



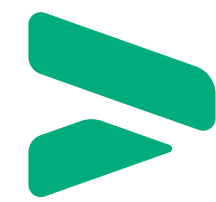
Health & Life Sciences Regional Industry

Advisory Meeting

Biotechnology Careers



December 2nd, 2022



Housekeeping



Enable your video camera (optional)



Please stay on  unless you are called on to ask a question



Submit all questions and commentary using the chat function



This meeting will be recorded and will be provided as part of the post-meeting materials



Please take time after the meeting to complete the post-event survey

Welcome & Introduction

Yzabelle Dela Cruz, Valley Vision
Project Manager, Workforce Development



Agenda

10:00 AM: Welcome and Introduction

10:10 AM: Labor Market & Trend Analysis

10:40 AM: Industry Panel Discussion

11:30 AM: Education & Training Programs

11:55 AM: Conclusion

Thank you

to all of our supporters



Labor Market & Trend Analysis

Aaron Wilcher, Research Manager
North/Far North Center of Excellence
Los Rios Community College District



***Regional Industry advisory
Biotech and Life Sciences
Greater Sacramento region
Fall 2022***



www.coeccc.net

Aaron Wilcher, Director
COE, Greater Sacramento (North)
Biotech, Life Sciences panel December 2, 2022

About the Centers of Excellence (COE)

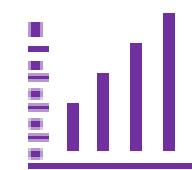
California Community Colleges need to ensure that CTE curriculum produces workers with the skills relevant to the regional and statewide economies.

The COE provide **quality labor market data and information** to help colleges respond to workforce needs.

Uses of the data:



Investing in new and relevant programs



Assessing labor market needs



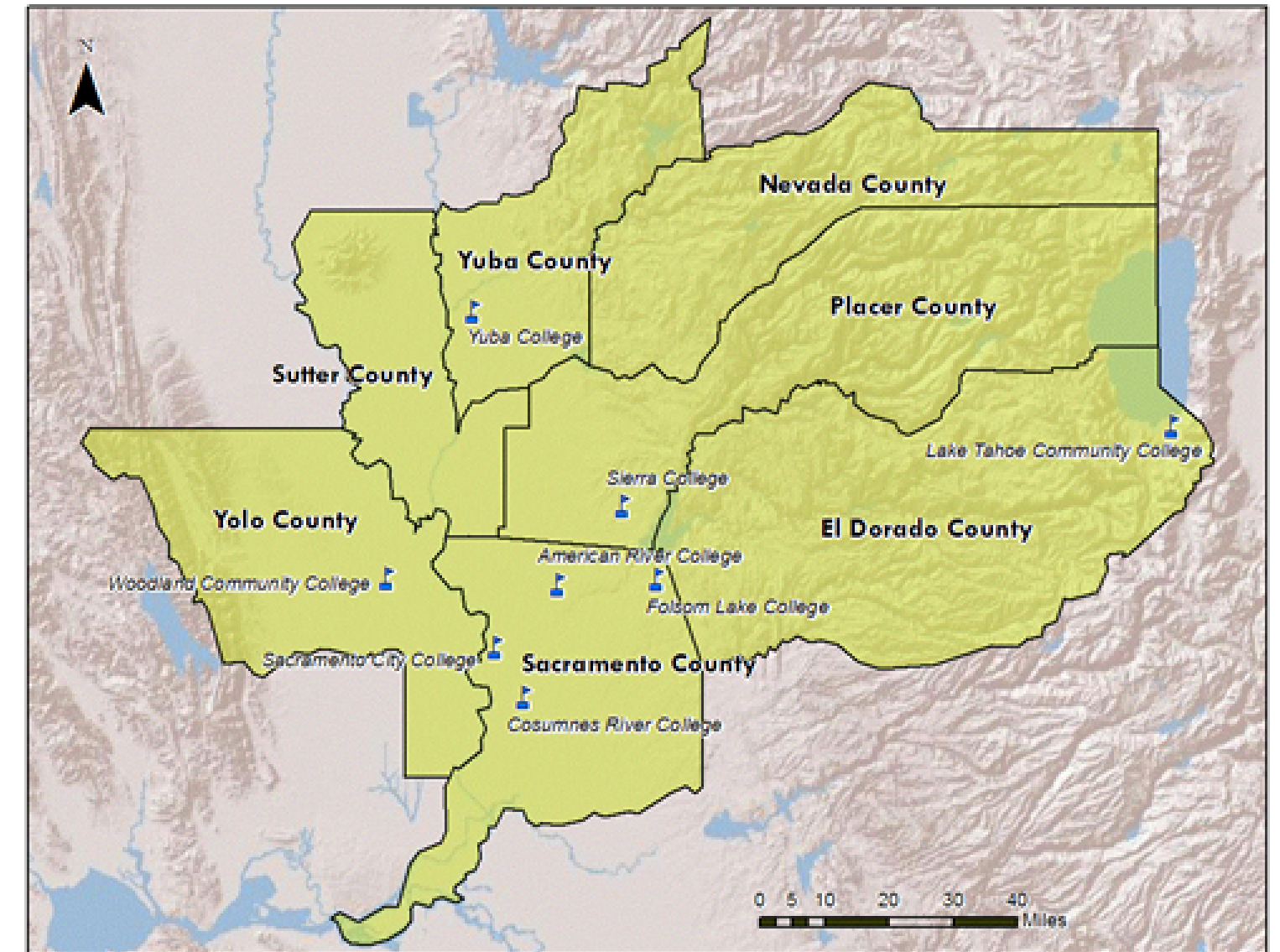
Reviewing existing programs



Pursuing grants

COE Presentation Overview

- Industry analysis
- Occupations “Skilled Technical Workforce”
- Industry sector findings
- Jobs postings analysis
- Education and training programs
- Key takeaways



COE Presentation Overview

- COE- history of reporting for biotech sector- CCSF & NSF connections
- Industry and Occupation definitions
- Program inventory
- 2021 Statewide report

Read the report:

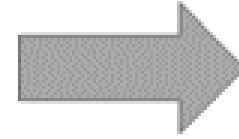
<https://coeccc.net/california/2022/10/biotechnology-5/>



Biotechnology and life sciences **industry analysis**

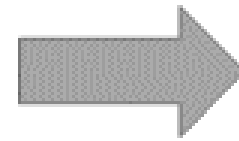
Biotech & Life Sciences Subsectors

❖ Agricultural feedstock and industrial biosciences



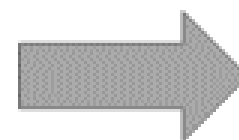
Ag production and processing, chemical/ fertilizer manufacturing, ethanol and biofuels

❖ Bioscience-related distribution



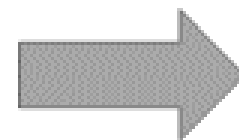
Delivery of bioscience products across segments

❖ Drugs and pharmaceuticals



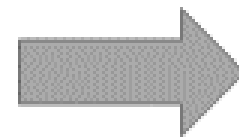
Biological and medicinal products- manufacturing pharmaceuticals and diagnostics

❖ Medical devices and equipment



Manufacture surgical and medical instruments, and supplies, lab equipment, MRI and ultrasound equipment, dental equipment

❖ Research, testing, and medical laboratories



R&D in biosciences, testing and medical laboratories, contract and clinical R&D organizations

Industry overview- jobs, LQ, earnings (2016-2026)

Subsector	2016 Jobs	2021 Jobs	2026 Jobs	2016-2021 % Change	2021 Location Quotient	2021 Average Earnings Per Job
Research, Testing, & Medical Laboratories	4,104	4,982	5,530	21.4%	0.90	\$174,396
Bioscience-Related Distribution	1,732	1,829	1,750	5.6%	0.48	\$95,927
Medical Devices & Equipment	985	1,317	1,608	33.7%	0.47	\$133,546
Drugs & Pharmaceuticals	621	931	1,097	50.0%	0.39	\$125,852
Agricultural Feedstock & Industrial Biosciences	333	361	405	8.2%	0.71	\$145,802
Total Biotech	7,775	9,419	10,390	21.2%	0.63	\$157,720

Greater Sacramento region-

- 9,419 jobs
- Generally small LQ
- 21% historical growth rate
- High annual earnings
- 10.3% projected growth by 2026

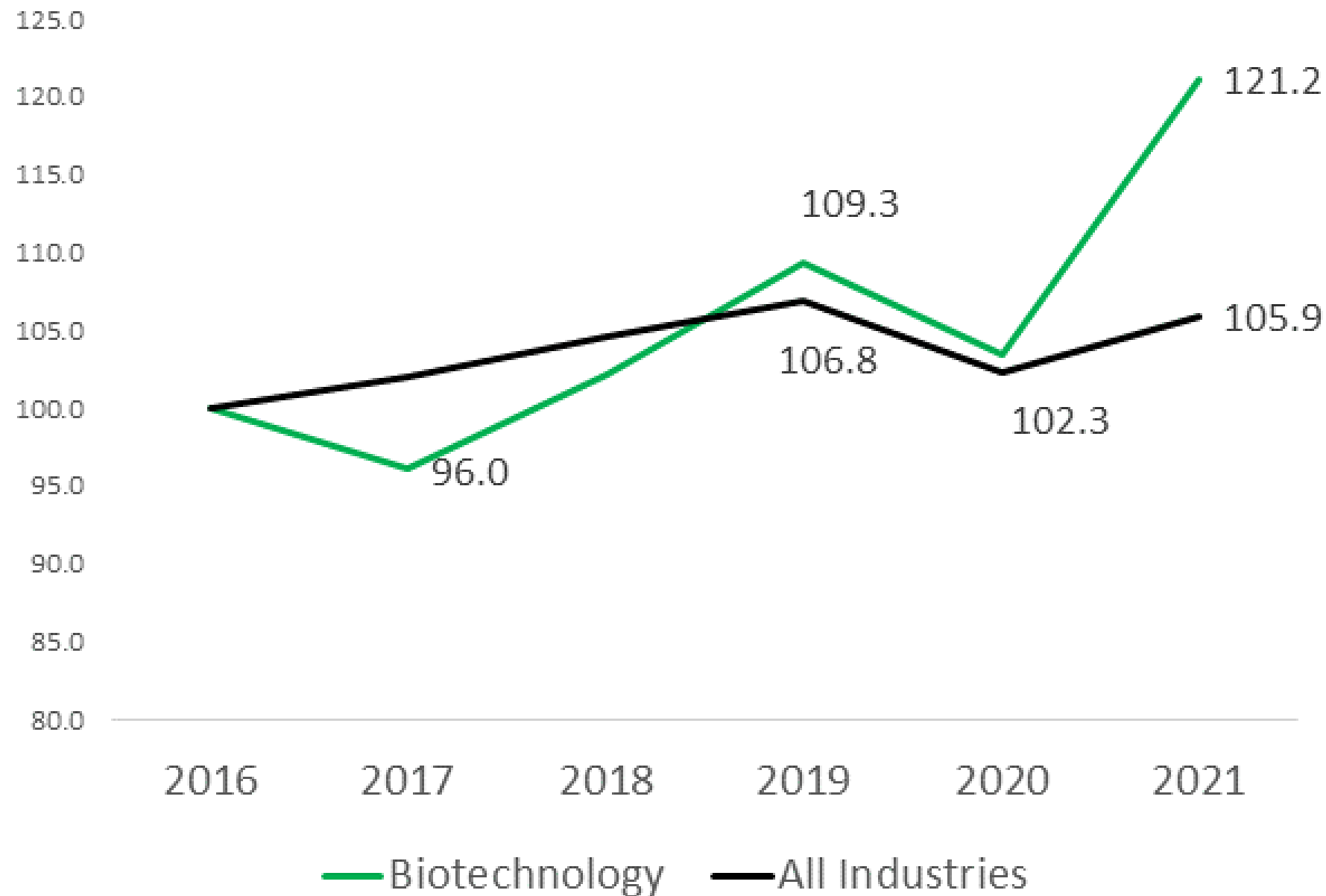
Subsector	2016 Jobs	2021 Jobs	2026 Jobs	2016-2021 % Change	2021 Location Quotient	2021 Average Earnings Per Job
Research, Testing, & Medical Laboratories	110,218	147,678	167,212	34.0%	1.61	\$227,675
Medical Devices & Equipment	64,583	77,629	83,845	20.2%	1.67	\$164,765
Bioscience-Related Distribution	52,136	62,593	65,611	20.1%	0.98	\$154,335
Drugs & Pharmaceuticals	51,179	49,894	52,843	-2.5%	1.24	\$206,641
Agricultural Feedstock & Industrial Biosciences	3,435	4,159	4,777	21.1%	0.49	\$99,109
Total Biotech	281,551	341,953	374,289	21.5%	1.36	\$195,201

