


Maryland Life Sciences Advisory Board

MEETING OF THE BOARD

**Chair: Tom Watkins
President & CEO
Human Genome Sciences**

October 29, 2008

**Human Genome Sciences
Rockville, MD**




Maryland Life Sciences Advisory Board

**Call to Order/Roll Call
Chairman's Welcome
Agenda Review
Minutes Approval**



LSAB October 29, 2008




LSAB MEETING AGENDA

Monday October 29, 2008

Location: Human Genome Sciences
14200 Shady Grove Road
Rockville, MD 20850

9:00 a.m. – 9:30 a.m.	LSAB Call to Order Roll Call Chairman’s Opening Remarks September 24, 2008 Minutes	Tom Watkins
9:30 a.m. – 11:00 a.m.	Battelle Report: Core Competency Scan	Mitch Horowitz Marianne Clarke
11:00 a.m. – 11:05 a.m.	Proposed Executive Closed Session (Vote of LSAB)	
11:05 a.m. – 11:15 a.m.	Break	
11:15 a.m. – 4:00 p.m.	Executive Closed Session	
4 p.m.	Adjourn	





Maryland Life Sciences Advisory Board

BATTELLE REPORT

Maryland Core Competencies

Mitch Horowitz & Marianne Clarke



LSAB October 29, 2008

Study of the Life Sciences Community in Maryland:

Briefing on Maryland Core Competency Scan

Technology Partnership Practice

October 2008

Recap Project Purpose & Today's Agenda

Project Purpose:

- Further the analysis and assessment of Maryland's competitive position, future prospects and critical directions for the continued development of the life sciences cluster

Specific Project Objectives:

- *Identify bioscience areas that are likely to provide the greatest opportunity for growth in the future based on a core competency analysis*
- *Prepare a competitive benchmarking analysis of Maryland's position in key focus areas related to biosciences development*
- *Assist in the development of strategic policy actions – including best practice models and lessons to inform design and tactical approaches*

Today's Agenda:

- Assessment of Maryland's Biosciences Core Competencies
 - Recap of Methodology
 - Core Competencies Identified and their Relative Presence in Maryland
 - Suggested Technology Platform Focus Areas for Maryland

Overview of Maryland's Competitive Position

- **On the high level fundamentals, Maryland's biosciences sector shows positive signs:**
 - Overall biosciences industry employment in Maryland is growing robustly.
 - Maryland has one of the nation's largest biosciences research complexes, notable for its federal intramural research activities and major universities.
 - University biosciences research has grown substantially in recent years.
 - Maryland remains a talent magnet in the biosciences.
- **Despite these positive fundamentals, the most striking aspect of Maryland's current position is the still untapped potential of its biosciences base.**
 - Maryland is still less developed in its bioscience industry base than leading competitor states.
 - Maryland's success in bioscience industry development is found primarily in the research and development component of the overall bioscience sector.
 - Looking to the future, the bioscience research and development industry can be viewed as the pipeline for creation and early growth of innovative biosciences companies.
 - The biosciences development challenge for Maryland is to foster an environment that sustains and leverages the state's extensive research complex, and actively supports the progress of product-oriented biosciences research and development companies in bringing their products to market and continuing to grow.

7

Success in Today's Global Knowledge Economy Requires Finding Your "Niche"

▶ **Similar to private industry, states and regions need to bring a strategic focus in understanding the opportunities that their university and industry base can sustain and leverage**

- The industry, university and federal labs base should be viewed as a portfolio of core competencies that can be linked to market opportunities.
- Recognize that not all regions are built alike ... **It is the differences that can best define how a region can succeed** in technology-based economic development.
- Efforts should primarily be focused in specific areas of technology development where a region has a comparative advantage
 - Plant and life sciences in St. Louis
 - Vaccines & global health for Georgia
 - Applied personalized medicine for Arizona

Hamel and Prahalad in their landmark study, *Competing for the Future*, explain how a focus on core competencies can improve competitiveness:

"To successfully compete for the future a company must be capable of enlarging its opportunity horizon. This requires top management to conceive of the company as a portfolio of core competencies rather than a portfolio of individual business units ... Core competencies are the gateways to future opportunities."

