Appendix A:
Life Sciences Sector Industry Analysis Detail

A.1 Life Sciences Sector Definitions

To define the life sciences sector, RTI and Georgia Bio drew on the industry sector definitions used in prior reports including Shaping Infinity (2012) and TEConomy (2017). Additionally, the team added North American Industry Classification System (NAICS) codes agreed upon as appropriate for the life sciences sector in the state. RTI used private-sector totals only.

Table A-1. Industry Definitions of the Life Sciences Industry

NAICS	Subsector/Industry
	Biopharmaceuticals
325411	Medicinal and botanical manufacturing
325412	Pharmaceutical preparation manufacturing
325413	In-vitro diagnostic substance manufacturing
325414	Other biological product manufacturing
	Medical Devices
333314	Optical instrument and lens manufacturing
334510	Electromedical apparatus manufacturing
334516	Analytical laboratory instrument manufacturing
334517	Irradiation apparatus manufacturing
339112	Surgical and medical instrument manufacturing
339113	Surgical appliance and supplies manufacturing
339114	Dental equipment and supplies manufacturing
339115	Ophthalmic goods manufacturing
339116	Dental laboratories
	Research, Testing, and Medical Laboratories
541380	Testing laboratories
541713[a]	Research and development in nanotechnology
541714[a]	Research and development in biotechnology (except nanobiotechnology)
541715[a]	Research and development in the physical, engineering, and life sciences (except nanotechnology and biotechnology)
621511	Medical laboratories
621512	Diagnostic imaging centers
621991	Blood and organ banks

(continued)

Table A-1. Industry Definitions of the Life Sciences Industry (continued)

NAICS	Subsector/Industry
	Agricultural Feedstock & Industrial Biosciences
311224	Soybean and other oilseed processing
325193	Ethyl alcohol manufacturing
325199	All other basic organic chemical manufacturing
325311	Nitrogenous fertilizer manufacturing
325314	Fertilizer, mixing only, manufacturing
325320	Pesticide and other ag. chemical manufacturing
	Bioscience-Related Distribution
423450	Medical equipment merchant wholesalers
424210	Druggists' goods merchant wholesalers
424910	Farm supplies merchant wholesalers

[a] BLS redefined NAICS 541713, 541714, and 541715, which replaced NAICS 541711 (research and development in biotechnology) and 541712 (other physical and biological research) in 2017. The percentage change is the total job growth across the three industries compared with the prior definition.

Based on the NAICS codes defined in Table A-1, RTI gathered data on the life sciences sector as a whole, subsectors of NAICS codes, and individual industries.

Table A-2. Private-Sector Employment, Establishments, Wages, and Location Quotient in Life Sciences Industries in Georgia: 2017

NAICS	Subsector/Industry	Emp.	Estabs.	Avg Wages	LQ	5 Yr % Chg.
	Core subsectors					
	Biopharmaceuticals					
325411	Medicinal and botanical manufacturing	522	15	$76,637	0.60	20%
325412	Pharmaceutical preparation manufacturing	2,177	73	$103,424	0.35	23%
325413	In-vitro diagnostic substance manufacturing	–	7	–	–	–
325414	Other biological product manufacturing	–	7	–	–	–
	Medical Devices					
333314	Optical instrument and lens manufacturing	63	12	$82,491	0.10	17%

(continued)

Table A-2. Private-Sector Employment, Establishments, Wages, and Location Quotient in Life Sciences Industries in Georgia: 2017 (continued)

NAICS	Subsector/Industry	Emp.	Estabs.	Avg Wages	LQ	5 Yr % Chg.
334510	Electromedical apparatus manufacturing	382	37	$71,496	0.19	257%
334516	Analytical laboratory instrument mfg.	33	8	$53,812	0.03	−20%
334517	Irradiation apparatus manufacturing	46	9	$54,625	0.11	53%
339112	Surgical and medical instrument manufacturing	1,819	49	$104,122	0.49	57%
339113	Surgical appliance and supplies manufacturing	2,340	64	$64,563	0.77	−12%
339114	Dental equipment and supplies manufacturing	90	16	$58,520	0.19	55%
339115	Ophthalmic goods manufacturing	888	18	$61,790	1.15	−14%
339116	Dental laboratories	1,374	218	$41,300	1.01	−3%
	Research, Testing, and Medical Laboratories					
541380	Testing laboratories	2,719	220	$67,134	0.54	8%
541713	Research and development in nanotechnology	27	8	$112,769	0.04	50%[a]
541714	Research and development in biotechnology (except nanobiotechnology)	1,283	129	$90,994	0.24	50%[a]
541715	Research and development in the physical, engineering, and life sciences (except nanotechnology and biotechnology)	3,938	245	$108,428	0.33	50%[a]
621511	Medical laboratories	5,387	718	$58,352	0.91	23%
621512	Diagnostic imaging centers	1,197	159	$56,642	0.54	−14%
621991	Blood and organ banks	1,538	51	$47,089	0.71	5%
	Noncore subsectors					
	Agricultural Feedstock & Industrial Biosciences					
311224	Soybean and other oilseed processing	242	8	$53,199	0.93	−51%
325193	Ethyl alcohol manufacturing	101	4	$73,714	0.31	–
325199	All other basic organic chemical mfg.	576	20	$104,836	0.50	−31%

(continued)

Table A-2. Private-Sector Employment, Establishments, Wages, and Location Quotient in Life Sciences Industries in Georgia: 2017 (continued)

NAICS	Subsector/Industry	Emp.	Estabs.	Avg Wages	LQ	5 Yr % Chg.
325311	Nitrogenous fertilizer manufacturing	259	9	$94,781	1.07	4%
325314	Fertilizer, mixing only, manufacturing	367	21	$44,518	1.45	48%
325320	Pesticide and other ag. chemical mfg.	294	13	$48,315	0.74	−17%
	Bioscience-Related Distribution					
423450	Medical equipment merchant wholesalers	8,105	452	$92,956	1.32	38%
424210	Druggists‘ goods merchant wholesalers	5,343	295	$120,889	0.88	13%
424910	Farm supplies merchant wholesalers	2,606	275	$55,579	0.74	14%

Source: Bureau of Labor Statistics Quarterly Census of Employment and Wages (QCEW)

Emp.= annual average employment Estabs. = establishments, Avg Wages = average annual wages, LQ= Location Quotient, 5yr % chg. = percentage change in jobs from 2012 to 2017.

[a] BLS redefined NAICS 541713, 541714, and 541715, which replaced NAICS 541711 (research and development in biotechnology) and 541712 (other physical and biological research) in 2017. The percentage change is the total job growth across the three industries compared with the prior definition.

Location quotient (LQ) is a measure of relative concentration of jobs in an industry: an LQ of 1 means that the number of jobs is proportional to the nation, while an LQ of greater than 1 means there is a relatively high concentration. Similarly, a LQ of less than 1 indicates a relatively low concentration of jobs.

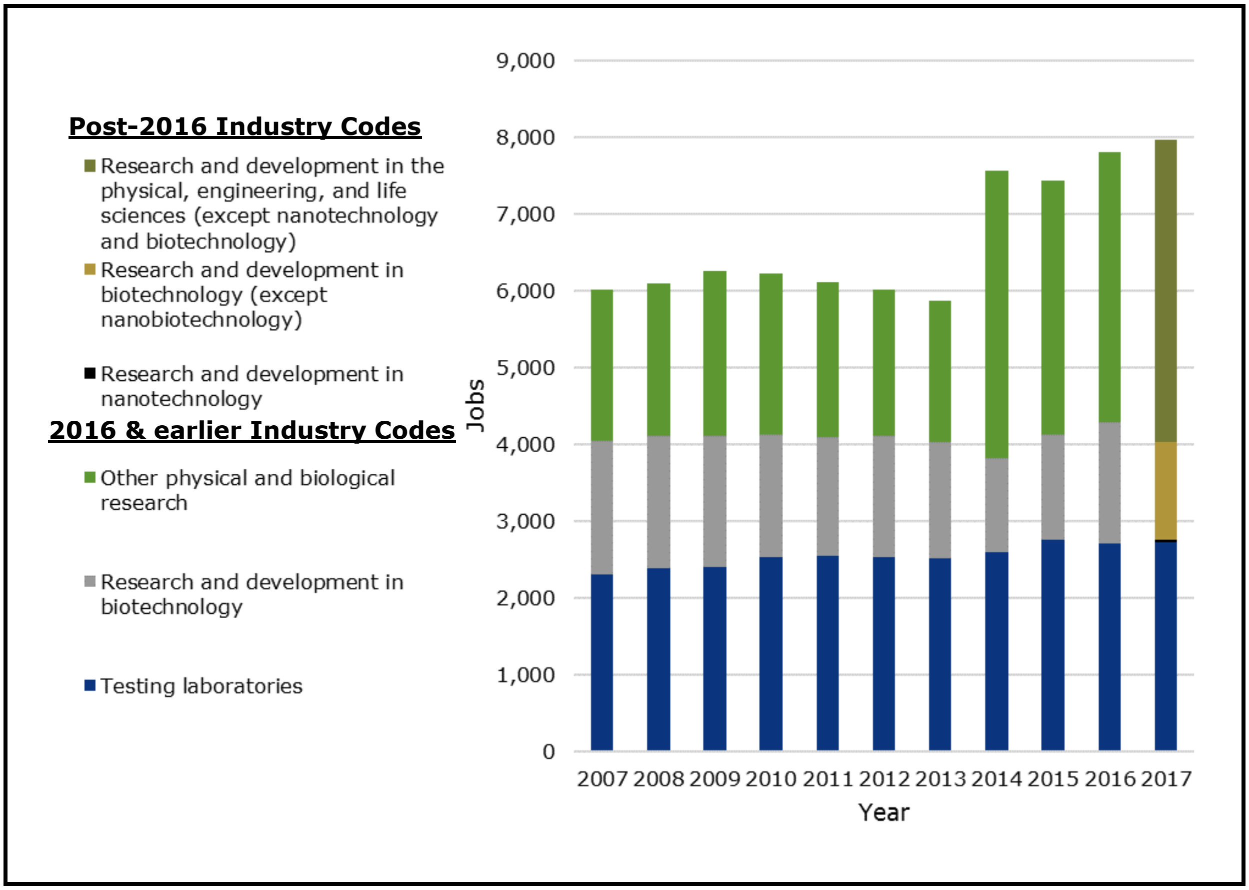
A.1.1 Subsectors of the Life Sciences Sector

Research and Development

The research, testing, and medical laboratories subsector employ nearly 8,000 people in Georgia and has been one of the fastest growing sectors over the last decade. The biggest growth in jobs occurred between 2013 and 2014, when the industry added nearly 2,000 jobs in physical and biological research.[1]

[1] The 2017 revision to the NAICS replaced NAICS 541712 (other physical and biological research) with 541715 (research and development in the physical, engineering, and life sciences (except nanotechnology and biotechnology).

