to thank you for the opportunity to work with the Bioinformation Steering Committee on this new program of importance to the State of Washington. If we can be of any further assistance, do not hesitate to contact me.

Best regards,

Bruce Guile

Attachments.

WASHINGTON ADVISORY GROUP REPORT

Bio 21

The State of Washington's Bio 21 program will invest $250 million of State funds over the next five years to enhance or create Washington-based centers of excellence in biomedical research, technology development and health care-related commercialization. These investments have the three-fold purpose of improving the health and health care of Washingtonians, furthering the State's reputation and performance as the international center of world health, and moving the State into a leadership role in the biomedical and bio-information industries of the 21st century.

Program Goals and Complementary Initiatives

The biomedical revolution the world will see in the 21st century represents a unique economic opportunity for those regions that are able to become centers of excellence in research, commercialization and health care applications. By 2005 global demand for bio-based diagnostics and therapeutics, bio-engineered applications, and health care informatics are expected to reach $229 billion. Attachment I illustrates the fundamental nature of the revolution in biomedical sciences and its impact on health care. Bio 21 is designed to position the State to be a significant contributor in these markets by providing financial incentives for new and mature companies to partner with Washington research and health care organizations.

This bold program of research, development, and commercialization funding would be an important new direction for the State of Washington which ranks 46th among all the states in per capita spending on R&D. In other states, most with less biomedical research capability than Washington, substantial state investments in research – in the range of $50 million to $300 million – have been matched dollar for dollar by federal or private funds. The near term results are increases in key elements of the "ecology" of economic innovation, growth, and job creation – immediate increases in employment of a highly-skilled workforce, a steady improvement in technology transfer for rapidly growing science and technology-based start-ups, and a significant increase in the State's attractiveness as a location for new or relocating corporate and federal R&D facilities. Washington has not begun to tap these leveraging opportunities and it is time to redress this imbalance.

Complementary policy initiatives at the state and regional levels, such as extension of the R&D tax incentives, greater local investment by the Washington State Investment Board, and the build-out of the South Lake Union will also help to ensure that the rich pipeline of intellectual property generated through this initiative leads to the creation, attraction and retention of companies and jobs in Washington.

Further, health care is the largest single component of the U.S. economy and expenditures on health care in Washington are already approximately $33 billion. There is tremendous

promise that the convergence of information technology with new biomedical research applied in health care can and will lead to predictive and preventive health care, fewer errors, and significant cost savings. Even small percentage reductions in the cost of health care and small qualitative improvements in health care in the State can have an enormous impact on the economy and on the quality of life in the State.

While $50 million per year is a large investment in challenging economic times, Washington has a great deal at stake; this incremental investment by the State is scaled and targeted to create both short-and long-term benefits to Washington State's $220 billion economy and the lives of 5.9 million residents of the State.

Competitive Grant Program: Selecting the Highest Value Investments

The State's public and private health care, information technology, and biomedical research institutions and companies will be invited to compete for multi-year, research and development center funding. Competitive applications will be evaluated on the basis of four fundamental program criteria:

- The quality, focus and timeliness of the research, development or commercialization effort proposed;
- The potential for commercial and/or health care impact in the State of Washington;
- The degree and quality of collaboration among non-profit research organizations, companies, and clinical enterprises; and
- The degree to which State's investment will be matched by private or federal investment, a minimum requirement being that State funds are matched 1-to-1 by other funds.

These criteria—and the strong peer-review process by which competitive proposals will be evaluated—are designed to assure that State funds will not simply follow existing federal and private funding patterns but will be invested to enhance or create centers that can make a material contribution to program's goals of a stronger Washington economy, leadership in world health, and health benefits for the citizens of the State. For example, using these criteria, State funding of $250 million over an initial five-year period will be leveraged to at least $500 million of new investment through a combination of matching federal, corporate and philanthropic resources.