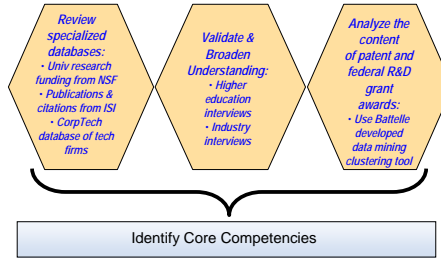
8

Identify Core Competencies Through Use of Clustering Analysis, Specialized Databases & Select Interviews

- Key Factors Used to Identify Core Competencies

- Presence in cluster analysis of abstracts across federal grant awards, patents and NIH intramural publications
- Industry presence
- Publications performance of Maryland research institutions
- Major competitively funded research programs or centers
- Reputational standing

Proven methodology used in projects from Massachusetts, Arizona, Colorado, Iowa, and Georgia, among others.



Translating Core Competencies into Strategic Technology Opportunities

Strategic technology opportunities draw upon multiple core competencies and offer multiple development opportunities in significant expanding and emerging market niches.



Results of Core Competency Analysis

19 Specific Core Competency Areas Identified in Biosciences for Maryland

- **Eleven of the core competencies involve disease and bio-based product applications:**
 - Aging Research
 - Asthma & Respiratory Disorders
 - Cancer & Oncology
 - Cardiology & Cardiovascular Systems
 - Diabetes & Metabolic Disorders
 - Ecological Sustainability & Ecosystem Management
 - Food, Agricultural Sciences & Bioenergy
 - Infectious Diseases
 - Maternal & Infant Health
 - Neurosciences (including neurological disorders)
 - Stem Cell Biology/Regenerative Medicine
- **Eight of the core competencies are in more cross-cutting areas** representing broad areas of research that underpin or are supportive of multiple fields:
 - Bioengineering/Biomedical Engineering
 - Bioinformatics & Biostatistics
 - Genetics & Genomics
 - Immunology
 - Molecular & Cellular Biology
 - Pharmacology/Pharmaceutical Sciences
 - Structural Biology/Biochemistry
 - Systems Biology & Biophysics

Cluster Analysis

- Cluster analysis examines the relationships and key themes found across abstracts of NIH intramural publications, federal research grant awards and patents.
 - Through the use of proprietary data mining software, clusters of activity are identified based on the connections of words in sentences from the abstracts and titles of grants.

Presence in Cluster Analysis of Grant Awards, Patents and NIH Publications: An internal measure of activity within Maryland.

- Top Tier: Related meta-clusters contain 5 percent or more of all 12,376 records
- Middle Tier: Related meta-clusters contain 2.5 to 5 percent of all 12,376 records
- Lower Tier: Related meta-clusters contain less than 2.5 percent of all 12,376 records
- No Presence (n/p): No related meta-clusters
- Crosscutting: Presence across more than several meta-clusters

Results of Cluster Analysis

- Battelle analyzed the abstracts of 12,376 records including:
 - 3,330 intramural NIH publications from 2004 to July 2008
 - 6,861 competitive research grants in the life sciences awarded by NIH, NSF, and USDA to Maryland research organizations from 2004 to July 2008
 - 2,185 patents in the life sciences invented by or assigned to Maryland organizations from 2004 to July 2008
- 26 cluster “theme” areas identified