Figure A-1. Jobs in Research, Testing, and Medical Laboratories in Georgia: 2007–2017

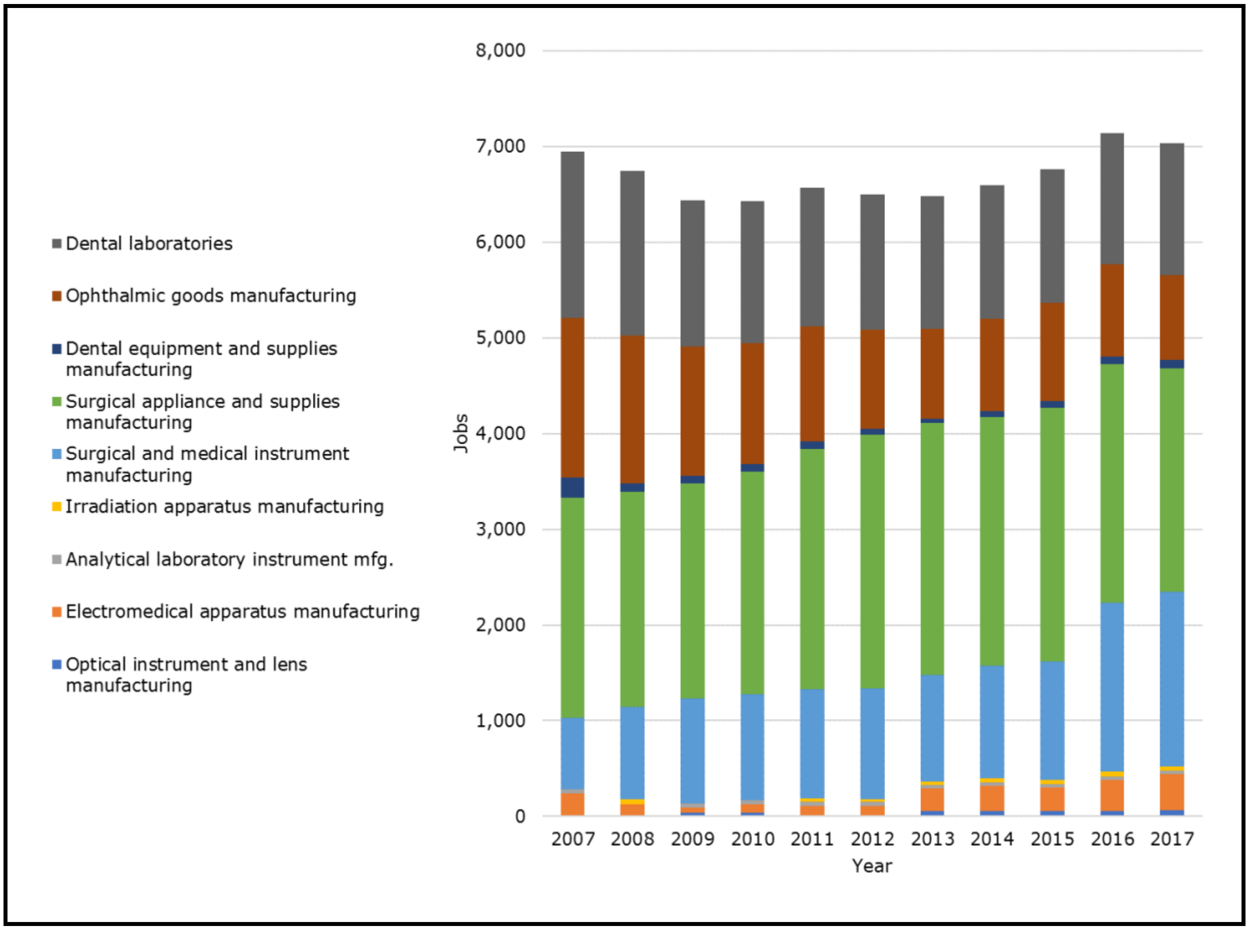


Source: Bureau of Labor Statistics. Quarterly Census of Employment and Wages (QCEW). Accessed November 2018 at [https://www.bls.gov/cew/.](https://www.bls.gov/cew/)

Medical Devices

In 2017, over 7,000 people were employed in medical device manufacturing in Georgia, as defined by the NAICS industry definitions in Figure A-2. The industry has slowly added jobs since 2010, but the profile has changed. Ophthalmic goods manufacturing has seen the biggest decline in employment, from 1,674 jobs in 2007 to 888 in 2017. Over that same time period, other industries have added jobs, including surgical and medical instrument manufacturing and electromedical apparatus manufacturing.

Figure A-2. Jobs in Medical Devices in Georgia: 2007–2017



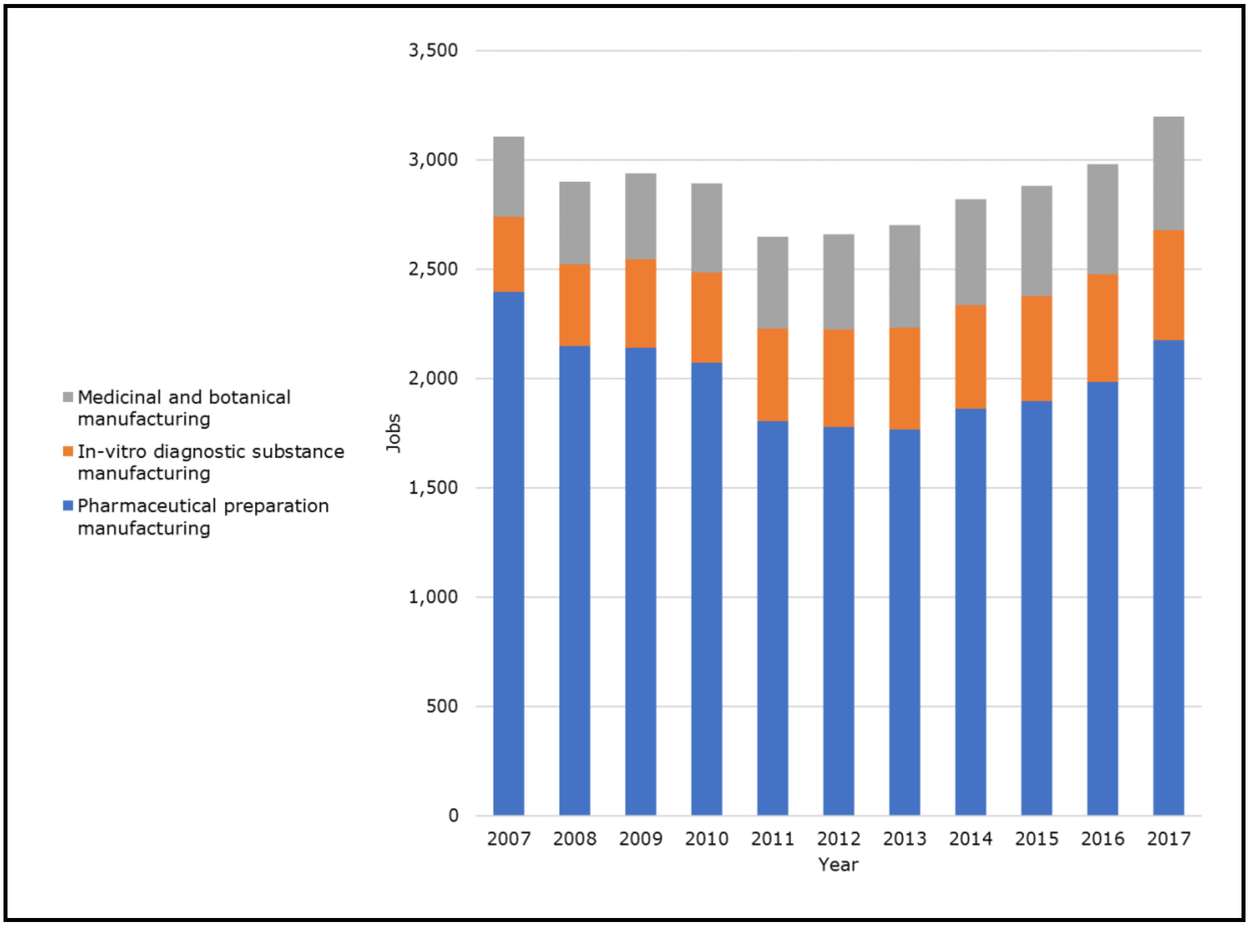
Source: Bureau of Labor Statistics. Quarterly Census of Employment and Wages (QCEW). Accessed November 2018 at https://www.bls.gov/cew/.

Biopharmaceuticals

Compared with the R&D and medical device sectors, the biopharmaceutical sector in Georgia is smaller, employing approximately 3,200 people.[2] As seen in Figure A-3, jobs in the sector declined from 2007 to 2011 but returned to above their prerecession levels by 2017. Pharmaceutical preparation manufacturing is consistently the largest industry in biopharmaceuticals in the state, employing 2,177 people in 2017.

[2] Job totals are an estimate because of BLS nondisclosure of NAICS 325411 and 325413. RTI approximated the totals based on moving averages of available data.

Figure A-3. Jobs in Biopharmaceuticals in Georgia: 2007–2017



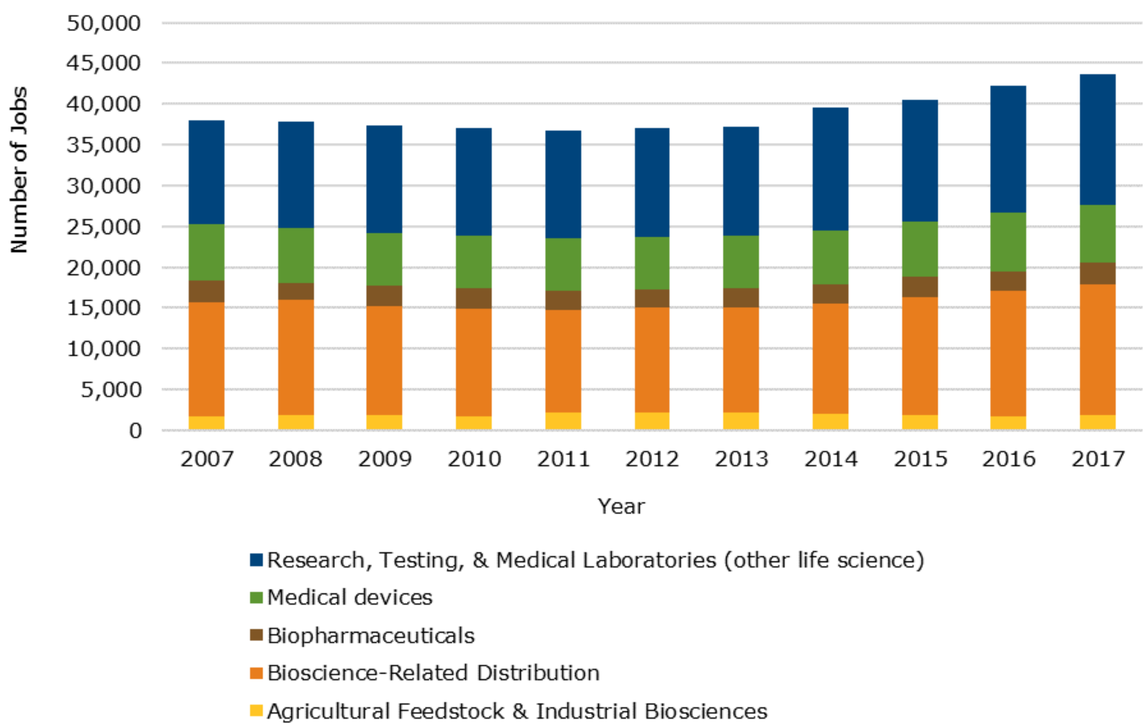
Source: Bureau of Labor Statistics. Quarterly Census of Employment and Wages (QCEW). Accessed November 2018 at https://www.bls.gov/cew/.

Note: For certain years, medicinal and botanical manufacturing and in vitro diagnostic substance manufacturing are approximations of totals because of BLS nondisclosure.

Total Private-Sector Employment in Life Sciences: By Subsector

As seen in Figure A-4, private-sector employment in life sciences grew consistently between 2011 and 2017, with the highest percentage of jobs in research, testing, and medical laboratories and bioscience-related distribution.

Figure A-4. Private-Sector Employment in Bioscience Subsectors in Georgia: 2007–2017



Source: Bureau of Labor Statistics. Quarterly Census of Employment and Wages (QCEW). Accessed November 2018 at https://www.bls.gov/cew/.

A.2 Workforce Definitions and Data

RTI defined the life sciences workforce by combining industry-level employment figures in Georgia with national industry-occupation averages to get an estimate of the types of jobs, wages, and education levels required in the life sciences sector. Table A-3 outlines the top 20 occupations in life sciences with 500 or more estimated jobs in the state.

