Comparative Analysis of the Biotechnology Clusters in Seattle and Kobe
シアトル及び神戸における バイオ技術クラスターの比較分析

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Prepared for presentation at the 12th Regional Cluster Seminar,
Research Institute of Economy, Trade, and Industry, Tokyo, Japan, 6 August 2004

Outline

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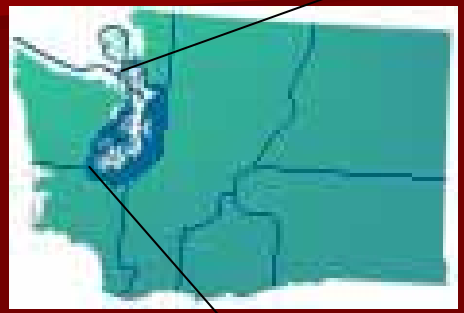
Part I. Biotechnology in Washington State
I.1 Introduction

- Located in the Pacific Northwest, bordering Canada (British Columbia) to the north, Oregon to the south, and Idaho to the east.
- Area is 176,600 square kilometers (20th largest in US), which is about one-half the area of Japan
- Population in 2000 was 5.9 million, making it the 15th most populous state.

Puget Sound Region



Home to 3.4 million people, or about 55 % of the state's total population

Population and industry are heavily concentrated in the Puget Sound region, a 4-county region, including the cities of Seattle, Everett, and Tacoma, bounded on the west by Puget Sound and on the east by the Cascade Mountains.

Indicators of Washington State's Competitiveness

- Home to Microsoft, Starbucks, Amazon.com, RealNetworks, Nintendo America, and AT&T Wireless; and to major operations of Boeing and Amgen.
- Has highest rate of new company formation in the US (12 business starts per 1000 employees).
- Also ranks second in the rate of company closings (20.5 percent of all businesses closed in 2002).
- The aerospace (75,656 jobs in 2002) and software industries (35,783 jobs) employ 17 percent of the state's workforce.
- 12 percent of employment is in high technology sectors
  - Excluding aerospace, 9 percent of employment.
- Ranks first in exports on a per capita basis.
  - Ranks fourth in the total value of exports.
  - 55 percent of exports are in the aerospace sector.
- Leads the nation in technology sector wages.
- Ranks 7th nationally in broadband access.

- Washington ranks 10th nationally out of 11 regions in venture capital investment.
  - Roughly $568 million of VC invested in 2002, compared to slightly more than $6.9 billion in Silicon Valley.
  - By industry, software received 23 percent of VC investment, telecommunications 24 percent, consumer products 14 percent, medical devices 15 percent, and biotechnology 8 percent.
- In a survey of 50 high technology metropolitan regions, Seattle ranked 11th in the location coefficient of high technology output (2.06) in 1998, according to the Milken Institute.
  - Six high technology sectors had coefficients greater than one, compared to 10 in San Jose and 11 in Boston.

Trends in High Tech Employment in Puget Sound Region

Industry	1995	2001	2002	% change 1995-2001	% change 2001-2002
Aerospace	9,525	11,866	10,100	24.6	-14.9
Biotech	**8,076**	**11,668**	**12,824**	**44.5**	**9.9**
Chemicals	754	725	553	-3.8	-23.7
Computer-related	8,247	23,093	17,793	180	-23
Electronic equipment	9,912	13,941	11,062	40.6	-20.7
Instruments	10,180	11,579	11,181	13.7	-3.4
Software	23,096	53,103	48,785	129.9	-8.1
Telecommunications	14,129	22,889	21,571	62	-5.8
High Tech total	83,919	148,864	133,869	77.4	-10.1
Region Total	1,401,460	1,676,031	1,606,409	19.6	-4.2

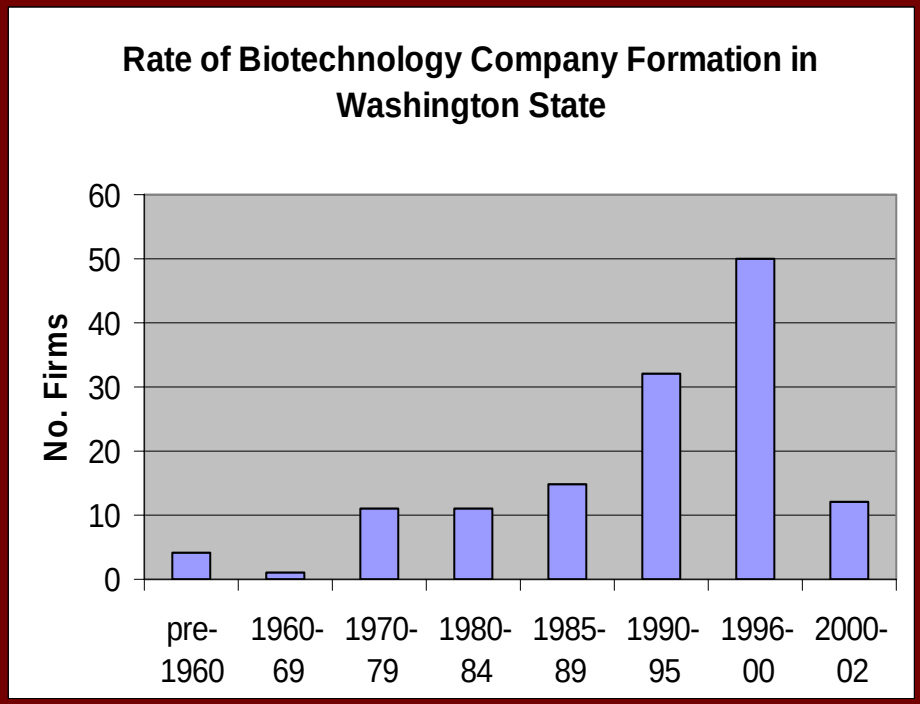
The Puget Sound economy benefited greatly from the “internet bubble” of the of the late 1990s, then suffered greatly when the bubble burst.
The exception is biotech, which has maintained steady and continuous growth.