Meta-cluster	Key Associated Terms/Topics	# of Records
Cancer & Oncology	Cancer, carcinoma, angiogenesis, DNA, gene expression, breast cancer	1585
Neuroscience, Mental Health & Behavior	Mental health, depression, anxiety, stroke, motor, neuroscience, pain, sleep, skin	1438
Immunology	Immune, antigen, cytokine, inflammation, antibody, vaccine, antigen, peptide, wound	1376
Genetics & Genomics	Gene expression, mRNA, RNA, enzyme, DNA, chromosome, replication, recombination, gene mutation, genotype	1264
Protein Sciences	Peptide, mass spectrometry, proteomics, ligand, nuclear magnetic resonance, nucleotide, E. coli, plasmid, enzyme, metabolism, kinase, phosphorylation, tyrosine	839
Infectious Disease: General	Virus, viral, infect	609
HIV/AIDS	HIV, viral, drug abuse	543
Cardiovascular	Blood, cardiovascular, vascular	477
Diabetes & Metabolic Disorders	Glucose, insulin, diabetes, kidney, renal, obesity, metabolism	354
Substance Abuse	Alcohol, sexual behavior, substance abuse, drug abuse, addiction, mental health	286
Surgical/Medical Instruments	Surgical, biomedical imaging, repair, sound, oral, dental, optical, array, nuclear medicine, pain, electrode, sensor	229
Vision	Retinal, eye, visual, vision	226
Pulmonary	Lung, pulmonary, airway	203
Trauma/Injury	Injury, nerve, stroke	187
Membrane Biology	Membrane, plasma, lipid	177
Diet & Nutrition	Nutrition, metabolism, dietary	170
Microbiology	Pathogen, E. coli, virulence	141
Imaging	Magnetic resonance imaging, biomedical imaging, biomedical	119
Obstetrics & Neonatology	Infant, neonatal, maternal, pregnancy, fetus	113
Infectious Disease: Malaria	Malaria, plasmodium, parasite	109
Musculoskeletal	Muscle, skin, membrane	78
Hormones	Hormone, estrogen, kidney	72
Bioinformatics & Biostatistics	Bioinformatics, biostatistics, epidemiology, proteomics	63
Asthma	Asthma, chemotherapy, skin	43
Infectious Disease: Tuberculosis	Tuberculosis, chemotherapy, infectious	40
Infectious Disease: Influenza	Influenza, bioterrorism, worker	23

University Publications Analysis, Presence of Major Centers and Reputational Standing

Position in USI Publications and Citations Analysis: Analyzes Maryland's share of all U.S. publications per field and degree of citations per publication.

- **Top Tier:** Relevant fields of research with relative impact at least 20 percent higher than the national average for the field
- **Middle Tier:** Relevant fields of research with relative impact between 10 and 20 percent higher than the national average for the field; or relative impact between 1 and 10 percent higher than the national average with above-average share of U.S. publications
- **Lower Tier:** Relevant fields of research with relative impact between 1 and 10 percent higher than the national average for the field; or relative impact below the national average with above-average share of U.S. publications
- **Bottom Tier:** Relevant fields of research with relative impact below the national average
- **Not Available (n/a):** No relevant field of research tracked by USI

Presence of Major Competitively Funded Program Projects and Research Centers: Reviews major grant awards for programs or centers funded since 2003 that support a broad team of researchers.

- **Top Tier:** Ten or more competitively funded programs or centers
- **Middle Tier:** Five to ten competitively funded programs or centers
- **Lower Tier:** One to five competitively funded programs or centers
- **No Presence (n/p):** No competitively funded programs or centers

Institutional Reputation Standing: Considers the 2007 *U.S. News & World Report* rankings on bioscience-related research programs and clinical fields.

- **Top 10:** At least one top 10 ranking
- **Top 25:** At least one top 25 ranking
- **Top 50:** At least one top 50 ranking
- **Not Ranked (n/r):** Not ranked within top 50 institutions
- **Not Available (n/a):** No relevant research or clinical field tracked by *U.S. News & World Report*

Results of Publications Analysis

- **Quantity:** Level of publications measures Maryland's share of U.S. publications for that life sciences research field.
 - From 2003 to 2007, Maryland's share overall was an impressive 3.9% of all U.S. publications. In general, Battelle considers shares over 3% to be significantly high, and shares between 2% and 3% to be above average.
- **Quality:** Relative impact measures citations per publication for Maryland institutions compared with the U.S. average for a specific field.
 - If equal to 1, then Maryland is equal to the U.S. average; if greater than 1, Maryland exceeds the U.S. average in citations per publication; if less than 1, Maryland is below the U.S. average in citations per publication.
- In 16 fields, Maryland publications account for at least 4% of all U.S. publications in that field *and* have a relative impact at least 25% higher than the national average:
 - **Gerontology** (6.6% share of U.S. Gerontology publications; 43% higher level of citations per publication)
 - **Ophthalmology** (6.0%; 31%)
 - **Medicine General & Internal** (5.8%; 54%)
 - **Radiation Nuclear Medicine & Medical Imaging** (5.6%; 26%)
 - **Medical Legal** (5.6%; 70%)
 - **Pathology** (5.5%; 27%)
 - **Urology & Nephrology** (5.3%; 32%)
 - **Andrology** (5.1%; 49%)
 - **Oncology** (4.9%; 25%)
 - **Medical Laboratory Technology** (4.8%; 75%)
 - **Microbiology** (4.5%; 26%)
 - **Cardiac & Cardiovascular Systems** (4.3%; 26%)
 - **Anesthesiology** (4.3%; 33%)
 - **Engineering Biomedical** (4.2%; 37%)
 - **Biophysics** (4.1%; 28%)
 - **Psychology** (4.0%; 27%)

Industry Presence

Presence in Industry – Patents and Firms (with either 100 or more employees or \$20 million or greater in VC funding since 2005): A measure of commercial strength within Maryland.