Broadening and Enhancing the Value of Washington's Centers of Excellence

There are many nationally recognized centers of biomedical research or health care technology excellence in Washington. Enterprises such as the FHCRC, the UW Department of Bioengineering, the Pacific Northwest National Laboratory, Amgen's Seattle-based research facility, Merck/Rosetta Pharmaceutical, or Inland Northwest Health Systems are the foundation of the State's future in the convergence of information technology, health care and biomedical research. Attachment II illustrates the strength and depth of Washington's assets in these areas.

It is these centers of excellence and their peer organizations in the state—already attracting well over $2 billion in federal and private biomedical research and development funding—which can best leverage the State's leading position in biomedical research to be more effective in creating

economic opportunity and improving health care. A rather modest state investment could leverage the enormous federal investment in biomedical research for the benefit of Washington.

Where research excellence and scale already exist: In areas of research, development and commercialization where the State already has one or more centers of excellence – is already attracting the best researchers and collateral corporate or private equity investment – the Bio 21 program will invest where there are critical gaps in moving new research discoveries to commercial application, in implementing the State's capability for healthcare and in bridging critical research sectors that cannot be funded by federal research dollars or by venture capital. State support to an existing center of excellence can provide the resources necessary:

- To substantially broaden and deepen beneficial collaboration among non-profit research enterprises, companies, and clinical enterprises in the State;
- To invest in pilot funding to generate new federal grants;
- To invest in proof-of principle funding to move a laboratory insight to become a start-up company; and
- To explore or ramp-up new areas of applied technology to enhance the ability of academic research to generate commercial products.

Where excellence and/or scale need to be created: In areas of biomedical research, commercialization or leading edge health care where the State has less proven capability new collaborative center grants will jump-start the process of creating deep and long-lasting core competence to benefit the citizens of the State. Such centers can be real or virtual, in a single location with a single facility, at two locations separated by hundreds of miles, or distributed among a dozen nodes located around a State. The key features of a "new" center are:

- A shared research and development agenda of material scale and scope in a disease or functional area of therapeutics, diagnostics, bioengineering or research/clincial informatics;
- Cooperative structures and incentives for company, public, and non-profit research and development teams to work together; and
- A clear and compelling case that the whole is more than the sum of the parts.

While such new centers are likely to be a product of new partnerships and approaches by already strong State-based institutions and companies the intent in creating a new center of excellence is clear. Such centers should fill a gap in the State's portfolio of biomedical research or commercialization and be able to attain a standard of excellence and visibility where they can attract out-of-state public and private research funds, corporate interest and collateral investment, and the world's leading research, development and clinical personnel.

The importance of center-scale activity and funding: The focus on funding center-scale activities–whether they are substantial enhancements to existing centers of excellence or entirely new enterprises—is critical to attaining the program's goal of having a major impact on the State's position in biomedicine. While $250 million is a large State investment, the total five-year leveraged amount of $500 million represents less than the State's premier non-profit research organizations win in competitions from the NIH in a single year. Further, as already noted, the State attracts substantial corporate R&D investment in the biology-information

technology space with major facilities or institutional relationships with Amgen, Microsoft, Merck, GE, Intel, and many others.

For Bio 21 to have a material Statewide impact, the State's limited resources need to be concentrated in a limited set of areas where the State can enhance, develop, and maintain a distinctive competence. The need for careful, targeted choices argues powerfully for a sharp focus on creating centers of excellence with fewer, larger, multi-year grants. This helps minimize the risk that State funds get spread too thin, create nothing distinctive, or simply displace funds that would have otherwise come from the federal government or private sources.

Where Biomedical Research, Information Technology and Health Care Converge in the 21st Century

While the specific centers to be funded will be identified through the competitive process, the expectation is that the State's considerable strengths biomedical research and information technology will lead to the enhancement or establishment of centers of excellence and collaboration in areas such as:

- Biochemistry and medicinal chemistry – chemistry is the critical step between understanding the human genome (where Washington is already a world leader) and the identification and development of new pharmaceuticals, and, perhaps, a keystone investment if Washington is to grow a more robust industry in mature and start-up therapeutics (drug) companies.