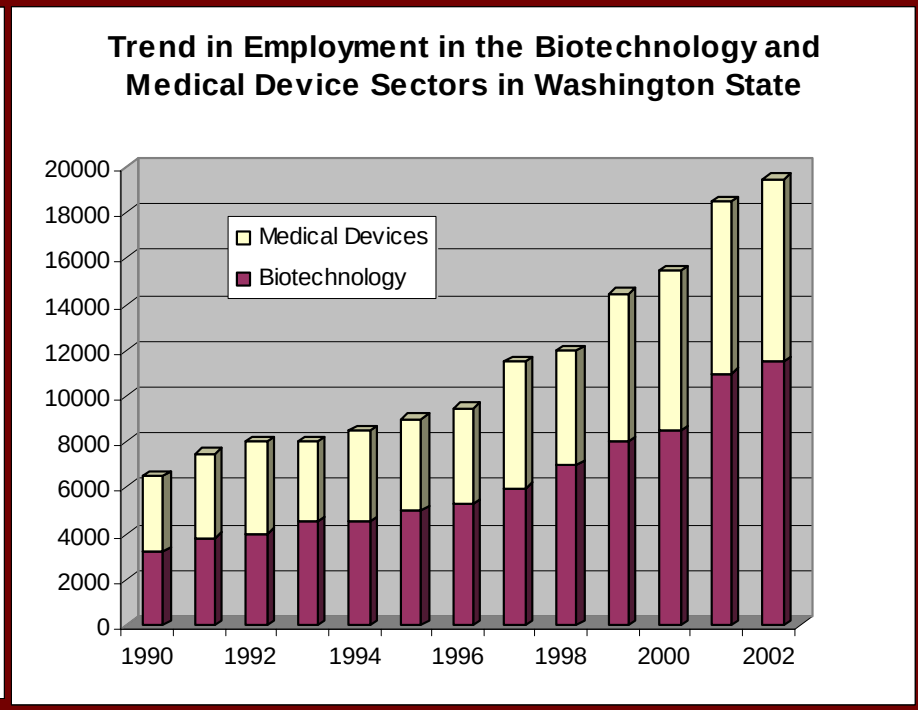
Data from Puget Sound Regional Council

I.2 Overview of Washington's Biotechnology and Biomedical Sector

- More than 190 biotechnology and medical device companies are headquartered or have a significant presence in Washington State.
  - 133 biotechnology firms and 57 medical device firms.
  - 21 companies are publicly traded
- These companies employed 19,360 people in 2002.
- Indirect employment attributed to the biotechnology and biomedical sectors is roughly 43,000.
- Biotech/biomedical firms contributed $3.5 billion to Washington's gross state product in 2000, 1.5 percent of total GSP.
- Washington state biotechnology and biomedical firms generate roughly $ 1 billion in revenue and $ 500 million in exports annually.
- By market segment, half of all biotechnology firms specialize in therapeutics, 12 percent in diagnostics, 11 percent in genomics/informatics, and 7 percent in agriculture.

Accelerating Rate of Company Formation and Employment Growth





- Source: Washington Biotechnology and Biomedical Association

Broader economic impacts are substantial

	Direct Impact	Total Impact	Multiplier
Employment	19,360	62,530	3.23
Labor Income	$ 1.316 million	$ 2.961	2.25
Value added	$ 1.652 million	$ 3.503 million	2.12

Source: Washington State Input-Output Study

Major Firms in the Puget Sound Biotechology/Biomedical Cluster

Firm (with live links to firms' web sites)	Employment in region	Year established locally	Location	Location of Parent or HQ
Philips Ultrasound	2,100	1969	Bothell	Royal Philips Electronics, the Netherlands
Medtronic Physio-Control	963	1955	Redmond	Medtronic, Inc, Minneapolis, Minnesota
Amgen, Inc.	815	Immunex in 1981, acquired by Amgen 2002	Seattle	Amgen, Inc., Thousand Oaks, CA
Icos Corp	674	1990	Bothell	Same
Spacelabs Medical	456	1982	Issaquah	GE Medical, Waukesha, Wisconsin
Zymogenetics	363	1981	Seattle	Same
Corixa Corp.	344	1994	Seattle	Same
Cell Therapeutics	264	1991	Seattle	Same
Rosetta Informatics	263	1996	Kirkland	Merck, Inc., New Jersey
Siemens Medical Solutions UltraSound Div	250	1991	Issaquah	Mountain View, California