- Top Tier: More than 100 directly related patents; and 10 or more firms
- Middle Tier: More than 100 directly related patents and between 1 and 10 firms; or more than 20 patents and 5 or more firms
- Lower Tier: More than 20 directly related patents; and between 1 and 10 firms
- No Presence (n/p): No directly related patents or firms

Meta-cluster	Patents	Total Records in Meta-cluster	Patents as % of Total Records
Immunology	455	1376	33.1%
Protein Sciences	334	839	39.8%
Cancer & Oncology	263	1585	16.6%
Genetics & Genomics	170	1264	13.4%
Surgical/Medical Instruments	128	229	55.9%
Infectious Disease: General	105	609	17.2%
Neuroscience, Mental Health & Behavior	76	1438	5.3%
Cardiovascular	57	477	11.9%
Membrane Biology	38	177	21.5%
Diabetes	36	354	10.2%
Vision	35	226	15.5%
HIV/AIDS	28	543	5.2%
Microbiology	27	141	19.1%

Field	# of Companies with >100 Employees or >\$20M VC funds	Companies
• Pharmaceuticals & Biopharmaceuticals	19	• Alba Therapeutics; Avalon Pharmaceuticals; CoGenesys/Teva Biopharmaceuticals; Emergent BioSolutions; GenVec; Guilford Pharmaceuticals/MGI Pharma; Human Genome Sciences; MacroGenics; Medimmune/AstraZeneca; McKesson Drug; Middlebrook Pharmaceuticals; Osiris Therapeutics; Otsuka America Pharmaceutical; PharmAthene; Sequella; Sequoia Pharmaceutical; Supernus Pharmaceutical; United Therapeutics; Vanda Pharmaceutical; Virxsys
• Molecular Diagnostics	5	• BD Diagnostic Systems; Cylex; Digene/Qiagen; Innovative Biosensors; Sleep Solutions
• Medical Devices	7	• ArthroWave Medical Technologies; GE Healthcare; Dynasplint Systems; Hanger Orthopedic; Nucletron; Trinity Sterile
• Research Support: Tools & Services	12	• Aeroflex/Weinschel; Bioqual; Chesapeake Biological Labs; Fisher Bioservices; Fusion UV Systems; Harford Systems; InVitrogen; Lonza; Orchid Cellmark; Pharmaceuticals International; United BioSource Corporation; W.L. Gore & Associates
• Biomedical Information Technologies	6	• Celera; CTIS; Gene Logic; Legato Software; REI Systems; Systems Integration
• Bioproducts	4	• Martek; Medifast; Spherix; Tishcon
• Biodefense	3	• Human Genome Sciences; Lockheed Martin; Mantech Systems Engineering; Northrup Grumman; PharmAthene

Primary Disease and Bio-Based Product Competencies

Core Competency	Presence in Cluster Analysis	Presence in Industry	Position in Publications and Citations Analysis	Presence of Major Funded Programs or Centers	Reputational Standing
<i>Primary Disease and BioBased Product Areas</i>					
Cancer & Oncology	TOP	TOP	TOP	TOP	TOP 10
Neurosciences, Mental Health & Behavior	TOP	MIDDLE	MIDDLE	TOP	TOP 10
Infectious Diseases	TOP	TOP	TOP	TOP	TOP 10
Cardiology & Cardiovascular Systems	MIDDLE	MIDDLE	TOP	TOP	TOP 10
Aging Research	n/p	n/p	TOP	TOP	TOP 10

