Consortium for Pediatric Cellular Immunotherapy

Symposium: Biomanufacturing Workforce

March 20, 2023

CPCI
Consortium for Pediatric Cellular Immunotherapy

AGENDA

Setting the Stage
Julie Park, MD

GMP Needs & Strategies for Addressing | CHLA Perspective
Mohamed Abou-el-Enein, MD, PhD, MSPH

University of Washington Programs
Teddy Johnson, PE, MBA

Shoreline Community College Programs
Guy Hamilton, PhD

Open Discussion

Biomanufacturing Workforce Development

Mohamed Abou-el-Enein, MD, PhD, MSPH
Executive Director, USC/CHLA Cell Therapy Program
Associate Professor of Clinical Medicine (Oncology), Pediatrics,
and Stem Cell Biology & Regenerative Medicine

March 20, 2023

Disclaimer

Certain commercial products, equipment, instruments and materials mentioned in this presentation should not be considered as a recommendation or endorsement nor does it imply that these products are necessarily the best available for the purpose.

Agenda

- *USC/CHLA Cell Therapy Program*
- *Biomanufacturing of Cell Therapies*
- *Workforce Required Skills*
- *Workforce Challenges*
- *Approaches to Improve Workforce Training*
- *Summary*

USC/CHLA Cell Therapy Program

- ✓ Launched in 2021 with investment from **Keck School of Medicine (KSOM) of USC, Keck Medicine (KM) of USC, and Children's Hospital Los Angeles (CHLA).**
- ✓ Create a mature **ecosystem** for clinical translation of cell and gene therapy research.
- ✓ Provide comprehensive support; from strategic planning and **training** to product manufacturing and quality testing.

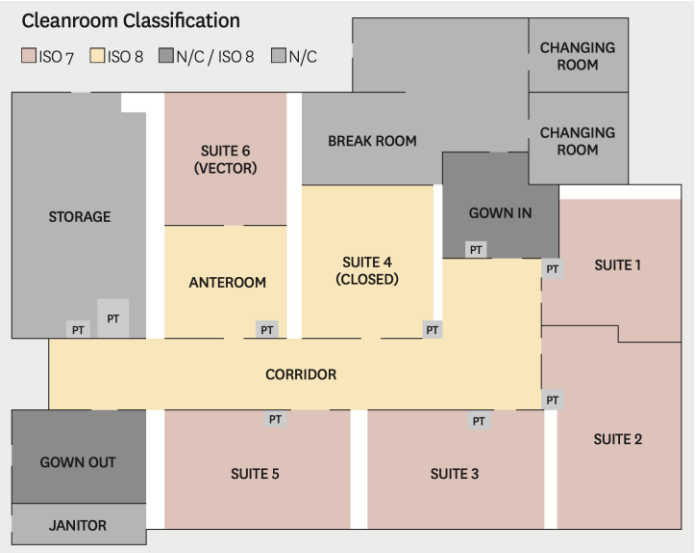
USC/CHLA cGMP Facility

The cGMP facility spans **3,184 sf** and has:

- Four ISO-7 cleanrooms for product manufacturing
- One ISO-7 cleanroom for vector manufacturing
- One ISO-8 closed system manufacturing

Supporting infrastructure:

- 800 sf **Quality Control lab**
- 300 sf **Process Development lab**
- Storage area