Source: Puget Sound Business Journal (12-18 March 2004), 14a, 24a

Public Companies with HQ in Washington: Top 12 by Employment

Firm	Location	Employees	Market Cap 3/1/04 $ million	Key products/Focus
Icos Corp.	Bothell	674	2,420	Cialis to treat erectile dysfunction
Zymogenetics	Seattle	363	860	Recombinant Human Growth Factor XIII for bleeding disorders
SonoSite Inc.	Bothell	350	313	Portable/handheld ultrasound systems
Corixa Corp.	Seattle	344	348	Bexxar to treat non-Hodgkin's lymphoma
Cell Therapeutics	Seattle	264	441	Trisenox injection for leukemia, Pixantrone anthracyline
Quinton Cardiology Systems	Bothell	228	122	Diagnostic cardiology equipment, heart stress test monitors
Dendreon	Seattle	117	613	Provenge immunotherapy for prostate cancer
Combimatrix	Mukilteo	99	194	Customizable DNA arrays for diagnostic testing and research
Seattle Genetics	Bothell	97	325	Monoclonal antibodies and antibody-drug conjugates for cancer
Targeted Genetics	Seattle	85	154	Gene delivery systems for cystic fibrosis, AIDS, inflammatory diseases
Epoch Biosciences	Bothell	67	62	DNA probe systems
Nastech Pharmaceutical	Bothell	63	137	Nasal drug delivery systems for treatment of obesity, erectile dysfunction, osteoporosis

How Does the Puget Sound Region Compare with other Regions?

Ranking of regions on basis of various indicators.

Region	Number of Firms	NIH Funding	Number of patents 1975-99	Value of strategic alliances	Venture capital invested 1995-2001
Boston	2	1	4	1	2
San Francisco	1	4	2	2	1
San Diego	4	5	7	3	3
Raleigh-Durham	6	9	12	8	7
New York	3	3	1	4	4
Philadelphia	8	6	3	9	5
Los Angeles	7	7	8	11	8
Washington, DC	5	3	5	6	11
SEATTLE	***9***	***8***	***14***	***5***	***6***

Source: Brookings Institution, “Signs of Life”

Sub-Regional Clustering

- Two sub-regions account for roughly 85 percent of total employment in biotechnology and medical device firms.
- About 60 percent are located in downtown Seattle in a triangle connecting the University of Washington, the south shore of Lake Union, and downtown Seattle.
  - These firms tend to be focused on research, exploiting close proximity to the Fred Hutchinson Cancer Research Institute and University of Washington.
- About 25 percent of biotech jobs (spread out among 35 companies) are located in Bothell, a suburban area within a 30-45 minute drive of downtown Seattle.
  - These firms tend to be at a more advanced stage of product development, requiring construction of a production facility. Availability of land, presence of large business parks, and land-use policies favor development of larger production and pilot plant facilities, while firms still enjoy convenient access to Seattle.

South Lake Union, Seattle

- Home to the Fred Hutchinson Cancer Research Institute, a nationally designated cancer research center.
  - Pioneer of bone marrow transplantation in leukemia treatment and other advanced stem cell transplantation techniques.
  - Recipient of $167 million of NIH funding in 2002 (28th among NIH grant recipients)
  - Home to two Nobel Laureates, including present head of the institute Leland Hartwell.

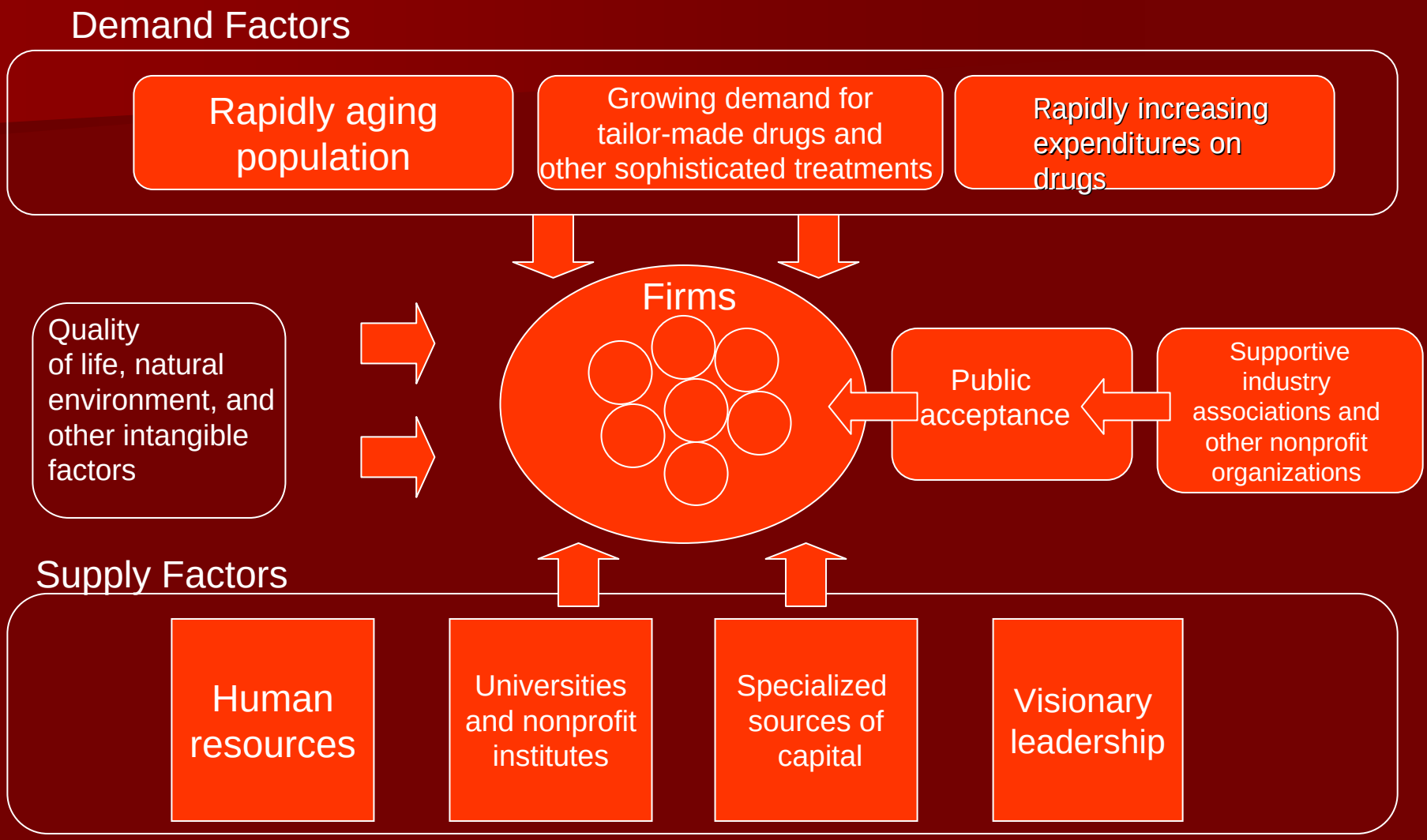
- In close proximity are Zymogenetics, Amgen, and the non-profit Institute for Systems Biology.
- “Hutch” researchers have been involved in the start up of no less than 10 biotech companies in the Puget Sound region.

