

ARIZONA'S
BIOSCIENCE
ROADMAP

2014-2025

Advancing the
Biosciences and
Improving Health
Outcomes

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WHAT IS ARIZONA'S BIOSCIENCE ROADMAP?

- 20-year plan to bring Arizona to competitiveness in bioscience.
- Commissioned by the Flinn Foundation, tracked by TEConomy Partners.
- Goals: economic strength and diversity; access to health innovations for Arizonans.
- Focus: Leverage research strengths and build 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 FOR ARIZONA IN 2025

“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.”

Source: Second Decade Roadmap, available at www.flinn.org

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:

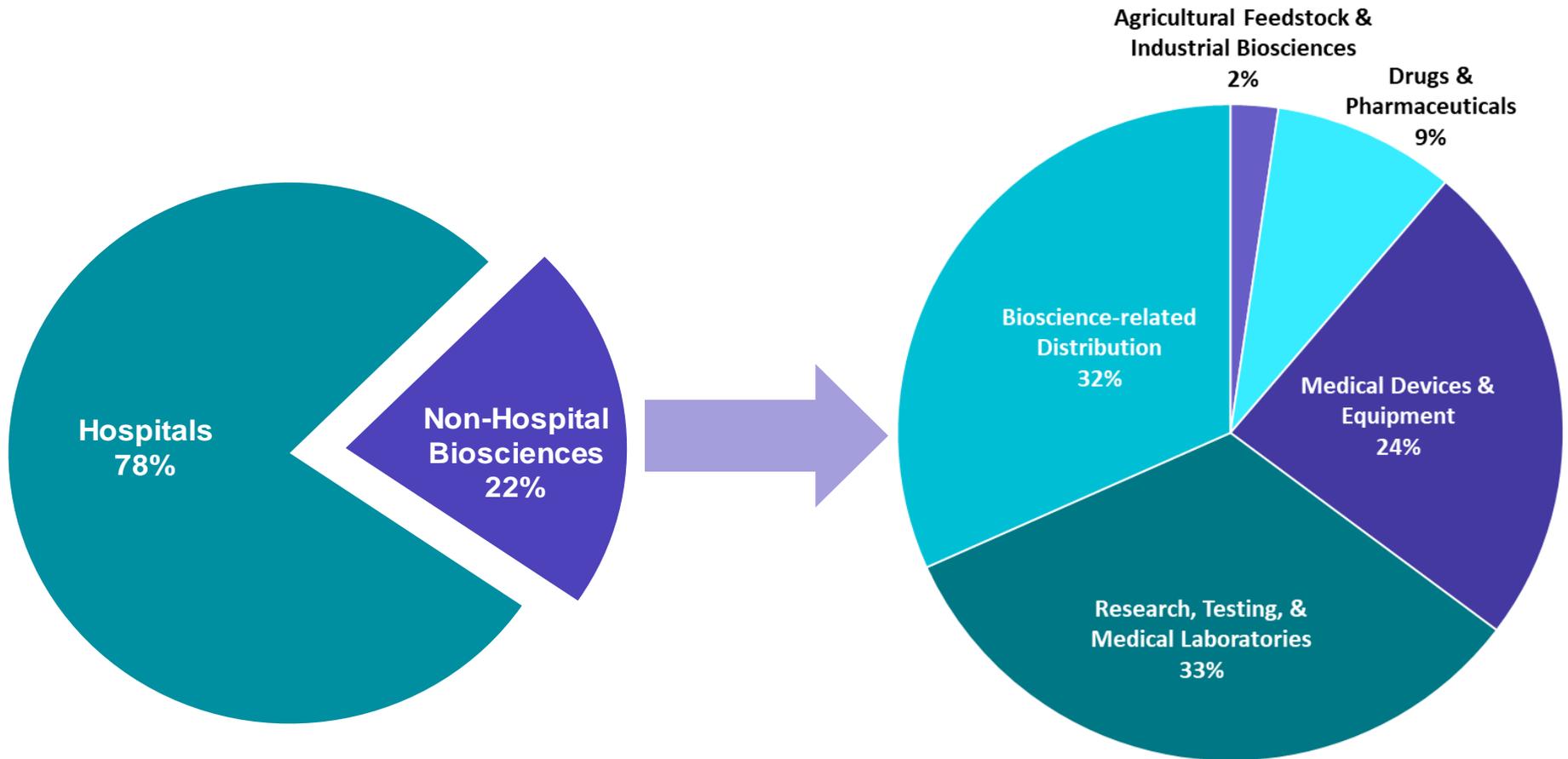
- Prioritized based on feasibility, impact
- Designed to evolve
- Available at www.flinn.org

WHAT ARE THE BIOSCIENCES?

- Agricultural Feedstock & Industrial Biosciences
- Bioscience-Related Distribution
- Drugs, Pharmaceuticals & Diagnostics
- Medical Devices & Equipment
- Research, Testing & Medical Labs
- Hospitals