California-

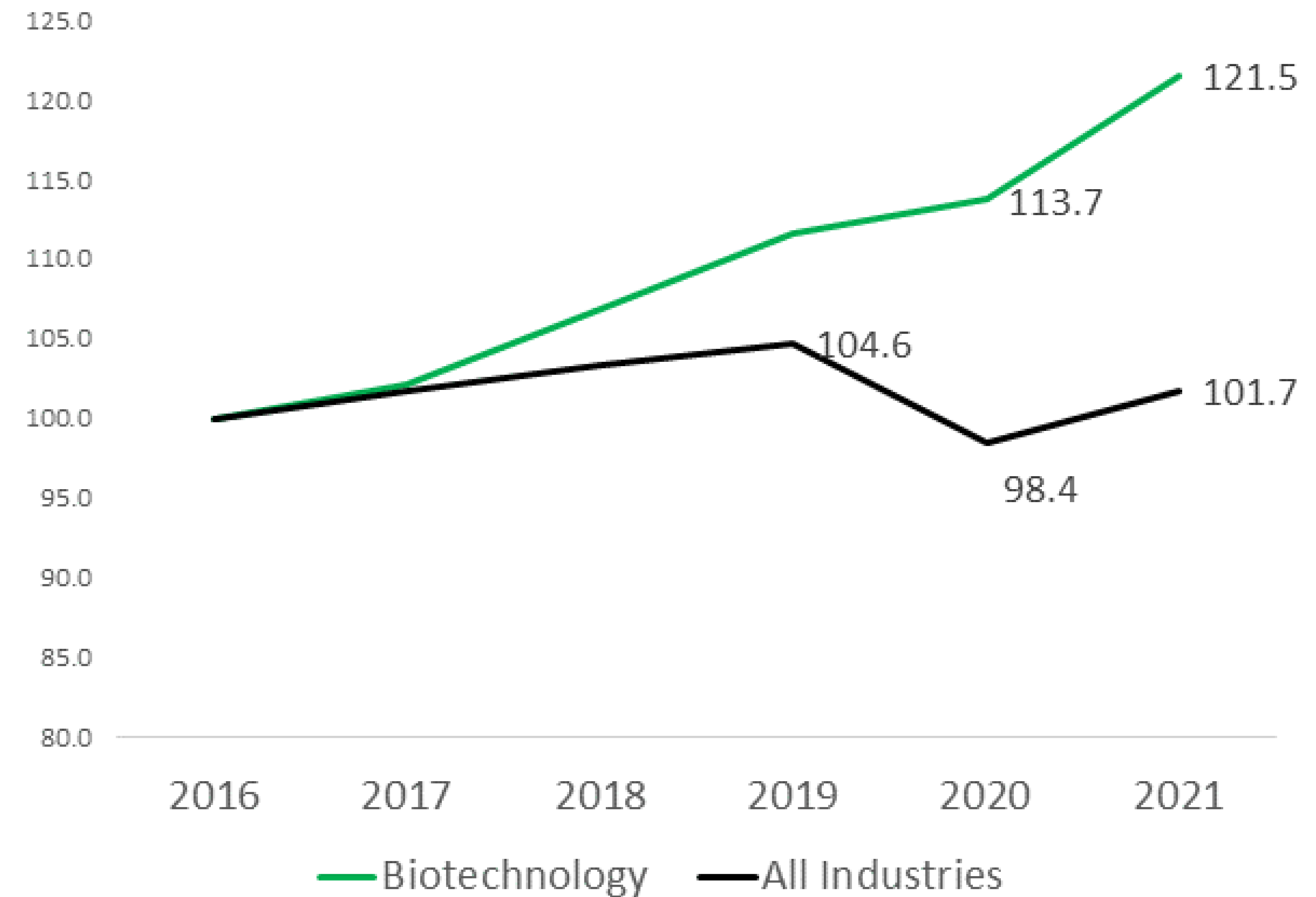
- 341,953 jobs
- Above average LQ
- 21% historical growth rate
- High annual earnings
- 8.6% projected growth by 2026

Industry historical growth vs. total economy (2016-2021)

Greater Sacramento Employment Index,
2016=100.0



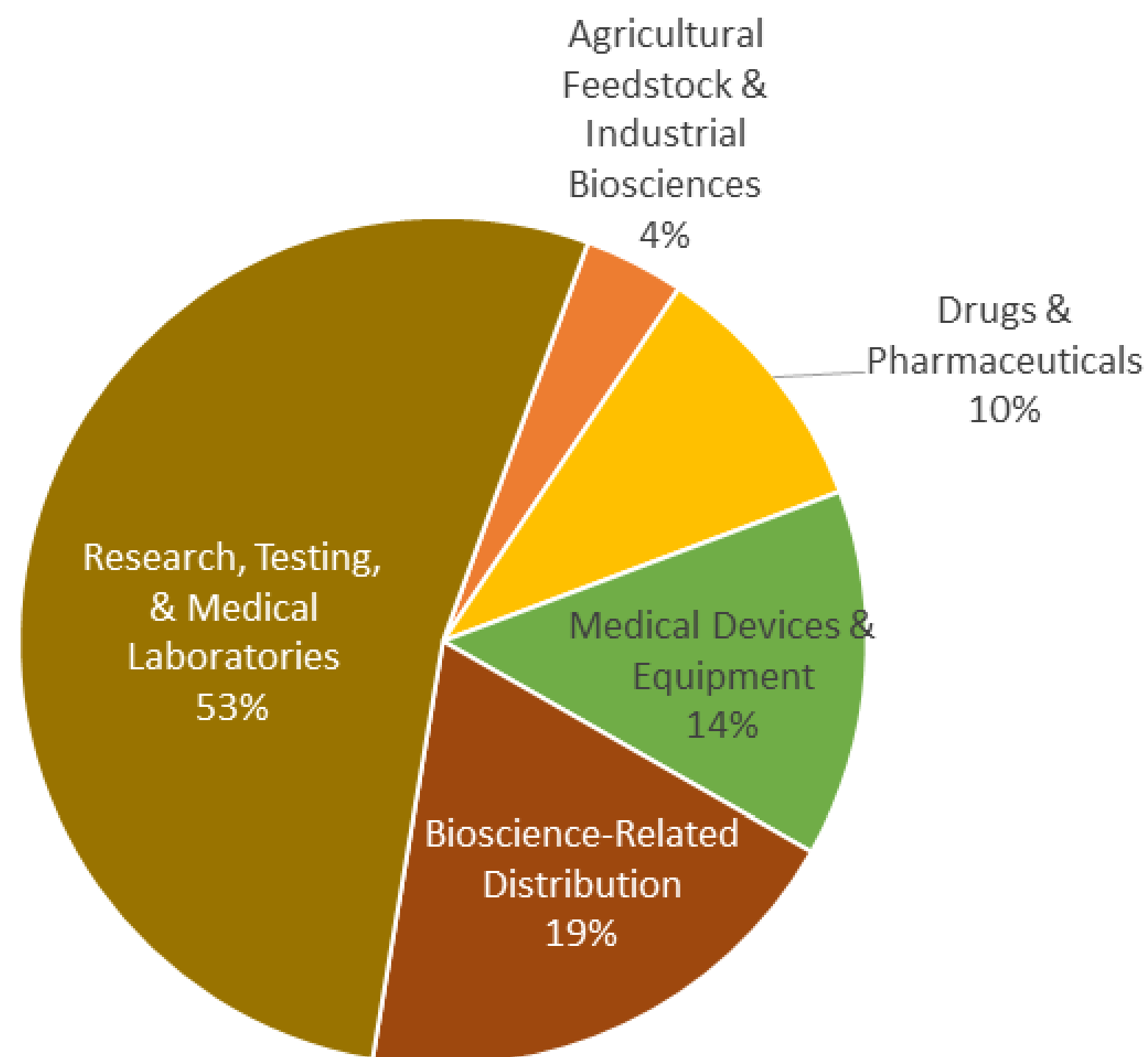
California Employment Index, 2016=100.0



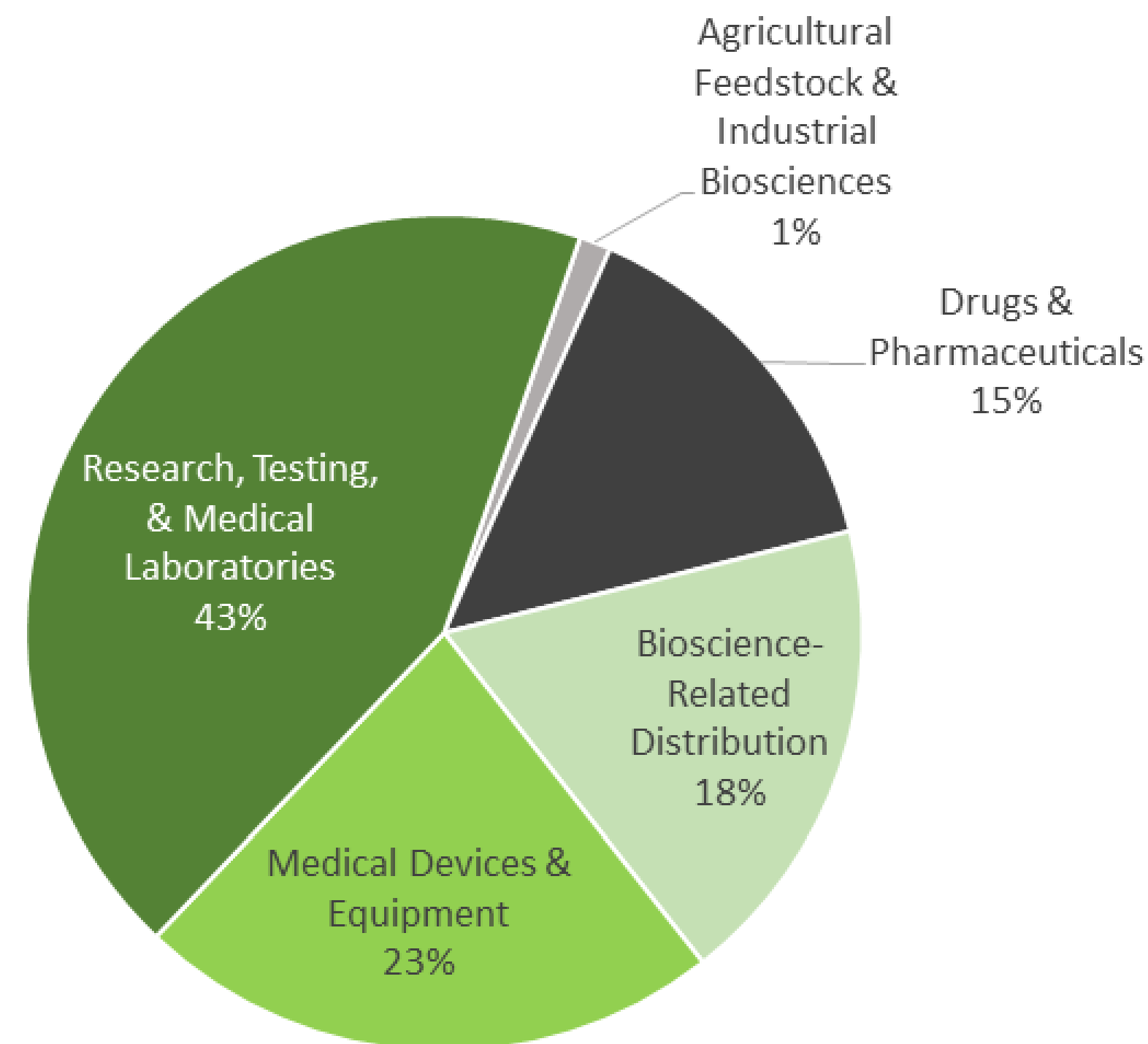
Biotechnology and life sciences **occupation analysis**