South Lake Union: An Emerging Hotbed for Biotech

- The Mayor of Seattle is asking that the city invest $550 million in infrastructure improvements to support further development of the biotechnology industry on the south end of Lake Union.
- Much of the property in this area is owned by Vulcan, headed by Paul Allen, co-founder of Microsoft.
- Allen last fall announced plans to build a $100 million dollar “Allen Institute for Brain Science” to study the genetic basis of brain function.
- Leroy Hood, founder of the Institute for Systems Biology and inventor of the automated gene sequencer, last year established “The Accelerator,” a biotechnology incubator in south Lake Union. With $15 million from three of the world’s largest health-care venture capital companies, it aims to finance six biotech start-ups over the next 3 years. Hood offers access to the ISB’s facilities in return for ownership stakes in the companies.

Vulcan’s Interurban Exchange III building (136,000 square feet) at its South Lake Union campus. The building is fully leased out to Rosetta Informatics

I.3 Factors Driving Cluster Development in Biotechnology



Supportive public policies, especially supports for academic R&D, protection of IP, smooth regulatory processes, and a strong framework for technology transfer

Application to the Puget Sound Biotechnology Cluster

- Demand Factors:
  - Rate of spending on health care expected to grow 6.9 percent a year for the next decade, reaching more than 17 percent of GDP.
  - Although pharmaceuticals represent only 8 percent of spending on health care, and medical devices 3 percent, drug prices are projected to rise at an annual rate of 11 percent.
  - An aging society means more spending on health care. (Though only 13 percent of the population, those 65 and older consume 33 percent of the pharmaceutical output.
  - Pressures will increase to improve efficiency and reduce costs, which will favor non-invasive drug and medical device therapies over conventional invasive techniques. It will also favor technologies that enable customized administration of drugs based on genetic analysis.
  - A major risk is public backlash against genetically modified foods, stem cell research and cloning.

- Supply Factors
  - Human Resources:
    - The region has benefited from a large pool of post-doctoral researchers willing to work for biotechnology firms.
    - A smaller pool of research scientists has kept up a steady stream of new start-ups.
    - Community colleges will be increasingly called upon to supply workers with knowledge of basic laboratory techniques, manufacturing, and quality control.
    - Managers with a successful record running profitable companies will increasingly replace scientist/founders as more companies progress from the research to commercialization stage.

- Universities and Public Research Institutes:
  - More than half of the state's biotechnology and medical device firms are founded on technologies developed at the state's universities and public research institutes.
  - The University of Washington and Fred Hutchinson Cancer Research Institutes are the crown jewels in the state's science and technology infrastructure. The Battelle/ Pacific Northwest National Laboratory, Pacific Northwest Research Institute, and the Benaroya Research Institute at Virginia Mason round out the state's formidable array of public research facilities

University of Washington

- UW is one of the country's leading performers of basic research in medicine and biomedical science.
- UW ranked third in the nation in 2002 in the receipt of NIH grants ($ 406 million), and first among public universities.

A Comprehensive Framework for Technology Transfer

- Faculty and students at UW have contributed to the formation of 195 start-up companies over the past 30 years, 156 of which are still active.
  - Since 2000, start-up companies have spun out at the rate of almost one per month.
- Faculty disclose innovations at the rate of about 200 per year, of which 60 to 80 are licensed to startup companies.
- Since 1956, UW research has given rise to 32 biotechnology start-up companies.
- Nine of the top ten revenue-generating technologies are related to biotechnology.
  - The most valuable technology to date has been the “Hall technologies” for expressing polypeptides in yeast cells. Revenues from this license exceeded $ 5.4 million in 2003.

- Specialized sources of capital: Here, the Puget Sound region has lagged in recent years.
  - In 2002, only $76 million in early-stage financing was committed to biotechnology, compared with $667 million San Francisco, $394 million in Boston, and $194 million in Research Triangle, North Carolina.
  - Pre-seed and seed funding has been especially scarce in biotechnology.
  - As a result, the yield on federal research spending in terms of spinning off new companies is fairly low compared to other regions.
  - Many ideas thus fall into the “death valley” between the basic research and product development stages.
  - Seed and VC is prevalent in the region; it is just not going into early stage biotechnology.

