Mitch Horowitz
Principal and Managing Director
TEConomy Partners, LLC
March 29-31, 2016
WHAT IS THE ROADMAP?

Arizona’s Bioscience Roadmap:

• 20-year plan to bring Arizona to competitiveness in bioscience

• Commissioned by the Flinn Foundation; compiled by Battelle, tracked by TEConomy Partners

• Goals: economic strength and diversity, access to health innovations for Arizonans

• Focused on leveraging research strengths, building critical mass of firms
FIRST DECADE: 2002-2012

Outcomes:

• Substantial statewide development
• Industry grew rapidly, even during Great Recession
• Research funding grew, rate slowed in final years
• Risk capital dropped precipitously after 2002
• Progress on all 19 Roadmap actions, substantial progress on 10
• AZ: top emerging bio state with “collaborative gene”
Vision:

“Arizona is **globally competitive** and a **national leader** in the biosciences in such fields as precision medicine, cancer, neurosciences, bioengineering, diagnostics, and agricultural biotechnology.

“It excels in offering a **deep talent base**, a critical mass of entrepreneurs and enterprises, and **clinical excellence** to turn discovery into firms, products, and talent.”
SECOND “DECADE”: 2013-2025

17 Strategies to Achieve 5 Goals:

• Provide direction for Roadmap implementation
• To be re-examined at midpoint of Second Decade Roadmap

77 Potential Actions to Implement Strategies:

• Prioritized based on feasibility, impact
• Designed to evolve
• Available at www.flinn.org
WHAT ARE THE BIOSCIENCES?

• Agricultural Feedstock and Chemicals
• Bioscience-Related Distribution
• Drugs, Pharmaceuticals and Diagnostics
• Medical Devices and Equipment
• Research, Testing and Medical Labs
• Hospitals
Arizona Bioscience Jobs Composition

- Hospitals: 78%
- Non-Hospital Biosciences: 22%
- Bioscience-related Distribution: 33%
- Medical Devices & Equipment: 25%
- Research, Testing, & Medical Laboratories: 31%
- Drugs & Pharmaceuticals: 8%
- Agricultural Feedstock & Chemicals: 3%

Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data from IMPLAN Group LLC
AZ & U.S. Bioscience Employment: 2002-14

Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data from IMPLAN Group LLC
Non-Hospital Bioscience Employment: 2002-14

Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data from IMPLAN Group LLC
## Employment Across Business Cycles

<table>
<thead>
<tr>
<th>Industry Subsector</th>
<th>Economic Expansion</th>
<th>Recession</th>
<th>Recovery/Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Private Sector</td>
<td>19.8%</td>
<td>6.0%</td>
<td>-11.3%</td>
</tr>
<tr>
<td>Total Biosciences</td>
<td>22.2%</td>
<td>7.8%</td>
<td>6.8%</td>
</tr>
<tr>
<td>Total Non-Hospital Biosciences</td>
<td>19.0%</td>
<td>5.8%</td>
<td>6.2%</td>
</tr>
<tr>
<td>Agricultural Feedstock &amp; Chemicals</td>
<td>20.0%</td>
<td>-6.8%</td>
<td>-1.7%</td>
</tr>
<tr>
<td>Bioscience-related Distribution</td>
<td>14.4%</td>
<td>7.8%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Drugs &amp; Pharmaceuticals</td>
<td>17.1%</td>
<td>-0.1%</td>
<td>-8.7%</td>
</tr>
<tr>
<td>Medical Devices &amp; Equipment</td>
<td>33.4%</td>
<td>1.9%</td>
<td>13.8%</td>
</tr>
<tr>
<td>Research, Testing, &amp; Medical Laboratories</td>
<td>17.5%</td>
<td>14.6%</td>
<td>10.9%</td>
</tr>
<tr>
<td>Hospitals</td>
<td>23.1%</td>
<td>8.6%</td>
<td>7.0%</td>
</tr>
</tbody>
</table>

Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data from IMPLAN Group LLC
<table>
<thead>
<tr>
<th>INDUSTRY SUBSECTOR</th>
<th>JOBS</th>
<th>ESTABLISHMENTS</th>
<th>AVERAGE WAGES</th>
<th>LOCATION QUOTIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Feedstock &amp; Chemicals</td>
<td>595</td>
<td>14</td>
<td>$53,324</td>
<td>0.41</td>
</tr>
<tr>
<td>Bioscience-Related Distribution</td>
<td>8,021</td>
<td>755</td>
<td>$94,975</td>
<td>0.95</td>
</tr>
<tr>
<td>Drugs &amp; Pharmaceuticals</td>
<td>1,867</td>
<td>47</td>
<td>$54,289</td>
<td>0.34</td>
</tr>
<tr>
<td>Medical Devices &amp; Equipment</td>
<td>6,082</td>
<td>107</td>
<td>$67,354</td>
<td>0.94</td>
</tr>
<tr>
<td>Research, Testing &amp; Medical Labs</td>
<td>7,475</td>
<td>362</td>
<td>$71,059</td>
<td>0.82</td>
</tr>
<tr>
<td>Hospitals</td>
<td>86,370</td>
<td>127</td>
<td>$57,777</td>
<td>0.98</td>
</tr>
<tr>
<td><strong>Total Non-Hospital Biosciences</strong></td>
<td>24,040</td>
<td>1,284</td>
<td><strong>$76,360</strong></td>
<td>0.78</td>
</tr>
<tr>
<td><strong>TOTAL BIOSCIENCES</strong></td>
<td>110,410</td>
<td>1,411</td>
<td><strong>$61,823</strong></td>
<td>0.92</td>
</tr>
</tbody>
</table>

1 Industry data are from 2014.
2 Location quotient is the level of industry concentration relative to the nation; 1.0 represents the national average.
Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data from IMPLAN Group LLC
## Bioscience Wage Growth: 2013-14

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Bioscience-related Distribution</td>
<td>$95,642</td>
<td>$94,975</td>
<td>-1%</td>
</tr>
<tr>
<td><strong>Total Non-Hospital Biosciences</strong></td>
<td>$74,881</td>
<td>$76,360</td>
<td>2%</td>
</tr>
<tr>
<td>Research, Testing, &amp; Medical Laboratories</td>
<td>$66,094</td>
<td>$71,059</td>
<td>8%</td>
</tr>
<tr>
<td>Medical Devices &amp; Equipment</td>
<td>$65,345</td>
<td>$67,354</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Total Biosciences</strong></td>
<td>$60,864</td>
<td>$61,823</td>
<td>2%</td>
</tr>
<tr>
<td>Hospitals</td>
<td>$56,891</td>
<td>$57,777</td>
<td>2%</td>
</tr>
<tr>
<td>Drugs &amp; Pharmaceuticals</td>
<td>$51,873</td>
<td>$54,289</td>
<td>5%</td>
</tr>
<tr>
<td>Agricultural Feedstock &amp; Chemicals</td>
<td>$48,503</td>
<td>$53,324</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Total Private Sector</strong></td>
<td>$45,503</td>
<td>$46,514</td>
<td>2%</td>
</tr>
</tbody>
</table>

Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data from IMPLAN Group LLC
SPOTLIGHT: BIO-DISTRIBUTION

Distribution of:

- Agricultural chemicals/seeds
- Biomedical equipment/supplies
- Drugs/pharmaceuticals

Specializes in:

- Cold storage
- Product monitoring
- Automated pharmaceutical distribution systems

In Arizona:

- Jobs: 8,021 (33%)*
- Establishments: 755 (59%)*
- Location quotient: 0.95
- Average Wages: $94,975

* Percentage among non-hospital subsectors
AZ & U.S. Bioscience Establishments: 2002-14

Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data from IMPLAN Group LLC
Non-Hospital Bioscience Establishments: 2002-14

Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data from IMPLAN Group LLC
Non-Distribution Bioscience Establishments: 2002-14

Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data from IMPLAN Group LLC
Non-Distribution/Hospital Bio Establishments: 2002-14

Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data from IMPLAN Group LLC
INNOVATION ECOSYSTEM

- Research & Development
- Technology Commercialization
- Venture Development
- Existing Business Promotion
- New Business Attraction
- New Enterprise Development
- Growing Biosciences Industry
METRIC: BIOSCIENCE R&D