Table A-3. Top Occupations in Life Sciences in Georgia: 2017

Occupation Title (detailed)	Estimated Jobs in Life Sciences	Median Annual Wage in Georgia	Typical Education Needed for Entry	Work Experience in a Related Occupation	Typical on-the-Job Training Needed to Attain Competency in the Occupation
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	1,945	$54,080	High school diploma or equivalent	None	Moderate-term on-the-job training
Clinical Laboratory Technologists and Technicians	1,578	$47,740	Associate degree or Bachelor's degree	None	None
Customer Service Representatives	1,348	$31,710	High school diploma or equivalent	None	Short-term on-the-job training
Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	1,183	$69,500	Bachelor's degree	None	Moderate-term on-the-job training
Laborers and Freight, Stock, and Material Movers, Hand	1,158	$24,450	No formal educational credential	None	Short-term on-the-job training
Phlebotomists	1,128	$31,180	Postsecondary nondegree award	None	None
General and Operations Managers	981	$92,430	Bachelor's degree	5 years or more	None
Assemblers and Fabricators, All Other, Including Team Assemblers	964	$28,180	High school diploma or equivalent	None	Moderate-term on-the-job training
Office Clerks, General	837	$27,180	High school diploma or equivalent	None	Short-term on-the-job training
Stock Clerks and Order Fillers	709	$23,520	High school diploma or equivalent	None	Short-term on-the-job training
Shipping, Receiving, and Traffic Clerks	648	$30,370	High school diploma or equivalent	None	Short-term on-the-job training
Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	644	$33,830	High school diploma or equivalent	None	Short-term on-the-job training
Emergency Medical Technicians and Paramedics	633	$31,470	Postsecondary nondegree award	None	None

(continued)

Table A-3. Top Occupations in Life Sciences in Georgia: 2017 (continued)

Occupation Title (detailed)	Estimated Jobs in Life Sciences	Median Annual Wage in Georgia	Typical Education Needed for Entry	Work Experience in a Related Occupation	Typical on-the-Job Training Needed to Attain Competency in the Occupation
Inspectors, Testers, Sorters, Samplers, and Weighers	621	$33,580	High school diploma or equivalent	None	Moderate-term on-the-job training
Dental Laboratory Technicians	612	$37,440	High school diploma or equivalent	None	Moderate-term on-the-job training
Heavy and Tractor-Trailer Truck Drivers	588	$41,770	Postsecondary nondegree award	None	Short-term on-the-job training
Packaging and Filling Machine Operators and Tenders	553	$28,610	High school diploma or equivalent	None	Moderate-term on-the-job training
First-Line Supervisors of Office and Administrative Support Workers	513	$52,530	High school diploma or equivalent	Less than 5 years	None
Medical Scientists, Except Epidemiologists	505	$56,260	Doctoral or professional degree	None	None
Bookkeeping, Accounting, and Auditing Clerks	504	$38,070	Some college, no degree	None	Moderate-term on-the-job training

Source: Bureau of Labor Statistics, Occupational Employment Statistics, 2017. Estimated jobs based on national averages for occupation by industry. Table only includes occupations with at least 500 estimated jobs in life sciences in Georgia.

Additionally, national occupation growth projections, outlined in Table A-4, offer insight into the future jobs that will be in demand in the life sciences sector in the next decade.

Table A-4. Projected Job Growth in Life Science Occupations: 2016-2026

Occupation Title (detailed)	Estimated Jobs in Life Sciences (2016)	Median Annual Wage in Georgia	Typical Education Needed for Entry	Projected Job Growth 2016–2026
Phlebotomists	1,128	$31,180	Postsecondary nondegree award	24.5%
Emergency Medical Technicians and Paramedics	633	$31,470	Postsecondary nondegree award	15.1%
Dental Laboratory Technicians	612	$37,440	High school diploma or equivalent	14.4%
Medical Scientists, Except Epidemiologists	505	$56,260	Doctoral or professional degree	13.4%
Clinical Laboratory Technologists and Technicians	1,578	$47,740	Associate degree or Bachelor's degree	12.7%
General and Operations Managers	981	$92,430	Bachelor's degree	9.1%
Laborers and Freight, Stock, and Material Movers, Hand	1,158	$24,450	No formal educational credential	7.6%
Heavy and Tractor-Trailer Truck Drivers	588	$41,770	Postsecondary nondegree award	5.8%
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	1,945	$54,080	High school diploma or equivalent	5.2%
Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	1,183	$69,500	Bachelor's degree	5.1%
Stock Clerks and Order Fillers	709	$23,520	High school diploma or equivalent	5%
Customer Service Representatives	1,348	$31,710	High school diploma or equivalent	4.9%
First-Line Supervisors of Office and Administrative Support Workers	513	$52,530	High school diploma or equivalent	3.4%
Packaging and Filling Machine Operators and Tenders	553	$28,610	High school diploma or equivalent	1.7%
Shipping, Receiving, and Traffic Clerks	648	$30,370	High school diploma or equivalent	0%
Office Clerks, General	837	$27,180	High school diploma or equivalent	–1%

(continued)

Table A-4. Projected Job Growth in Life Science Occupations: 2016-2026

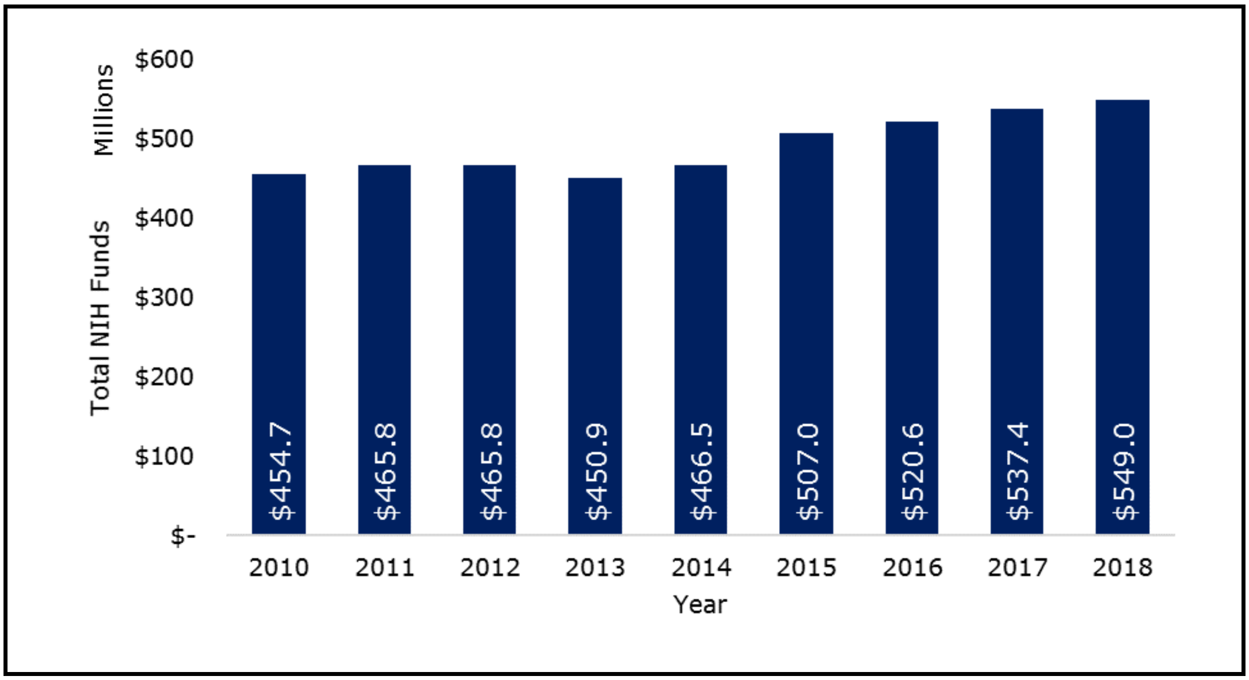
Occupation Title (detailed)	Estimated Jobs in Life Sciences (2016)	Median Annual Wage in Georgia	Typical Education Needed for Entry	Projected Job Growth 2016–2026
Bookkeeping, Accounting, and Auditing Clerks	504	$38,070	Some college, no degree	−1.5%
Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	644	$33,830	High school diploma or equivalent	−6.5%
Inspectors, Testers, Sorters, Samplers, and Weighers	621	$33,580	High school diploma or equivalent	−10.7%

Source: Bureau of Labor Statistics, Occupational Employment Statistics, 2017. Estimated jobs based on national averages for occupation by industry. Table only includes occupations with at least 500 estimated jobs in life sciences in Georgia.

A.3 Research and Discovery Data

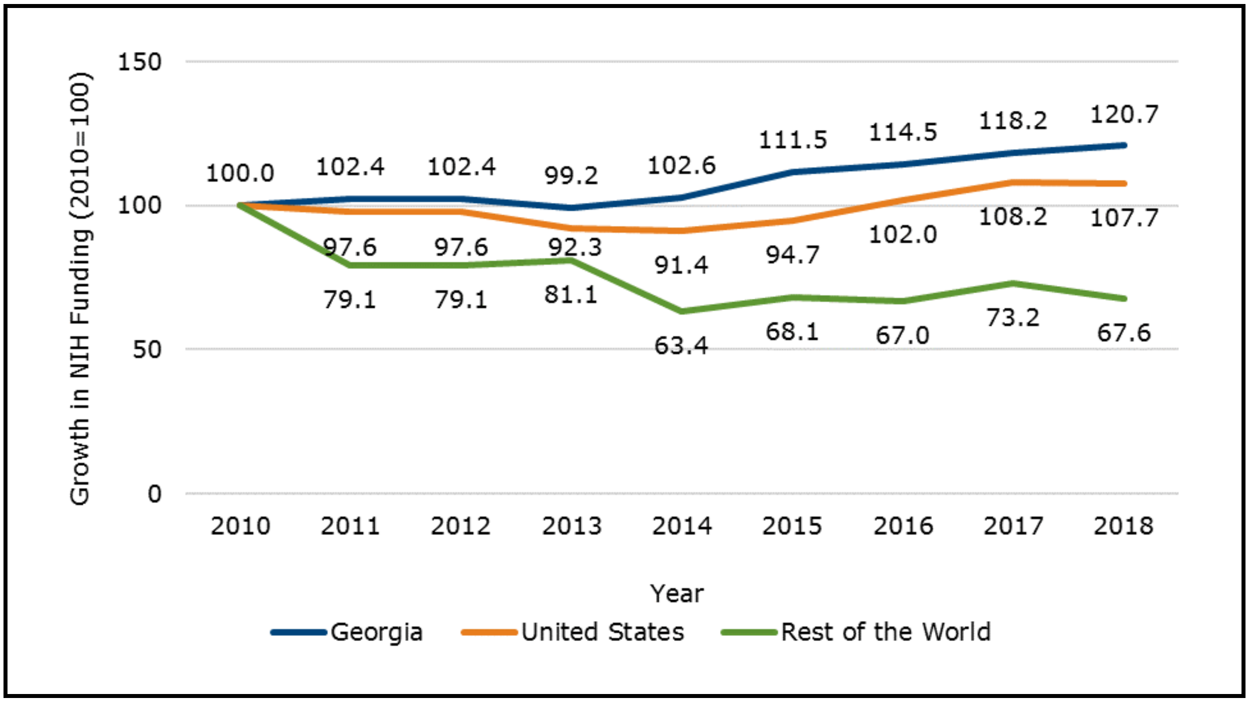
Research funding from the National Institutes of Health (NIH), outlined in Figures A-5 and A-6, is the primary source of public funding for life sciences research.

Figure A-5. NIH Funding Received by Georgia-Based Institutions: 2010–2018



Source: National Institutes of Health. Research Portfolio Online Reporting Tools (RePORT). Accessed November 2018 at https://report.nih.gov/award/index.cfm?ot=&fy=2017&state=GA&ic=&fm=&orgid=&distr=&rfa=&pid=#tab2

Figure A-6. Growth in NIH Funding in Georgia, the United States, and the Rest of the World, 2010–2018



Source: National Institutes of Health. Research Portfolio Online Reporting Tools (RePORT). Accessed November 2018 at https://report.nih.gov/award/index.cfm?ot=&fy=2017&state=GA&ic=&fm=&orgid=&distr=&rfa=&pid=#tab2

Note: Growth is indexed to NIH funding in year 2000=100.

Additionally, Table A-5 shows reported research funding from all public and private sources to universities in Georgia. Small businesses are eligible for federal research funding the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR). Their research funding activities are found in Table A-6 and Figure A-7.