- Visionary Leadership:
  - Bill Gates, whose $12 million grant to UW in 1991 helped it lure Leroy Hood from CalTech and create the Department of Molecular Biotechnology. The Bill and Melinda Gates Foundation, the world's largest foundation, has given generously to promote research on global health at the Seattle Biomedical Research Institute and Program for Appropriate Technology in Health.
  - Leroy Hood, founder of the Institute for Systems Biology, former chair of the Molecular Biotechnology Program at UW, and founder or cofounder of 11 biotechnology firms.
  - Paul Allen, whose company is developing the South Lake Union neighborhood into a a biotechnology hub.
  - Governor Gary Locke, who has proposed "BIO21" plan as a framework for advancing the commercialization of biotechnology in Washington State.
  - George Rathmann, who left Amgen in 1989 to co-found Icos Corporation in Bothell and worked tirelessly to promote public awareness and build support for the industry through the 1990s.

Other Supporting Factors

- Supportive industry associations and other nonprofit organizations. These promote public education and debate, as well as raise awareness among lawmakers of issues bearing on the industry's future:
  - Northwest Association for Biomedical Research: promotes bioethics education in public schools and awareness of the ethical use of animals in research.
  - Washington Biotechnology Foundation: promotes public understanding of biotechnology among school teachers; sponsors a regional biotechnology science fair for high school students.
  - Technology Alliance of Washington: an organization of technology professionals that monitors the performance of the state's high technology industries and makes policy recommendations for enhancing it.
- Quality of life:
  - CEOs consistently rate the high quality of life in the Pacific Northwest as one of the main reasons for locating their company in the Puget Sound area.
- An entrepreneurial ethos that pervades the region:
  - Washington State has highest rate of new business formation in US

The Missing Piece: A State Government Policy for Biotechnology

- Washington State is 46 out of 50 states in state support of R&D.
  - The state's constitution prohibits direct state financing of private industry.
- What are other states doing?
  - **North Carolina**, in 2003, offered Merck $36 million in tax breaks and cash to lure it to build a $300 million vaccine plant in Durham County.
  - **Pennsylvania** has budgeted $300 million on three life science "greenhouses" to accelerate the commercial development of research done in the state's universities.
  - **Michigan** launched the $1 billion Life Sciences Corridors initiative in 1998, using funds awarded to states to settle lawsuits with tobacco companies.
  - **California, Massachusetts, and Maryland** have established venture capital funds for early stage biotechnology companies.

- In contrast, the government of Washington State...
  - Has ***NO*** bioscience strategy.
  - Provides ***NO*** public support for venture funding of biotechnology.
  - Offers ***NO*** facilities financing for companies.
  - Provides ***NO*** financing of research parks or incubators.
- The governor has thus proposed the Bio21 initiative. *If approved* by the legislature, it would provide grants of up to $50 million dollars a year for ten years to firms whose proposals pass a rigorous peer review process and that provide matching funds. Funding would come from the state's allotted award from the settlement of a class action suit against tobacco companies.

Part II. Comparison with Kobe
II.1 Introduction

- Population of Kobe is about 1.5 million, a little more than double that of its sister-city Seattle.
- *Like Seattle*, Kobe developed as a major port city with a significant foreign population.
- *Like the Puget Sound Region*, the Kansai region is home to many excellent universities and research institutes:
  - Especially the schools of medicine of Kobe, Osaka, and Kyoto Universities; and the RIKEN Center for Developmental Biology and Tissue Engineering Research Center.
- *Unlike Puget Sound*, the Kansai region is home to several large drug companies, such as Shionogi, Takeda, Eisai, and Fujisawa.
- A major difference between Kobe and Seattle is that the Kobe cluster is taking shape as part of a grand plan: the Kobe Medical Industry Development Project.

- A second major difference is the occurrence of the Great Hanshin Earthquake in 1995, from the which the Kobe economy never completely recovered.
- A third major difference is that the Kobe biotechnology cluster is part of a larger super-cluster spread across the Kansai region (**関西広域クラスター**).
  - **播磨科学公園都市　(遺伝子構造解析)**
    - **中核研究機関：** Spring-8**施設**
  - **彩都 (国際文化公園都市) (創薬)**
    - **中核研究機関：　大阪大学、医薬基盤技術研究所　(仮称) 及び医薬品メーカー**
  - **関西文化学術研究都市　(バイオインフォマティクス)**
    - **中核研究機関：　奈良先端科学技術大学院大学や**IT**関連研究施設**
  - **神戸医療産業都市　(再生医療)**
    - **中核研究機関：　理化学研究所発生･再生科学総合研究センターや先端医療センター等**
- A fourth major difference is that the city of Kobe owns land (Port Island) that it can lease or sell to companies on its own terms; the city of Seattle owns very little land suitable for biotechnology firms
  - But Mayor Greg Nickels has proposed that the city buy land in the South Lake Union area from Vulcan that it can use to promote biotechnology development in that region.

II.2 Kobe Medical Industry Development Project

- Conceived in 1998 as a means of revitalizing the Kobe economy (which was still only at 80 % of its pre-earthquake strength).
- A commission led by Dr. Hiro Imura, who had just retired as president of Kyoto University and assumed the position of director of Kobe City General Hospital on Port Island, studied the project.
- Launched in summer 1999 under the leadership of Dr. Imura with the following three goals:
  - Build up existing industries and revitalize the Kobe economy by creating new jobs.
  - Improve the quality of medical services in Kobe.
  - Make a global contribution, including improvement of medical technology in Asian countries.
- 200 companies were involved in the various working groups that launched the project. 380 are involved today.

- Why the life sciences?
  - Expectations of rapid growth in domestic and international markets for health, welfare, and medical-related products.
  - The market size in Japan expected to double over ten years because of the aging of society deregulation, and increased application of IT in medicine.
  - This same logic is behind the effort accelerate commercialization of biotechnology and medical devices in the Seattle region and elsewhere.