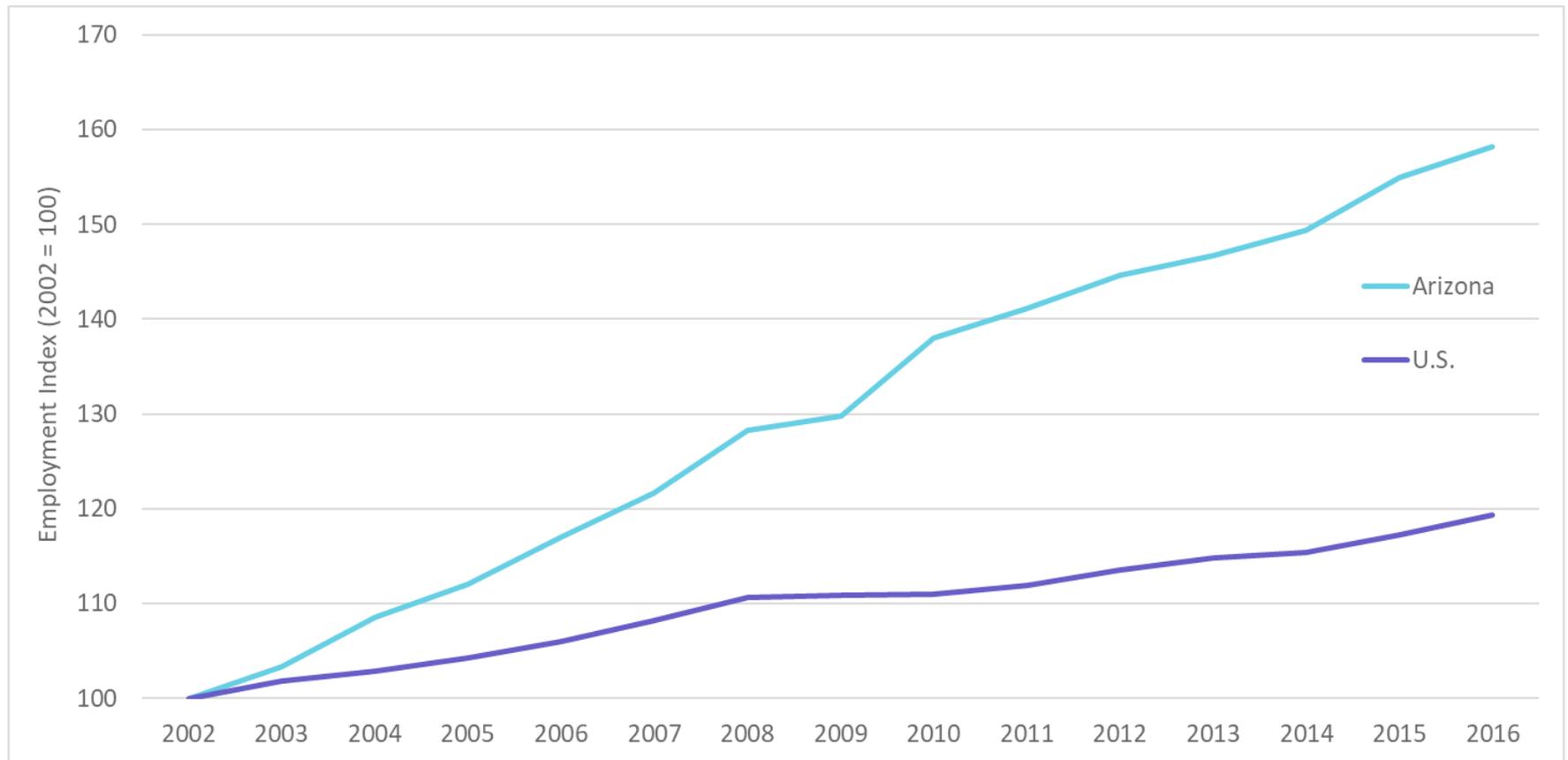


Composition of Bioscience Jobs in AZ



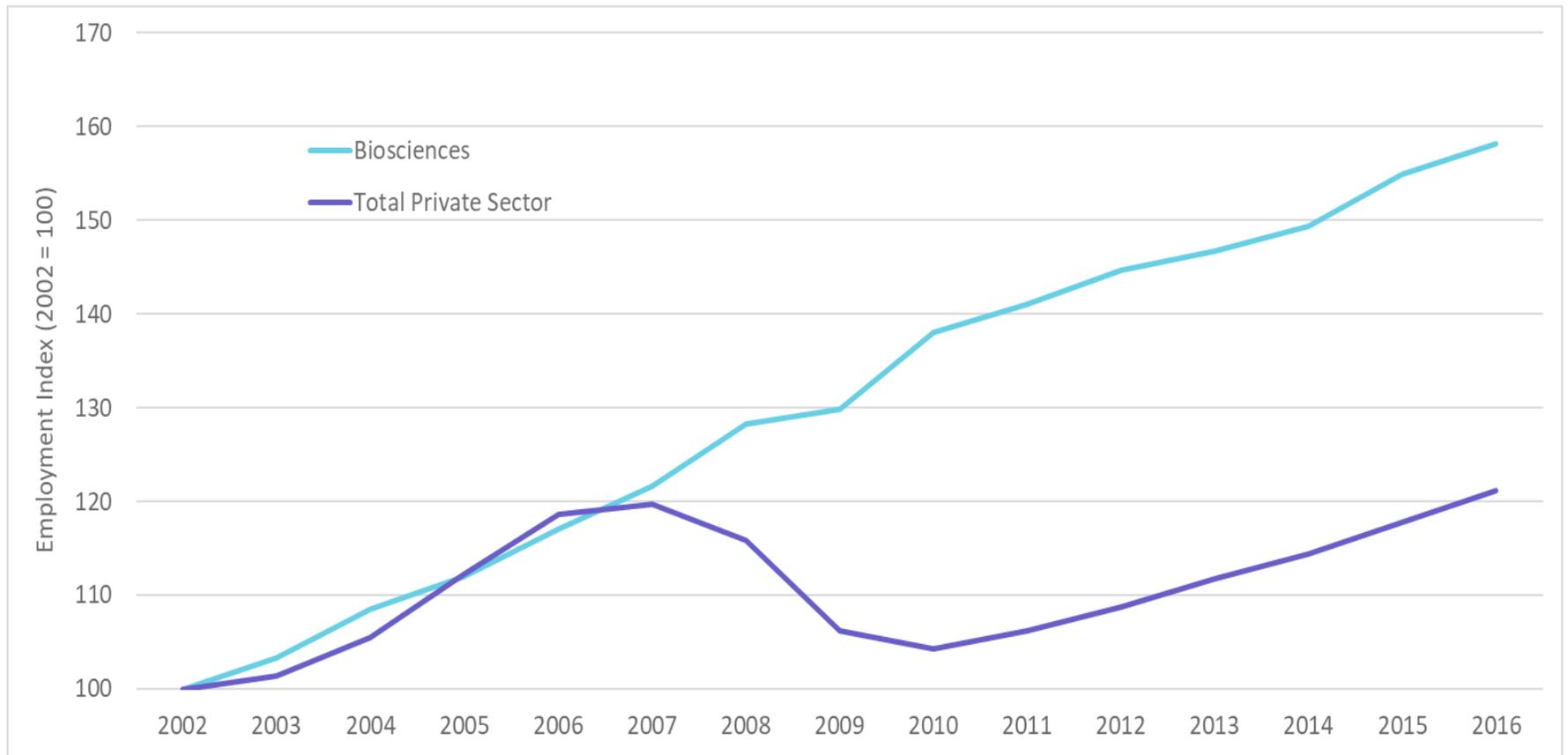
METRIC: JOBS

AZ & U.S. Bioscience Employment: 2002-16



METRIC: JOBS

Arizona Employment: 2002-16



Employment Across Business Cycles

Industry Subsector	2002-2007 Expansion		2007-2009 Recession		2009-2016 Recovery/Expansion	
	AZ	U.S.	AZ	U.S.	AZ	U.S.
Total Private Sector	+19.8%	+5.9%	-11.3%	-6.2%	+14.0%	+12.3%
Total Biosciences	+21.6%	+8.3%	+6.7%	+2.5%	+21.9%	+7.6%
Total Non-Hospital Biosciences	+16.3%	+7.4%	+5.9%	-1.0%	+29.0%	+9.8%

Employment Across Business Cycles

Industry Subsector	Economic Expansion		Recession		Recovery/Expansion	
	AZ Change 2002-07	U.S. Change 2002-07	AZ Change 2007-09	U.S. Change 2007-09	AZ Change 2009-16	U.S. Change 2009-16
Total Private Sector	19.8%	5.9%	-11.3%	-6.2%	14.0%	12.3%
Total Biosciences	21.6%	8.3%	6.7%	2.5%	21.9%	7.6%
Total Non-Hospital Biosciences	16.3%	7.4%	5.9%	-1.0%	29.0%	9.8%
Agricultural Feedstock & Industrial Biosciences	20.0%	0.7%	-1.7%	-2.5%	9.3%	1.9%
Bioscience-related Distribution	14.4%	7.7%	2.0%	-3.3%	-3.3%	5.7%
Drugs & Pharmaceuticals	17.1%	0.1%	-8.7%	-4.7%	125.0%	-1.5%
Medical Devices & Equipment	33.4%	2.7%	13.8%	-0.1%	39.2%	3.9%
Research, Testing, & Medical Laboratories	7.9%	20.2%	10.1%	4.1%	54.3%	28.2%
Hospitals	23.1%	8.5%	7.0%	3.7%	20.0%	6.9%

METRIC: JOBS

Arizona Gaining Market Share in Biosciences Industry

INDUSTRY SUBSECTOR	2002 Arizona Share Of U.S. Total Jobs	2016 Arizona Share Of U.S. Total Jobs		2016 Arizona Specialization Relative to U.S. (Location Quotient)
Agricultural Feedstock & Industrial Biosciences	0.68%	0.87%	↑	0.46
Bioscience-Related Distribution	1.69%	1.73%	↑	0.92
Drugs & Pharmaceuticals	0.30%	0.76%	↑	0.40
Medical Devices & Equipment	0.87%	1.72%	↑	0.91
Research, Testing & Medical Labs	1.37%	1.56%	↑	0.83
Hospitals	1.40%	1.84%	↑	0.98
Total Non-Hospital Biosciences	1.09%	1.48%	↑	0.78
TOTAL BIOSCIENCES	1.31%	1.74%	↑	0.93

METRIC: WAGES

Bioscience Wage Growth: 2015-16

Major AZ Industries & Subsectors	Avg. Annual Wages, 2016	Change 2015-16
Total Non-Hospital Biosciences	\$77,807	1.9%
Total Biosciences	\$63,801	1.9%
Total Private Sector	\$48,081	1.2%

METRIC: WAGES

Bioscience Wage Growth: 2015-16

Major AZ Industries & Subsectors	Avg. Annual Wages, 2015	Avg. Annual Wages, 2016	Change 2015-16
Bioscience-related Distribution	\$96,782	\$96,295	-0.5%
Total Non-Hospital Biosciences	\$76,346	\$77,807	1.9%
Research, Testing, & Medical Laboratories	\$68,854	\$73,630	6.9%
Medical Devices & Equipment	\$68,368	\$69,823	2.1%
Total Biosciences	\$62,631	\$63,801	1.9%
Hospitals	\$58,780	\$59,838	1.8%
Drugs & Pharmaceuticals	\$56,055	\$55,766	-0.5%
Agricultural Feedstock & Industrial Biosciences	\$52,197	\$51,515	-1.3%
Total Private Sector	\$47,489	\$48,081	1.2%