- Molecular diagnostics – the science of understanding a disease or condition at the level of genes or proteins combined with the bioengineering to translate the scientific understanding into a useable diagnostic test is the leading edge of the new wave of predictive and preventive health care.

- Imaging – information technology, biological science and high-quality health care converge in imaging, ranging from common current clinical practices such as MRI and ultrasound diagnostic tests through advanced research applications of the same technology and into molecular level imaging where biomedical scientists, as well as plant and animal biologists working on human health issues, increasingly "see" and work with molecules in the same ways that a structural engineer sees and works with steel beams and concrete.

- Medical Devices and Instrumentation – the State of Washington is already home to a vibrant bioengineering community and strong medical device and biomedical instrumentation industries but in these rapidly changing fields—especially as emerging micro- and nano-scale technologies are revolutionizing these industries—dominance is impossible and even leadership is transient; investments in these areas would be to maintain leadership in a time of dramatic scientific and technological change

- Advanced Health Care Informatics – biomedical research (including the $27 billion in research supported by the U.S. National Institutes of Health) is ultimately focused on improving health and health care and, in our increasingly digital age, there is tremendous

potential to link the fundamental research laboratory, the clinical research enterprise, the hospital and the individual doctor's office to provide better health care (fewer errors, more personalized and advanced health care) at lower cost.

Governance and Management of the Program

The Bio 21 program will be governed by an entity operating under bias and conflict of interest policies that meet the highest standard of public scrutiny with regard to the allocation of the funds. This body will be responsible for ensuring that the program is responsive to the rapidly evolving scientific and commercial environment and that it attains its stated goals by:

- Selecting and retaining one or more companies or non-profit entities to manage the program;
- Preparing an annual Program Directions Brief suggesting (but not unduly constraining) broad scientific, technical and commercial directions for center funding applications;
- Design and approval of each year's Request for Proposals, including details of qualifying requirements and of evaluation criteria;
- Oversight of the peer-review process to guarantee that the proposals are rated and ranked using the best available experience and judgment and consistent with the stated qualifying and evaluation criteria;
- Making the annual grant decisions after receipt of the peer-review ratings and rankings, as well as oversight of any negotiations with grant recipients over budget, milestones or center structures; and
- Preparing an annual review and evaluation of the program's accomplishments.

The BioInfo 21 Steering Committee, convened by the Governor in mid-2003 and managed and staffed by the Washington Technology Alliance, prepared an Illustrative Initial Program Design, included as Attachment III. This program design is consistent with the program goals and objectives described in this document—could easily be the basis of the first RFP issued by the program—and could be used by the governing entity to jump start the program as early as mid-year 2004.

WASHINGTON ADVISORY GROUP REPORT

Attachment I: The Opportunity

Discoveries in the life sciences are creating the most significant technological advances of our era. The Human Genome Project and other biological research is revolutionizing the diagnosis and treatment of such previously intractable diseases as cancer, cystic fibrosis, and heart disease. Similar revolutions in infectious disease, agriculture, materials, and energy beckon over the next several decades.

These underlying advances in scientific understanding of biological processes are enabled through the integration of information technology into biological research and health care, on at least three broad fronts:

- First, in the biological sciences such computational tools as modeling and simulation, subcellular, cellular and whole body visualization, process control, computer-enabled automation, structural biology, and device-enabled research are unlocking critical new information about biological and biochemical processes, leading to unprecedented advances in medical diagnostics (predictive, preventive and personalized medicines) therapeutics and other biomedical innovations. Data integration, as well as the storage and mining of genomic data provide yet other examples of the need for technology support to maximize the impact of scientific advances.