- After studying life sciences clusters in the US, the city of Kobe decided that the requirements for cluster formation would be:
  - The establishment of core research facilities.
  - The development of collaborative relationships between universities and core research institutes
  - The development of a new airport that would provide fast and easy access to the cluster.
- The facilities are sited on Port Island, a man-made island 3 miles south of downtown and served by the Portliner monorail system.
  - The new Kobe airport is being built on another man-made island just south of Port Island. The Portliner monorail will transport passengers from downtown to the airport in only 16 minutes.
- Based on planning studies, the city determined that over two decades, the project would create 18,000 new jobs in Kobe alone, and 23,000 in the entire Kansai region.

Aerial View of Port Island Phase 2, showing newly completed core life science facilities

Photo April 2004

Source: Mr. Yamamoto, Kobe Trade Information Office, Seattle

Core Institutes on Port Island

- RIKEN Center for Developmental Biology:
  - Japan's first center of excellence in regenerative medicine, opened April, 2002.
  - Approximately 250 full-time researchers and 30 research teams.
- Institute of Biomedical Research and Innovation:
  - Core facility for bridging basic research and clinical application.
  - Constructed through joint investments by Kobe city, the national government, and private companies.
  - It is operated by the Foundation of Biomedical Research and Innovation.
  - Provides a platform for three major research initiatives: research on medical devices (especially imaging systems), clinical support for drug development (including recruitment of subjects for clinical trials in accordance with new GCP guidelines), and clinical application of regenerative medicine (especially cell therapy and tissue engineering).

- Translational Research and Informatics Center:
  - Aims are to support translational research activities of MEXT, provide data management support for clinical trials, and distribute information on cancer research reported monthly by the US National Cancer Institute.
  - Funded by MEXT and Kobe city.
- The Biomedical Accelerator:
  - Developed by MEXT and operated by Kobe University.
  - Designed to foster cross-university and cross-disciplinary collaboration that will open up new opportunities for new bio-business creation.
  - Will be merged with Kobe University's Incubation Center.
- Kobe International Business Center
  - Offers warehouse, assembly, and manufacturing space; R&D laboratory space, and office space.
  - Will include a business incubation facility and center to support clinical trials.
  - Managed by Kobe City Urban Development Corporation