Biotech- Life Sciences Industrial Composition (2021)

Greater Sacramento region, n = 9,419 jobs



California, n = 341,953 jobs



Entry-level occupations employment trends (2021-2026)

SOC	Description	2021 Jobs	2026 Jobs	2021 - 2026 Change	2021 - 2026 % Change	Avg. Annual Openings
17-3029.09	Manufacturing Production Technicians	388	411	23	6%	41
19-4013	Food Science Technicians	69	76	6	9%	10
19-4021	Biological Technicians	506	544	38	8%	73
19-4031	Chemical Technicians	213	234	21	10%	28
19-4099.01	Quality Control Specialists	654	676	21	3%	85
29-2018	Clinical Laboratory Technologists and Technicians	1,930	2,064	133	7%	153
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	2,264	2,281	17	1%	277
Total		6,025	6,286	260	4%	669

Greater Sacramento region-

- 6,025 jobs
- 669 projected annual openings
- 4% projected growth rate

SOC	Description	2021 Jobs	2026 Jobs	2021 - 2026 Change	2021 - 2026 % Change	Avg. Annual Openings
17-3029.09	Manufacturing Production Technicians	11,807	12,054	247	2%	1,164
19-4013	Food Science Technicians	2,263	2,273	9	0%	298
19-4021	Biological Technicians	9,352	10,085	733	8%	1,366
19-4031	Chemical Technicians	7,806	8,057	251	3%	926
19-4099.01	Quality Control Specialists	11,911	12,424	513	4%	1,581
29-2018	Clinical Laboratory Technologists and Technicians	27,644	30,391	2,747	10%	2,380
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	64,350	60,424	(3,925)	(6%)	7,526
TOTAL		135,132	135,707	575	0%	15,240

California-

- 135,132 jobs
- 15,240 projected annual openings
- 0% projected growth rate

Source: Lightcast, QCEW, Non-QCEW, Self-employed, 2022.4

Note 1: Quality Control Analysts and Manufacturing Production Technicians are embedded in two broad occupation groups which includes many other occupations. Therefore, the employment and projection may be overrated.

Note 2: Medical and Clinical Laboratory Technicians couldn't be found in EMSI and was replaced by Clinical Laboratory Technologists and Technicians.

Biotech- Life Sciences Industrial Composition (2021)

Entry-level Occupations

1. Biological Technicians
2. Chemical Technicians
3. Food Science Technicians (part of SOC 19-4011 Agricultural and Food Science Technicians)
4. Inspectors, Testers, Sorters, Samplers, Weighers
5. Manufacturing Production Technicians (part of SOC 17-3029 Engineering Techs, Except Drafters, All Other)
6. Medical & Clinical Laboratory Technicians (part of SOC 29-2018 Clinical Laboratory Technologists and Technicians)
7. Quality Control Analysts (part of SOC 19-4099 Life, Physical, and Social Science Technicians, All Other)

Pathway Occupations

1. Biochemists & Biophysicists
2. Biomedical Engineers
3. Biostatisticians (part of SOC 15-2041 Statisticians)
4. Chemists
5. Clinical Data Managers (part of SOC 15-2041 Statisticians)
6. Clinical Research Coordinators (part of SOC 11-9121 Natural Science Mgrs.)
7. Compliance Officers
8. First-Line Supervisors/Mgrs. of Production and Operating Workers
9. Laboratory Managers (part of SOC 11-9121 Natural Science Mgrs.)
10. Manufacturing Engineers (part of SOC 17-2199 Engineers, All Other)
11. Medical Scientists, Except Epidemiologists
12. Microbiologists
13. Sales Representatives, Wholesale & Mfg., Technical & Scientific Products

Statewide report (2021)-

- “Pathway occupations” have more than 2x jobs (21,500 vs. 45,000 jobs)
- Pathway jobs – 2x annual openings (2,500 vs. 5,000)
- Pathway job pay >\$20 per hour more (\$24 per hour vs. \$46 per hour)

Entry-level occupations hourly wages (2021)

SOC	Description	Pct. 25 Hourly Earnings	Median Hourly Earnings	Pct. 75 Hourly Earnings
17-3029.09	Manufacturing Production Technicians	\$20.54	\$28.58	\$38.51
19-4013	Food Science Technicians	\$18.40	\$22.26	\$28.15
19-4021	Biological Technicians	\$18.55	\$22.90	\$28.21
19-4031	Chemical Technicians	\$18.97	\$23.25	\$29.50
19-4099.01	Quality Control Specialists	\$18.64	\$22.06	\$29.73
29-2018	Clinical Laboratory Technologists and Technicians	\$23.76	\$35.30	\$38.12
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	\$15.36	\$18.65	\$24.17
TOTAL		\$19.17	\$24.71	\$30.91

SOC	Description	Pct. 25 Hourly Earnings	Median Hourly Earnings	Pct. 75 Hourly Earnings
17-3029.09	Manufacturing Production Technicians	\$23.22	\$29.65	\$42.16
19-4013	Food Science Technicians	\$17.95	\$22.05	\$28.50
19-4021	Biological Technicians	\$19.15	\$24.11	\$30.40
19-4031	Chemical Technicians	\$18.18	\$23.14	\$29.52
19-4099.01	Quality Control Specialists	\$20.61	\$27.05	\$36.34
29-2018	Clinical Laboratory Technologists and Technicians	\$22.72	\$29.68	\$38.13
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	\$17.11	\$21.46	\$28.22
TOTAL		\$19.85	\$25.31	\$33.32

Greater Sacramento region-

- Average wage range –
 - \$19.17 to \$30.91
- Self-sufficiency wage
 - \$29.15

California-

- Average wage range –
 - \$19.85 to \$33.32
- Self-sufficiency wage
 - \$30.48

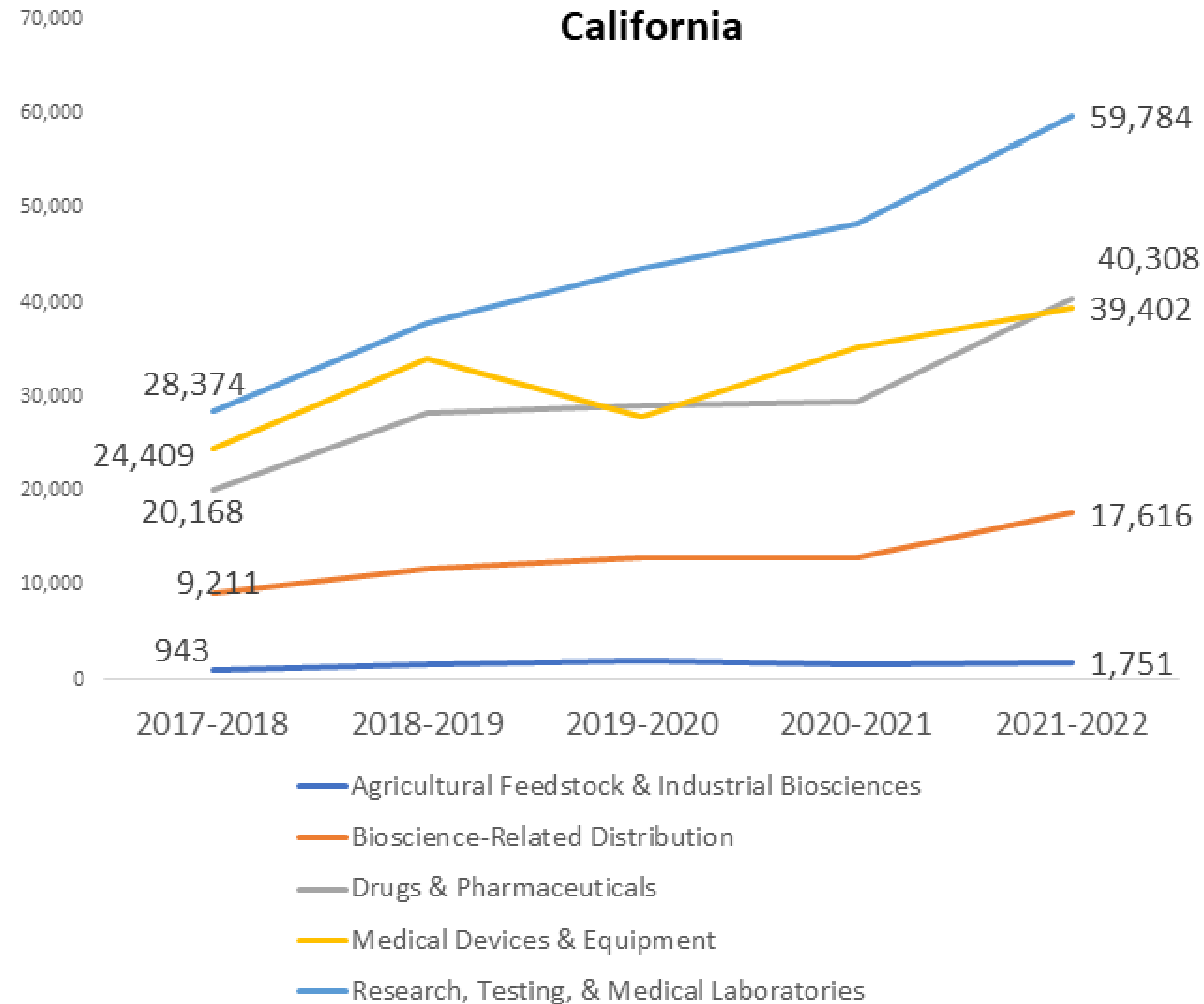
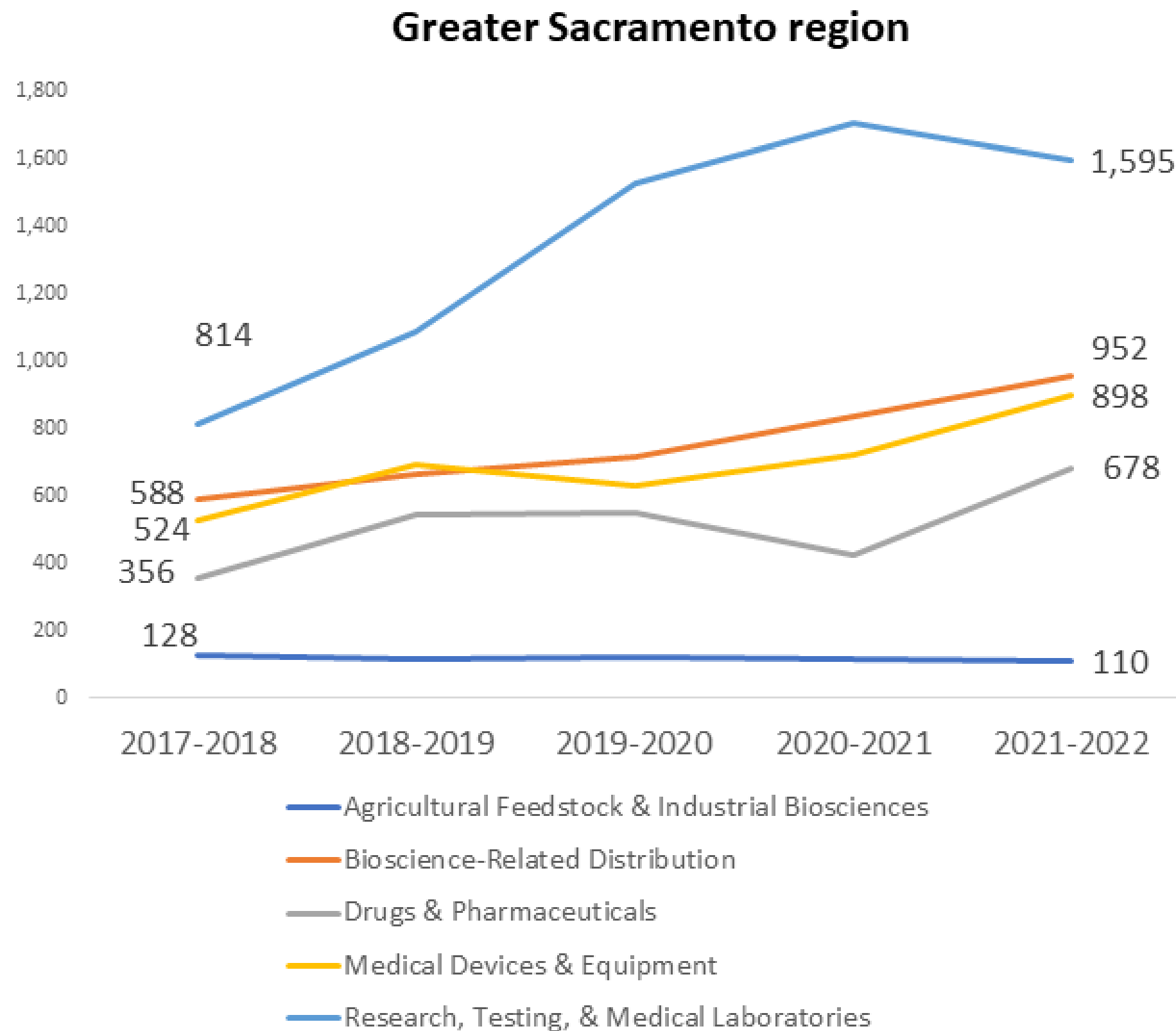
Source: Lightcast, QCEW, Non-QCEW, Self-employed, 2022.4

Note 1: Quality Control Analysts and Manufacturing Production Technicians are embedded in two broad occupation groups which includes many other occupations.