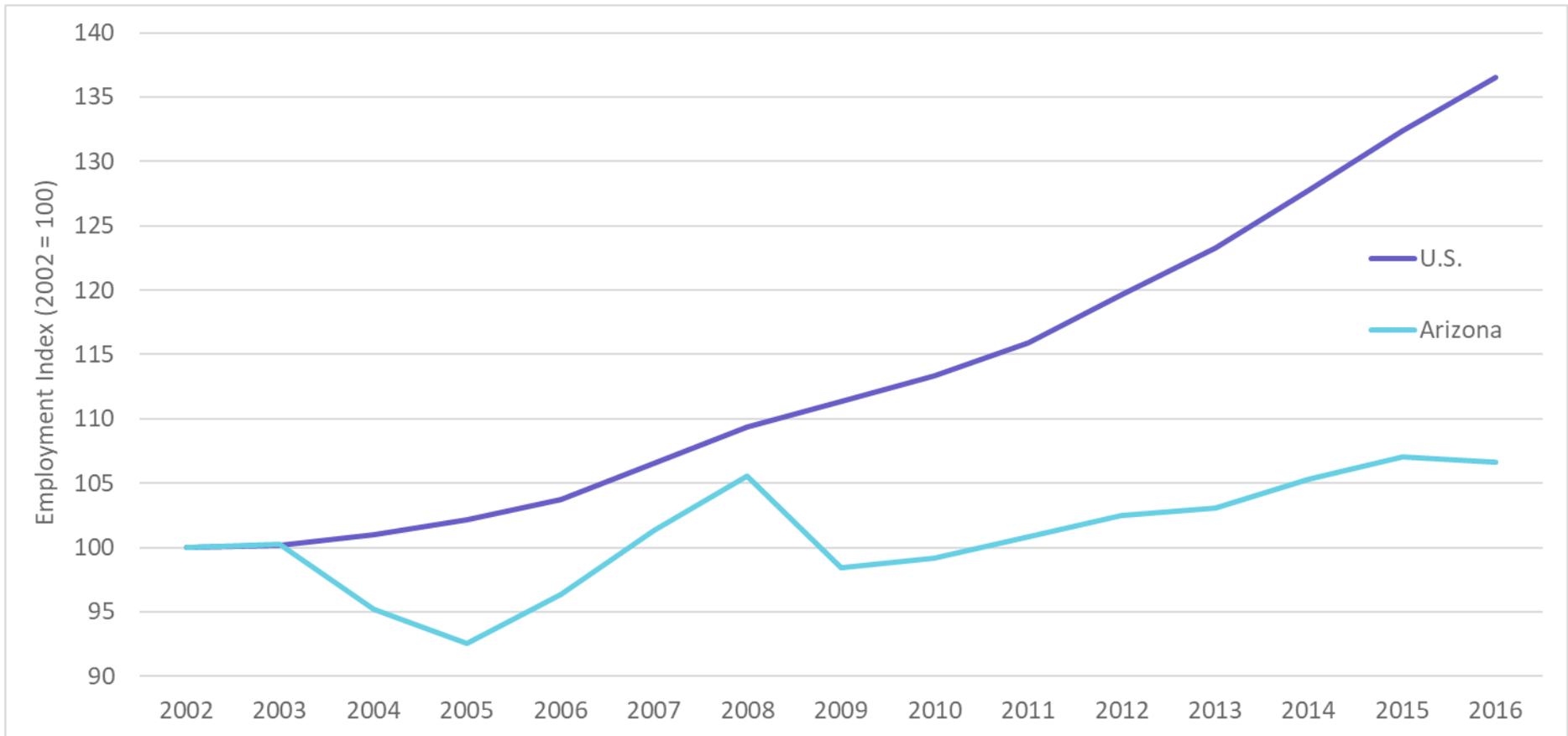
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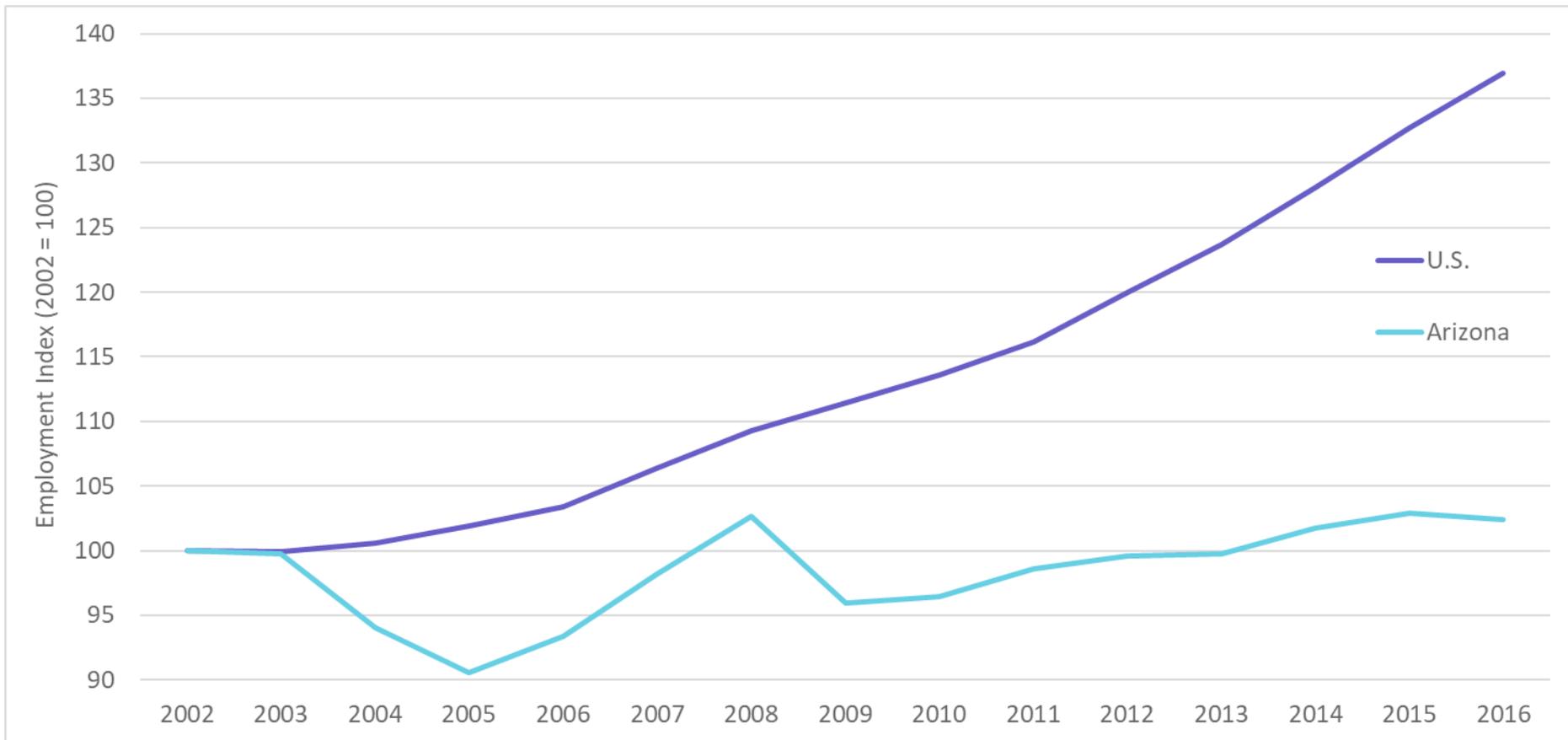
METRIC: ESTABLISHMENTS