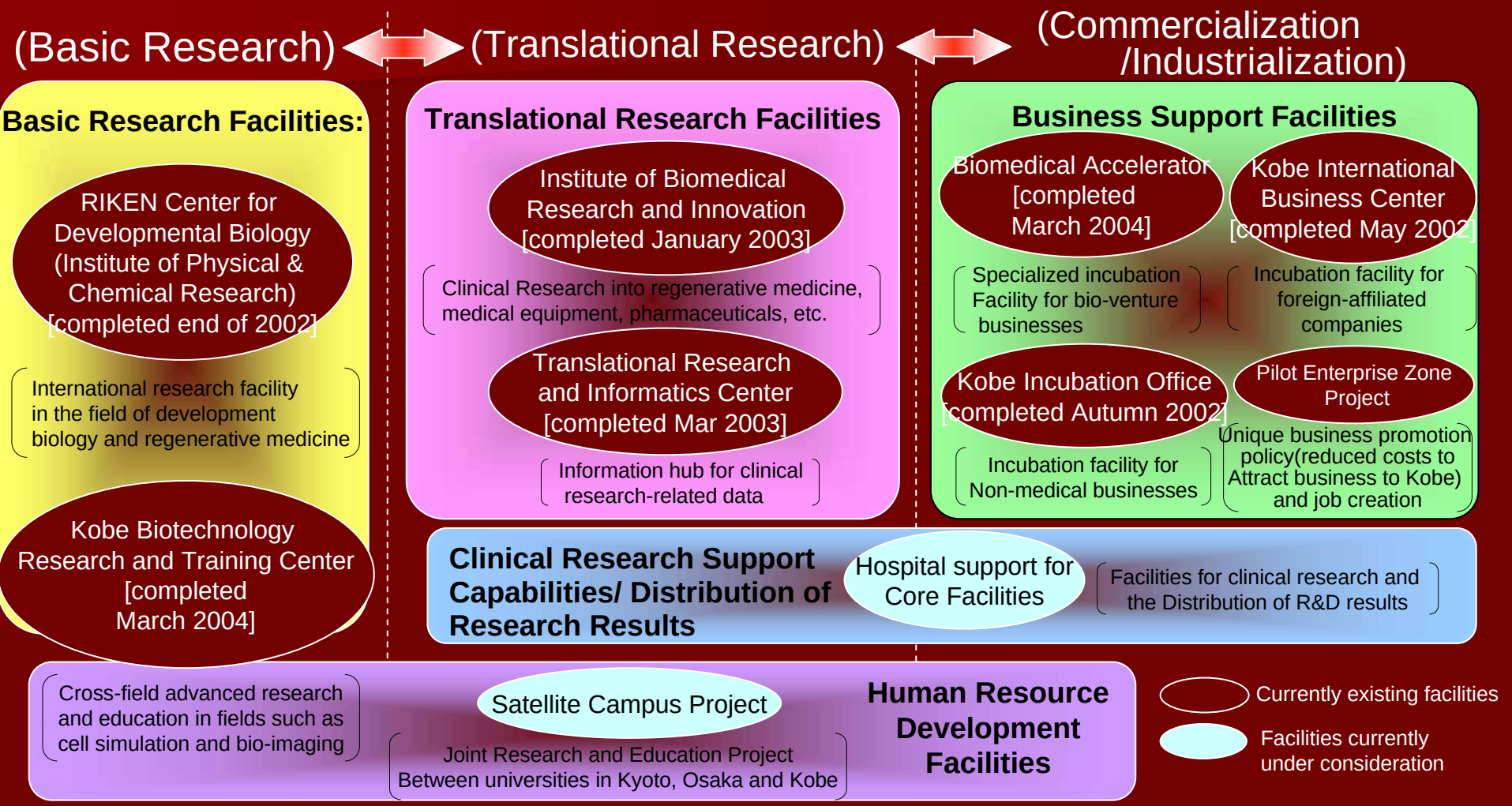
Financial Support

- Kobe city provides incentives for companies to establish operations in designated enterprise zones, including rent subsidies, reduced taxes on fixed assets, and various lease payment systems.
- Kobe Biomedical Fund: Established by Sumitomo Mitsui Financial Group to support venture businesses related to biotechnology and medicine. Three funds, totaling 6.3 billion yen, have been established to date.

Leveraging the Research Potential of the Kansai Region

- Kobe Translational Research Cluster:
  - Kobe has been selected, along with Saito, to form the Cooperative Link of Unique Science and Technology for Economic Revitalization (CLUSTER), a super-cluster centered on the Institute of Biomedical Research and Innovation, RIKEN Center for Developmental Biology, and Kyoto and Kobe Universities.
  - Industry participants include Stem Cell Sciences KK, Sumitomo Pharmaceuticals, and others.
  - Major research goals are systematic development of stem cell technologies for clinical applications, development of new technologies through fusion of stem cell biology and tissue engineering, and development of new technologies combining post-genomic and cell signaling research.
  - A unique feature is the “Biocirculator” Concept: This is a framework for the rapid application of research results by securing patents and identifying appropriate licensing arrangements.
- Kinki Bio Clusters: Bio Five-Star Company & Tissue Engineering Project
  - A METI-supported cluster project involving (as of summer 2003) 220 companies, 36 bio-related universities, and about 2,000 researchers.

Putting it all Together: Future Plans for Core Facilities



This and the next slide are courtesy of Mr. Takeshi Yamamoto, Director of the Kobe Trade and Information Office in Seattle.

中核施設整備の将来像

(基礎研究) ⟷ (臨床への展開研究) ⟷ (事業化・産業化)

基礎研究機能

発生・再生科学総合研究センター
(理化学研究所)
[H14末全体完成]

発生・再生分野の世界的な研究機関

神戸バイオテクノロジー研究・人材育成センター
[H16.3末完成]

臨床への展開研究機能
(トランスレーショナル・リサーチ)

先端医療センター
[H15.1末全体完成]

再生医療・医療機器・医薬品等の臨床研究の実践

神戸臨床研究情報センター
トランスレーショナルリサーチ・インフォマティクスセンター
[H15.3末完成]

臨床研究のデータ解析と情報の拠点

医療ビジネス支援機能

神戸バイオメディカル創造センター
[H16.3月完成]

神戸国際ビジネスセンター
[H14.5全体完成]

バイオベンチャー支援に特化したインキュベーション施設

外資系企業向けインキュベーション施設

神戸インキュベーションオフィス
[H14秋完成]

パイロットエンタープライズゾーン構想

一般ベンチャー向けインキュベーション施設

独自の企業誘致策(進出コスト軽減)と雇用創出

臨床研究支援 研究成果普及機能

中核機能の支援病院構想

臨床研究の支援の場
研究開発成果の普及の場

人材育成機能

細胞生体機能シミュレーション、バイオイメージング等の先端融合分野の研究と教育

サテライトキャンパス構想

京阪神の大学連携型の実践的研究・教育機関
(医学工学連携、バイオビジネス講座等)