- Second, in the field of bioengineering, software, hardware, microchip, bioprocessing, and transgenic technologies are being applied in a host of health care or biomedical applications, ranging from microarrays, biomaterials, biosensors, bioprocessing systems and microfluidic devices through clinical and research instruments to clinical devices such as computer controlled surgery, virtual reality based training systems, implanted devices, imaging-based diagnostic tools and biomedical products produced in pharmaceutical plants derived through biotechnology.

- Third, in the field of informatics in support of clinical research and health care delivery, information technology is having a broad and varied impact ranging from electronic medical records and computerized prescriber order entry to clinical decision making to entirely new forms of health care delivery such as evidence-based or information-based medicine. As the NIH observes: "An enriched pipeline of biomedical discoveries, an infrastructure to facilitate their translation from the lab to the clinic and a robust force of clinical investigators will make it possible to test new therapeutic and preventive strategies in larger numbers of patients far sooner than at present. These large studies are often best conducted through networks of investigators who are equipped with tools to facilitate collaboration and information sharing."

As they dramatically change the face of medicine and improve human health, these advances are also creating huge new markets. By 2005, global demand is expected to reach $74 billion for bio-based diagnostics and therapeutics, $125 billion for bioengineered applications, and $30 billion for health care informatics. This revolution thus represents a unique economic

opportunity for those regions that are able to advance to become centers of excellence in these fields while also allowing the select few regions with the capabilities to leave a dramatic mark on the field of medical research.

There is a strong tendency for the biopharmaceutical and medical device industries to cluster such functions as product development, marketing, and manufacturing in geographic proximity to the research centers that make the discoveries on which their businesses are based. Bio 21 is designed to exploit and reinforce that tendency by providing financial incentives for new and mature companies to partner with Washington research and health care organizations.

WASHINGTON ADVISORY GROUP REPORT

Attachment II: Washington's Assets

The key driver in generating new industries and health care advances is the research capacity to generate the innovations on which these advances are based. Washington has a solid research base on which to build:

- The state's universities, federal laboratories, and non-profit research institutions conduct over $1 billion in R&D annually. Industry R&D totals more than $7 billion per year, fourth among all states nationally;
- The University of Washington has led the nation's public universities in competing for federal research and training grants since 1974. Its Genome Science, Bioengineering, and Computer Science departments are among the best in the nation.
- Leading edge biotechnology, bioengineering, bioprocessing and information technology companies such as Amgen, Merck, Intel, Microsoft, GE Medical System, Siemens, Phillips, Hollister-Stier, and IBM Life Sciences are all active investors and participants in Washington's life sciences research economy.
- In recent years, the Fred Hutchinson Cancer Research Center has been the largest recipient of federal funding among the nation's independent comprehensive cancer research institutes.
- The Bill and Melinda Gates Foundation is dedicated to eradication of infectious disease in developing countries and is engaged in supporting and developing myriad innovative research efforts toward these ends. The worldwide research and clinical networks being created through the Gates Foundation is making Washington what some have described as the new Geneva in World Health and represents an enormous opportunity for research organizations and companies located here, such as the Program for Appropriate Technology in Health (PATH) and the Seattle Biomedical Research Institute.
- Since 1989, the state has produced five Nobel Prize winners.
- In less than four years, the Institute for Systems Biology has grown to a staff of 170, attracted more than $140 million in funding, and become internationally renowned for pioneering the new field of Systems Biology.
- Pacific Northwest National Laboratory makes available world-class instrumentation to the research community, including the world's largest and most stable magnet imaging system for chemical, biological, and materials research and the nation's fastest supercomputer performing unclassified work.
- Washington State University has particular strengths in safe food and in plant animal and microbial science, including the implications of microbes on safe food. WSU leads the nation in plant biochemistry/plant biology research and is developing particular expertise in the production of health products from natural systems including microbes and output-trait plants derived through biotechnology.
- The statewide Community Health Network of Washington is one of the most progressive and successful managed care systems for the underserved in the

United States, supported by state of the art proprietary technology recently selected to be used in establishing the first health care network for the country of India.