Note 2: Medical and Clinical Laboratory Technicians couldn't be found in EMSI and was replaced by Clinical Laboratory Technologists and Technicians.

Biotechnology and life sciences **jobs postings** analysis

Jobs postings volumes by industry segment, 5-year trend (2017-2022)



Source: Burning Glass Labor Insight, 2022.4

Note: Some Job postings in Research, Testing & Medical Laboratories might not be directly relevant to biotechnology so the job posting count for this subsector might be overrated.

Jobs postings top employers, Greater Sac region, 12 months (through Oct. 2022)

All industries, 7 key occupations (n=114)

Employer	Job Postings
Eurofins Scientific	29
Quest Diagnostics Incorporated	22
MilliporeSigma	17
Agilent Technologies, Inc.	10
IDEXX Laboratories, Inc.	8
Bayer Corporation	8
Merck & Company	5
The Jackson Laboratory	2
Regeneron	2
Lincare	2
Thermo Fisher Scientific Inc	1
Scotts Company	1
Millipore Corporation	1
McKesson Corporation	1
Eli Lilly	1
Bioreliance Corporation	1
BeiGene	1
Abbott Laboratories	1

All industries, all occupations (n=2,149)

Employer	Job Postings
Quest Diagnostics Incorporated	279
Eurofins Scientific	181
The Jackson Laboratory	166
Thermo Fisher Scientific Inc	138
Icon Medical Imaging	72
Takeda Pharmaceuticals North America, Inc.	71
Optum	71
Bayer Corporation	67
McKesson Corporation	64
PerkinElmer	59
Agilent Technologies, Inc.	58
BeiGene	51
MilliporeSigma	50
Medtronic	48
Baxter International Incorporated	40
American Institutes for Research	37
Bureau Veritas	35
Pfizer	34

Jobs postings top occupations, Greater Sac region, 12 months (through Oct. 2022)

All industries, 7 key occupations (n=114)

Occupation	Job Postings
Medical and Clinical Laboratory Technicians	57
Quality Control Analysts	24
Inspectors, Testers, Sorters, Samplers, and Weighers	13
Cytotechnologists	10
Manufacturing Production Technicians	8
Medical and Clinical Laboratory Technologists	2

All industries, all occupations (n=2,149)

Occupation	Job Postings
Sales Representatives, Wholesale and Manufacturing	156
Phlebotomists	152
Sales Managers	86
Managers, All Other	66
Medical and Clinical Laboratory Technicians	57
Medical and Health Services Managers	50
Maintenance and Repair Workers, General	50
General and Operations Managers	49
Laborers and Freight, Stock, and Material Movers, Hand	47
Software Developers, Applications	46
Marketing Managers	46
Sales Representatives, Wholesale and Manufacturing	45
Medical Scientists, Except Epidemiologists	41
Operations Research Analysts	30
Registered Nurses	29
First-Line Supervisors of Retail Sales Workers	27
Quality Control Analysts	24
Management Analysts	23
Secretaries and Administrative Assistants	20

Jobs postings top job titles, Greater Sac region, 12 months (through Oct. 2022)

All industries, 7 key occupations (n=114)

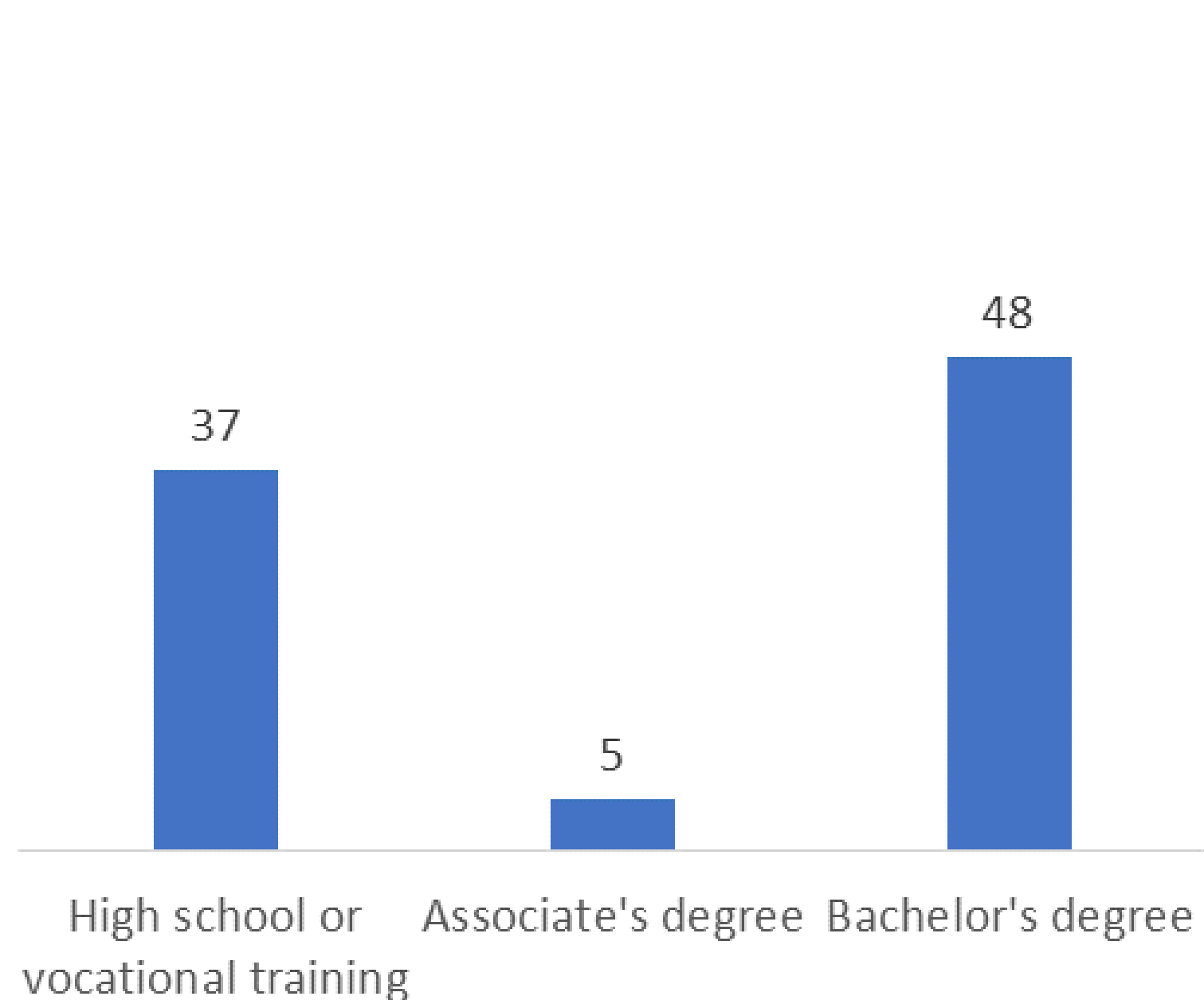
Job Title	Job Postings
Mold/Asbestos Analyst - Eurofins Emlab P&K	5
Cytotechnologist I	4
Laboratory Technician	4
Sample Control Technician I - Eurofins Test America	4
Laboratory Analyst II	3
Laboratory Assistant	3
Laboratory Technician/Assistant - Eurofins Emlab P&K	3
Quality Control Analyst	3
Specimen Technician I	3
Driver/Technician - Medical	2
Head Of Quality	2
Laboratory Coordinator	2
Lcms Prep Laboratory Technician I- Multiple Shifts	2
Medical Laboratory Technician	2
Pcr Laboratory Analyst	2
Quality Analyst	2
Quality Assurance Assistant	2
Quality Assurance Coordinator	2

All industries, all occupations (n=2,149)

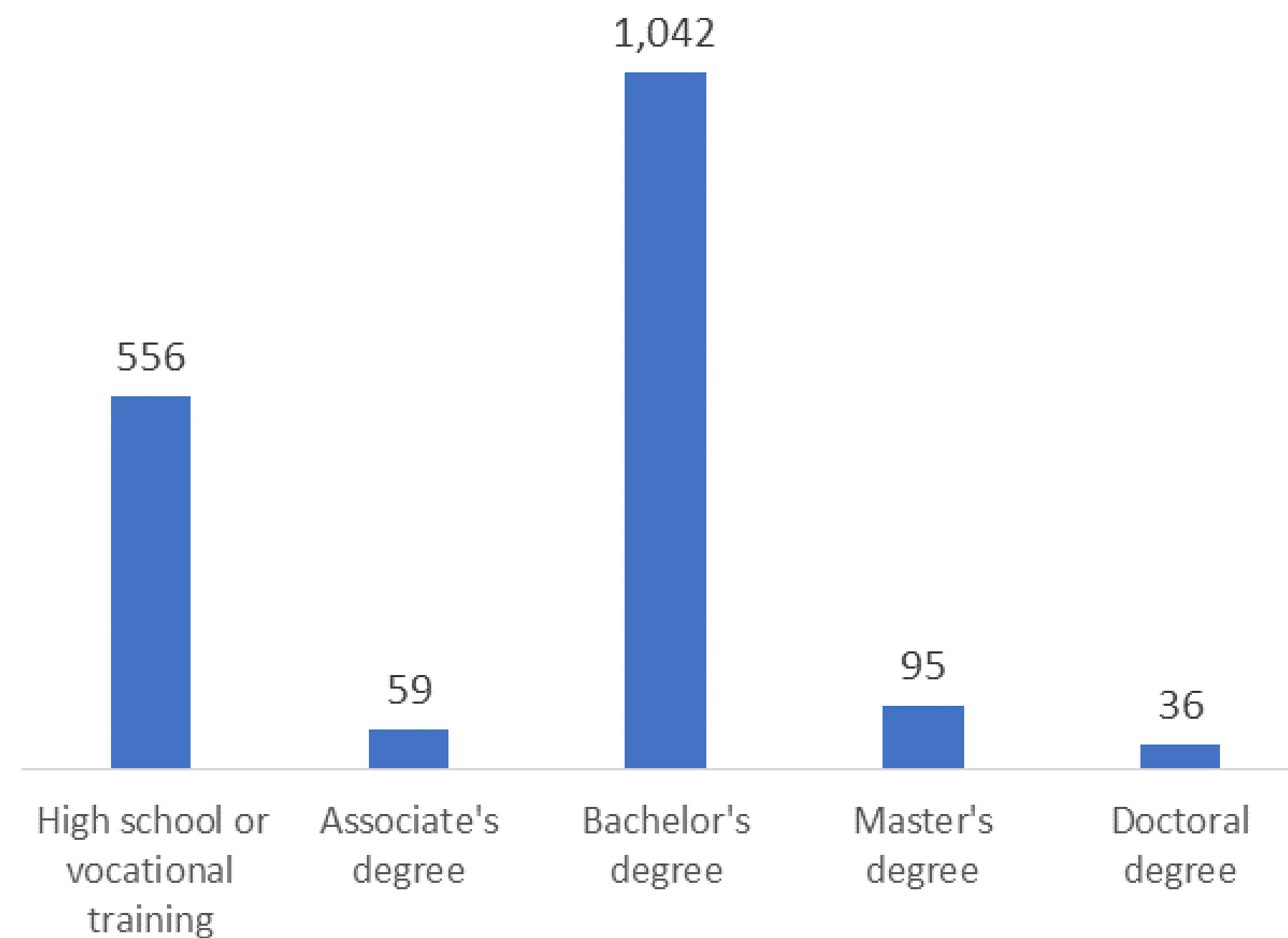
Job Title	Job Postings
Phlebotomist I	42
Phlebotomist	29
Phlebotomist II - Float	15
Representative Ps I Phleb	11
Field Service Technician I	10
Phlebotomist II	10
Production Associate I	9
Building Inspector	8
Plans Examiner	8
Production Planner	8
Regulatory Affairs Consultant/Project Manager	8
Retail Key Holder Pt	8
Senior Sales And Business Analyst	8
Territory Manager	8
Associate Sales Representative - Ics - , Or	7
Customer Service Representative	7
Medically Trained Mobile Phlebotomist Pt	7
Mobile Phlebotomist Pt	7
Representative, Ps I Phleb	7