AZ & U.S. Bioscience Establishments: 2002-16

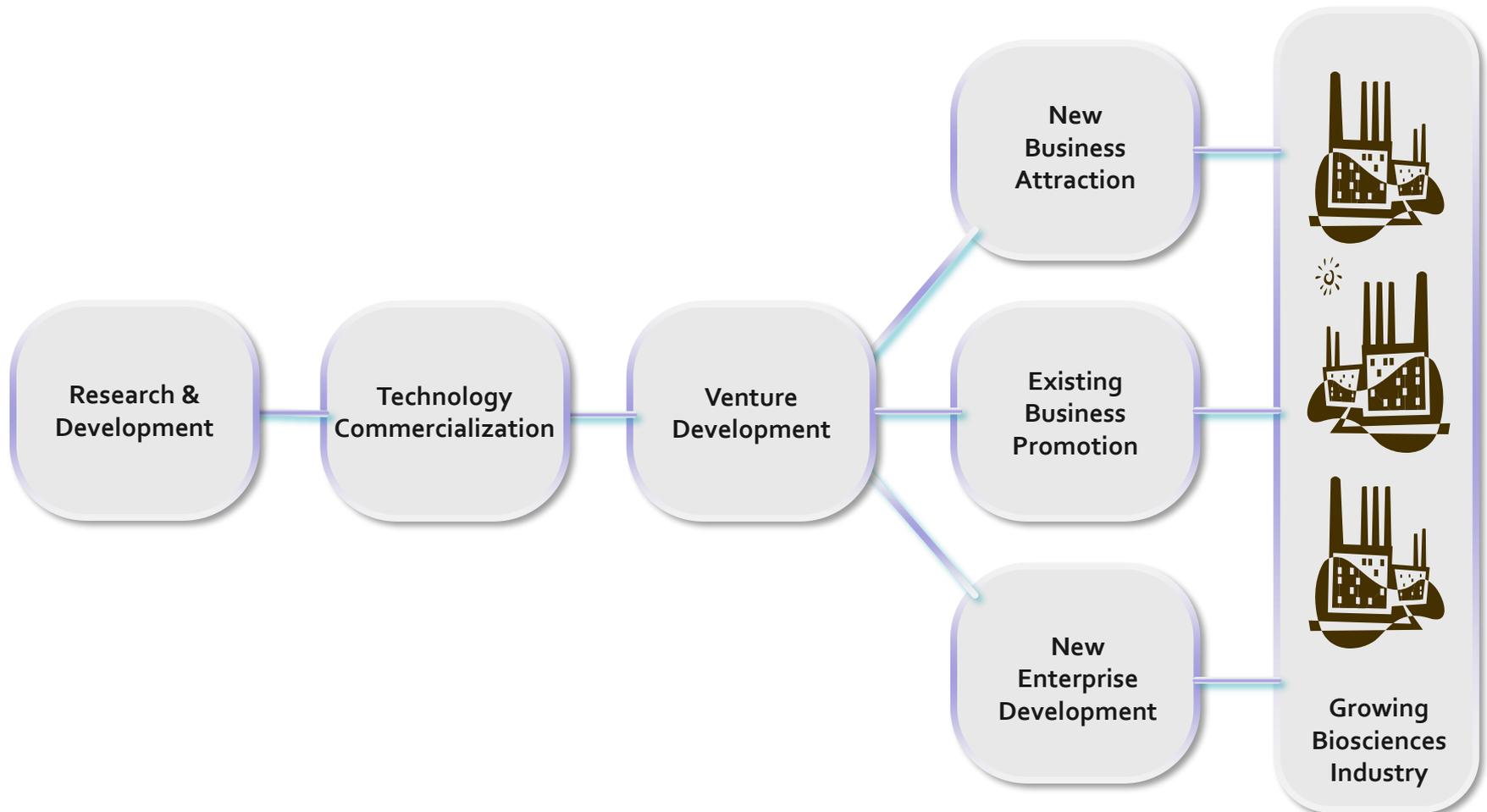


METRIC: ESTABLISHMENTS

Non-Hospital Bioscience Establishments: 2002-16



INNOVATION ECOSYSTEM



METRIC: BIOSCIENCE R&D

AZ Academic R&D: FY 2016

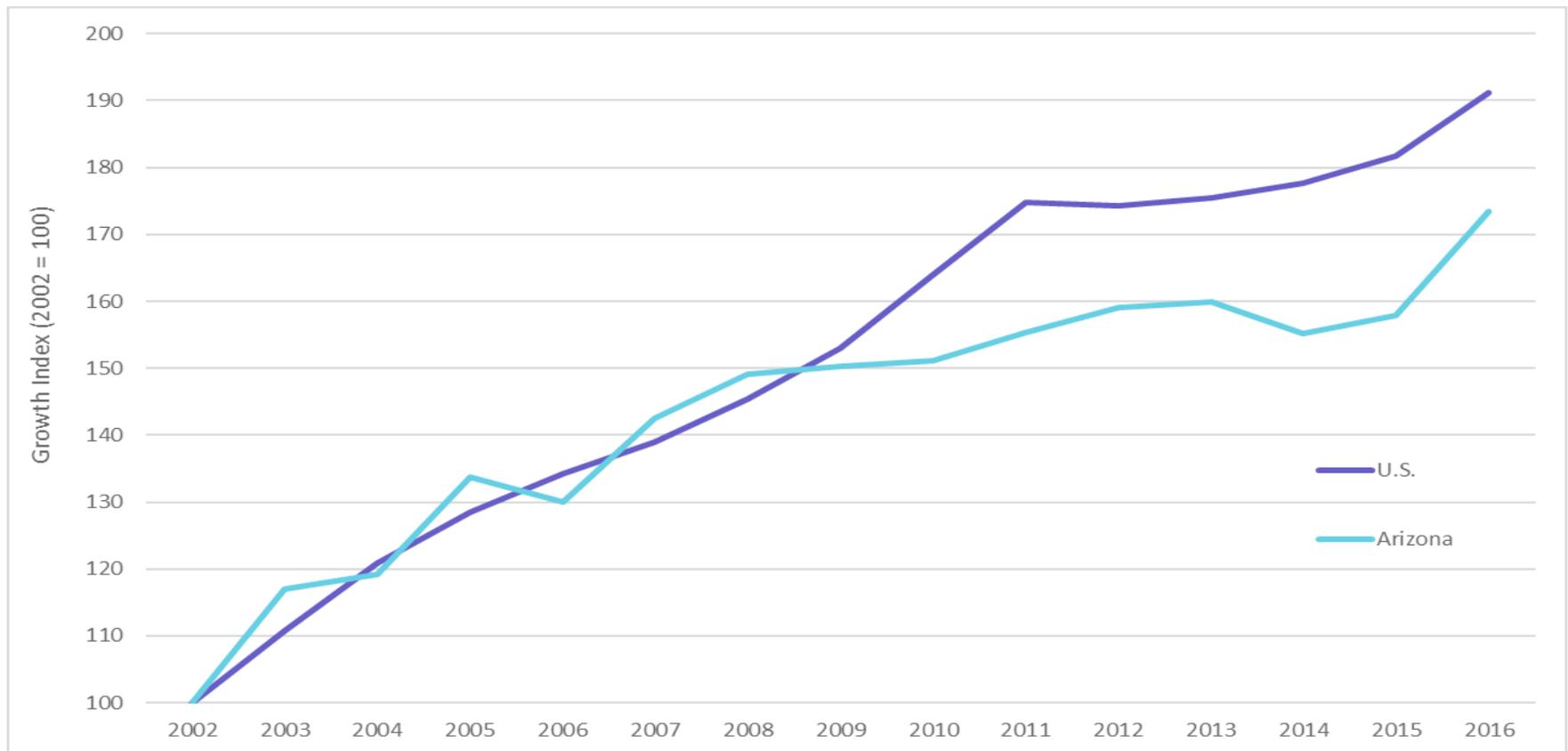
- Total bioscience-related R&D: \$504M
- Total non-bioscience-related R&D: \$568M

U.S. Academic R&D: FY 2016

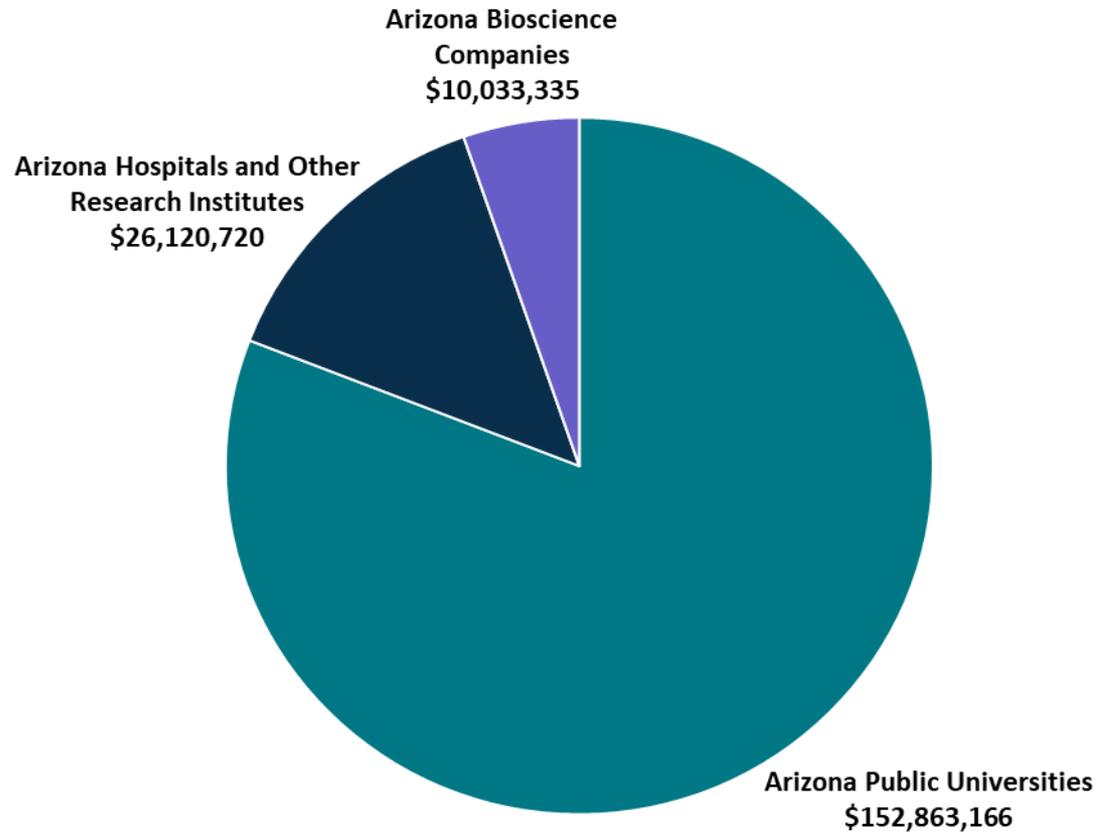
- Total bioscience-related R&D: \$45.0B
- Total non-bioscience-related R&D: \$22.7B