AZ Academic R&D in Bio-Related Fields: FY 2014
• Total bioscience-related R&D: $451M
• Total non-bioscience-related R&D: $536M

• Total bioscience-related R&D: $41.7B
• Total non-bioscience-related R&D: $22B

Source: NSF Academic S&E R&D Expenditures and TEConomy Partners calculations
METRIC: BIOSCIENCE R&D

Distribution of Academic R&D in Bio-Related Fields

Arizona

- Medical Sciences $124,779
- Biological Sciences $161,094
- Psychology $18,775
- Other Life Sciences $26,190
- Bio/Biomed Engineering $24,517
- Chemistry $32,669

U.S.

- Medical Sciences, $20,686,408
- Biological Sciences, $11,703,597
- Psychology, $1,140,755
- Agricultural Sciences $3,373,268
- Bio/Biomed Engineering, $952,682
- Other Life Sciences, $2,157,971
- Chemistry, $1,724,364

(Figures in $ Millions)

Source: NSF Academic S&E R&D Expenditures and TEConomy Partners calculations
AZ & U.S. Bioscience Academic R&D: 2002-14

Source: NSF Academic R&D Expenditures and TEConomy Partners calculations
AZ & U.S. NIH Funding: 2002-15

Source: NIH RePORT database, and TEConomy Partners calculations
METRIC: NIH

AZ & U.S. NIH Funding: 2002-15

Source: NIH RePORT database, and TEConomy Partners calculations
METRIC: NIH

NIH Grants, Funding Growth: 2002-15

Source: NIH RePORT database, and TEConomy Partners calculations
AZ NIH Funding Distribution: FY 2015

- Arizona Public Universities: $118,048,930
- Arizona Hospitals and Other Research Institutes: $24,964,596
- Arizona Bioscience Companies: $7,757,195

Source: NIH RePORT database, and TEConomy Partners calculations
Arizona Share of NIH Support

Source: NIH RePORT database, and TEConomy Partners calculations
## AZ University Bioscience Tech Transfer: 2014-15

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Bioscience R&amp;D Expenditures</td>
<td>$736.4M</td>
<td>n/a</td>
<td>34.2%</td>
</tr>
<tr>
<td>Invention Disclosures Received</td>
<td>521</td>
<td>54.1%</td>
<td>53.0%</td>
</tr>
<tr>
<td>Total U.S. Patent Applications Filed</td>
<td>397</td>
<td>21.0%</td>
<td>54.8%</td>
</tr>
<tr>
<td>U.S. Patents Issued</td>
<td>81</td>
<td>72.3%</td>
<td>44.0%</td>
</tr>
<tr>
<td>Licenses &amp; Options Executed</td>
<td>121</td>
<td>26.0%</td>
<td>37.0%</td>
</tr>
<tr>
<td>Adjusted Gross License Income Received</td>
<td>$7.7M</td>
<td>30.9%</td>
<td>77.2%</td>
</tr>
<tr>
<td>Bioscience Startups from University IP</td>
<td>21</td>
<td>23.5%</td>
<td>42.9%</td>
</tr>
</tbody>
</table>

Source: Arizona university technology transfer offices

Source: Thomson Reuters Thomson One Database with TEConomy Partners Calculations

Source: Thomson Reuters Thomson One Database with TEconomy Partners Calculations
AZ & U.S. Venture Capital by Stage

Source: Thomson Reuters Thomson One Database with TEconomy Partners Calculations
## METRIC: VENTURE CAPITAL

### AZ & U.S. Bio Share of Venture Capital, 2002-15*

<table>
<thead>
<tr>
<th>Metric</th>
<th>ARIZONA</th>
<th>U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Deals</td>
<td>126</td>
<td>479</td>
</tr>
<tr>
<td>Number of Individual Companies Invested in</td>
<td>40</td>
<td>168</td>
</tr>
<tr>
<td>Investment (in $ Millions)</td>
<td>$716</td>
<td>$3,687</td>
</tr>
</tbody>
</table>

Source: Thomson Reuters Thomson One Database with TEConomy Partners Calculations

* Because the Thomson One Database is continually updated, VC data presented may not correspond exactly to data in previous iterations of this report.
Share of VC Investments by Bio-Related Industry