Jobs postings Education cited, prev. 12 months (through Oct. 2022)

All industries, 7 key occupations (n=114)



All industries, all occupations (n=2,149)



Jobs postings top skills, Greater Sac region, 12 months (through Oct. 2022)

All industries, 7 key occupations (n=114)

Skill	Skill Postings
Quality Assurance and Control	62
Data Entry	27
Good Manufacturing Practices (GMP)	24
Quality Management	23
Specimen Processing	22
Vaccination	22
Chemistry	21
Current Good Manufacturing Practices (CGMP)	20
SAP	20
Biology	19
Laboratory Testing	18
Scheduling	16
Technical Support	16
Cytology	14
ISO Standards	13
Laboratory Equipment	13
Pipettes	12
Test Ordering	12
Project Management	11

All industries, all occupations (n=2,149)

Skill	Skill Postings
Customer Service	472
Sales	397
Vaccination	369
Budgeting	312
Project Management	302
Quality Assurance and Control	298
Customer Contact	265
Data Entry	262
Scheduling	232
Phlebotomy	214
Customer Billing	212
Chemistry	190
Biotechnology	186
Retail Industry Knowledge	184
Business Planning	160
Sales Goals	159
Vaccines	158
Business Development	156
Specimen Collection	155

Biotechnology and life sciences education and training programs analysis

Companies most frequently in the Top 5 of employers in the jobs postings in the past 5 Years

Agricultural Feedstock & Industrial Biosciences

- Marrone Bio Innovations
- Mosaic
- Nutrien
- J.R. Simplot Company (new to postings)

Bioscience-Related Distribution

- ProMedica
- McKesson
- Stryker
- Cardinal Health

Drugs & Pharmaceuticals

- Johnson & Johnson
- Takeda Pharmaceutical Company

Medical Devices & Equipment

- Thermo Fisher Scientific
- Smile Brands
- Agilent Technologies
- Medtronic

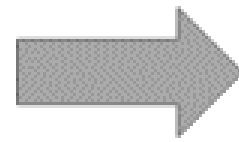
Research, Testing, & Medical Laboratories

- Bayer
- Quest Diagnostics
- IQVIA
- Eurofins (new to postings)

Biotech & Life Sciences programs and awards

Average annual awards

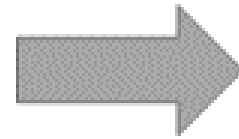
- ❖ Sacramento City College
 - Chemical Technology
 - A.S. and certificates
 - TOP 0955.00 Laboratory Science Technology



Sequence of certificates in Chemical Technician – Beginning, Intermediate, Advanced; targets f, lab tech roles in food and beverage, water treatment, environmental monitoring, pharmaceuticals

3 associate
6 certificates

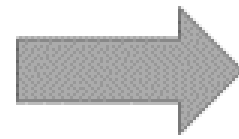
- ❖ American River College
 - Biotechnology and Biomedical Technology
 - A.S. and certificate
 - TOP 0430.00 (same name)



Prepares for entry-level work in bioscience industry for R&D, production, testing, and diagnostics. Industry targets: biotech, pharmaceutical, and hospitals and agency labs.

10 associate
4 certificates

- ❖ Folsom Lake College
 - Medical Laboratory Technology
 - A.S. degree; pre-clinical certificate
 - TOP 1205.00 (same name)



Prepares for work in medical laboratories, trains to the Medical Laboratory Technology license exam; for medical lab technician, lab assistant, or research technician

11 associate

Biotech & Life Sciences awards and annual openings

	Average annual awards
❖ Sacramento City College - Chemical Technology - A.S. and certificates - TOP 0955.00 Laboratory Science Technology	3 associate 6 certificates
❖ American River College - Biotechnology and Biomedical Technology - A.S. and certificate - TOP 0430.00 (same name)	10 associate 4 certificates
❖ Folsom Lake College - Medical Laboratory Technology - A.S. degree; pre-clinical certificate - TOP 1205.00 (same name)	11 associate

Description	2021 Jobs	Avg. Annual Openings
Manufacturing Production Technicians	388	41
Food Science Technicians	69	10
Biological Technicians	506	73
Chemical Technicians	213	28
Quality Control Specialists	654	85
Clinical Laboratory Technologists and Technicians	1,930	153
Inspectors, Testers, Sorters, Samplers, and Weighers	2,264	277
	6,025	669

Key takeaways

Key takeaways

- >>> Sacramento region industry growth rates and earnings on par with California, Employment and LQ smaller, industry concentration stronger in R&D (Greater Sac)
- >>> Focused “Skilled technical workforce” is small for 5 segments, but related occupations across industries have hundreds of annual openings.
- >>> wages for “entry-level” middle skill occupations – \$19 - \$31 per hour, with median at \$25 per hour \$25 per hour
- >>> 3 core programs in Sac region at Sacramento City College (Chem Tech); Folsom Lake College (Medical Laboratory Technology); and American River College (biotechnology)
- >>> Data indicates that there is significant, related employment in other industries beyond biotech and life sciences (hospitals, labs, agencies), and that there are many middle skill jobs in biotech beyond “skilled technical workforce”
- >>> Small numbers of awards invites further investigation for opportunity- supply – demand gap appears large

For more information on the research, please contact

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➤ Industry Panel Discussion



Craig Bush

Miltenyi Biotec
Associate Director of
Service Sales &
Operations



Damian Curtis

BioConsortia Inc.
Director of Synthetic
Biology and Genomics



Lara Kramer

Bayer Crop Science
Head of Global
Pipeline Digital
Operations



Barry Kersting

Hygieia Biological
Laboratories
Director of
Manufacturing



Laura Niznik
Williams

UC Davis Health
Director of Government
and Community
Relations

➤ Education & Training Spotlights



Dr. Adam Telleen

Professor, Biology &
Biotechnology

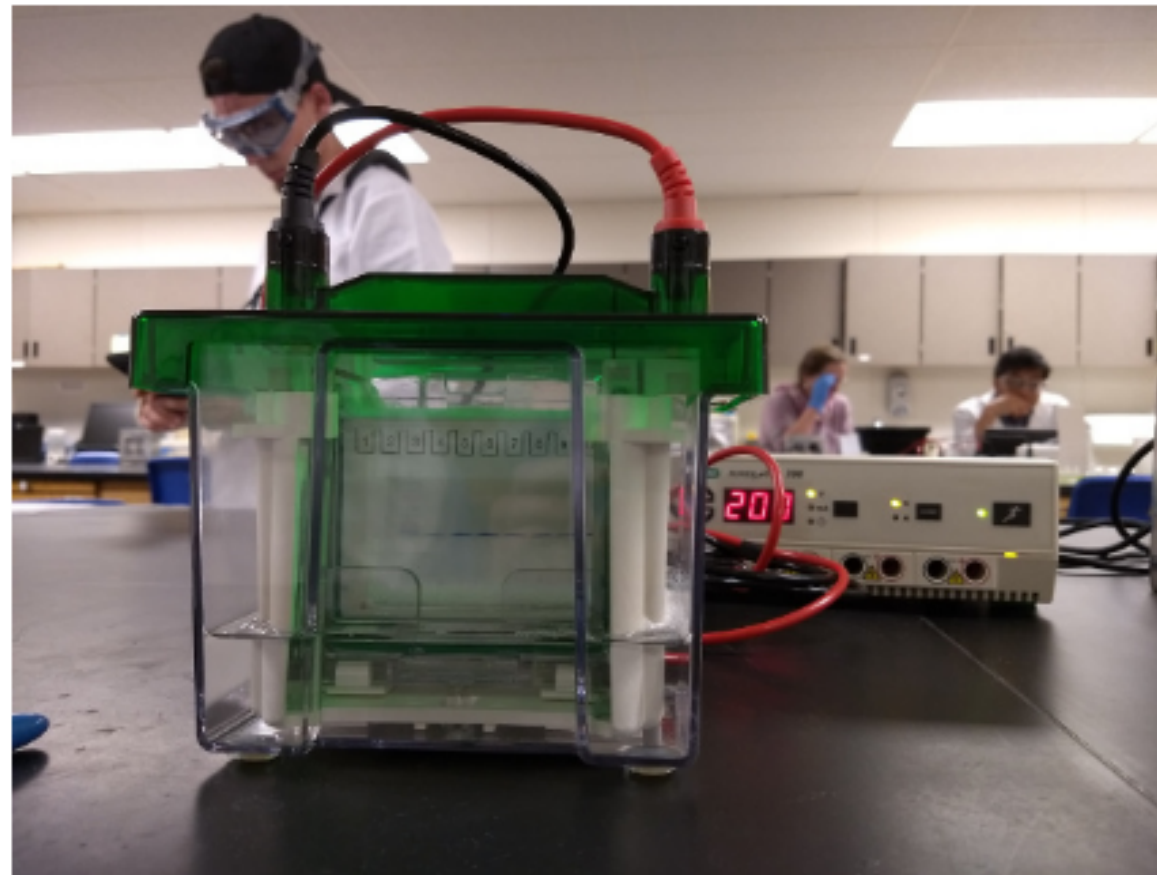


Justin Cecil

Coordinator, Biotech
Academy, Sheldon High
School



**Valley Vision
Health and Life Sciences Advisory Meeting
2 December 2022**



**Adam Telleen, PhD
telleea@arc.losrios.edu**



ARC Biotechnology Program

Training for entry-level positions in biotechnology

Preparation for transfer to four-year institutions

Important concepts and applications

Practical hands-on skills





ARC offers Biotechnology Certificate and A.S. degree

Biotechnology Certificate

This certificate provides the theory and skills necessary for entry into the biotechnology field, which uses cellular and molecular biology processes for industry or research. Course work includes practical laboratory skills with emphasis on good laboratory practice, quality control, and regulatory issues in the biotechnology workplace. This certificate is suitable for preparing the student for the biotechnology workplace at the support personnel level.

Catalog Date: August 1, 2022

— Student Learning Outcomes

Upon completion of this program, the student will be able to:

- apply biological and chemical concepts to biotechnology research and its practical applications.
- demonstrate biotechnology laboratory procedures involving protein and DNA techniques, cell culture methods, and solution preparation.
- design and interpret experiments involving biotechnology laboratory procedures.
- evaluate biotechnology laboratory practices in the context of good laboratory practice, quality control, and regulatory issues.
- assess the impact of biotechnology on social and ethical issues.