Niche or Emerging Disease and Bio-Based Product Competencies

Core Competency	Presence in Cluster Analysis	Presence in Industry	Position in Publications and Citations Analysis	Presence of Major Funded Programs or Centers	Reputational Standing
<i>Niche or Emerging Disease and BioBased Product Areas</i>					
Diabetes & Metabolic Disorders	MIDDLE	MIDDLE	LOWER	LOWER	TOP 10
Asthma & Respiratory Disorders	LOWER	LOWER	MIDDLE	TOP	TOP 10
Ecological Sustainability & Ecosystem Management	n/p	n/p	TOP	MIDDLE	n/r
Food, Agricultural Sciences & Biobased Products	LOWER	LOWER	TOP	LOWER	n/a
Stem Cell Biology/ Regenerative Medicine	n/p	n/p	MIDDLE	LOWER	n/a
Maternal & Infant Health	LOWER	LOWER	TOP	LOWER	TOP 10

Cross-Cutting Competencies

Core Competency	Presence in Cluster Analysis	Presence in Industry	Position in Publications and Citations Analysis	Presence of Major Funded Programs or Centers	Reputational Standing
Primary Cross-cutting Competencies					
Molecular & Cellular Biology	CROSS-CUTTING	TOP	MIDDLE	n/p	TOP 10
Immunology	TOP	TOP	LOWER	n/p	TOP 10
Genetics & Genomics	TOP	TOP	TOP	TOP	TOP 10
Structural Biology/Biochemistry	CROSS-CUTTING	TOP	TOP	n/p	TOP 10
Bioengineering/Biomedical Engineering	MIDDLE	TOP	TOP	MIDDLE	TOP 10
Niche or Emerging Cross-cutting Competencies					
Pharmacology/Pharmaceutical Sciences	CROSS-CUTTING	MIDDLE	LOWER	n/p	TOP 10
Bioinformatics & Biostatistics	LOWER	LOWER	TOP	n/p	TOP 10
Systems Biology & Biophysics	n/p	n/p	TOP	LOWER	TOP 10

Identification of Technology Platforms

Five Technology Platforms Identified

- **Biopharmaceuticals**
- **Contract Bioscience Research Services**
- **Molecular Diagnostics & Personalized Medicine**
- **Biodefense and Emerging Infectious Diseases**
- **Biobased Products**

Strategic Technology Platform: Biopharmaceuticals

Opportunity Defined: Biopharmaceuticals are biologics such as proteins, peptides, antibodies, DNA, RNA, antisense oligonucleotides, genes and cells that are produced or engineered using biotechnology and used for therapeutic or preventative purposes.

Internal Assessment Criteria		External Assessment Criteria	
Key Core Competencies	Genetics & Genomics; Molecular & Cellular Biology; Systems Biology; Immunology; Pharmacology & Pharmaceutical Sciences; Broad array of disease area competencies	Overall Market Assessment	Sizable near term potential
		Leading Potential Market Niches for Maryland	<ul style="list-style-type: none"> • Cancer • Neurological Disorders • Infectious Diseases • Vaccines • Cell-based Therapies • Gene-based Therapies
Leading Maryland Firms	<ul style="list-style-type: none"> • Strong presence in patients • Many leading Maryland-based companies, such as Avalon Pharmaceuticals; CoGenesys/Teva Biopharma; Guilford Pharmaceuticals/MGI Pharma; Human Genome Sciences; Medimmune/ AstraZeneca; Osiris Therapeutics; United Therapeutics 	Competition from Other States	Intense competition across academic medical centers
		External Funding Prospects	Very strong across federal, foundation and private capital

Strategic Technology Platform: Contract Bioscience Research Services

Opportunity Defined: Contract bioscience research services support the biotechnology and pharmaceutical industries by performing biological, chemical, screening, testing, production, optimization, clinical research, biostatistical analysis, and regulatory services to aid the speed of technologies to the marketplace.