- Inland Northwest Health Systems in Spokane has developed a four state regional medical information system that is a model for the country.
- Microsoft is the largest software company in the world and Microsoft Research is ranked among the top computer science research organizations in the world.

WASHINGTON ADVISORY GROUP REPORT

Attachment III: Illustrative Initial Program Design

The Bio 21 Initiative Steering Committee (roster attached) proposes a highly leveraged, program of competitive research, development and demonstration awards to the State's universities, federal laboratories, non-profit research institutions, and health care organizations. Startup, high-growth, and mature companies would have an opportunity to participate jointly in these projects. The program would provide State funds—to be matched at least dollar for dollar by new federal, corporate or philanthropic monies or resources—to support research capacity for cross-disciplinary collaboration that creates a rich pipeline of technology to be commercialized in Washington.

Annual awards would be made to the highest ranked, qualifying proposals in three areas that will affect global health: (1) basic biological research in support of diagnostics and therapeutics, (2) research and development in bioengineering, (3) and development and demonstration of advanced health care informatics.

Biological Sciences. Applications should demonstrate how State funding would be leveraged to create or extend biological research capabilities that drive the development and production of diagnostics or therapeutics. Such research could extend to any of the life sciences, including animal and plant biology. Thus, meritorious projects could include, for example, the use of plants to synthesize pharmaceuticals and vaccines, or the study of protein folding within microorganisms growing under extreme conditions which could lead to new ways of stabilizing vaccines without refrigeration. Projects would be required to be of sufficient scale, scope and quality to affect the State's international standing in such emerging fields of regional strength as genomics, proteomics, computational biology, structural biology, and systems biology. Projects could also be designed to fill regional gaps in areas of strategic importance to diagnostics or therapeutics, such as medicinal chemistry.

Following are illustrative projects in biological research that would have the potential to benefit from the program:

- Intel is installing at the Fred Hutchinson Cancer Research Center a highly sensitive piece of spectroscopy equipment and providing a physicist and biologist to operate it, and $300,000 in pilot funding, to evaluate potential of this equipment to advance discovery of biomarkers for early detection. With state matching funds, the pilot funds could be increased and more investigators from other research institutions could explore the potential for this equipment in their work.

- IBM worked with the Fred Hutchinson to develop better communication tools for investigators and clinicians studying the MHC region of one of our chromosomes (used in tissue typing) to be able to transfer genomic information back and forth across labs. With state matching funds, this hardware and software could be made available to a broader array of investigators around the region for the general transmission of genomic information with strong security provisions.

- The federal government has submitted a request for proposals to develop drug design facilities that are a partnership between industry and academia. The concept is that a shared resource would be established to test various molecular targets identified by lab investigators with libraries provided by industry. The federal government would provide up to $600,000. To complete the project, $450,000 in matching funds would be needed (plus indirect costs). The libraries would be donated by industry—the usual cost is in excess of $100,000. Intellectual property would be shared across all the parties. Fred Hutchinson and the University of Washington want to jointly submit an application but are having problems identifying matching funds.

- Washington State University is developing novel technologies which employ cereal grains, soybeans and other plants to produce health products. For example, the USDA and the Murdock Trust recently provided funding to engineer barley which will produce collagen, a model mammalian protein. Similarly, ongoing work funded by the USDA and the Department of Energy has identified lipoxygenase products produced in soybeans which can serve as inflammation mediators and anti-cancer agents in humans. With significant additional investment, WSU could lead the nation in the development of health products from natural sources, such as plants and microorganisms.