— Career Information

This certificate prepares the student for entry-level work in the bioscience industry in the areas of research and development, production, clinical testing, and diagnostic work. Potential employers include biotechnology and pharmaceutical companies, as well as laboratories in hospitals, government, and universities.

A.S. in Biotechnology

This degree provides the theory and skills necessary for entry into the biotechnology field, which uses cellular and molecular processes for industry or research. Course work includes practical laboratory skills with emphasis on good laboratory practice, quality control, and regulatory issues in the biotechnology workplace. Completion of the degree also prepares the student for transfer at the upper division level to academic programs involving biotechnology.

Catalog Date: August 1, 2022

— Student Learning Outcomes

Upon completion of this program, the student will be able to:

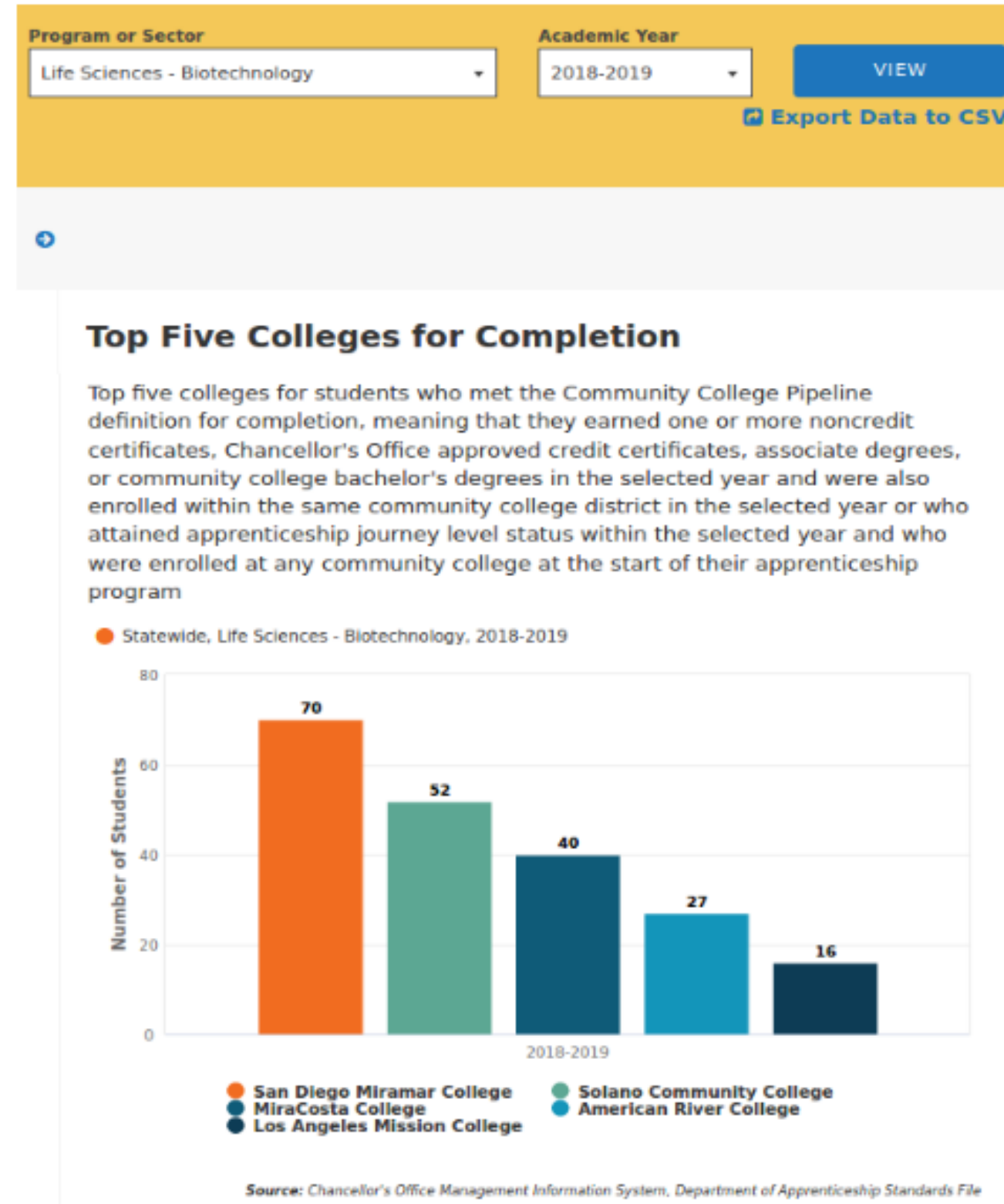
- apply biological and chemical concepts to biotechnology research and its practical applications.
- demonstrate biotechnology laboratory procedures involving protein and DNA techniques, cell culture methods, and solution preparation.
- design and interpret experiments involving biotechnology laboratory procedures.
- evaluate biotechnology laboratory practices in the context of good laboratory practice, quality control, and regulatory issues.
- analyze biotechnology data using mathematical and statistical methods.
- integrate laboratory skills and theory into job-related tasks in the biotechnology workplace.
- appraise social and ethical issues related to advances in biotechnology research and its practical applications.

— Career Information

This degree prepares the student for entry-level work in the bioscience industry in the areas of research and development, production, clinical testing, and diagnostic work. Potential employers include biotechnology and pharmaceutical companies, as well as laboratories in hospitals, government, and universities.



We have been in the Top 5
Community Colleges in
California for Degree/Certificate
completion in
Life-Sciences/Biotech TOP
Code!





Student Profile

Our students have different educational goals:

- A.S. degree / Certificate into Job market
- A.S. degree / Certificate into transfer to 4 year institution
- Already have B.S. degree, returning for lab skills

Our enrollments are small, so
Program demographics vary
from semester to semester

Ethnicity demographics
for ARC as a whole:

ETHNICITY	% OF STUDENTS
African American	7.4
Asian	11.7
Filipino	2.5
Hispanic/Latino	28.3
Multi-Race	6.7
Native American	0.5
Other Non-White	0.2
Pacific Islander	1.0
Unknown	3.6
White	38.1
	100.0%



Courses:

Lecture Course (16-week):

BIOT 301 – Biotechnology and Human Health

Biotechnology Laboratory Methods (8-week):

BIOT 311 – Molecular Methods

BIOT 312 – Microbial and Cell Culture Techniques

Online Courses (8-week):

BIOT 305 – Introduction to Bioinformatics

BIOT 307 – Biotechnology and Society

Internship/Independent Study:

BIOL 495 – Independent Study

BIOT 498 – Work Experience

Run through Work Experience and Internship Program (CTE)



BIOT 307 Biotechnology and Society

Units:	2
Hours:	36 hours LEC
Prerequisite:	None.
Transferable:	CSU; UC
Catalog Date:	August 1, 2022

This course examines the scientific and social impact of biotechnology by introducing basic technical concepts to examine recent advances. Topics include biotechnology applications in medicine, agriculture, industry, and the environment, and their ethical implications and public perception.

— Student Learning Outcomes

Upon completion of this course, the student will be able to:

- explain biotechnology applications in medicine, agriculture, and industry.
- correlate recent advances in biotechnology research with new products and processes.
- evaluate social and ethical issues involving biotechnology.



BIOT 307 – Biotechnology and Society
2 Unit – Online, Lecture

This is our introductory course providing an overview of Biotechnology. *No prerequisites!*

Key Topics Covered:

- Molecular Biology Concepts in Biotechnology
- Principles of Genetics
- Biotechnology Techniques
- Genomics
- Medical Biotechnology
- Agricultural Biotechnology
- Biotechnology in the Environment
- Biotechnology in the Legal System
- Ethical Issues in Biotechnology



BIOT 301 Biotechnology and Human Health

Units:	3
Hours:	54 hours LEC
Prerequisite:	BIOL 303, BIOL 310, BIOL 400, BIOL 440, BIOL 442, or BIOT 307 with a grade of "C" or better
Transferable:	CSU
Catalog Date:	August 1, 2022

This course introduces biotechnology as it pertains to human health and disease. Topics include an introduction to molecular biology and genetics, recombinant DNA technology, biopharmaceutical products, forensics and genetic testing, stem cells and regenerative medicine, genomics and bioinformatics, and ethical issues arising from biotechnology disease diagnosis and treatment.

— Student Learning Outcomes

Upon completion of this course, the student will be able to:

- relate biological macromolecules, such as nucleic acids and proteins, to their physical properties and cellular function.
- integrate the roles of DNA, RNA, and proteins with the expression of genetic traits of cells and organisms.
- analyze the scientific concepts underlying biotechnology techniques.
- evaluate new developments in biotechnology research on current human health and disease issues.
- explain how information-based biotechnology approaches, such as genomics and bioinformatics, are used to address biomedical issues.
- examine current ethical and social issues in the use of biotechnology for human health.



BIOT 301 – Biotechnology and Human Health

3 Units – Lecture, Online?

Key Topics Covered:

- Overview of Biotechnology
- Cells, Biomolecules, and Metabolism
- Molecular Genetics
- Human Genetics
- Recombinant DNA
- Genomics and Bioinformatics
- Microbial Biotechnology
- DNA Profiling
- Biotechnology and Human Disease
- Biotechnology and Cancer
- Gene Therapy and Regenerative Medicine
- Agricultural Biotechnology
- Biotechnology Regulations
- Ethical Issues in Biotechnology



BIOT 311 Biotechnology Laboratory Methods - Molecular Techniques

Units:	2
Hours:	18 hours LEC; 54 hours LAB
Prerequisite:	BIOL 300, BIOL 303, BIOL 310, BIOL 400, BIOL 440, BIOL 442, or BIOT 307 with a grade of "C" or better
Transferable:	CSU
Catalog Date:	August 1, 2022

This course covers basic concepts and techniques to work effectively in a bioscience laboratory. Topics include laboratory solution preparation, recombinant DNA methods and nucleic acid analysis techniques, protein separation and analytical techniques, good laboratory practice, and product quality issues.

— Student Learning Outcomes

Upon completion of this course, the student will be able to:

- organize and prepare materials needed for nucleic acid and protein laboratory techniques.
- calculate reagent amounts and concentrations to prepare laboratory solutions for nucleic acid and protein analysis.
- design and perform laboratory procedures involving manipulation of nucleic acid and protein samples.
- interpret and evaluate the results of nucleic acid and protein analysis experiments.
- assess biotechnology laboratory procedures on the basis of good laboratory practice, quality control, and regulatory issues.



BIOT 312 Biotechnology Laboratory Methods - Microbial and Cell Culture Techniques

Units:	2
Hours:	18 hours LEC; 54 hours LAB
Prerequisite:	BIOL 300, BIOL 303, BIOL 310, BIOL 400, BIOL 440, BIOL 442, or BIOT 307 with a grade of "C" or better
Transferable:	CSU
Catalog Date:	August 1, 2022

This course covers basic concepts and techniques to work effectively in a bioscience laboratory. Topics include media preparation, microbial and plant cell culture techniques, biosafety guidelines, and DNA and enzyme diagnostic techniques.

— Student Learning Outcomes

Upon completion of this course, the student will be able to:

- organize and prepare materials needed for culture media preparation, aseptic cell cultures, and DNA and enzyme diagnostic tests.
- design and perform laboratory procedures involving microbial and cell culture techniques, DNA analysis of microbiological samples, and microbial enzyme diagnostic tests.
- interpret and evaluate the experimental results of cell culture experiments, microbial DNA analysis, and enzyme diagnostic tests.
- assess the quality of laboratory data using descriptive statistical measures.
- assess needs for specific personal protective equipment and safety procedures based on an evaluation of general, chemical, and biological hazards present in laboratory situations.

BIOT 311 and 312 – Biotechnology Lab Methods
2 Units each – Lecture and Lab – 8-week Courses

Key Topics/Skills Covered:

- DNA Extraction
- Restriction Enzyme
and PCR analysis
- PCR primer design
- Recombinant DNA
construction
- Protein chromatography
- Solution/Media preparation
- Microbial isolation and culturing
- Plant tissue culture
- Bacteriophage isolation and culturing
- Microbial enzyme analysis (qualitative/quantitative)
- Protein analysis by SDS-PAGE and Western blot
- The regulated laboratory workplace





BIOT 305 Introduction to Bioinformatics

Units:	1
Hours:	14 hours LEC; 14 hours LAB
Prerequisite:	BIOL 303, BIOL 310, BIOL 400, BIOL 440, BIOL 442, BIOT 301, or BIOT 307 with a grade of "C" or better
Transferable:	CSU
Catalog Date:	August 1, 2022

This course examines the basic concepts and techniques in bioinformatics, the computer analysis of nucleic acids and proteins. Topics include biotechnology databases, database searching, structure and function analysis of biological molecules, sequence alignment and analysis, and biological applications of bioinformatics.