METRIC: BIOSCIENCE R&D

AZ & U.S. Bioscience Academic R&D: 2002-16

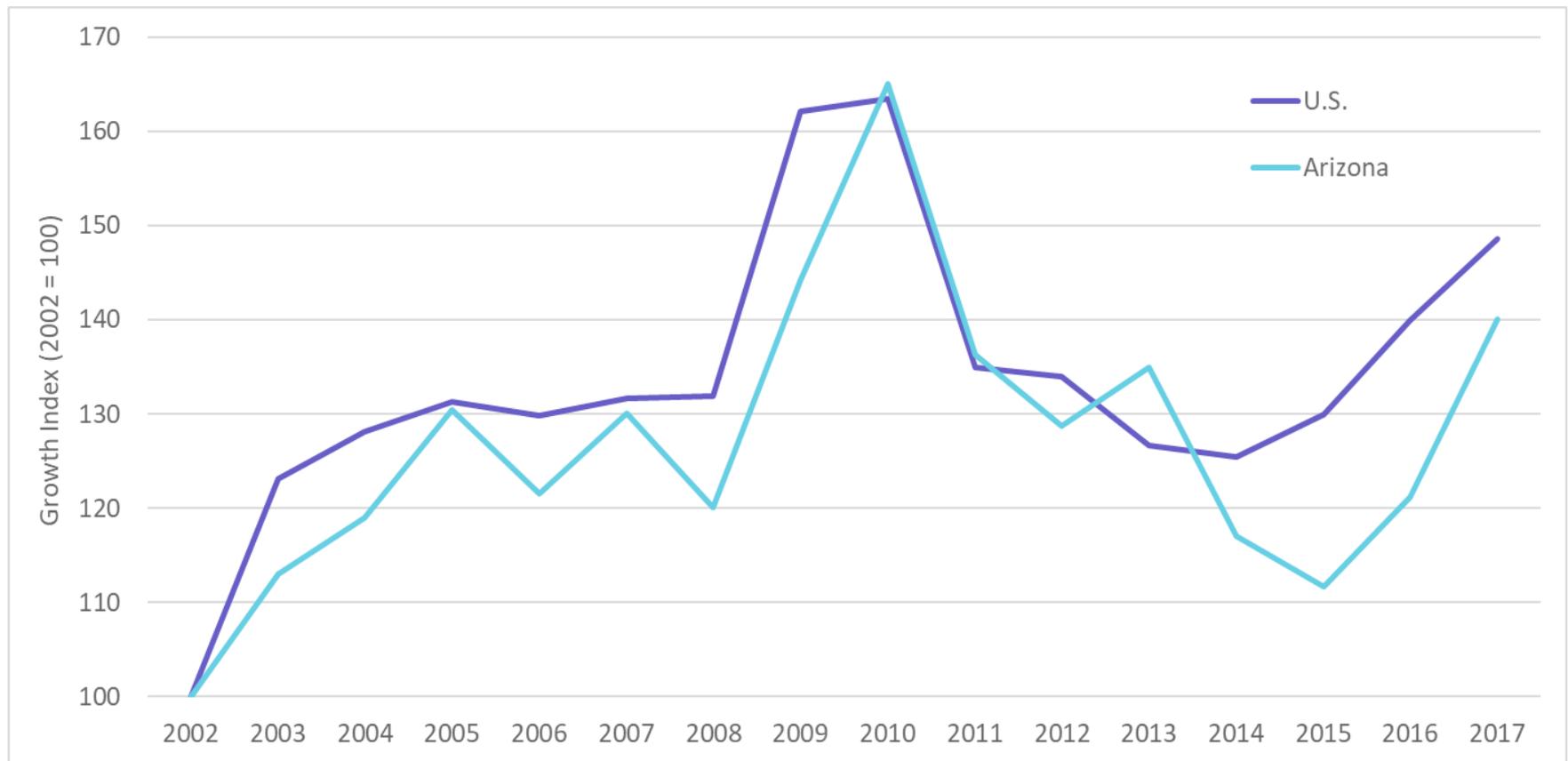


AZ NIH Funding Distribution: FY 2017



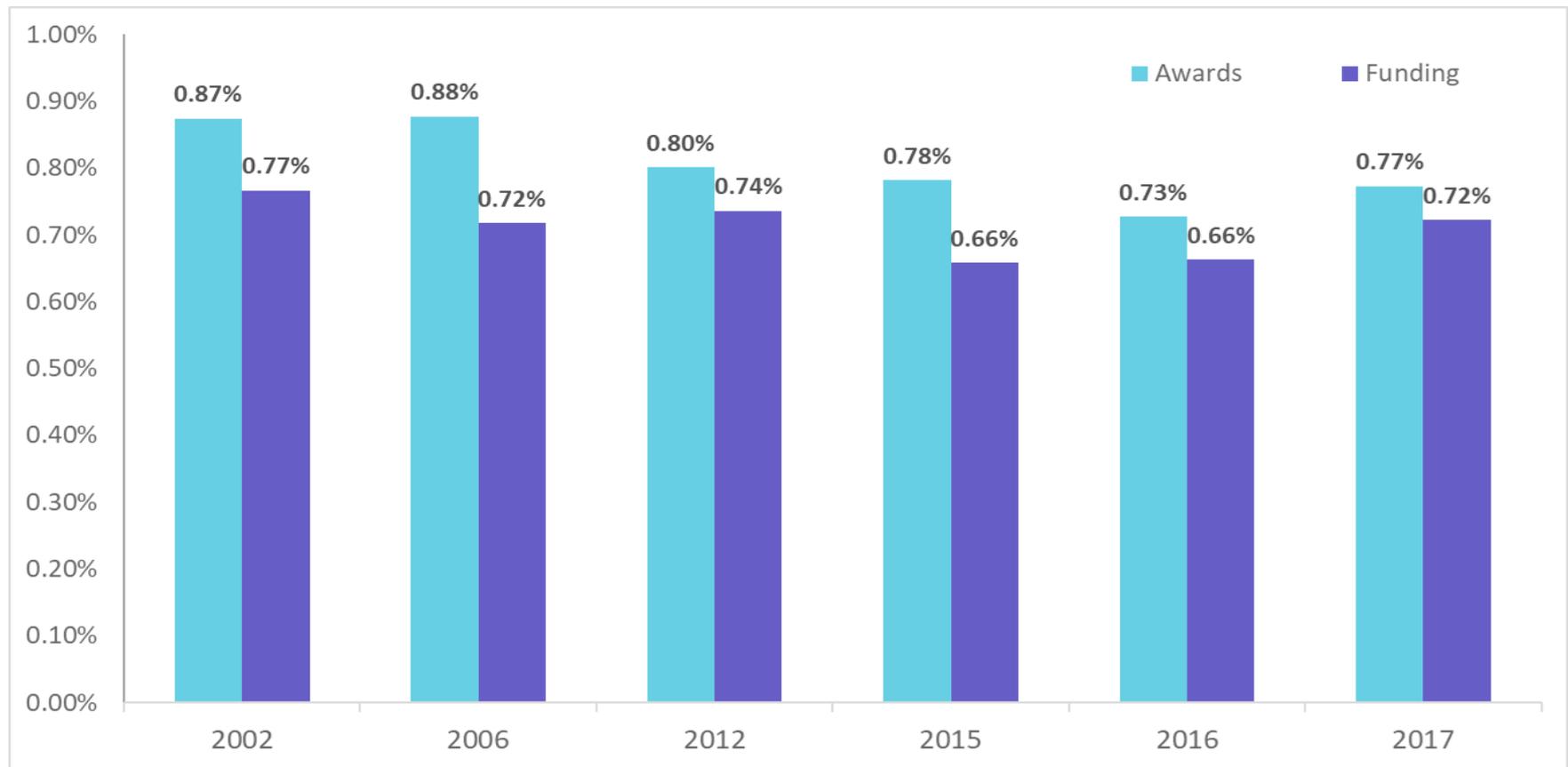
METRIC: NIH

AZ & U.S. NIH Funding: 2002-17



METRIC: NIH

Arizona Share of NIH Support



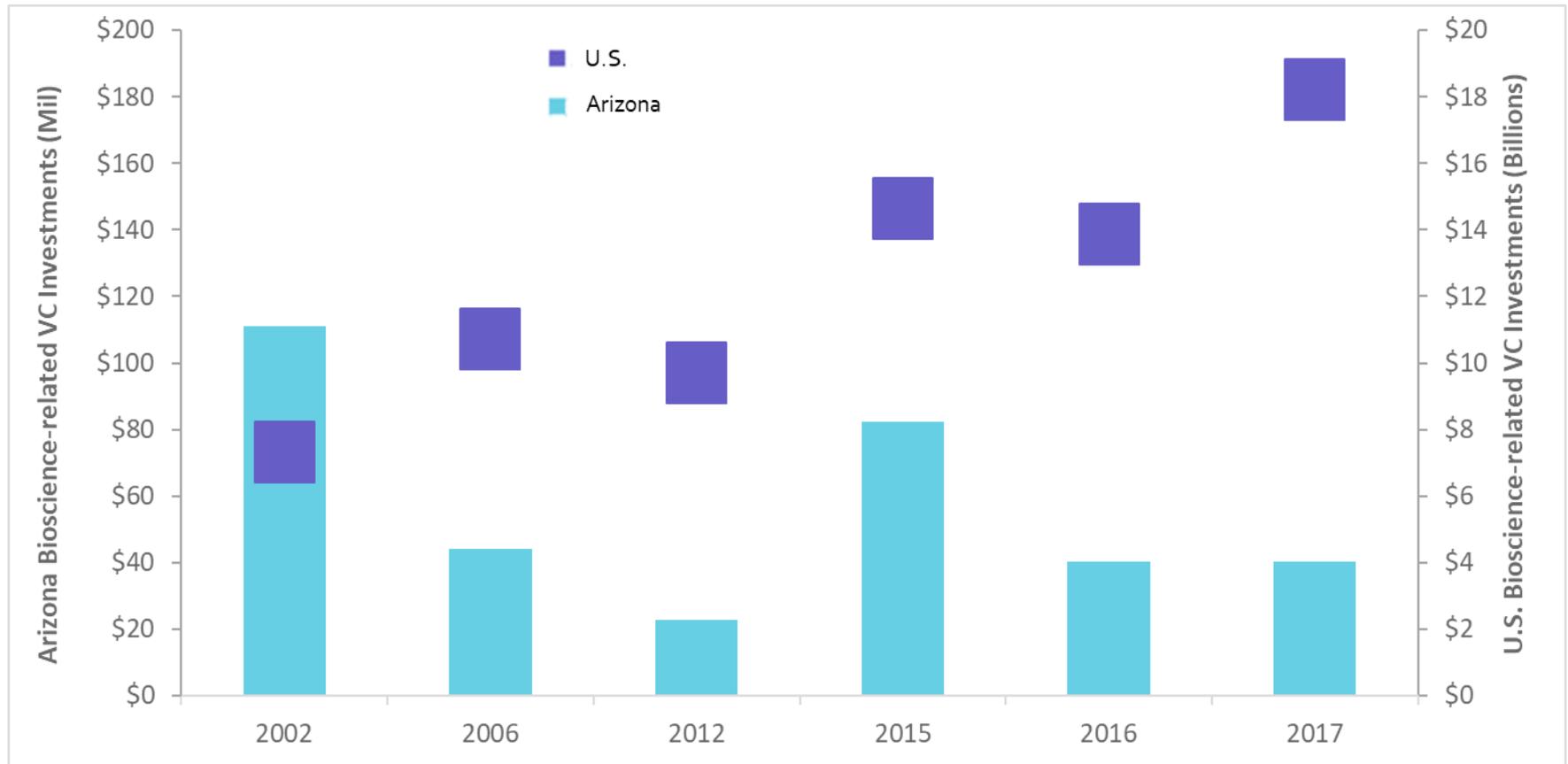
METRIC: TECHNOLOGY TRANSFER

Arizona University Bio Tech Transfer: 2016-17

Key Tech-Transfer Metrics	Total 2016-2017	Growth 2014-15 to 2016-17	Bio Share of Tech Transfer 2016-17	2016-17 Change in Bio Share from 2014-15
Bioscience R&D Expenditures	\$962 m	+31%	41%	↑
Invention Disclosures Received	584	+12%	51%	↔
Total U.S. Patent Applications Filed	571	+44%	56%	↔
U.S. Patents Issued	119	+47%	50%	↑
Licenses & Options Executed	131	+8%	34%	↓
Adjusted Gross License Income Received	\$13.5 m	+76%	82%	↑
Bioscience Startups from University IP	33	+57%	57%	↑