Table A-5. Research & Development Expenditures in Life Sciences at Universities in Georgia: 2017

University	Core Life Sciences R&D	% of Georgia Core Life Sciences R&D	Agricultural Sciences	Natural Resources and Conservation	Other Life Sciences	Total Life Sciences	% of Georgia Life Sciences R&D
Albany State U.	$622,000	0.1%	$422,000	$60,000		$1,104,000	0.1%
Augusta U.	$95,799,000	9.4%			$3,584,000	$99,383,000	8.6%
Clark Atlanta U.	$5,536,000	0.5%				$5,536,000	0.5%
Emory U.	$595,466,000	58.4%			$14,015,000	$609,481,000	52.8%
Fort Valley State U.	$295,000	0.0%	$4,790,000			$5,085,000	0.4%
Georgia Institute of Technology	$18,607,000	1.8%	$3,787,000			$22,394,000	1.9%
Georgia Southern U.	$4,629,000	0.5%			$51,000	$4,680,000	0.4%
Georgia State U.	$60,979,000	6.0%	$289,000	$31,000	$14,335,000	$75,634,000	6.6%
Kennesaw State U.	$3,611,000	0.4%				$3,611,000	0.3%
Mercer U.	$3,651,000	0.4%			$1,521,000	$5,172,000	0.4%
Morehouse C.	$113,000	0.0%			$13,000	$126,000	0.0%
Morehouse School of Medicine	$35,454,000	3.5%				$35,454,000	3.1%
Savannah State U.	$450,000	0.0%				$450,000	0.0%
Spelman C.	$759,000	0.1%				$759,000	0.1%
U. Georgia	$193,676,000	19.0%	$88,456,000		$3,142,000	$285,274,000	24.7%
U. North Georgia		0.0%	$1,000			$1,000	0.0%
Total	**$1,019,647,000**		**$88,457,000**	**$31,000**	**$3,142,000**	**$1,154,144,000**	**100.0%**

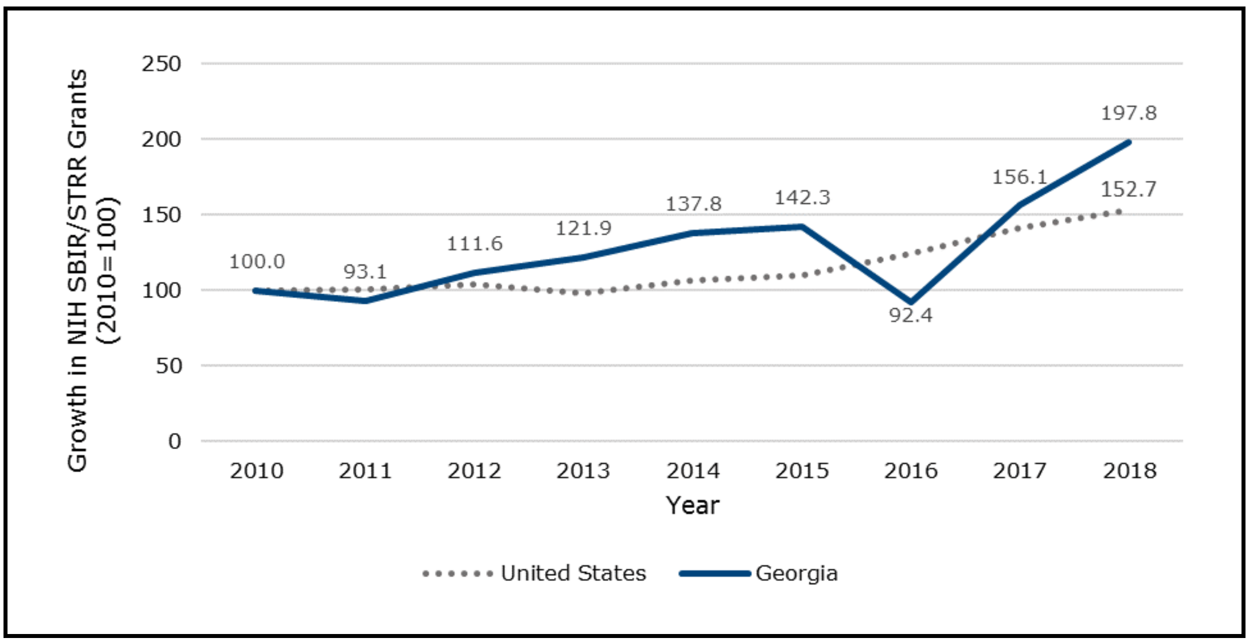
Source: National Science Foundation NCSES Interactive Data Tool. https://ncsesdata.nsf.gov/herd/2017/html/herd2017_dst_70.html
Note: Core is biological and biomedical sciences + health sciences. Data are reported by university and include research funding from USDA, DoD, DoE, HHS (including NIH), NASA, NSF, and other federal agencies, as well as state, local, private-sector, foundation, and international funders.

Table A-6. Top 10 Georgia-Based Organizations Receiving NIH SBIR/STTR Funding: 2010–2018

Organization Name	Total NIH SBIR/STTR Funding Received
Virtually Better, Inc.	$14,307,061
KDH Research and Communication, Inc.	$9,991,693
Inhibikase Therapeutics	$8,287,499
Neurop, Inc.	$8,212,048
Axion Biosystems, LLC	$7,170,437
Expression Therapeutics	$7,108,044
IS3D, LLC	$3,884,253
Glycosensors And Diagnostics, LLC	$3,851,116
Geovax, Inc.	$3,458,389
Syntermed, Inc.	$3,440,740

Source: National Institutes of Health. Research Portfolio Online Reporting Tools (RePORT). Accessed November 2018 at https://report.nih.gov/award/index.cfm?ot=&fy=2017&state=GA&ic=&fm=&orgid=&distr=&rfa=&pid=#tab2

Figure A-7. Growth in NIH SBIR/STTR Grants to Organizations in Georgia, Compared with the Nation: 2010–2018 (2010=100)



Source: National Institutes of Health. Research Portfolio Online Reporting Tools (RePORT). Accessed November 2018 at https://report.nih.gov/award/index.cfm?ot=&fy=2017&state=GA&ic=&fm=&orgid=&distr=&rfa=&pid=#tab2

The patent totals by year assignees outlined in Table A-7 and Table A-8 come from the patent codes defined in Appendix A.4.

Table A-7. Number of Patents Granted by Category

Category	2010	2011	2012	2013	2014	2015	2016	2017	% Chg 10–17
Agricultural Bioscience	7	7	17	15	15	24	22	23	229%
Biochemistry	27	28	39	40	38	45	50	45	67%
Medical & Surgical Devices	85	134	138	150	200	201	223	227	167%
Microbiology & Genetics	36	40	37	47	54	49	54	58	61%
Bioinformatics & Health IT	4	10	5	6	3	0	3	4	0%
Drugs & Pharmaceuticals	24	26	33	56	75	64	57	56	133%
Biological Sampling & Analysis	15	17	14	16	25	13	18	24	60%
Total	**198**	**262**	**283**	**330**	**410**	**396**	**427**	**437**	**121%**

Source: U.S. Patent and Trademark Office PatentsView. Accessed December 2018 at http://www.patentsview.org/web/#viz/comparisons&cmp=all/state/numDesc/2018
Note: Category definitions found in Appendix A.

Table A-8. Top 5 Most Frequent Patent Assignees in Bioscience in Georgia, By Category: 2010–2017

Category	Assignee	Number of Patents Granted
Medical & Surgical Devices	1. AT&T Intellectual Property, L.P.	156
	2. NCR Corporation	152
	3. Avent, Inc.	75
	4. Amendia, Inc.	71
	5. Venetec International, Inc.	68
Drugs & Pharmaceuticals	1. Cormatrix Cardiovascular, Inc.	53
	2. Emory University	46
	3. Surfatech Corporation	38
	4. MiMedx Group, Inc.	37
	5. Vivex Biomedical, Inc.	15
Microbiology & Genetics	1. University of Georgia Research Foundation, Inc.	75
	2. Merial, Inc.	55
	3. Emory University	40
	4. Georgia Tech Research Corp.	29
	5. API Intellectual Property Holdings, LLC	24

(continued)

Table A-8. Top 5 Most Frequent Patent Assignees in Bioscience in Georgia, By Category: 2010–2017 (continued)

Category	Assignee	Number of Patents Granted
Biochemistry	1. Emory University	89
	2. University of Georgia Research Foundation, Inc.	35
	3. Merial, Inc.	30
	4. Morehouse School of Medicine	16
	5. Georgia Tech Research Corp.	15
Biological Sampling & Analysis	1. Siemens Industry, Inc.	28
	2. AT&T Intellectual Property, L.P.	26
	3. Emory University	8
	4. Morehouse School of Medicine	7
	5. Georgia Tech Research Corp.	6
Agricultural Bioscience	1. Merial, Inc.	42
	2. University of Georgia Research Foundation, Inc.	19
	3. Arch Chemicals, Inc.	6
	4. Osmose Utilities Services, Inc.	5
	5. Georgia-Pacific Chemicals LLC	4
Bioinformatics & Health IT	1. AT&T Intellectual Property, L.P.	7
	2. Carticept Medical, Inc.	7
	3. Health Discovery Corporation	6
	4. Greenway Medical Technologies, Inc.	3
	5. Matria Healthcare, Inc.	2

Source: U.S. Patent and Trademark Office PatentsView. Accessed December 2018 at http://www.patentsview.org/web/#viz/comparisons&cmp=all/state/numDesc/2018

A.4 Patent Code Definitions

Table A-9. Bioscience Related Patents by Category and Patent Class

Bioscience Patent Category	Patent Class
Agricultural Bioscience	A01H
	A01N
	C05B
	C05C
	C05D
	C05F
	C05G
Biochemistry	C07D
	C07H
	C07J
	C07K
Bioinformatics & Health IT	G06F 19/1, 19/2, 19/3
	G06Q 50/22, 50/24
Biological Sampling and Analysis	G01N 24, 25, 26, 28, 33
	G01R 33
Drugs and Pharmaceuticals	A61K
Medical and Surgical Devices	G06K 9
	G06T 7
	A61B
	A61C
	A61D
	A61F
	A61G
	A61H
	A61J
	A61L
	A61M
	A61N
Microbiology and Genetics	C12M
	C12N
	C12P
	C12Q

Source: U.S. Patent and Trademark Office PatentsView. Accessed December 2018 at http://www.patentsview.org/web/#viz/comparisons&cmp=all/state/numDesc/2018

A.5 Venture Capital Industry Categories

RTI searched Pitchbook in October of 2018 using the following categories for venture-backed companies:

- Ownership Status: Privately Held (backing)
- Backing Status: VC-backed
- Location: United States > Southeast > Georgia
- Search HQ only

Appendix B: Economic Contribution Analysis—Methodology

To assess the economic contributions of Georgia's life sciences sector, RTI assembled an inventory of private-sector establishment-level data on life sciences companies operating in Georgia. There are differences in data collection and reporting between this section and the life sciences sector industry analysis, as explained in the following section.

The approach used the inventory and accounted for multiplier effects of how money cycles through the economy, specifically through the supply chains for goods and services and how households spend their labor income.[3] In these estimates, we distinguish between the core life sciences and the noncore life sciences. Additionally, this model includes:

- Digital health companies: This sector is not readily defined by traditional industry metrics including NAICS.
- Centers for Disease Control and Prevention (CDC): The CDC headquarters in Atlanta is a substantial government presence in the life sciences sector.