- With investments totaling more than $1.3 million from the NIH, the Murdock Trust and the institution, WSU is installing a state-of-the-art proteomics facility which includes an FTICR mass spectrometer, a unique Northwest university capability. In addition, PNNL was recently awarded $10.7 million to develop a proteomics user facility. With state matching monies, the WSU facilities could be coordinated more closely with the proteomics facility being developed at the PNNL, allowing additional researchers around the region access to complementary facilities at the university and national laboratory. This coordinated, complementary university/laboratory facility could then attract still more research and development funds to the region.

Bioengineering. Applications should demonstrate how State funding would build or enhance existing multi-participant, bioengineering research enterprises with a high probability of contributing to commercial applications. In these areas of research and development, many of the opportunities are closer to the market than in the basic biological research. Accordingly, the 1-to-1 match for State funds would be expected to come primarily from the private sector. Thus proposals including an established or start-up biotechnology, pharmaceutical, medical device, bioprocessing or instrumentation company involved in the development or production of products or services would be highly favored.

The following represent areas of bioengineering strength that could be further strengthened through collaborative bioengineering center investments:

- Scientific research will spur pioneering developments in engineering: to advance capabilities in the replacement and repair of damaged human tissue. These developments will enhance the quality of life for the nation's and world's aging population, victims of

burns and other injuries, and chronic disease sufferers, while reducing the cost of healthcare delivery.

- Distributed Diagnosis and Home Healthcare (D2H2) is a new paradigm for the practice of medicine to monitor people's health conditions and treat sick patients. There is a growing need for rapid diagnosis of disease and for the combination of diagnosis with therapy, in the emerging field of "theranostics." This involves microfluidics and molecular-based diagnostics for sensing and delivery of therapy, intelligent data processing, communications, and healthcare informatics.

- The Puget Sound region has been a leader in diagnostic ultrasound. This leadership needs to be maintained and extended, e.g., by moving into therapeutic ultrasound. Furthermore, use of several imaging modalities (e.g., PET, MR, ultrasound and optical imaging) from nano to macro level can revolutionize not only diagnosis, but also image-guided therapies and drug-discovery process.

- Washington State University will receive $1million through the Office of Naval Research to develop novel bone replacement technologies which use porosity matched ceramic structures and a person's own stem cells to create novel bone replacement materials having the potential to dramatically extend the life of bone implants.

Advanced Informatics for Linked Research and Health Care Delivery. In contrast to the other two program areas where a wide variety of science and technology are of interest this area is focused on research and demonstration of software, computers, networks, and communication and data sharing protocols as applied to links among basic biomedical research, clinical research, and health care delivery. Applications should demonstrate how State of Washington funding would be leveraged to exploit Washington's considerable strengths in software and information technology and apply them creatively in a paired research and clinical settings to pioneer new and better approaches to health care in Washington and the world. The Distributed Diagnosis and Home Healthcare (D2H2) example falls partly within this program area. The following example from Minnesota illustrates the type of project that could be funded under in the advanced health care informatics program area:

- IBM and Mayo Clinic are jointly developing an information system designed to give Mayo Clinic investigators access to information that can help them more quickly identify potential clinical trial participants faster. When completed, the new system could enable Mayo Clinic's medical staff, including 2,400 physicians and scientists in more than 100 specialty areas, to quickly draw meaning from a wealth of medical data to support medical treatments, including genomic information from public and private databases and retrospective studies of millions of archived records collected from informed, consenting patients.

APPENDIX C
INTERVIEWS CONDUCTED BY THE WASHINGTON ADVISORY GROUP LLC

Arnold, Robert
Steering Committee Member; President & COO, Geospiza, Inc.
Interviewed by: Gil Omenn

Blair, James
Interim Vice Provost for Research, Virginia Tech
Interviewed by: Maxine Savtiz

Bridon, Regis D.
Senior Enterprise Program Manager, Platform Strategy Group
and Mohan Rao Cavale
Technical Evangelist, Microsoft Corporation
Interviewed by: Bruce Guile

Cheatham, R. Lee
Steering Committee Member; Executive Director, Washington Technology Center
Interviewed by: Bruce Guile