USC/CHLA cGMP Capabilities

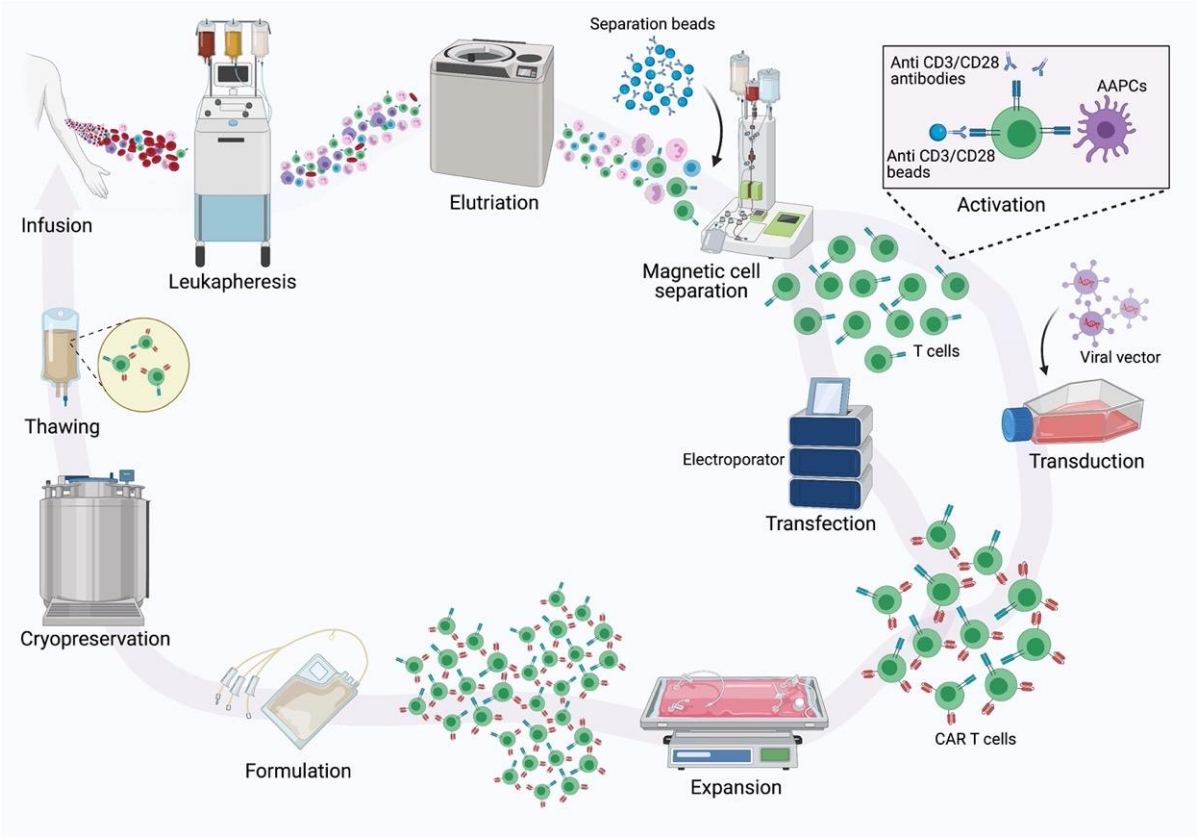
What is GMP?

- Availability of well-trained personnel with precise allocation of responsibilities
- Premises and equipment with proper maintenance, suitable for the intended use
- Acceptable specifications for materials, intermediates products, and finished product
- Documentation management system
- A quality control (QC) system that is operationally independent of the manufacturing
- Identification of defects and deviations, investigation of causes, and taking appropriate measures
- Ensure traceability of manufactured products and corresponding starting and critical raw materials

Why Cell Therapy Manufacturing is Complex?

- Challenges with securing sufficient starting biological material
- Variability concerns arising from the complexity of biological raw materials
- Intricate mechanisms of action involving multiple pathways
- Labor-intensive processes with risks of contamination and inconsistencies between batches
- High costs and complexity associated with production process

Biomanufacturing of Cells



Abou-el-Enein et. al. Blood Cancer Discov., 01 September 2021

cGMP Manufacturing: Required Skills

Process Development:

- ✓ Proficiency in process design, optimization, and scale-up/scale-down
- ✓ Current with latest manufacturing technologies and innovations
- ✓ Experience in tech transfer and risk management
- ✓ Strong project management and organizational skills
- ✓ Continuous improvement mindset and adaptability to change

Product Manufacturing:

- ✓ Proficiency in advanced aseptic and cell culture techniques
- ✓ Familiarity with cGMP laboratory operations and requirements
- ✓ Knowledge of equipment operation, maintenance, and troubleshooting
- ✓ Adherence to safety procedures and risk management practices
- ✓ Flexibility to work in shifts and adapt to changing priorities

cGMP Manufacturing: Required Skills

Quality Control:

- ✓ Strong biomolecular background for assay development
- ✓ Proficiency in analytical methods and instrumentation
- ✓ Experience in method validation, verification, and troubleshooting
- ✓ Statistical process control and data analysis skills
- ✓ Strong documentation practices and adherence to quality standards

Quality Assurance:

- ✓ In-depth understanding of cGMP regulations and compliance
- ✓ Balanced skillset of regulatory, compliance, and technical knowledge
- ✓ Experience in internal and external auditing and inspection
- ✓ Proficient in root cause analysis and CAPA implementation
- ✓ Familiarity with quality management systems and continuous improvement

cGMP Manufacturing: Workforce Challenges

1. Limited personnel availability and high turnover rates
2. Insufficient sector-wide knowledge among early career professionals
3. Reluctance among early career professionals to pursue cGMP roles
4. Rapid transition to industry due to higher financial incentives, challenging academia's ability to compete
5. Intensive, time-consuming, and independent tasks
6. Unclear time commitment expectations for roles
7. Inadequate recognition for critical sector contributions
8. Few candidates committed to high-demand work environments

cGMP Manufacturing: Our Approach

In-House Training Program
Customized operator training programs tracked through electronic management system (Bluecord)