— Student Learning Outcomes

Upon completion of this course, the student will be able to:

- explain biological applications of bioinformatics concepts.
- design data retrieval strategies from bioinformatics databases.
- set up a data analysis using bioinformatics computational tools.
- analyze structure and function bioinformatics data.



BIOT 305 – Introduction to Bioinformatics

1 Unit – Online, Lecture and Lab

Key Topics Covered:

- Biotechnology Concepts in Bioinformatics
- Retrieve and Compile Information from Public Databases
- Overview of Bioinformatics Databases
- Searching for Primary and Review Articles
- Genomics
- Retrieve and Summarize Gene and Genome Data
- Alignments to Analyze Nucleic Acid and Protein Sequences
- BLAST Searches and Analysis of Results
- Phylogenetics
- Specialized Databases
- Design and Perform Specific Search Procedures

Trial run of Dual Enrollment course with Sheldon HS Biotech Academy in Spring 2022. We're hoping to continue DE offerings again starting next academic year.



BIOT 498 – Work Experience BIOL 495 – Independent Study

BIOT 498 Work Experience in Biotechnology

Units:	0.5 - 4
Hours:	30 - 300 hours LAB
Prerequisite:	None.
Enrollment Limitation:	Students must be in a paid or unpaid internship, volunteer position, or job related to biotechnology with a cooperating site supervisor. Students are advised to consult with the Biotechnology Department faculty to review specific certificate and degree work experience requirements.
Advisory:	Eligible for ENGRD 310 or ENGRD 312 AND ENGWR 300; OR ESLW 340.
Transferable:	CSU
General Education:	AA/AS Area III(b)
Catalog Date:	August 1, 2022

This course provides students with opportunities to develop marketable skills in preparation for employment or advancement within the field of biotechnology. It is designed for students interested in work experience and/or internships in transfer-level degree occupational programs. Course content includes understanding the application of education to the workforce, completion of Title 5 required forms which document the student's progress and hours spent at the work site, and developing workplace skills and competencies.

During the semester, the student is required to complete 37.5 hours of related paid work experience, or 30 hours of related unpaid work experience for 0.5 unit. An additional 37.5 or 30 hours of related work experience is required for each additional 0.5 unit. All students are required to attend the first class meeting, a mid-semester meeting, and a final meeting. Additionally, students who have not already successfully completed a Work Experience course will be required to attend weekly orientations while returning participants may meet individually with the instructor as needed. Students may take up to 16 units total across all Work Experience course offerings. This course may be taken up to four times when there are new or expanded learning objectives. Only one Work Experience course may be taken per semester.

— Student Learning Outcomes

Upon completion of this course, the student will be able to:

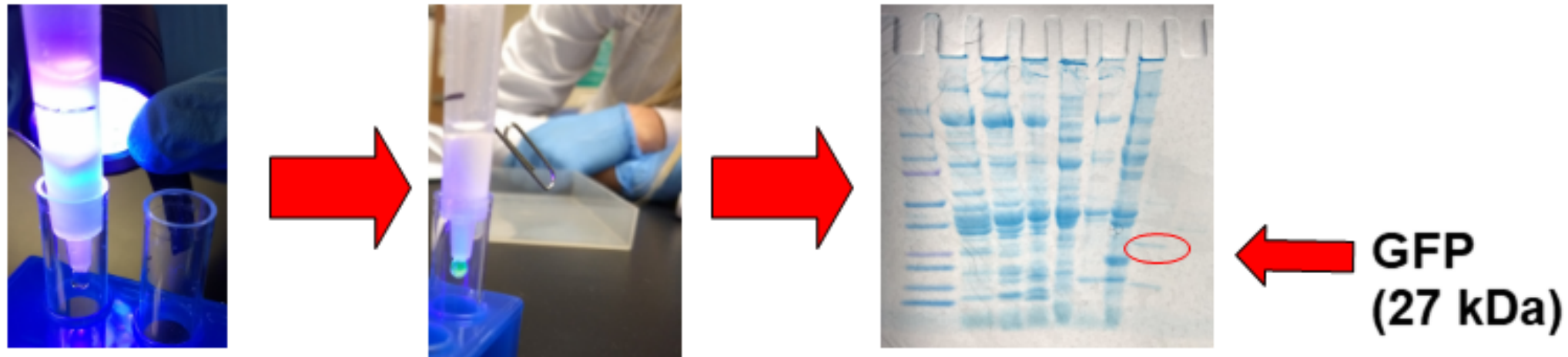
- demonstrate application of industry knowledge and theoretical concepts in biotechnology related to a transfer degree level career as written in the minimum three (3) learning objectives created by the student and their employer or work site supervisor at the start of the course.
- make effective decisions, use workforce information, and manage their personal career plans.
- behave professionally, ethically, and legally during work, consistent with applicable laws, regulations, and organizational norms.
- behave responsibly during work, exhibiting initiative and self-management in situations where it is needed.
- apply effective leadership styles during work, with consideration to group dynamics, team and individual decision making, and workforce diversity.
- communicate in oral, written, and other formats, as needed, in a variety of contexts during work.
- locate, organize, evaluate, and reference information during work.
- demonstrate originality and inventiveness during work by combining ideas or information in new ways, making connections between seemingly unrelated ideas, and reshaping goals in ways that reveal new possibilities using critical and creative thinking skills such as logical reasoning, analytical thinking, and problem-solving.

Course and Curriculum Updates

Lab Courses

Reworking labs to be more connected and include more unknown outcomes and authentic learning experiences (ALEs)

Recently added Western blots, currently developing qPCR lab

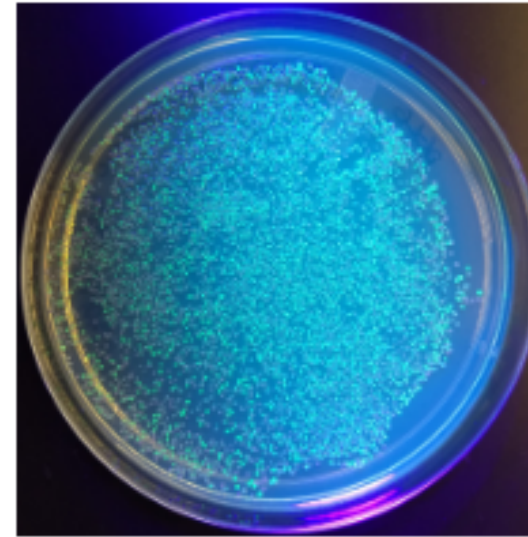
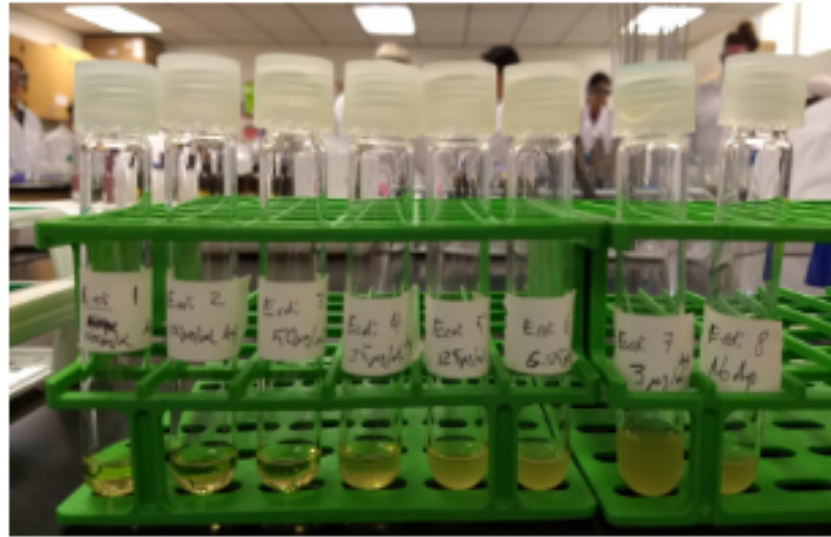


For SIRIUS II project (in collaboration with Sacramento State), we have adapted existing labs for a Bioprospecting ALE screening soil microbes for amylase production



Course and Curriculum Updates

Lab activities for other BIOL courses to raise awareness of our Biotech program



Currently beginning to update several of our course curricula:

BIOT 305 (Intro to Bioinformatics)

BIOT 307 (Biotech and Society)

Suggestions for new topics to include/emphasize???



BIOTECHNOLOGY

Equipment Updates

New Equipment in last few years:

Nanodrop

Bioanalyzer (donation from Bayer!)

Gel Doc System

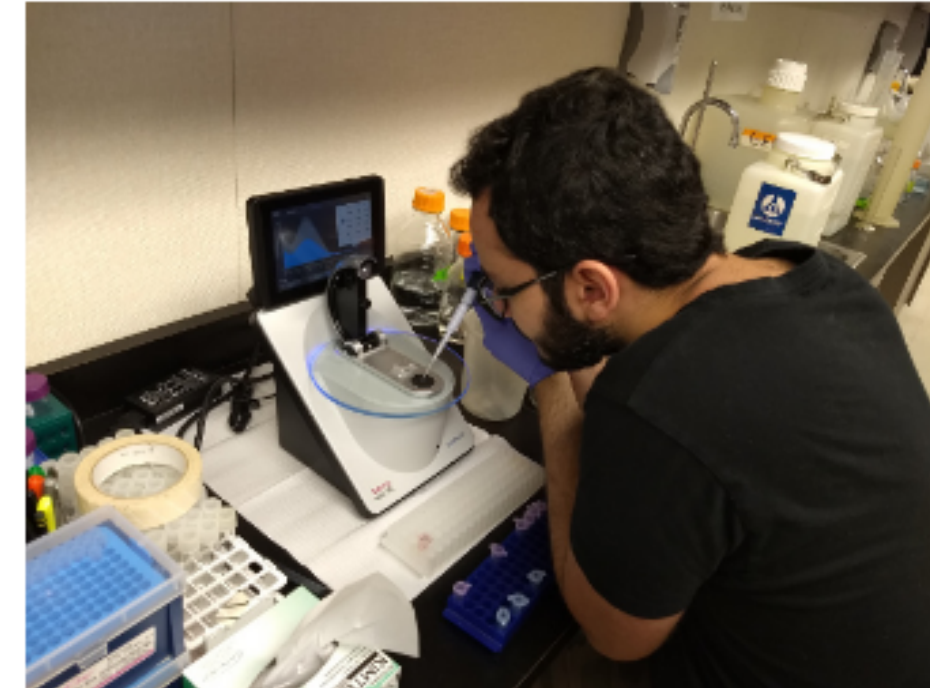
-80C Freezer

Autoclave

Western blot transfer device

qPCR machine

Tissue homogenizer



ARC BIOTECHNOLOGY

Activities outside of formal courses include...