Chin, Steve
Manager, Health Care Vertical Microsoft Corporation
Interviewed by: Bruce Guile

Compton, Jim
Seattle City Council Member
Interviewed by: Gil Omenn

Denton, Denice
Dean, College of Engineering University of Washington
Interviewed by: Bruce Guile

Frazier, Alan
Founder & Managing Partner, Frazier Healthcare Ventures/Co-Founder & Managing Partner, Frazier Technology Ventures
Interviewed by: Gil Omenn

Fritz, Tom
CEO
and Galusha, Fred
CIO, Inland Northwest Health Services
Interviewed by: Maxine Savitz

Fritzky, Ed
Board of Directors, Amgen
Interviewed by: Gil Ommen

Grinstein, Bill
Executive Committee Member; Associate Director for Public Affairs, Pacific Northwest National Laboratory
Interviewed by: Bruce Guile

Hartwell, Lee
President & Director, Fred Hutchinson Cancer Research Center
Interviewed by: Gil Omenn

Hirsch, Chuck
Executive Committee Member; Managing Director, Madrona Venture Group
Interviewed by: Gil Omenn

Hood, Leroy
President, Institute for Systems Biology
Interviewed by: Gil Omenn

King, John
Senior VP & COO, Rosetta Inpharmatics, Inc.
Interviewed by: Bruce Guile

Larson, Eric
Director, Center for Health Studies, Group Health Cooperative
Interviewed by: Gil Omenn

Lazowska, Ed
Steering Committee Member; Bill & Melinda Gates Chair in Computer Science, University of Washington
Interviewed by: Bruce Guile

Ling, Dan
Corporate Vice President, Research, Microsoft Corporation
Interviewed by: Bruce Guile

Malarkey, Susannah
Executive Committee Member; Executive Director, Technology Alliance
Interviewed by: Gil Omenn

Mann, Reinhold
Steering Committee Member; Associate Laboratory Director, Fundamental Science Directorate, Pacific Northwest National Laboratory
Interviewed by: Maxine Savitz

Means, Peggy
Steering Committee Member; Senior Vice President, Strategic Development and Planning, Fred Hutchinson Cancer Research Center
Interviewed by: Bruce Guile

Michaels, George
Steering Committee Member; Director of Bioinformatics, Biomolecular Systems Initiative, Pacific Northwest National Laboratory
Interviewed by: Maxine Savitz

Morris, Fred
Executive Committee Member; Executive Policy Advisor for Science & Technology, Governor's Executive Policy Office
Interviewed by: Bruce Guile

Morris, Scott
Senior VP, Avista Corporation; President, Avista Utilities
Interviewed by: Maxine Savitz

Nelsen, Robert
Managing Director, ARCH Venture Partners
Interviewed by: Gil Omenn

Newell, Janice L.
VP & CIO, Group Health Cooperative
Interviewed by: Bruce Guile

Payne, Dr. Thomas H.
Medical Director, UW Medicine Information Technology Services & Clinical Associate Professor of Medicine, University of Washington
Interviewed by: Bruce Guile

Peters, Leonard
Director, Pacific Northwest National Laboratory
Interviewed by: Maxine Savitz

Ramsey, Paul
VP for Medical Affairs & Dean, University of Washington School of Medicine
Interviewed by: Gil Omenn

Rice, Norman
Steering Committee Member; Chair, Board of Explore Life; President & CEO, Federal Home Loan Bank of Seattle; Mayor of Seattle 1990-1998
Interviewed by: Gil Omenn

Rosen, Dan
Co-Founder and Managing Partner, Frazier Technology Ventures
Interviewed by: Gil Omen

Royer, Charles
National Program Director, Robert Wood Johnson Foundation's Urban Health Initiative; Mayor of Seattle 1978-1990
Interviewed by: Gil Omen