**Arizona**
- Medical Devices, Equipment, and Supplies, 46.0%
- Biotechnology, 15.8%
- Drugs and Pharmaceuticals, 4.5%
- Bioscience IT, 24.5%
- Other Healthcare Services, 9.2%

**U.S.**
- Medical Devices, Equipment, and Supplies, 30.0%
- Drugs and Pharmaceuticals, 10.2%
- Other Healthcare Services, 5.5%
- Bioscience IT, 9.5%
- Biotechnology, 44.8%

Source: Thomson Reuters Thomson One Database with TEconomy Partners Calculations
REGIONAL BIO STRENGTHS

Flagstaff MSA

Medical Devices & Equipment; Hospitals

Phoenix-Mesa-Scottsdale MSA

Research, Testing & Medical Labs; Hospitals

Tucson MSA

Research, Testing & Medical Labs; Hospitals; Medical Devices & Equipment
<table>
<thead>
<tr>
<th>Key Bioscience Subsector</th>
<th>Establishments, Employment Level &amp; Concentration (2014)</th>
<th>Regional Strengths/Highlights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Devices &amp; Equipment</td>
<td>Establishments: 2</td>
<td>Flagstaff remains highly specialized in medical devices, at almost 18 times the average employment concentration of the nation.</td>
</tr>
<tr>
<td></td>
<td>Employed: 2,321</td>
<td></td>
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<tr>
<td></td>
<td>Employment Growth (02-14): 160%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Location Quotient: 17.94</td>
<td></td>
</tr>
<tr>
<td>Hospitals</td>
<td>Establishments: 2</td>
<td>The hospital subsector is a large employer in Flagstaff, with over 3,500 workers in 2014. It is also growing quickly, with employment increasing by 44% from 2002-14.</td>
</tr>
<tr>
<td></td>
<td>Employed: 3,566</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Employment Growth (02-14): 44%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Location Quotient: 1.96</td>
<td></td>
</tr>
</tbody>
</table>
### Key Bioscience Subsector

<table>
<thead>
<tr>
<th>Establishments, Employment Level &amp; Concentration (2014)</th>
<th>Regional Strengths/ Highlights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research, Testing &amp; Medical Laboratories</td>
<td>Employment in research, testing &amp; medical labs approaching 6,000 in metro Phoenix, with substantial growth of 63% from 2002-14.</td>
</tr>
<tr>
<td>Establishments: 266</td>
<td></td>
</tr>
<tr>
<td>Employed: 5,974</td>
<td></td>
</tr>
<tr>
<td>Employment Growth (02-14): 63%</td>
<td></td>
</tr>
<tr>
<td>Location Quotient: 0.88</td>
<td></td>
</tr>
<tr>
<td>Bioscience-related Distribution</td>
<td>Bioscience-related distribution in the Phoenix area is largest non-hospital subsector in metro Phoenix, 11% more concentrated than the U.S.</td>
</tr>
<tr>
<td>Establishments: 616</td>
<td></td>
</tr>
<tr>
<td>Employed: 6,913</td>
<td></td>
</tr>
<tr>
<td>Employment Growth (02-14): 14%</td>
<td></td>
</tr>
<tr>
<td>Location Quotient: 1.11</td>
<td></td>
</tr>
<tr>
<td>Hospitals</td>
<td>Hospitals remain the predominant subsector for bioscience employment in metro Phoenix, with 53% growth over 2002-14 period.</td>
</tr>
<tr>
<td>Establishments: 84</td>
<td></td>
</tr>
<tr>
<td>Employed: 54,801</td>
<td></td>
</tr>
<tr>
<td>Employment Growth (02-14): 53%</td>
<td></td>
</tr>
<tr>
<td>Location Quotient: 0.83</td>
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</tr>
</tbody>
</table>

Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data from IMPLAN Group LLC
### TUCSON METRO AREA