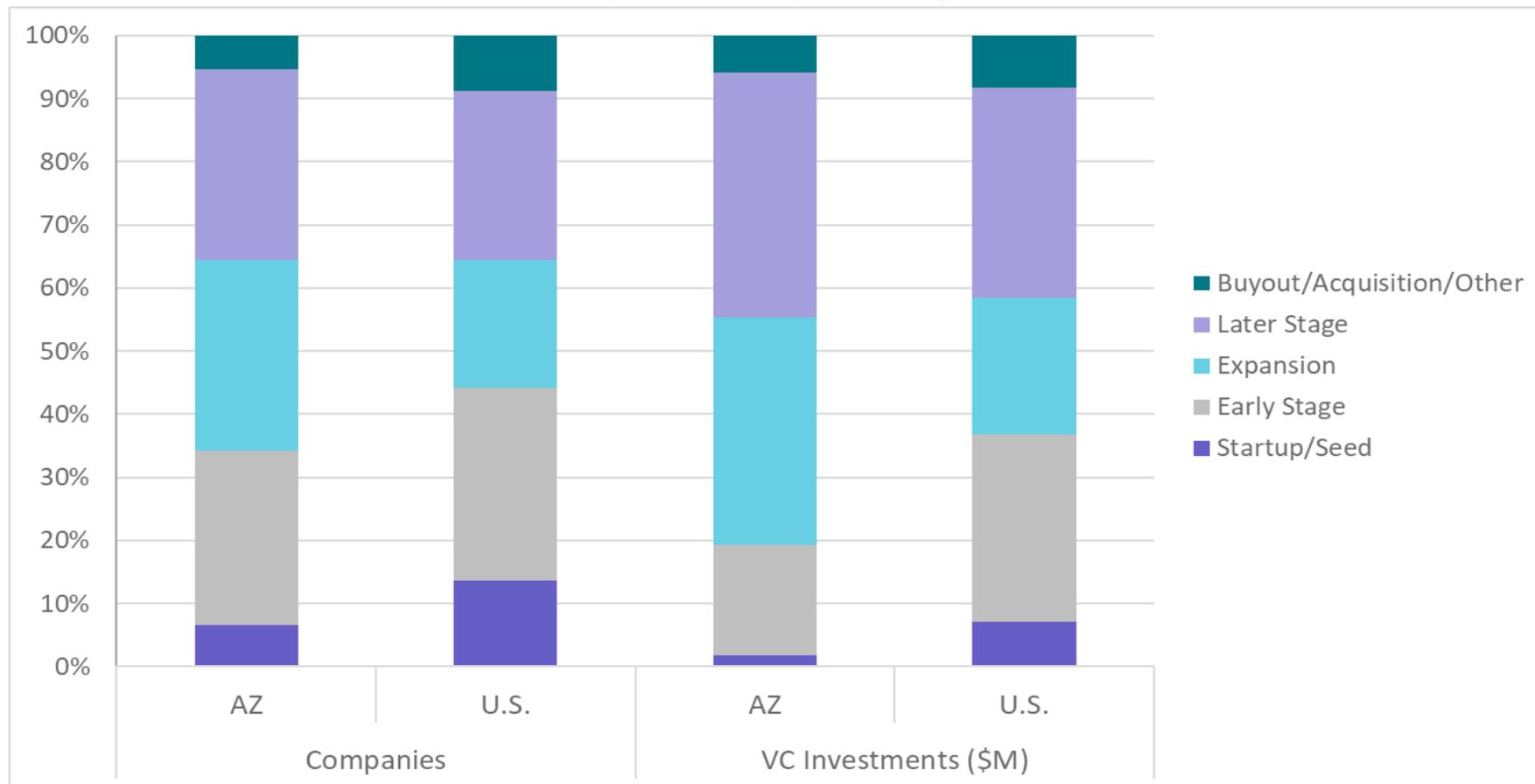
METRIC: VENTURE CAPITAL

AZ & U.S. Bio Venture Capital: 2002-17



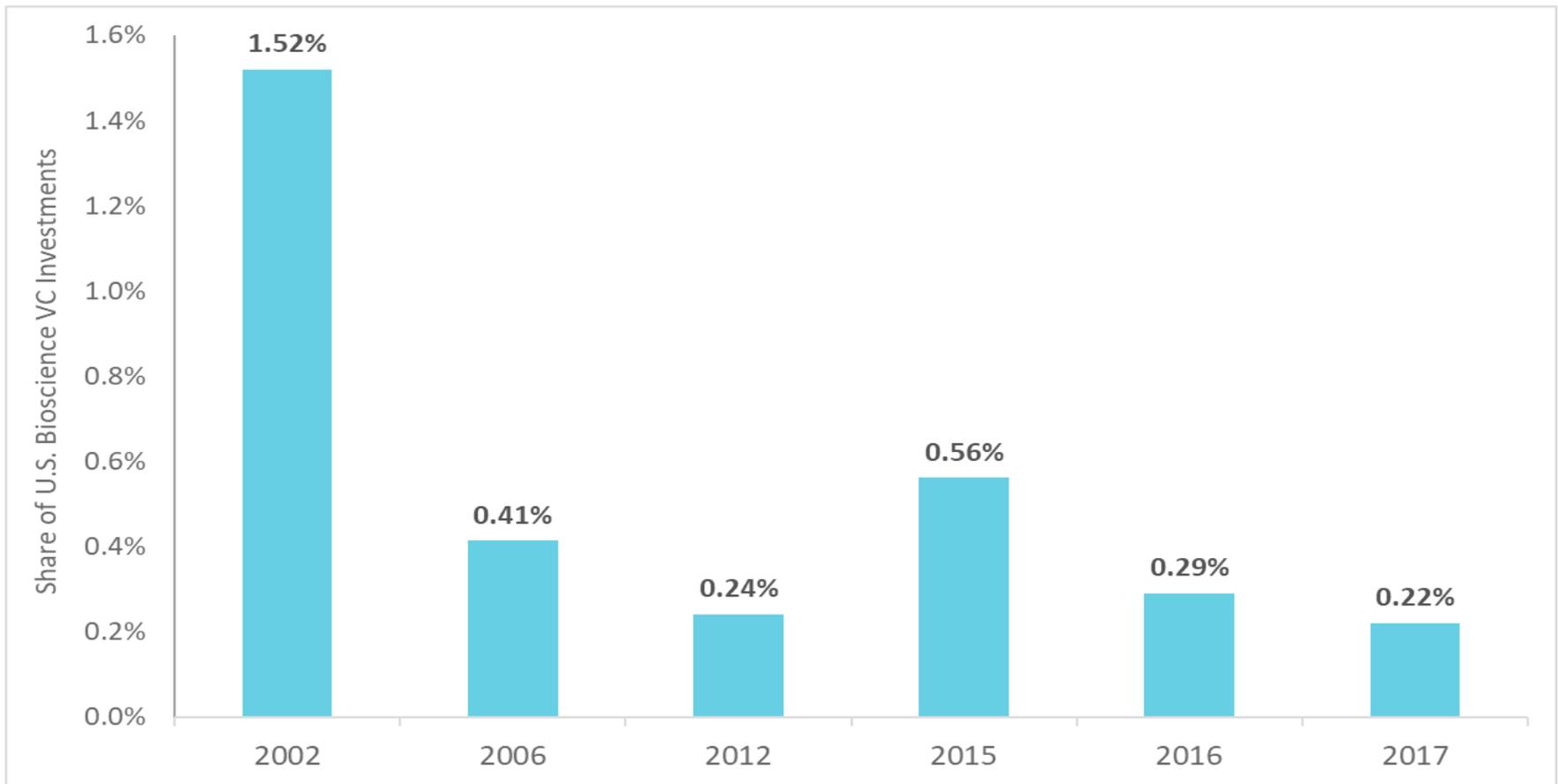
METRIC: VENTURE CAPITAL

AZ & U.S. Venture Capital by Stage, 2002-17



METRIC: VENTURE CAPITAL

AZ Share of U.S. Bio Venture Capital: 2002-17



METRIC: VENTURE CAPITAL

AZ & U.S. Bio Share of Venture Capital, 2002-17

Metric	ARIZONA				U.S.		
	Bio VC	Total VC	Bio Share of Total AZ VC	AZ Bio Share of U.S. Bio VC	Bio VC	Total VC	Bio Share of Total U.S. VC
Number of Deals	144	555	26%	0.7%	20,458	76,868	27%
Number of Individual Companies Invested in	47	192	24%	0.8%	5,803	27,001	21%
Investment (in \$ Millions)	\$796	\$4,079	20%	0.5%	\$175,050	\$693,984	25%

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.

METRIC: VENTURE CAPITAL

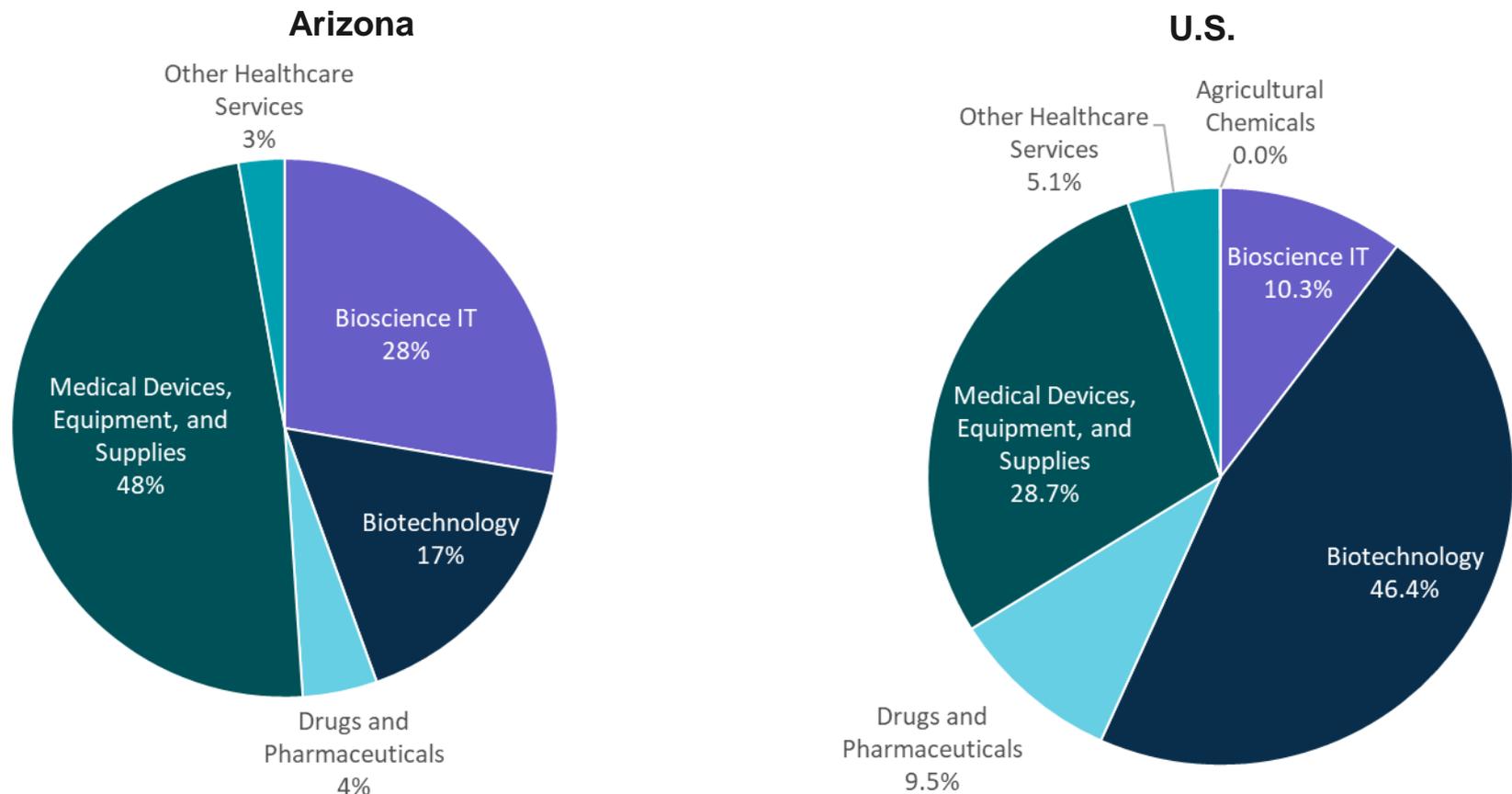
Perspective on Venture Capital

Arizona—not alone among emerging biosciences states—is underperforming in its share of VC funding compared to its share of NIH funding – *indicating lost opportunities.*