Scott, Ruth
Steering Committee Member; President, Washington Biotechnology & Biomedical Association (WBBA)
Interviewed by: Bruce Guile

Spitzer, Kenneth
Associate Vice Provost for Research, Washington State University & Executive Interim Director, WSU Research Foundation
Interviewed by: Maxine Savitz

Stafford, Bill
President, Trade Development Alliance of Greater Seattle
Interviewed by: Gil Omenn

Tam, Patrick
Executive Director, Spokane Intercollegiate Research & Technology Institute (SIRTI)
Interviewed by: Maxine Savitz

Waterston, Robert
Professor & Chair, Department of Genome Sciences, University of Washington
Interviewed by: Gil Omenn

Zhao, Lue Ping
Founder & CEO, Enodar Biologic
Interviewed by: Gil Omenn

ADDITIONAL INTERVIEWS [notes not provided]

Hinkston, Brent
Business Area Executive, IBM Life Sciences
Interviewed by: Bruce Guile

Shapiro, Bennett
EVP for Worldwide Licensing & External Research, Merck
Interviewed by: Bruce Guile

Perlmutter, Roger
EVP of Research & Development, Amgen
Interviewed by: Bruce Guile

APPENDIX D
ADDITIONAL EXAMPLES OF HOW BIO 21 WOULD LEVERAGE OUR ASSETS

How could Bio 21 make an immediate difference?

It is useful to see how limited state R&D dollars have been leveraged in the past:

- One program that Washington State did fund was the Advanced Technology Initiative (ATI). At UW, $1 million a year in state funds have been used to recruit key people in infectious disease to fill gaps in the UW faculty. The new faculty mounted an extensive expansion of UW's research in infectious diseases, with significant success. The most notable and recent example is a $50 million federal grant ($10 million per year for five years) in biodefense and infectious diseases. UW fully expects the grant to be renewed, meaning that $10 million will leverage $100 million over ten years.

- UW has launched a major effort in photonics, and the program has received remarkable federal and commercial interest. One of the UW's problems was coping with success – there was more grant money available than it could deal with given the facilities limitations. Last session, the Legislature made matching money available, and UW used the first installment to refurbish space for the photonics effort. UW is spending $2 million in state money on a one-time basis in support of a grant program that currently brings in $10 million per year and is growing. Also worthy of note, the photonics program already has significant involvement with Washington business: Boeing has a major federal contract tied to the UW technology, and a startup company, Lumera, has spun out of the program.

Examples of projects that could benefit from Bio 21 going forward:

- A state investment in establishing a HUB in Seattle on the proposed Ultranet connection between Oak Ridge, Argonne, PNNL and LBNL would provide Seattle-area computational science researchers with access to a high-speed, high-bandwidth research network environment, and would also link the researchers at UW and FHCRC directly to the supercomputer at PNNL in the Tri-Cities and to the high end instrumentation for proteomics research at PNNL. This investment would greatly increase the region's chances of putting together a consortium of UW, FHCRC, PNNL and Microsoft that could win designation as a National Center for Biomedical Computing (NCBC). The initial NCBC grants will be for $15 million over 5 years, and will be the entry ticket for further NIH funding in biomedical computing.

- A state investment in simply buying the instrumentation necessary for a high throughput production proteomics 'line', to parallel the one supplied to PNNL by the Department of Energy, would open up tremendous capacity within the region for biomarker discovery for cancer and other diseases and study of host-pathogen interactions, markers of

exposure and predictors of response to vaccination or therapy. The DOE instrumentation is currently oversubscribed for DOE projects, and there is simply little or no reserve available for collaborations in the biomedical area. Increasing the proteomics capacity could easily be leveraged 10 times over in research grants awarded to WSU, UW, FHCRC, PNNL and others. A 'production line' would require an investment of about $3 million. Each of the major grant proposals is worth at least $10 million over a 4 year period, so a $3 million investment would return $30 million in federal funds over 4-5 years.