<table>
<thead>
<tr>
<th>Key Bioscience Subsector</th>
<th>Establishments, Employment Level &amp; Concentration (2014)</th>
<th>Regional Strengths/Highlights</th>
</tr>
</thead>
</table>
| Research, Testing & Medical Laboratories       | Establishments: 65  
Employed: 1,167  
Employment Growth (02-14): 36%  
Location Quotient: 0.97                                                                              | The research, testing & medical labs subsector in the Tucson area increased employment by 36% over the 2002-14 period.                                                        |
| Hospitals                                      | Establishments: 13  
Employed: 16,243  
Employment Growth (02-14): 31%  
Location Quotient: 1.39                                                                                | Tucson has a large, growing, and specialized hospital subsector with 39% higher employment concentration than the nation.                                    |
| Medical Devices & Equipment                    | Establishments: 23  
Employed: 1,082  
Employment Growth (02-14): 88%  
Location Quotient: 1.30                                                                                 | Tucson's medical devices & equipment subsector grew by 88% over the 2002-14 period, 30% more highly concentrated than the nation.                  |

Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data from IMPLAN Group LLC
TRANSFORMATIVE MEASURES

Arizona’s Targets for 2025:

1. **Risk Capital**: Reach market share equal to population ($100-125M annually in bioscience venture capital, $25-40M in pre-seed/seed).

2. **Research**: Reach national performance level for bioscience research revenue at research-performing institutions ($782M annually).

3. **Infrastructure**: Invest $500-750M over 10 years in academic research infrastructure.

4. **Anchors**: Add 5-7 cornerstone bio institutions.

5. **Regional Connections**: Strengthen ties with economic partners beyond Arizona to support industry maturation and specialization.
Arizona’s Challenge

To achieve Arizona’s targets for 2025, it must enhance research that stimulates new venture formation and can attract capital—increasing the likelihood that new anchors will emerge in the state.
Increasing industry/academia collaborations:
Fast pace of basic scientific insights into biological processes informs advances in medical discovery.

Key BIO Report:
Advancing Translational Research for Biomedical Innovation: Measuring Industry-Academic Connections

• 23% increase over 10 years in joint industry-academic publications in biomedical-related fields;
• 81.5% increase over 10 years in industry patents citing academic research informing innovations.
# Emerging Best Practices

A “Real-World” Context of Developments to Advance Translational Research

<table>
<thead>
<tr>
<th>Basic &amp; Applied Research</th>
<th>Technology Development</th>
<th>Clinical Trials</th>
<th>New Product Launch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-Institutional/Multi-Company Collaborations</td>
<td>Partnerships of Clinicians-Engineers-Scientists</td>
<td>Regional Clinical Trials Consortia</td>
<td>Experimental Therapeutics Centers</td>
</tr>
<tr>
<td>Open Innovation Collaborations</td>
<td>New Venture Development Organizations</td>
<td>CRO-CTSI Partnerships</td>
<td>Advanced Biomanufacturing Centers</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Centralized Patient Registry</td>
</tr>
</tbody>
</table>
Building new research anchors with industry:

Indiana Biosciences Research Institute

- New public-private partnership launched in 2013
- $50M initial investment: $25M state investment matched by industry and foundations
- Focus on attracting 8-12 leading research teams to Indiana to collaborate and work alongside industry research-and-development teams
- Initial focus on metabolic health and nutrition
- Industry members include Lilly, Roche, Dow AgroSciences, Cook, and Biomet/Zimmer
- Anchoring new innovation district in Indy – “16 Tech”
Creating a signature shared-use facility to further commercialization:

Oregon Translational Research and Development Institute (OTRADI)

- Launched as a Signature Research Center of Oregon Inc. in 2007
- Focus on high-throughput and high-content new drug discovery
- Significant activities:
  - 35 Oregon company members using facilities
  - Partnerships with 150+ Oregon university researchers to advance medical discovery
- Recently added a wet-lab incubator facility for bio start-ups
Forming mechanism to create new bio ventures:

**GRA Ventures**

- Started in 2002 to develop companies from university research
- Multi-phased approach: Identify promising technologies, conduct due diligence, support proof-of-concept, and fund venture start-up
- Record of success:
  - 100 university-based companies assisted, generating $500M in private-equity investments and employment of 600
  - New $20M GRA Venture Fund, LLC. focused on Series A early-stage investments in 2009—state commitment of $7.5M in capital investment and income tax credits for investors of 25 percent
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