Internal Assessment Criteria		External Assessment Criteria	
Key Core Competencies	Genetics & Genomics; Pharmacology and Pharmaceutical Sciences; Bioinformatics and Biostatistics	Overall Market Assessment	Established market, with healthy growth Industry involves a few large CROs and many small companies
		Leading Potential Market Niches for Maryland	<ul style="list-style-type: none"> Contract biomanufacturing Pre-clinical and clinical research services
Leading Maryland Firms	<ul style="list-style-type: none"> Fueled by the large Federal lab presence in Maryland, the State is a national leader in the bioscience research and development industry Many leading companies, including Bioqual; Cheapeake Biological Labs; InVitrogen; Lonza; BIOCON 	Competition from Other States	Concentrated in a few key states with strong pharma and biotech firms
		External Funding Prospects	Not a strong attractor of private venture funding NIH and federal lab support steady, but growth unclear

25

Strategic Technology Platform: Molecular Diagnostics & Personalized Medicine

Opportunity Defined: Molecular diagnostics are methods that apply knowledge of genomic and proteomic data to identify a disease state or predisposition. Molecular diagnostics are integrally linked to the promise of advancing more personalized medicine approaches that embraces uses a person's genetic information to identify their risks for disease, and also advances individualized strategies for prevention and treatment.

Internal Assessment Criteria		External Assessment Criteria	
Key Core Competencies	Genetics & Genomics, incl epigenetics; Structural Biology & Biochemistry (proteomics); Bioinformatics & Biostatistics; Key Disease Areas, incl. cancer, infectious diseases; Bioengineering	Overall Market Assessment	Strong growth potential in in-vitro diagnostics, but integration of personalized medicine will take many years.
		Leading Potential Market Niches for Maryland	<ul style="list-style-type: none"> Cancer diagnostics Infectious disease diagnostics Advanced nano-related diagnostics, genotyping, and other tools
Leading Maryland Firms	<ul style="list-style-type: none"> Growing base of companies, but not extensive Among leading Maryland companies are BD Diagnostic Systems; Digene/Qiagen; Akonni Biosystems; Gene Logic; Celera; Theranostics Health 	Competition from Other States	Strong competition from states with well established academic medical centers as well as a number of upstart states and regions, such as Arizona and Florida
		External Funding Prospects	More limited in attracting venture capital funding Increasing partnerships with therapeutic companies

6

Strategic Technology Platform: Biodefense and Emerging Infectious Diseases

Opportunity Defined: Biodefense and emerging infectious disease is a relatively new market, which includes the detection of bioterror agents, development of countermeasures, protection of water, food and energy supplies, and biohazard containment. The U.S. government has identified a list of about 50 potential bioweapons including anthrax, smallpox, botulism, Ebola, and genetically engineered threats. Among these, vaccines are available for smallpox and anthrax, with development underway of next-generation vaccines that are more effective.

Internal Assessment Criteria		External Assessment Criteria	
Key Core Competencies	Infectious Diseases; Immunology; Bioengineering & Biomedical Engineering	Overall Market Assessment	Highly dependent upon federal and foundation funding
		Leading Potential Market Niches for Maryland	<ul style="list-style-type: none"> • Bioweapon detection • Vaccines • Therapeutics
Leading Maryland Firms	<ul style="list-style-type: none"> • Very limited base of companies, though many diagnostics and biopharmaceutical companies in Maryland have focused efforts in biodefense among their product portfolios. 	Competition from Other States	Strong interest from across many states since a relatively new area – and one in which federal funding is a big driver
		External Funding Prospects	Dependent on federal funding and only limited private capital available

Strategic Technology Platform: Bio-based Products

Opportunity Defined: Biobased products are those other than food or feed that are composed, in whole or in significant part, of renewable biological, agricultural, or forestry materials. Examples include biofuels, supplements, soy-based adhesives and lubricants for industrial uses, biodegradable mulches, biodegradable plastics, corn starch-based packaging, and many others.

Internal Assessment Criteria		External Assessment Criteria	
Key Core Competencies	Ecological Sustainability & Ecosystem Management; Food, Agricultural Sciences & Biobased Products; Bioengineering	Overall Market Assessment	Relatively new and fast emerging market that is hard to fully assess. Depends upon substitution of existing products.
		Leading Potential Market Niches for Maryland	<ul style="list-style-type: none"> • Algae-based biofuel • Nutraceuticals
Leading Maryland Firms	<ul style="list-style-type: none"> • An emerging base of companies in Maryland, but still of limited size. • Not a strong presence of specialty chemical or bioprocessing • Among bio-based product companies in Maryland are Market, Medifast, Spherix, Tishcon, Earthshell and NewAgriculture Inc. 	Competition from Other States	Strong interest from across states, especially more bioag-related states
		External Funding Prospects	Growing federal and private venture capital interest

Summary of Identified Technology Platforms & Market Niches