Field trips

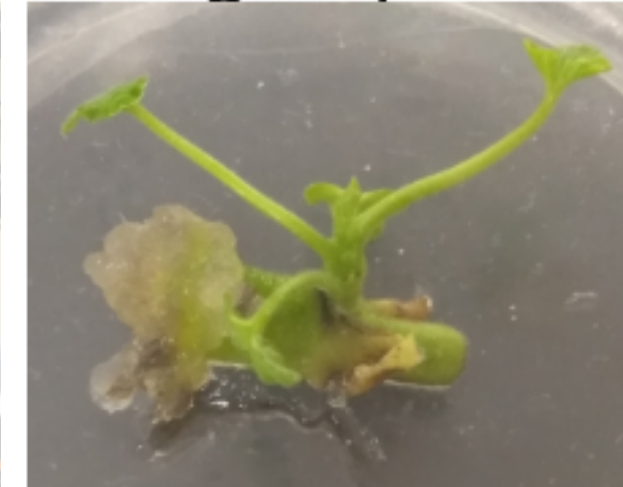
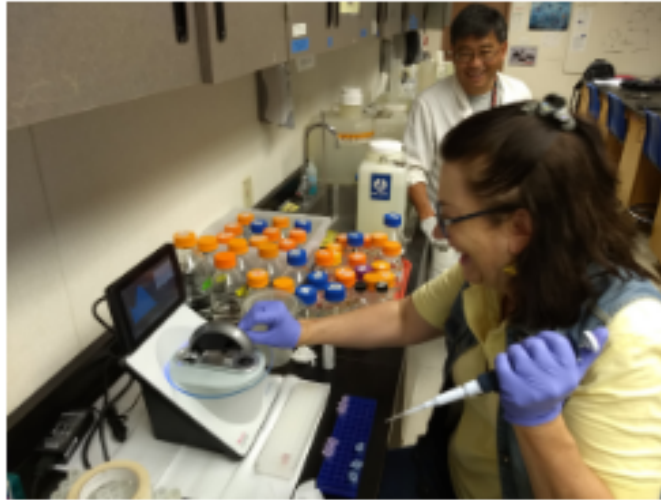
Past outings: Davis Genome Center Symposia, Lab tours (CSUS, USDA, etc.),
Conferences (e.g. SynBioBeta)



BIOTECHNOLOGY

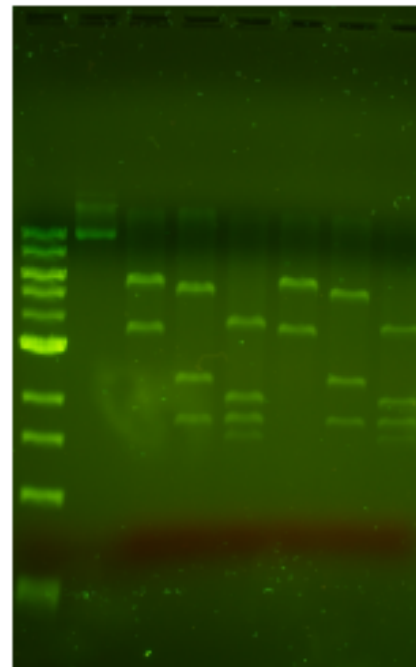
Activities outside of formal courses include...

Biotech Club and REAL STEM Coalition student research group



Activities including...

- Basic Lab Skills
- DNA extraction
and analysis
- Plasmid transformation
- PCR
- GMO testing
- Plant tissue culture



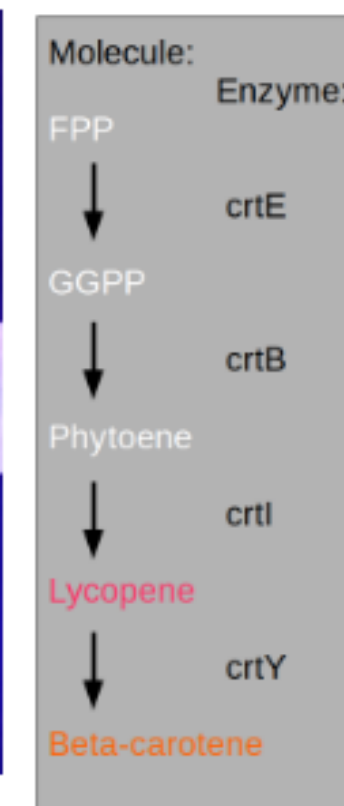
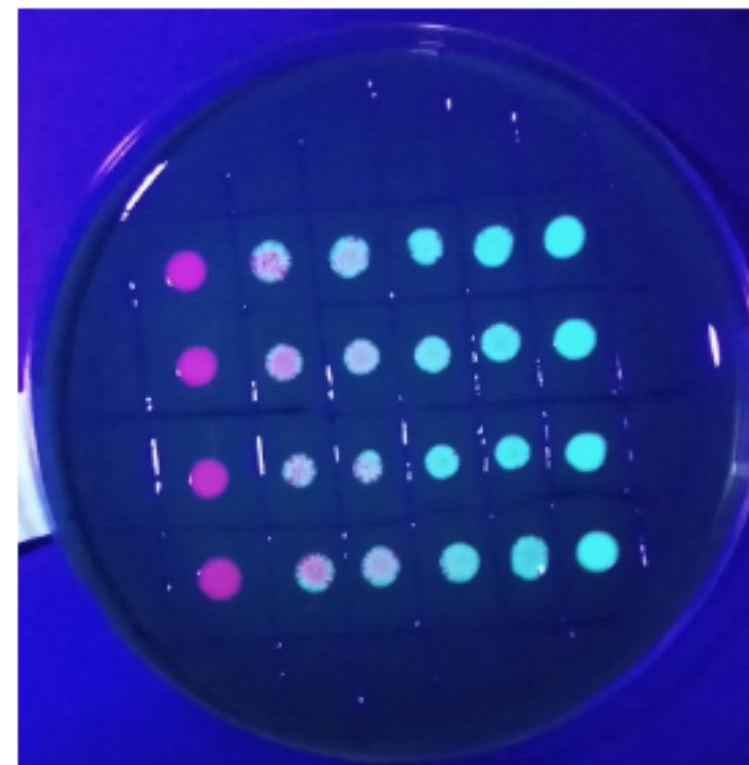
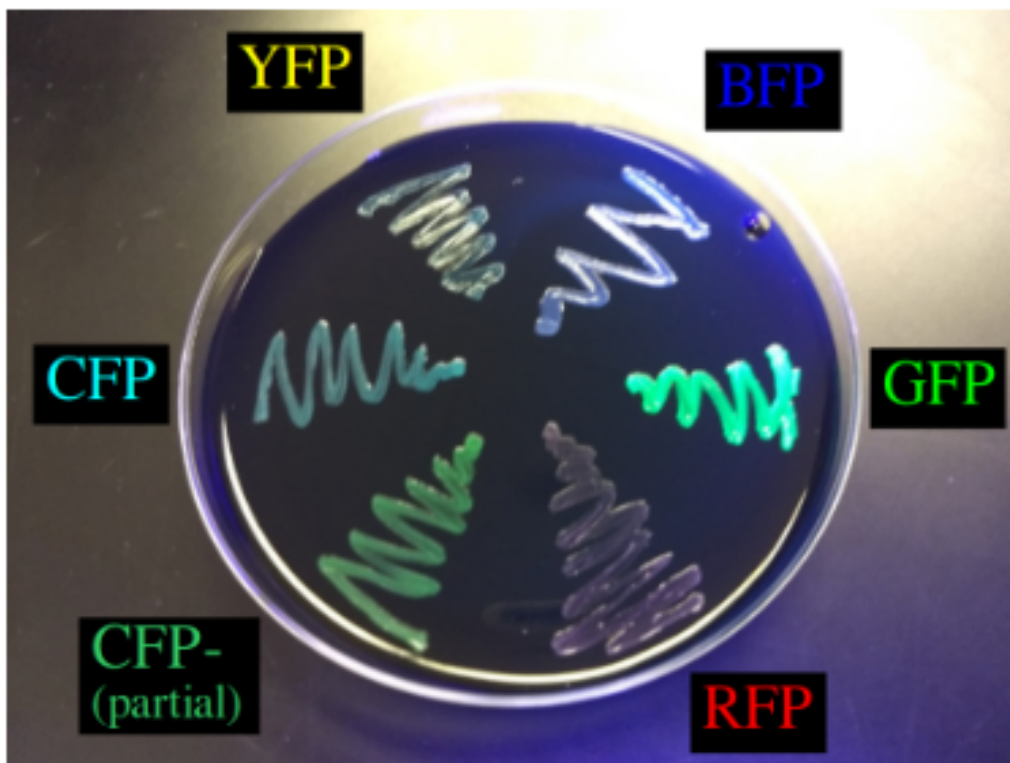
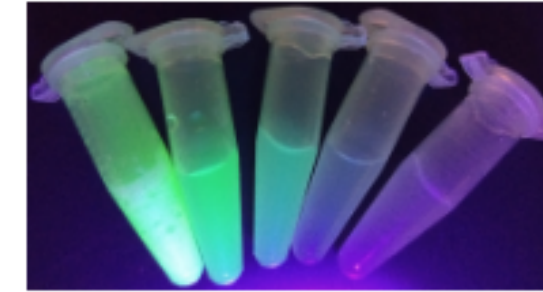


BIOTECHNOLOGY

We have multiple on-going lab projects for students to get involved outside of class

Project Examples:

- pGLO mutagenesis to create color variants
- Engineering pigment producing strains of *E. coli*
e.g. cloning Carotenoid biosynthesis genes from *P. agglomerans*
- Glowing geranium (early stages)
- American River Water Metagenomics project (early stages)





Impact of COVID-19 on Our Program

BIOT 312 cancelled for Spring 2020 semester

Campus closure occurred between 8-week courses

Lab courses were not offered in Fall 2020 or Spring 2021

Could not access lab to continue development of lab materials

We returned to on ground classes in Fall 2021!

Enrollments declined forcing cancellation of lab courses

Student preparedness has been negatively impacted!



Current Challenges

Low Enrollments

This is an issue across all CCC Biotech programs!

How to raise awareness and bring more students in?

Outreach/Advertising

More hands-on practice for students

Independent study, Work Experience students

Projects, e.g. Metagenomics

Finding internship and job opportunities

Tracking student data after they leave program

Lab facilities need updating



Questions, Comments, Suggestions???

You can find out more about ARC's Biotech program at:
<https://arc.losrios.edu/academics/programs-and-majors/biology-and-biotechnology> and/or reach out to me at
telleea@arc.losrios.edu

The screenshot shows the official website for the American River College (ARC) Biology and Biotechnology program. The browser address bar displays the URL: <https://arc.losrios.edu/academics/programs-and-majors/biology-and-biotechnology>. The website header includes the ARC logo, the text "AMERICAN RIVER COLLEGE" and "LOS RIOS COMMUNITY COLLEGE DISTRICT", and navigation links for "STUDENT LOGIN", "APPLY", "EMPLOYEES", and social media icons. A dark blue navigation bar contains links for "Why ARC?", "Admissions", "Academics", "Student Resources", "Campus Life", and "About Us". Below this, a breadcrumb trail reads "Home > Academics > Programs and Majors > Biology and Biotechnology". The main content area is titled "Biology and Biotechnology" and features a tabbed interface with "OVERVIEW" selected. The "OVERVIEW" tab shows a large image of a student using a microscope. To the left of the main content is a sidebar with a "Programs and Majors" section containing links for "Course Families", "Course Numbering", "College Catalog", "Degree Planner", and "Study Abroad". Below this is a "Check Out Degree Planner" section with a brief description and a "DEGREE PLANNER" button. At the bottom of the page, a paragraph describes the program's focus on meeting future challenges and improving human life.

https://arc.losrios.edu/academics/programs-and-majors/biology-and-biotechnology

AMERICAN RIVER COLLEGE
LOS RIOS COMMUNITY COLLEGE DISTRICT

STUDENT LOGIN • APPLY • EMPLOYEES • • • •

Why ARC? Admissions Academics Student Resources Campus Life About Us

Home > Academics > Programs and Majors > Biology and Biotechnology

Programs and Majors

- Course Families
- Course Numbering
- College Catalog
- Degree Planner
- Study Abroad

Check Out Degree Planner

If you're interested in a transfer degree (AA-T or AS-T), then check out Degree Planner, a tool that helps you complete your degree efficiently by mapping out what courses to take and when to take them.

DEGREE PLANNER

Biology and Biotechnology

OVERVIEW DEGREES/CERTIFICATES COURSES FACULTY

Biologists are fully engaged in meeting the challenges of the future, helping to improve the quality of human life and preserve our world's biodiversity. The Biology courses at ARC provide students with the breadth and depth of knowledge necessary to more fully understand the living world. The Biology Department offers a wide range of lecture, laboratory, and field courses for majors and non-majors alike, whether for transfer, vocational training, or

➤ Thank you for joining!

For more information, please contact:
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Please remember to take the post-event survey!