B.1 Data Sources

The following data sources were included in the inventory:

- **BusinessWise data**: Contributed by Georgia Power, this data source is the most comprehensive and was aligned with our NAICS codes, although there was some translation from NAICS to Standard Industrial Classification (SIC), which is the system BusinessWise is based on. Virtually all required information was included in these data, but some companies, like agricultural suppliers, had to be reviewed carefully for "fit" with our definition of life sciences.
- **GaBio member list**: Administrative data on members maintained by GaBio. Includes all key variables for analysis, but employment data are ranges.
- **Shaping Infinity report data**: Data collected by the study team that conducted GaBio's last life sciences impact assessment. Data are limited to company name, city, and category.
- **Technology Association of Georgia (TAG) Online Map[4]**: RTI extracted information from TAG's online inventory of health IT companies using the structured map data from the HTML script. TAG online map data included addresses and websites but no information on employment and industry.
- **Metro Atlanta Chamber bioscience datasets**: The Metro Atlanta Chamber provided various datasets. The main data that were not covered elsewhere were a list of medical device companies located in Georgia that were identified through FDA databases for device clearance and approval as well as an FDA registration database.[5]

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[3] We used IMPLAN Version 3.0 software for the input-output portion of the analysis.
[4] https://www.tagonline.org/wheregeorgialeads/#health-it
[5] http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfRL/rl.cfm

- **Georgia Research Alliance bioscience data**: The Georgia Research Alliance provided a list of active bioscience startup companies.
- **Georgia Universities**: Self-reported data on faculty, staff, and graduate students from Georgia universities engaged in funded life sciences research: Augusta University, Emory University, Kennesaw State University, Georgia State University, University of Georgia[6]

The backbone of our life sciences company inventory is the BusinessWise data, which is the most robust and complete of all the data sources.[7] The goal of combining these data sources was to create a comprehensive inventory of life sciences companies with employment estimates and industry classifications at each individual business location. The establishments included in each data source were initially appended into a single inventory with 2,769 total records.[8]

B.1.1 Differences with BLS QCEW Data

The Bureau of Labor Statistics (BLS) compiles county-, state-, and national-level establishment and employment data through the Quarterly Census of Employment and Wages (QCEW) as part of the unemployment insurance system. The BLS reports industry totals through NAICS, accounting for all nonfarm establishments, broken down by geography, industry classification, and ownership structure. QCEW is a national census of companies and is valuable for tracking industry activity over time and as a comparison to other states and regions. Our data inventory for the creation of the model involved a bottom-up approach, leveraging company lists from statewide providers and is a single-year snapshot of a narrower subset of private-sector establishments, as well as government employment through CDC. Key differences include the following:

- QCEW accounts for all establishments within each NAICS category, some of which are on the periphery of life sciences. The IMPLAN data model did not include the peripheral establishments.
- Our analysis of QCEW only included private-sector establishments and did not include university or government employment. The IMPLAN data include government employment through CDC.

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[6] McKinney, C., Augusta University. Email correspondence January 14, 2019 on number of faculty, staff, and students conducting grant-funded research in life sciences.
Cassidy, M., Emory Biomedical Catalyst, Emory University. Email correspondence January 8, 2019 on number of faculty, staff, and students conducting grant-funded research in life sciences.
Weyhenmeyer, J., Georgia State University. Email correspondence January 17, 2019 on number of faculty, staff, and research scientists conducting grant-funded research in life sciences.
Anderson, M., Kennesaw State University. Email correspondence January 17, 2019 on number of faculty, staff, and graduate students conducting grant-funded research in life sciences.
Klute, P., University of Georgia. Email correspondence February 15, 2019 on number of faculty, staff, and graduate students conducting grant-funded research in life sciences.

[7] We opted to use BusinessWise rather than other data sources like Hoovers because BusinessWise was recommended by partners in the state who have studies the life science industry in the past as much more reliable.

- The QCEW identified over 3,000 establishments in life sciences NAICS codes in Georgia, while the bottom-up approach identified 2,769, which was fewer than 2,000 once duplicates were removed.
- Our analysis of BusinessWise and private-sector data sources included employment at CDC and digital health firms, which were not captured by QCEW data.

Each dataset serves a different purpose and should not be interpreted as a side-by-side comparison.

B.2 Inventory Assembly

After combining data from the various sources, we had initially 2,769 records (see Table B-1). As expected, we quickly found that a significant number of establishments appeared in more than one of the data sources. Therefore, data needed to be de-duplicated so that companies listed multiple times at the same location were consolidated into a single, comprehensive record.

Table B-1. Number of Establishments in Original Dataset

Original Dataset	Number of Records
BusinessWise data (from Georgia Power)	1,313
GaBio member List	80
Shaping Infinity	424
Technology Association of Georgia Online Map	207
Georgia Alliance Inventory	445
Metro Atlanta Chamber Inventory	209
Georgia Research Alliance	91
Georgia Universities	5
Total	**2,774**

The combined inventory contained duplicate records for some establishments. The challenge of combining data sources is that we had to de-duplicate a large number of establishments that appeared in more than one dataset. We consolidated these duplicate records into a single, comprehensive record for each company using what we thought was the best representation of employment and industry classification for each record. To do this, RTI manually reviewed the combined inventory using the following multistep approach:

- Manually reviewed company names and addresses to identify duplicate records.
- Standardized company names and addresses and matched records across data sources with the exact same company name and address.

- Merged records for the same establishment into a single record, prioritizing data from datasets in the order listed in Table B-1.

B.3 Filling in Missing Data

After leveraging data from multiple sources as we assembled the inventory, some establishments were missing data for address, employment, and/or industry classification. To address data gaps, RTI and Georgia Bio searched for the employment and industry classification information in multiple additional data sources. Three data sources were used to address data gaps in the inventory:

- **Georgia Department of Labor, Labor Market Explorer:** The Labor Market Explorer includes data on address, employment, and industry classification for all establishments operating in Georgia. The Labor Market Explorer was the primary source of data for employment information[9] and industry classification data.
- **LinkedIn company pages**: LinkedIn has some estimates of employment for establishments whose employees have accounts on LinkedIn. LinkedIn was used only for single-establishment companies when other sources were not available.
- **Company websites**. Company websites, if available, were the primary source of address data. If the company website did not list address information, we used the Labor Market Explorer. Company websites were also helpful to determine industry classification when this information was either not available in Georgia Department of Labor data or when there was an obvious error. We reviewed websites in these cases to make an assessment of the company's primary line business and then assigned a NAICS code.

Table B-2 shows the number of establishments with each type of missing data prior to RTI and Georgia Bio reviewing the Labor Market Explorer, LinkedIn, and company websites and the number of establishments still with missing data after RTI's and Georgia Bio's review.

Although address information was available from a variety of sources for some companies, these sources were often contradictory, and the correct address could not be definitively identified. As a result, RTI was only able to find verified addresses for a small number of the establishments that were missing address data.

Table B-3. Number of Establishments with Missing Data

Type of Missing Data	Percentage of Establishments with Missing Data Before Review	Percentage of Establishments with Missing Data After Review
Address	26.7%	26.6%
Employment	37.8%	32.4%
Industry classification	40.6%	0.02%

[9] The employment data for companies in the Labor Market Explorer were typically presented as a range. RTI used the midpoint of the range to represent employment.

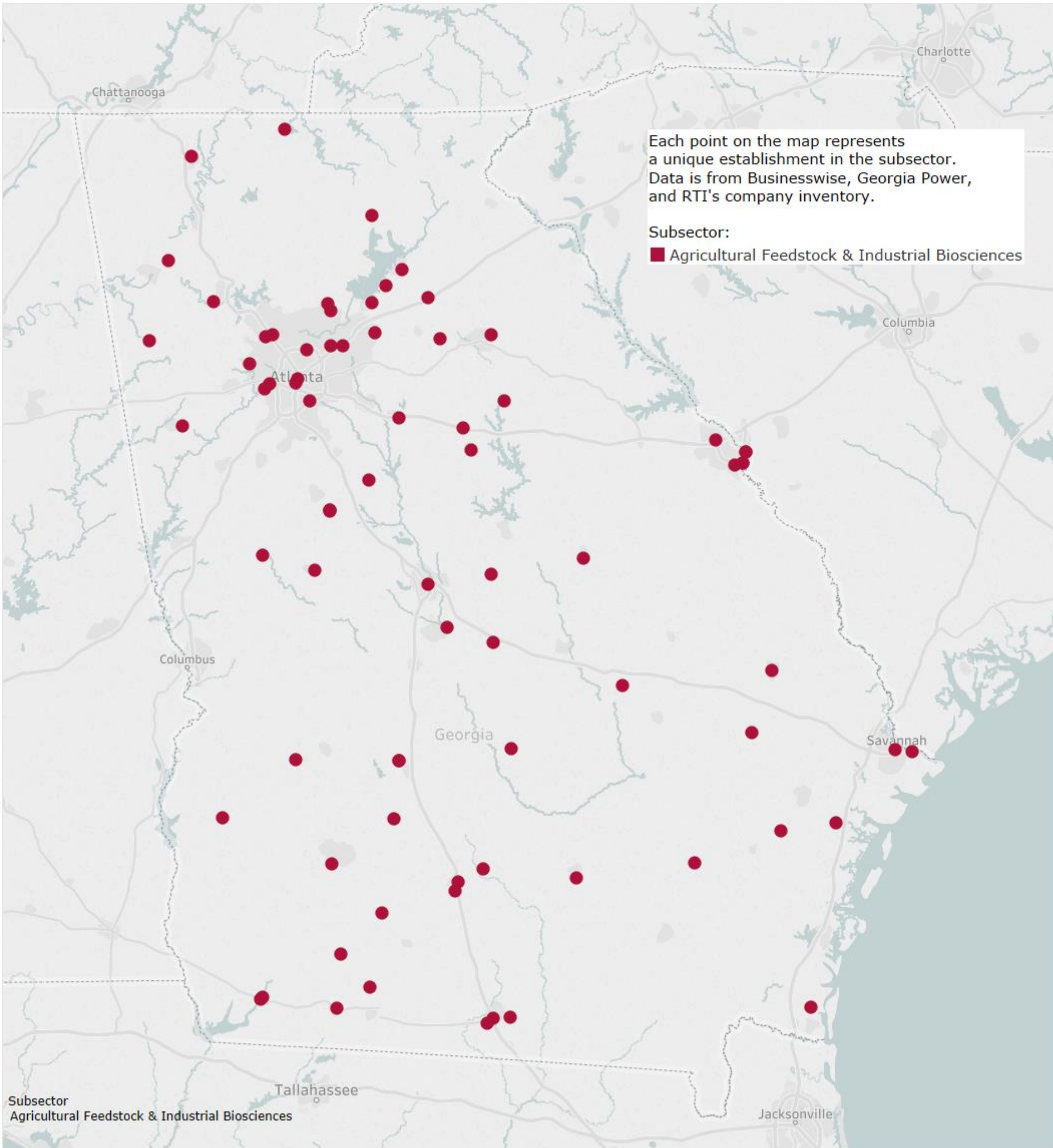
B.4 Geographic Scope of the Life Sciences Sector: Private Sector Companies

Companies working in life sciences are spread throughout the state of Georgia. Figures B-1 through B-6 outline the geographic scope of six of the subsectors within life sciences in Georgia: Biopharmaceuticals and digital health establishments tend to be concentrated around Atlanta with some presence in other areas of the state. In contrast, medical device establishments and research, testing, and medical laboratory establishments are distributed more broadly across Georgia. Bioscience distribution has a presence across the state with a concentration in Atlanta, but and agricultural feedstock and industrial bioscience establishments are more widely distributed throughout the state, reflecting the scope of the market for agricultural and bioscience products. The maps include the following:

- Figure B-1. Agricultural Feedstock and Industrial Biosciences
- Figure B-2. Biopharmaceuticals
- Figure B-3. Digital Health and Informatics
- Figure B-4. Bioscience Distribution
- Figure B-5. Medical Device
- Figure B-6. Research, Testing, and Medical Laboratories

Note that the maps track only private sector establishments, and do not include educational or government locations including Georgia's universities and Centers for Disease Control and Prevention in Atlanta.