既に整備されている施設

現在、検討中の構想

Accomplishments

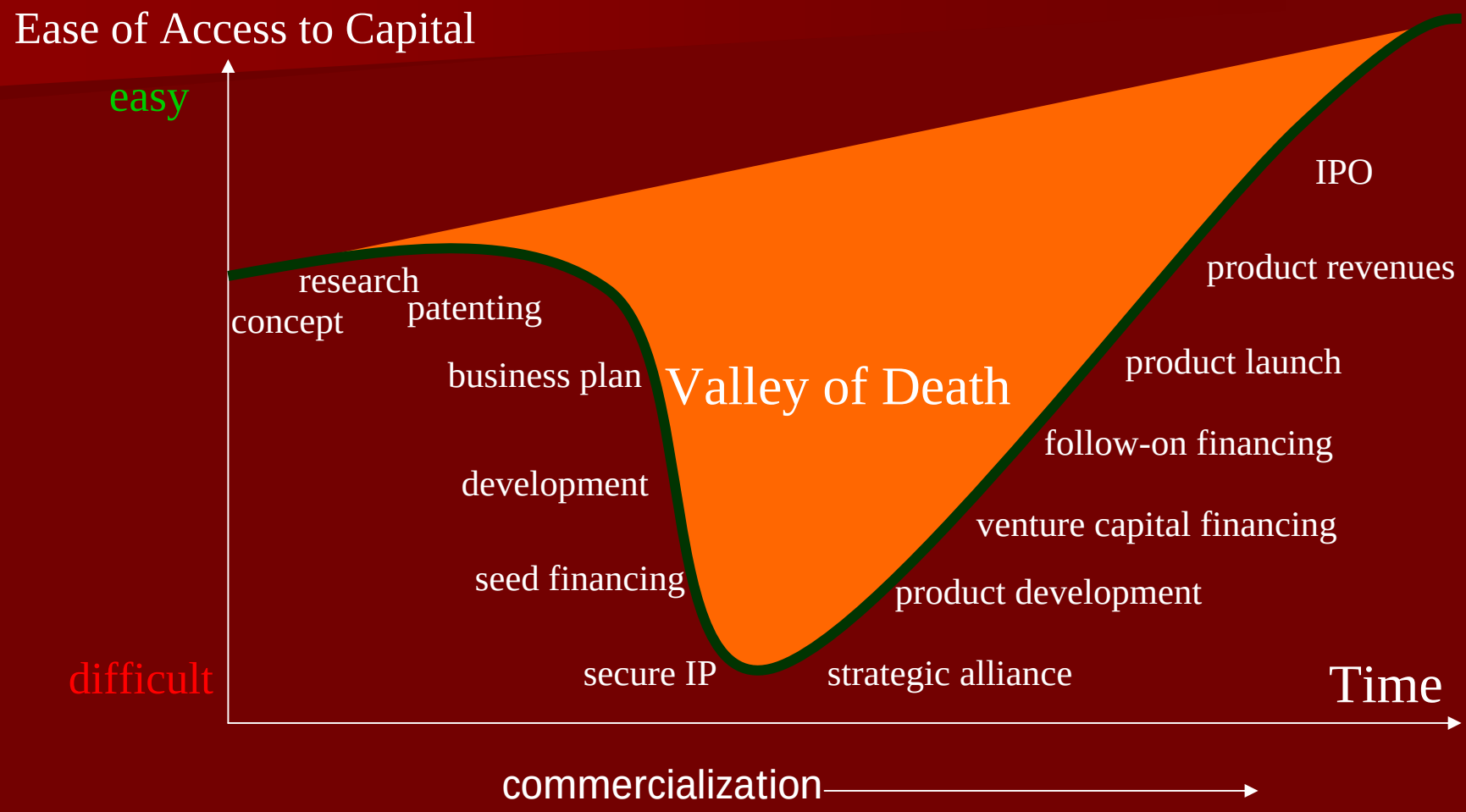
- The Kobe project has attracted 61 foreign and domestic firms to locate on Port Island.
  - 27 at KIBC (9 of which are foreign)
  - 12 at KIMEC (1 of which is foreign)
  - 6 at TRI (1 of which is foreign)
  - 5 each at BMA and IBRI (2 or which are foreign)
  - 9 at institutes other than the above.
- It has involved dozens of local SMEs, mostly metal and machinery companies, in research projects related to medical devices.
  - 28 medical equipment projects have been completed; 18 are in development.
- Major projects are underway in the clinical application of stem cell and tissue engineering:
  - leukemia treatment using cultivated umbilical cord blood.
  - Regeneration of skin, cartilage and bone.
  - Regeneration of nerve cells, pancreas cells, and blood vessels.

Part III. Conclusions

- The biotechnology clusters in the Seattle and Kobe regions are very different: different in their organization and different in how they developed.
  - The biotechnology/biomedical cluster in the Puget Sound region emerged over a period of several decades, growing rapidly in the late 1990s.
  - There has never been a comprehensive, targeted policy at the state level to promote the industry's development. Rather development has been spontaneous, usually taking the form of a professor-inventor at one of the state's universities deciding to commercialize an invention made using federal R&D funds.

- The most important enabling factors are:
  - The large amounts of federal research grants won by researchers at the state's universities through competitive peer-review.
  - The framework for handling intellectual property and transferring technology provided by the Bayh-Dole Act.
  - Visionary leaders and an extraordinary entrepreneurial culture have also favored heavy investment in biotechnology and a high rate of business starts.
- Difficulty accessing early-stage capital: this, and the near absence of incubation facilities, threatens the cluster's future, sending many potential ideas down into the "valley of death."
- Firms have few opportunities to partner locally because of the absence of large drug or other medically-related companies.

The Problem Facing High Tech Firms in the Puget Sound Region



- Kobe, even more than Seattle, has an industrial base and social structure supportive of biotechnology and biomedical innovation.
  - Favoring Kobe is its mix of large and small firms, proximity to the historical center of the pharmaceutical industry in Osaka, and proximity to many excellent universities and research institutes.
  - Also favoring Kobe is the crisis mentality that followed the 1995 earthquake. This probably forced the region's leaders to be more radical and creative in their thinking about how to revitalize the economy.
  - The Kobe Medical Industry Development Project is striking in its ambition and philosophy. In developing the biomedical cluster, it correctly acknowledges the importance of..
    - Translational research as a means of bridging basic research with clinical application.
    - Core institutions whose activities complement each other.
    - Its effort to invite participation from SMEs in more traditional manufacturing should also help those firms transition into higher value-added activities.

- The Kobe project has attracted more than 60 companies to Port Island Phase 2. I think this is a clear indicator of success. Their collaborations with the core research institutes suggest that a healthy cluster is indeed taking shape. It took forty years for the biomedical sector in Seattle to reach a similar level of development.
- On the other hand, when governments take the initiative, there is always the chance that firms will be responding not to the market but to the opportunity to receive public assistance. Will the Kobe cluster be self-sustaining once the public support has ended?
- Finally, the contribution of local universities is not yet clear to me.
  - Are universities in the region generating marketable inventions and transferring them into the market? (Osaka University seems to be a model of success. What about universities in Hyogo?)
  - Is academic research in the region competing with that of the core research institutes? Or are they complementary?