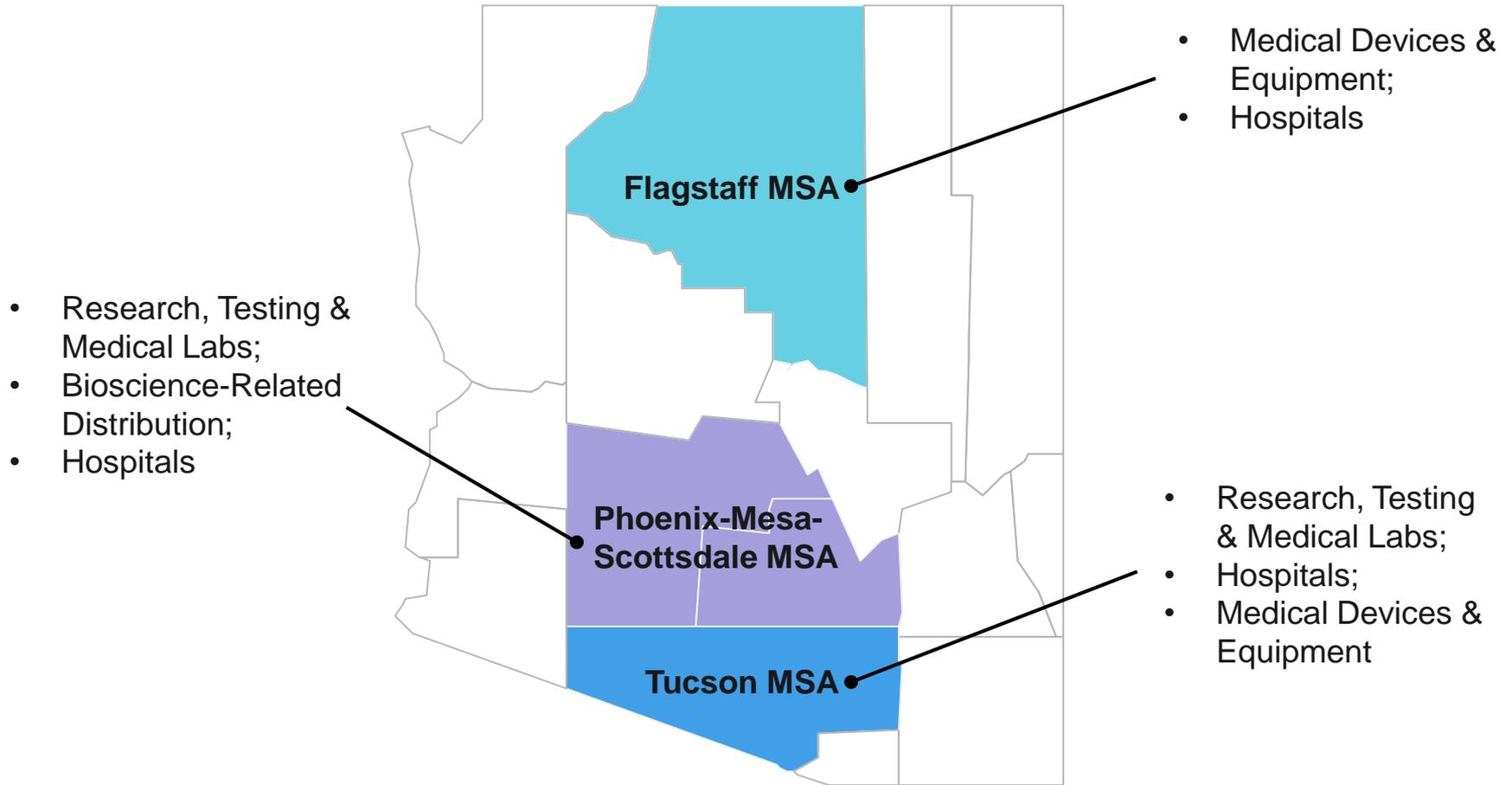
State	Amount of bioscience VC per \$1 in NIH funding
Arizona	\$0.21
Florida	\$0.27
Texas	\$0.33
<i>U.S. average</i>	<i>\$0.76</i>
Massachusetts	\$1.88
California	\$2.16

METRIC: VENTURE CAPITAL

Share of VC Investment by Bio-Related Sector, 2002-17



REGIONAL BIO STRENGTHS



FLAGSTAFF METRO AREA

Key Bioscience Subsector	Establishments, Employment Level & Concentration (2016)	Regional Strengths/ Highlights
Medical Devices & Equipment	Establishments: 2 Employed: 2,562 Employment Growth (02-16): 187.4% Location Quotient: 18.95	Flagstaff remains highly specialized in medical devices, at nearly than 19 times the average employment concentration of the nation.
Hospitals	Establishments: 3 Employed: 3,749 Employment Growth (02-16): 51.3% Location Quotient: 2.02	The hospital subsector is a large employer in Flagstaff, with over 3,700 workers in 2016. It is also growing quickly, with employment increasing by 51% from 2002-16.

PHOENIX-MESA-SCOTTSDALE

Key Bioscience Subsector	Establishments, Employment Level & Concentration (2016)	Regional Strengths/ Highlights
Research, Testing & Medical Laboratories	Establishments: 302 Employed: 7,062 Employment Growth (02-16): 94.5% Location Quotient: 0.92	Employment in research, testing & medical labs over 7,000 in metro Phoenix, with substantial growth of 95% from 2002-16.
Bioscience-related Distribution	Establishments: 571 Employed: 6,774 Employment Growth (02-16): 11.7% Location Quotient: 1.03	Bioscience-related distribution in the Phoenix area is largest non-hospital subsector in metro Phoenix, 3% more concentrated than the U.S.
Hospitals	Establishments: 92 Employed: 59,036 Employment Growth (02-16): 65.2% Location Quotient: 0.85	Hospitals remain the predominant subsector for bioscience employment in metro Phoenix, with 65% growth over 2002-16 period.

TUCSON METRO AREA

Key Bioscience Subsector	Establishments, Employment Level & Concentration (2016)	Regional Strengths/ Highlights
Research, Testing & Medical Laboratories	Establishments: 81 Employed: 1,054 Employment Growth (02-16): 30.6% Location Quotient: 0.81	The research, testing & medical labs subsector in the Tucson area increased employment by 31% over the 2002-16 period.
Hospitals	Establishments: 14 Employed: 16,282 Employment Growth (02-16): 31.0% Location Quotient: 1.38	Tucson has a large, growing, and specialized hospital subsector with 38% higher employment concentration than the nation.
Medical Devices & Equipment	Establishments: 19 Employed: 699 Employment Growth (02-16): 21.6% Location Quotient: 0.82	Tucson's medical devices & equipment subsector grew by 22% over the 2002-16 period, 18% less highly concentrated than the nation.

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.

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.

Critical Legislative Actions in 2017-2018

- Bonding for university infrastructure;
- Angel investment tax credit;
- Extension of TRIF.

HOW TO SUSTAIN GROWTH?

PwC, Global Innovation Survey, 2013

“**Talent** tops the list of innovation challenges for pharmaceutical executives, ahead of other critical areas such as speed to market, establishing an innovative culture and finding the right partners for collaboration.”

Arizona's Bioscience Roadmap, Goal 3

“Make Arizona a **bio-talent powerhouse** where such talent is developed, educated, trained and retained.”