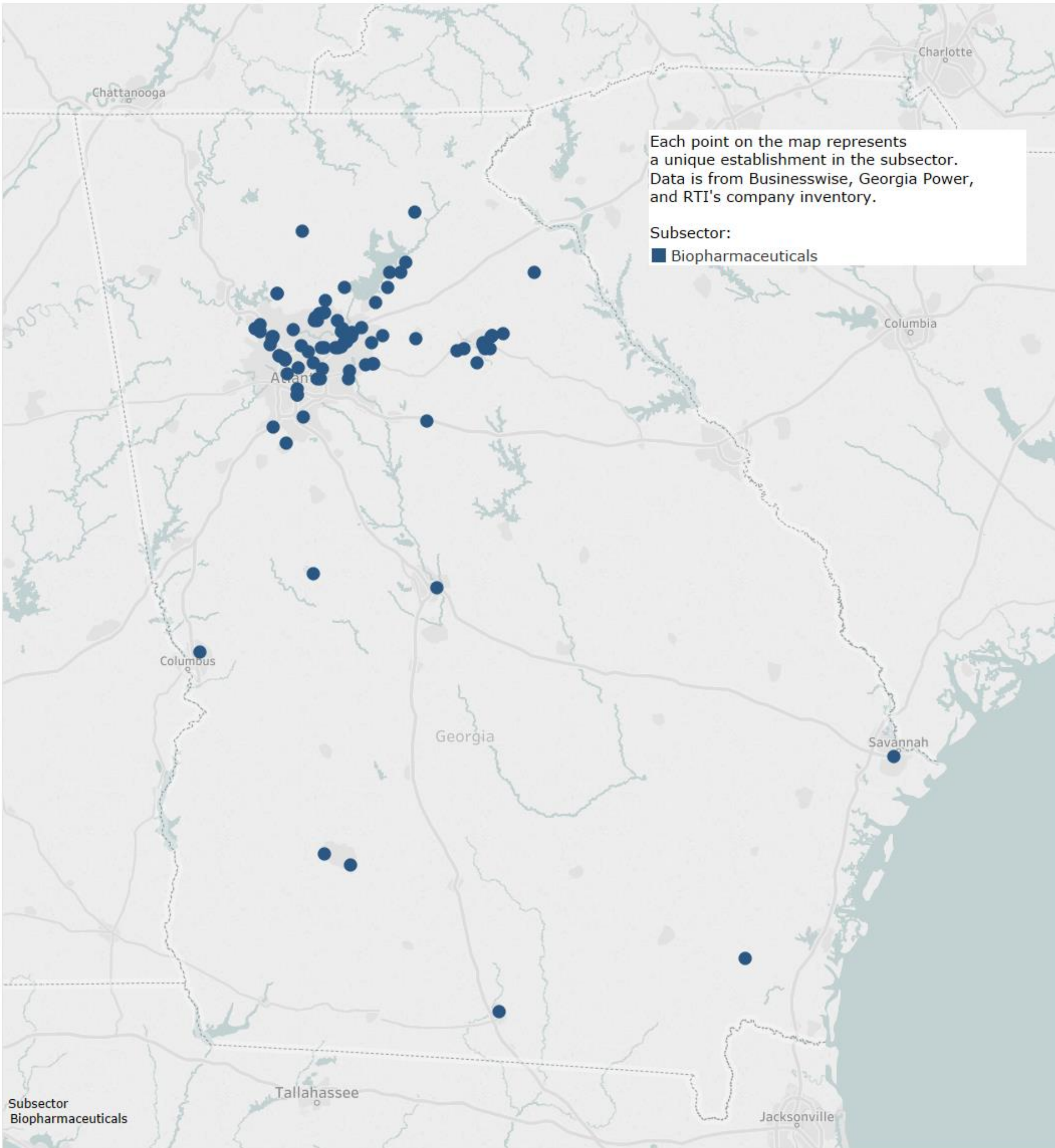
Figure B-1. Agricultural Feedstock and Industrial Biosciences



Sources: BusinessWise data (provided by GA Bio), GaBio member list, Shaping Infinity Report, TAG Online Map, Metro Atlanta Chamber Bioscience datasets, Georgia Research Alliance Bioscience data. See Appendix B, Section B.1 for detailed description of each data source.

Note: 40 establishments are not represented in the maps because of missing location information.

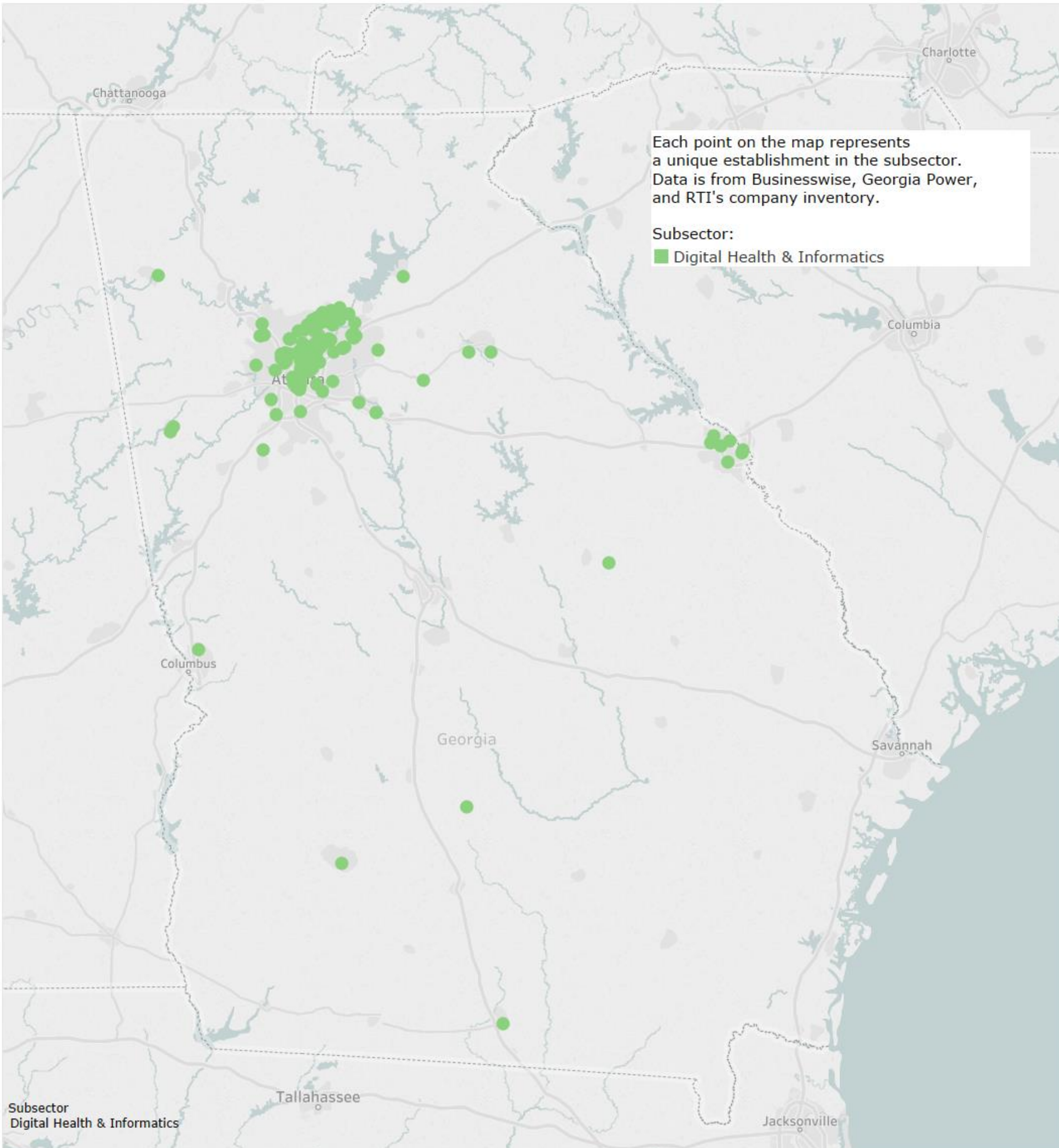
Figure B-2. Biopharmaceuticals



Sources: BusinessWise data (provided by GA Bio), GaBio member list, Shaping Infinity Report, TAG Online Map, Metro Atlanta Chamber Bioscience datasets, Georgia Research Alliance Bioscience data. See Appendix B, Section B.1 for detailed description of each data source.

Note: 40 establishments are not represented in the maps because of missing location information.

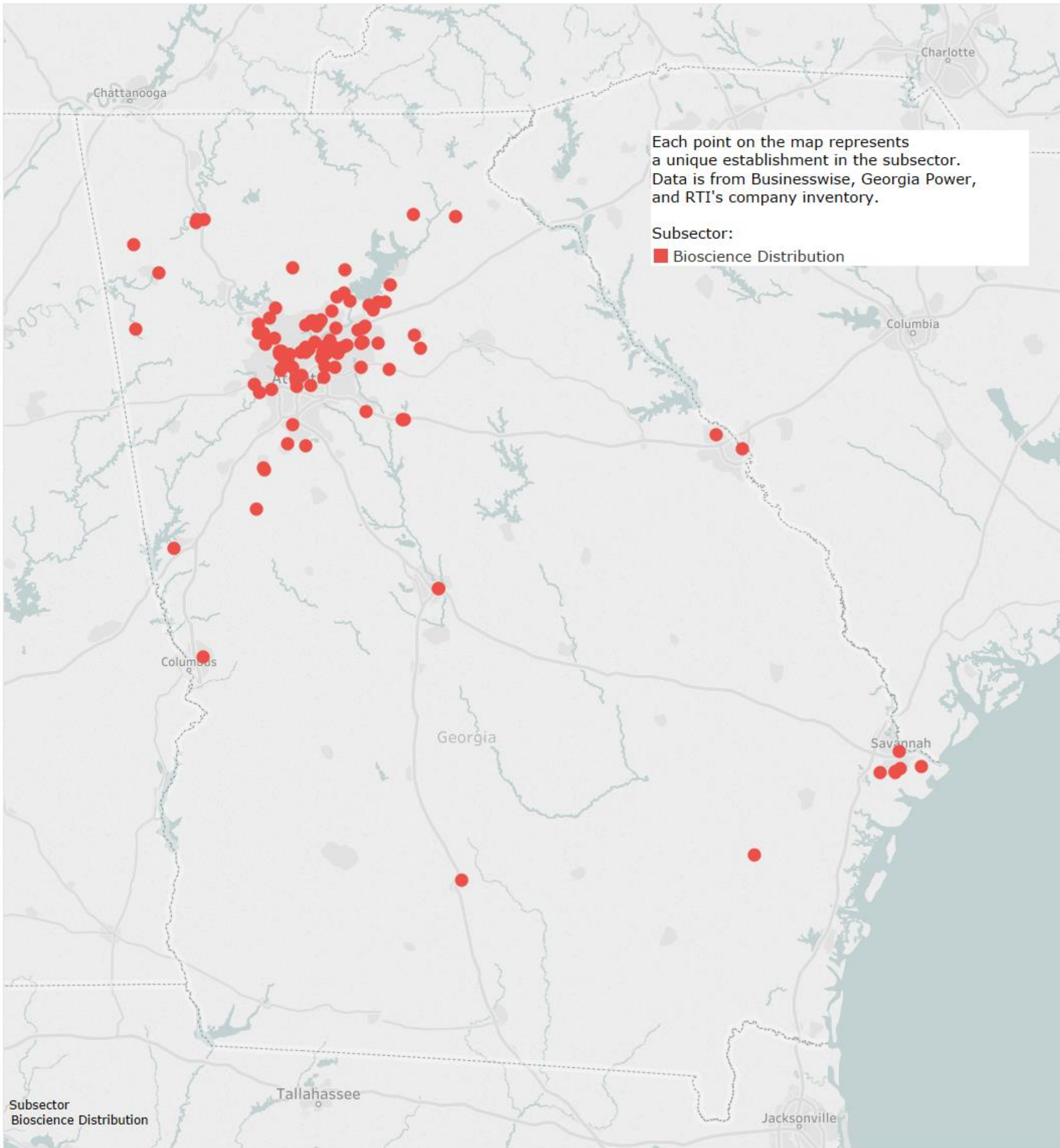
Figure B-3. Digital Health and Informatics



Sources: BusinessWise data (provided by GA Bio), GaBio member list, Shaping Infinity Report, TAG Online Map, Metro Atlanta Chamber Bioscience datasets, Georgia Research Alliance Bioscience data. See Appendix B, Section B.1 for detailed description of each data source.

Note: 40 establishments are not represented in the maps because of missing location information.

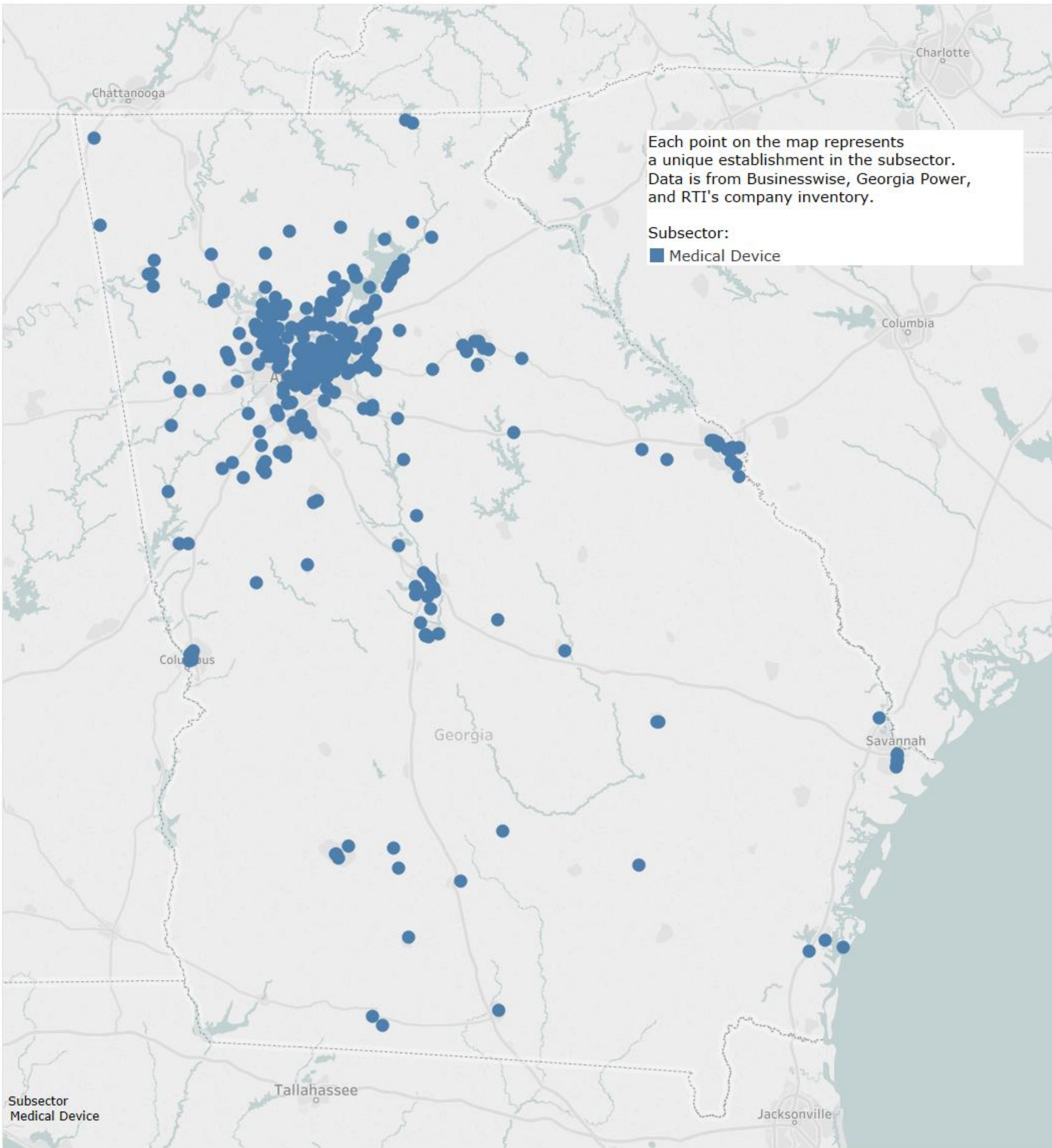
Figure B-4. Bioscience Distribution



Sources: BusinessWise data (provided by GA Bio), GaBio member list, Shaping Infinity Report, TAG Online Map, Metro Atlanta Chamber Bioscience datasets, Georgia Research Alliance Bioscience data. See Appendix B, Section B.1 for detailed description of each data source.

Note: 40 establishments are not represented in the maps because of missing location information.

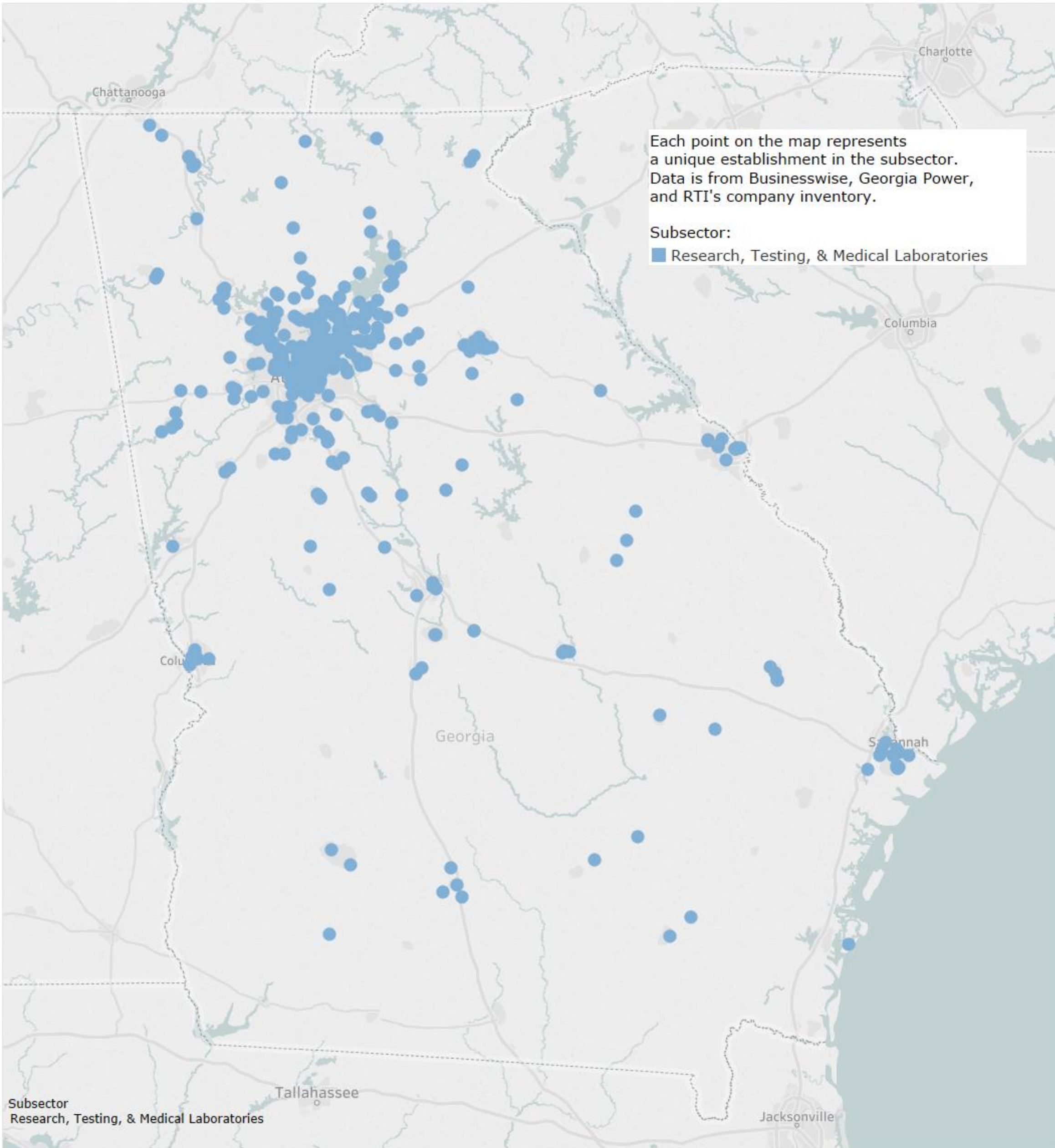
Figure B-5. Medical Device



Sources: BusinessWise data (provided by GA Bio), GaBio member list, Shaping Infinity Report, TAG Online Map, Metro Atlanta Chamber Bioscience datasets, Georgia Research Alliance Bioscience data. See Appendix B, Section B.1 for detailed description of each data source.

Note: 40 establishments are not represented in the maps because of missing location information.

Figure B-6. Research, Testing, and Medical Laboratories



Sources: BusinessWise data (provided by GA Bio), GaBio member list, Shaping Infinity Report, TAG Online Map, Metro Atlanta Chamber Bioscience datasets, Georgia Research Alliance Bioscience data. See Appendix B, Section B.1 for detailed description of each data source.

Note: 40 establishments are not represented in the maps because of missing location information.

B.5 Excluding Nonlife Science Establishments

The vast majority of establishments in the combined inventory had either an SIC code or a NAICS code. For consistency, all SIC codes were converted to NAICS codes using the NAICS to SIC Crosswalk (NAICS, 2018). NAICS codes were then manually reviewed and placed into one of three groups: NAICS codes that should be kept in the economic contribution analysis, NAICS codes that should be kept in the inventory but not included in the economic contribution analysis, and NAICS codes that should not be included in either the inventory or the economic contribution analysis. Table B-4 shows the NAICS codes included in each category and subcategory. With the exception of digital health, all establishments were assigned to subcategories based on their NAICS codes. Establishments were assigned to digital health based on the data source from which they originated and a review of the company website and product/service offerings.

Table B-4. Category and Subcategory NAICS Codes

Category	NAICS Codes of the Companies in the Inventory	Number of Estabs.	Total Employment
Core		**1,683**	**42,600**
Biopharmaceuticals	325411, 325412, 325413, 325414	245	8,400
Medical Devices	313210, 326130, 326199, 333314, 334510, 334516, 334517, 339112, 339113, 339114, 339115, 339116, 423440, 423490, 541330	552	7,900
Research Testing, & Medical Laboratories	333318, 541380, 541713, 541714, 541715, 541720, 621511, 621512, 621991, 813319	678	10,800
Digital Health & Informatics	238990, 325412, 334310, 334510, 334511, 334517, 339112, 339113, 423430, 423450, 423990, 424210, 425120, 443142, 454110, 511210, 518210, 519190, 524292, 541219, 541380, 541511, 541512, 541519, 541612, 541614, 541618, 541690, 541714, 541990, 551112, 561110, 561410, 561499, 561621, 561990, 621493, 621999, 624190, 813410	208	15,400
Non-core		**245**	**8,200**
Bioscience Distribution	325613, 325992, 423450, 424210	95	4,300
Agricultural Feedstock & Industrial Biosciences	113310, 311119, 311224, 311225, 324110, 325193, 325199, 325311, 325312, 325314, 325320, 325998, 424690, 454310	150	3,900

B.6 Input-Output Modeling Methodology

To estimate these broader economic contributions to the state of Georgia, RTI used an input-output analysis framework.[10] Input-output analysis treats data on an industry, set of

[10] IMPLAN software version 3.0, Georgia 2016 model.

industries, or external economic shock as an "input." A model that represents economic linkages in a specific region takes the "inputs" and converts them into "outputs" that show how "inputs" cycle through an economy to produce wider effects on macroeconomic indicators such as GDP, employment, and labor income. The model then returns three types of contributions: direct contributions, which are the life sciences sector's direct contribution to the economy; indirect contributions, which represent the effects of spending by suppliers of the life sciences industry; and induced contributions, which represent the effect of spending by employees in the life sciences industry.

B.6.1 Economic Contribution Key Concepts

Several key terms are relevant for understanding the contribution results:

- *GDP*: GDP is the value of all economic activity occurring within a given area.
- *Employment*: Employment represents the number of jobs generated by the economic activities of the life sciences industry.
- *Labor income*: Labor income is equivalent to payroll. In this analysis, it represents the effect of the life sciences industry's economic activities on the wages, salaries, and benefits of Georgia's workers.
- *Direct contribution*: The direct contribution represents the direct effect the life sciences sector on Georgia's economy.
- *Indirect contribution*: The indirect contribution includes the jobs created at and the purchases made by supply chain industries supporting the life sciences sector in Georgia.
- *Induced contribution*: The induced contribution represents the activities of employees of the life sciences sector and the employees in the supply chain.
- *Total contribution*: The sum of the direct, indirect, and induced contributions.
- *Multipliers*: Multipliers represent the degree to which the life sciences sector's direct contributions cycle through the state economy as a result of economic linkages. Multipliers in this study are calculated as the sum of indirect and induced contributions divided by direct contributions.

The 1,927 establishments included in the analysis were separated into the subcategories described in Table B-4. Each company was then assigned to a specific economic sector in IMPLAN. RTI used a crosswalk of IMPLAN sectors and NAICS codes to match the NAICS code of each company to its appropriate IMPLAN sector (IMPLAN, 2017).[11] RTI also included 9,000 employees at the CDC headquarters in Atlanta. These 9,000 employees were mapped to IMPLAN Sector 520, Other Federal Government Enterprises.

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[11] The one exception is two establishments that fall under NAICS code 325312. These establishments would normally be considered a part of IMPLAN Sector 170, Phosphatic Fertilizer Manufacturing; however, IMPLAN's model of Georgia does not include any establishments within this industry. To account for this, RTI mapped these two establishments to IMPLAN Sector 169, Nitrogenous Fertilizer Manufacturing, which we assumed would have a similar spending pattern to Sector 170.