THE ULTIMATE COMPETITION: FOR TALENT

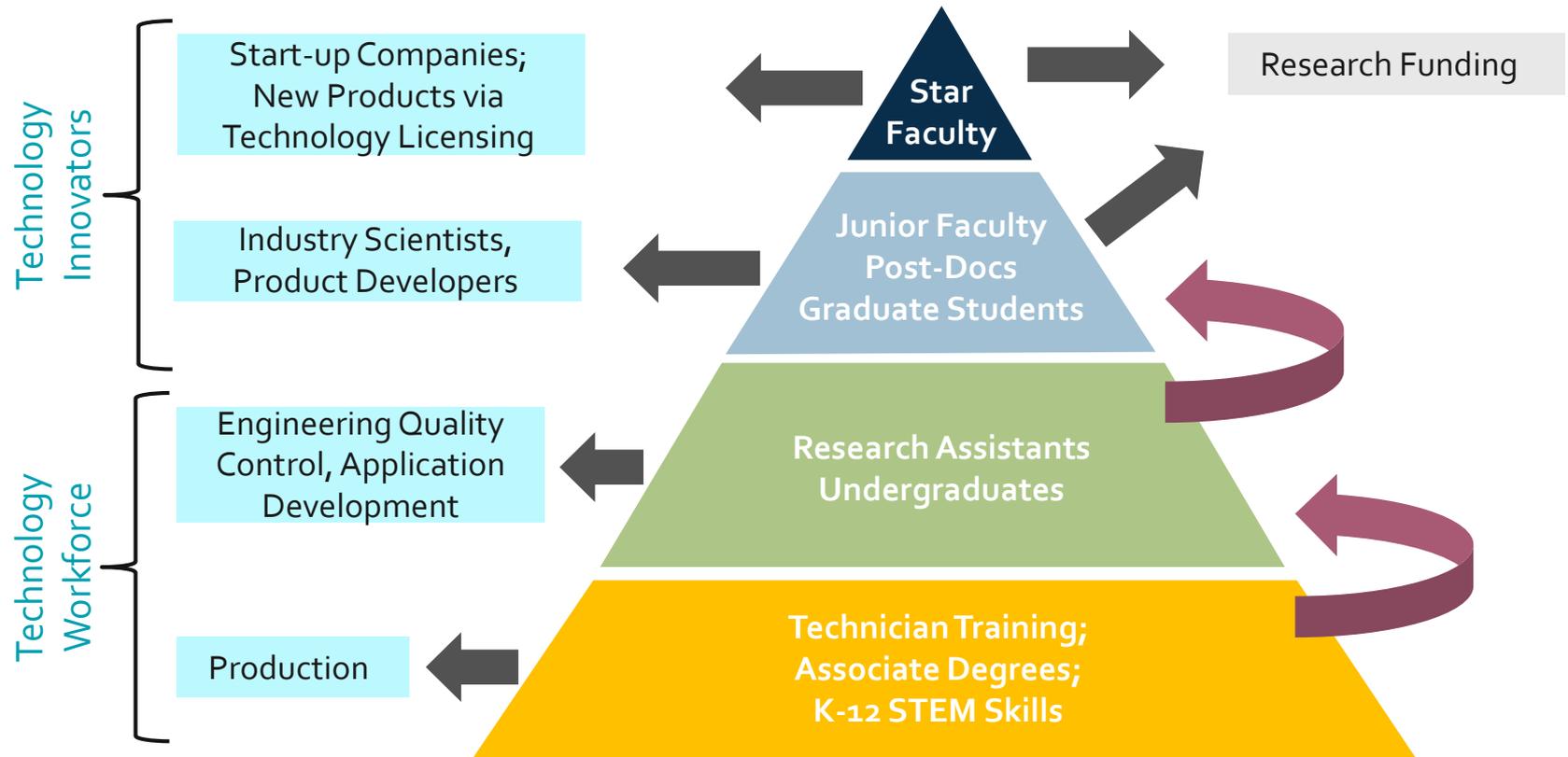
Innovation industry clusters compete on ability to educate, train, and recruit a workforce that meets industry needs.

Bioscience Workforce Requirements

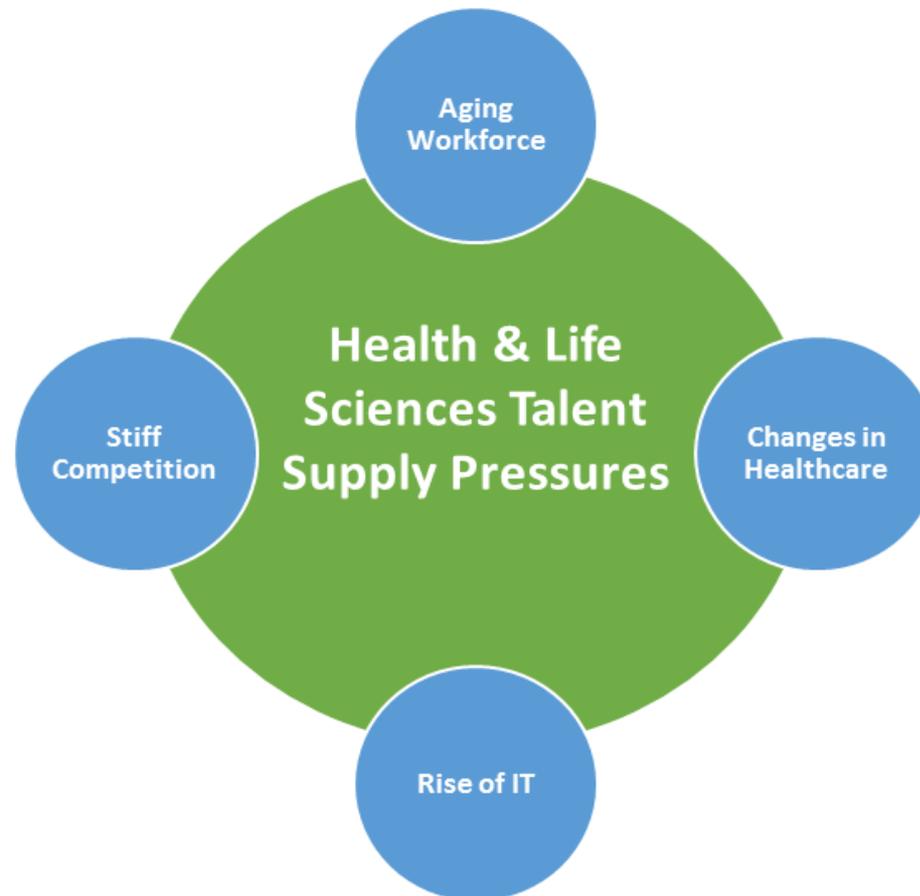
- Specialized knowledge;
- Diverse skills;
- Flexibility to match skill and training mandates of distinct industry subsectors.

THE ULTIMATE COMPETITION: FOR TALENT

A talent-development ecosystem powers innovation that produces economic gains.



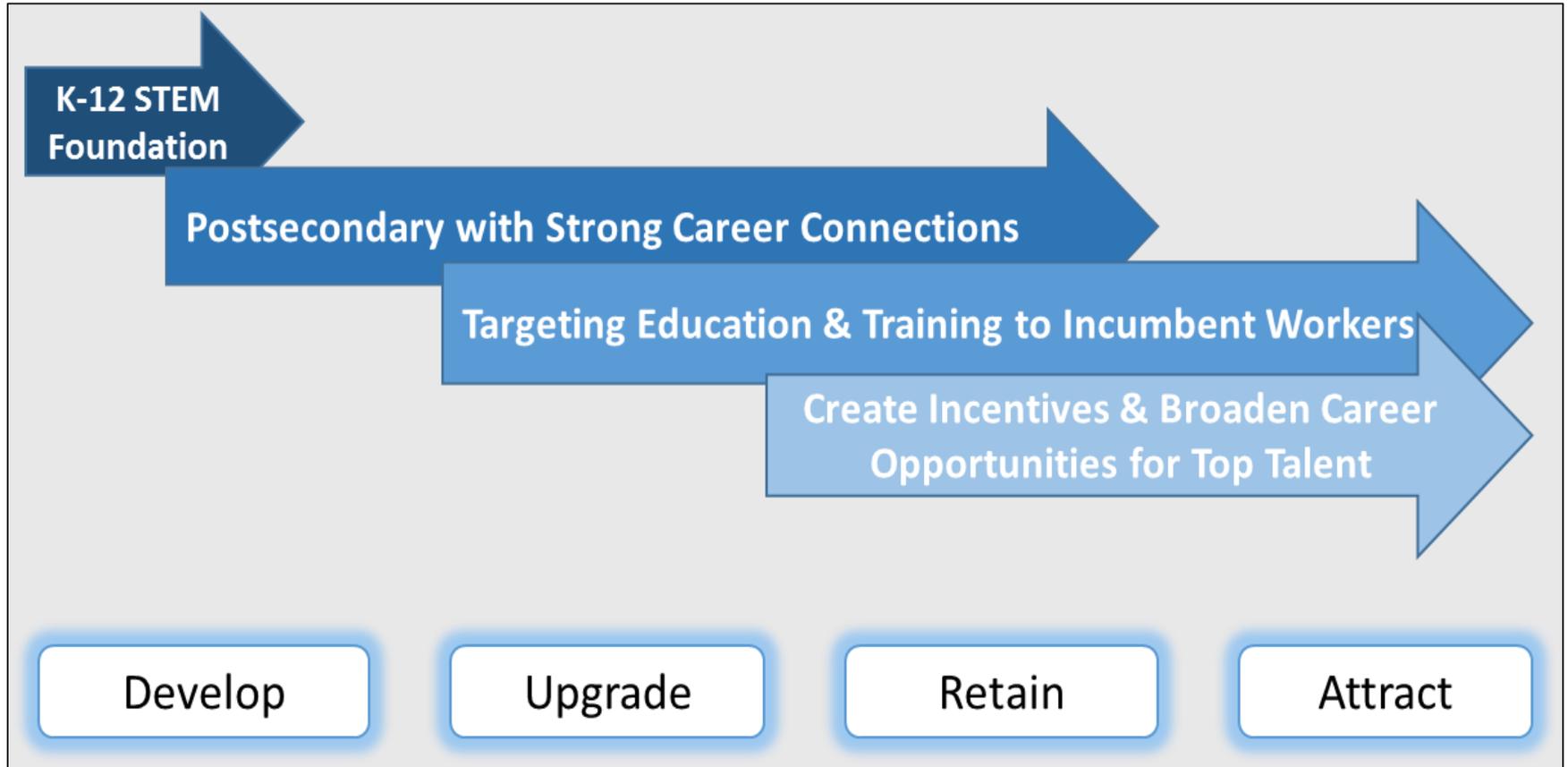
Findings from Recent Studies (*Indiana, Washington*)



Findings from Recent Studies (*Indiana, Washington*)

- Leading areas of science—e.g., precision medicine—are exerting influence across bioscience sub-sectors;
- Data/informatics skills are increasingly prized;
- Still important: soft skills *and* specialized training, e.g., regulation, clinical-trials, quality control.

BEST PRACTICES: BALANCED WORKFORCE STRATEGY



Building a Foundation in K-12 STEM

- California Life Sciences Institute
- Illinois iBio Institute's EDUCATE Center

Post-Secondary with Strong Career Connections

- Iowa Student Internship Program
- South Carolina Apprenticeship Effort

Targeting Education & Training to Incumbent Workers

- North Carolina BioNetwork
- Maryland EARN Initiative

Creating Incentives for Top Talent

- Massachusetts Global Entrepreneur-in-Residence Pilot Program
- Oklahoma Aerospace Engineer Workforce Tax Credit

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