RTI then created "inputs" with total employment in each IMPLAN sector for each subcategory. Table B-5 describes the inputs we used for the core life sciences, and Table B-6 describes the inputs we used for the noncore life sciences. These inputs were imported in an IMPLAN model of Georgia's economy to estimate economic contribution results. RTI relied on default model assumptions for this analysis.

Table B-5. IMPLAN Inputs for Core Life Sciences

Subcategory	IMPLAN Sector	Employment
Biopharmaceuticals	173	96
	174	6,835
	175	425
	176	1,059
Medical Device	113	580
	191	10
	195	50
	272	525
	314	1,176
	320	336
	321	74
	379	959
	380	2,470
	381	130
	382	302
	383	1,254
	395	45
	449	2
Research, Testing, & Medical Laboratories	274	13
	449	1,730
	456	3,592
	479	4,759
	481	721

(continued)

Table B-5. IMPLAN Inputs for Core Life Sciences (continued)

Subcategory	IMPLAN Sector	Employment
Digital Health & Informatics	307	75
	315	3
	379	75
	395	534
	398	24
	407	236
	422	1,590
	430	163
	431	44
	438	15
	448	189
	449	2
	451	4,058
	452	3,185
	453	37
	454	454
	461	7
	462	3,000
	465	189
	467	750
	470	10
	478	3
	481	604
	485	175
	516	7

Table B-6. IMPLAN Inputs for Noncore Life Sciences

Subcategory	IMPLAN Sector	Employment
Bioscience Distribution	181	55
	186	12
	395	3,822
Agricultural Feedstock & Industrial Biosciences	66	54
	71	16

(continued)

Table B-6. IMPLAN Inputs for Noncore Life Sciences (continued)

Subcategory	IMPLAN Sector	Employment
	72	290
	156	3
	165	1,862
	169	227
	171	392
	172	724
	187	696
	395	17
	407	23
CDC	520	9,000
Universities	473	8,573

B.7 Detailed Contribution Results

Table B-7 shows the direct, indirect, induced, and total employment, labor income, and GDP contributions by establishments in each category.

Table B-7. Economic Contribution of All Life Sciences Industry Establishments

Category	Type of Contribution	Employment	Labor Income	GDP
Core	Direct	42,600	$3.74 B	$7.41 B
	Indirect	38,100	$2.70 B	$4.07 B
	Induced	41,300	$1.89 B	$3.36 B
	Total	122,000	$8.33 B	$14.84 B
Noncore	Direct	8,200	$0.71 B	$1.55 B
	Indirect	13,000	$0.85 B	$1.39 B
	Induced	10,000	$0.46 B	$0.81 B
	Total	31,200	$2.01 B	$3.75 B
CDC	Direct	9,000	$0.52 B	$0.56 B
	Indirect	10,700	$0.74 B	$1.03 B
	Induced	8,100	$0.37 B	$0.66 B
	Total	27,800	$1.63 B	$2.26 B
Universities	Direct	8,600	$0.43B	$0.53B
	Indirect	1,700	$0.07B	$0.07B
	Induced	3,200	$0.26B	$0.15B
	Total	13,500	$0.95B	$0.95B

(continued)

Table B-7. Economic Contribution of All Life Sciences Industry Establishments (continued)

Category	Type of Contribution	Employment	Labor Income	GDP
Total	Direct	68,300	$5.40B	$10.04B
	Indirect	63,500	$4.35B	$6.66B
	Induced	62,600	$2.87B	$5.09B
	Total	194,400	$12.62B	$21.80B

The life sciences industry directly contributes 68,300 jobs and $10 billion to Georgia's GDP. These contributions represent 1.2% of all nonfarm employment in Georgia between October 2017 and October 2018 and 1.7% of Georgia's 2016 GDP (adjusted to 2018 dollars).

Accounting for multiplier effects, the life sciences industry supports a total of approximately 194,400 jobs and contributes $20.8 billion in GDP to Georgia's economy. This represents 3.7% of Georgia's 2016 GDP of $562.9 billion in 2018 dollars (U.S. Bureau of Economic Analysis [BEA], 2018). Similarly, the life sciences industry's total employment contribution of roughly 194,400 jobs represents 3.7% of Georgia's total nonfarm employment from October 2017 to October 2018 (BLS, 2018).

Core life sciences contribute a total of 122,000 jobs and $8.3 billion in GDP to Georgia's economy. This represents about two-thirds of the total contribution of the life sciences sector. Noncore life sciences support a total of 31,200 jobs and contribute $3.8 billion to GDP. CDC supports a total of 27,800 jobs and contributes $2.3 billion to GDP. Universities support a total of 13,500 jobs and $9.5 billion to GDP.

B.8 Multiplier Effects

The multiplier effects for the core establishments, noncore establishments, and CDC are shown in Table B-8. The multiplier effects represent the indirect and induced contributions for every 1 unit of direct contribution. Biopharmaceutical establishments have the highest jobs multiplier at 4.8. This multiplier means that each job in the noncore life sciences supports 4.8 jobs elsewhere in the economy. This high multiplier is likely due to the high paying jobs in this industry and the existing linkages in the state.

CDC has the highest GDP multiplier at 3.0. This means that for every $1.00 of GDP directly supported by CDC's economic activities in Georgia, $3.00 are supported elsewhere in Georgia's economy.

Table B-8. Multiplier Effects

Category	Jobs Multiplier	GDP Multiplier
Core	1.86	1.00
Biopharmaceuticals	4.75	0.95
Medical Devices	1.44	1.03
Research Testing, & Medical Laboratories	0.98	1.36
Digital Health & Informatics	1.14	0.97
Noncore	2.80	1.42
Agricultural Feedstock & Industrial Biosciences	4.05	1.99
Bioscience Distribution	1.44	0.71
CDC	2.09	3.01
Universities	0.57	0.86

B.9 Input-Output Modeling References

North American Industrial Classification System. (2018) *NAICS to SIC Crosswalk*. Retrieved from https://www.naics.com/naics-to-sic-crosswalk-search-results

Taylor, M. A. (2017, Jan 26) *NAICS (2017) to IMPLAN 536 Bridge*. Retrieved from http://oldsupport.implan.com/index.php?view=document&alias=92-naics-2017-to-implan-536-bridge&category_slug=536&layout=default&option=com_docman&Itemid=1764

U.S. Bureau of Economic Analysis. (2018). *Total Gross Domestic Product for Georgia [GANGSP].* Retrieved from https://fred.stlouisfed.org/series/GANGSP

U.S. Bureau of Labor Statistics. (2018). *Economic News Release: Table 1. Civilian labor force and unemployment by state and selected area, seasonally adjusted*. Retrieved from https://www.bls.gov/news.release/laus.t01.ht

Appendix C:
University Economic Contribution Analysis—Methodology

The university economic contribution analysis largely follows the same methodology as the larger economic contribution analysis. Data were collected by asking Georgia universities how many faculty, students, and staff they employed in life sciences research[12]. Administrative staff who support life sciences research but are not directly funded by grants were not included in employment headcounts. The universities surveyed and the employment headcounts they reported are listed in Table C-1.

Table C-1. University Life Sciences Employees

Faculty	
Augusta University	509
Emory University	1,342
Georgia State University	325
Kennesaw State University	39
University of Georgia	271
Subtotal	2,486
Staff	
Augusta University	465
Emory University	1,972
Georgia State University	Not given
Kennesaw State University	1
University of Georgia	778
Subtotal	3,216

(continued)

[12] McKinney, C., Augusta University. Email correspondence January 14, 2019 on number of faculty, staff, and students conducting grant-funded research in life sciences.
Cassidy, M., Emory Biomedical Catalyst, Emory University. Email correspondence January 8, 2019 on number of faculty, staff, and students conducting grant-funded research in life sciences.
Weyhenmeyer, J., Georgia State University. Email correspondence January 17, 2019 on number of faculty, staff, and research scientists conducting grant-funded research in life sciences.
Anderson, M., Kennesaw State University. Email correspondence January 17, 2019 on number of faculty, staff, and graduate students conducting grant-funded research in life sciences.
Klute, P., University of Georgia. Email correspondence February 15, 2019 on number of faculty, staff, and graduate students conducting grant-funded research in life sciences.

Table C-1. University Life Sciences Employees (continued)

Students	
Augusta University	197
Emory University	1,164
Georgia State University	Not given
Kennesaw State University	32
University of Georgia	1,478
Subtotal	2,871
Total	
Augusta University	1,171
Emory University	4,478
Georgia State University	325
Kennesaw State University	72
University of Georgia	2,527
Grand Total	**8,573**

The employment totals listed in Table C-1 were used to create inputs to an IMPLAN model of Georgia's economy. The employment totals for each school were assigned to IMPLAN sector 473: junior colleges, colleges, universities, and professional schools.

The results of our analysis in IMPLAN are shown in Table C-2.

Table C-2. University Life Science Contributions

Contribution Type	Employment Contribution	Labor Income (Payroll) Contribution	Total Value Added (GDP Contribution)
Direct contribution	8,600.0	$428 M	$525 M
Indirect contribution	1,700.0	$73 M	$164 M
Induced contribution	3,200.0	$148 M	$262 M
Total effect	13,500.0	$648 M	$951 M

As with the private sector and CDC contributions, the economic contributions of university employees can be described in terms of multiplier effects (the ratio of direct contributions to indirect and induced contributions). Table C-3 shows the multiplier effects of university life sciences contributions.

Table C-3. University Contribution Multiplier Effects

University Multiplier Effects	Multiplier
Jobs	0.57
GDP	0.86

Appendix D: References

Public Datasets and References

Bureau of Labor Statistics: Quarterly Census of Employment and Wages. Accessed November 2018 at https://www.bls.gov/cew/

National Institutes of Health, U.S. National Library of Medicine. Accessed November 2018 at https://clinicaltrials.gov/

National Institutes of Health. Research Portfolio Online Reporting Tools (RePORT). Accessed November 2018 at https://report.nih.gov/award/index.cfm?ot=&fy=2017&state=GA&ic=&fm=&orgid=&distr=&rfa=&pid=#tab2

National Science Foundation. Higher Education R&D Expenditures, by State. FY 2017. Accessed November 2018 at https://ncsesdata.nsf.gov/herd/2017/html/herd2017_dst_70.html

Technology Association of Georgia https://www.tagonline.org/wheregeorgialeads/#health-it

U.S. Patent and Trademark Office: PatentsView. Accessed December 2018 at http://www.patentsview.org/web/#viz/comparisons&cmp=all/state/numDesc/2018

University of Georgia, University of Georgia Terry College of Business, Georgia Bio: Shaping Infinity: The Georgia Life Sciences Industry Analysis 2012. Accessed at https://www.gabio.org/assets/docs/Shaping_Infinity_2012.pdf

Proprietary Datasets

Active Venture Capital Deals of Companies Headquartered in Georgia. Pitchbook. Data provided November 2018

Bioscience Company Directory. BusinessWise, provided by Georgia Power. Data provided August 2018.

Bioscience Membership List. Metro Atlanta Chamber. Data provided August 2018

Georgia Bio Membership List. Data provided October 2018

Georgia Research Alliance Membership list. Data provided November 2018.

IMPLAN Version 3.0. Georgia Model Year 2016.

Individual Contacts

Anderson, Mark; Kennesaw State University. Email correspondence January 17, 2019 on number of faculty, staff, and graduate students conducting grant-funded research in life sciences.

Cassidy, Mike; Emory Biomedical Catalyst, Emory University. Email correspondence January 8, 2019 on number of faculty, staff, and students conducting grant-funded research in life sciences.

Holloway, R., Centers for Disease Control and Prevention. Email correspondence November 27, 2018 on full-time staff employed at CDC in Atlanta.

Klute, Paul; University of Georgia. Email correspondence February 15, 2019 on number of faculty, staff, and graduate students conducting grant-funded research in life sciences.

McKinney, Christopher; Augusta University. Email correspondence January 14, 2019 on number of faculty, staff, and students conducting grant-funded research in life sciences.

Weyhenmeyer, James; Georgia State University. Email correspondence January 17, 2019 on number of faculty, staff, and research scientists conducting grant-funded research in life sciences.