Educational Courses
Translational Development of Cell and Gene Therapy Course

Monthly Seminars
Invited experts from the cell and gene therapy sector

Volunteering Program
Expanding sector awareness among undergrad students

Engaging in Workforce Training
Center for cGMP Workforce Development

cGMP Manufacturing: Educational Courses

Cell and Gene Therapy Development – Translating Basic Research into Clinical Applications (DSR 599)

- Product Development Life Cycle
- Quality Management Systems
- Good Manufacturing Practice (GMP)
- Regulatory Aspects of Cell-Based Therapeutics
- Industry perspectives on Cell Therapy and Clinical Trials
- Solving a case study on CAR-T cell therapy
- Hand-on Training in the cGMP lab

cGMP Manufacturing: Monthly Seminars

Peter Marks, MD, PhD
Director, Center for Biologics Evaluation and Research (CBER)
U.S. Food and Drug Administration

Marc Ferrer, Ph.D.
Director, 3-D Tissue Bioprinting Laboratory
National Center for Advancing Translational Sciences

Claudia Willmes, Ph.D.
Senior Scientific Editor
Cell

James (Jay) Bradner, M.D.
President of the Novartis Institutes for BioMedical Research (NIBR)

Leigh G. Turner, PhD
Executive Director, UCI Bioethics Program
Professor, Health, Society, and Behavior
University of California, Irvine

Kole Roybal, PhD
Assistant Professor
Department of Microbiology and Immunology
Parker Institute for Cancer Immunotherapy

Mechanism of support: California Institute for Regenerative Medicine (CIRM)

Mission is to accelerate world class science to deliver transformative regenerative medicine treatments in an equitable manner to a diverse California and world.

Educational Programs	USC/CHLA
ALPHA CLINICS (Staff)	• 4-unit course on cell and gene therapy development • Clinical Trial Quality Training
BRIDGES (Undergrad and Masters)	Collabo with Pasadena City College
Research Training Grant (predoctoral, postdoctoral and clinical fellows)	Training Program Bridging Stem Cell Research with Clinical Applications in Regenerative Medicine
COMPASS (Undergrad from underserved communities)	USC COMPASS: Guiding Undergraduates to Careers in Regenerative Medicine

CIRM 5-Year Strategic Plan: Build a diverse and highly skilled workforce to support the growing regenerative medicine economy in California

INFR5 (2023) - Leverage existing education pillar programs and the California manufacturing network:

- Coordinate the development of education curricula and hands-on training program for cell and gene therapy manufacturing at California community colleges and universities.
- Facilitate internship and certification programs in process development, manufacturing, and quality and CMC regulatory career pathways.
- Support recruitment and mentorship programs for the development of manufacturing leaders.

Summary

- cGMP Manufacturing is highly complex and demanding
- The technical skills required for cGMP workforce can varies
- Currently, there is shortage in skilled staff for cGMP manufacturing
- Training program focusing on cGMP workforce development are needed

THANK YOU

QUESTIONS?

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Biomanufacturing Workforce Development

Presented by:

Teddy Johnson, PE, MBA

Clinical Associate Professor - UW School of Pharmacy

Director of Technology Development - ITHS

ITHS | Institute of Translational Health Sciences

ACCELERATING RESEARCH. IMPROVING HEALTH.

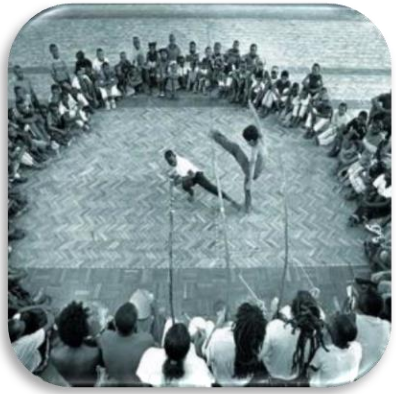
About Me

A.C.T. AMERICAN CONSERVATORY THEATER

Stanford ENGINEERING Mechanical Engineering

MICHIGAN ROSS SCHOOL OF BUSINESS

KERALA ayurveda™ wellness, naturally.



What I Do

My job is to help people
turn research into products
and products into companies.

How do we build the new workforce?

"The culture of our institutions has changed."

Maxine Hayes, MD, MPH, FAAP is a member of the National Academy of Medicine and the former State Health Officer for the Washington State Department of Health.

Supporting Biomanufacturing

The Master of Science in Biomedical Regulatory Affairs is geared to those who want to advance their careers in the medical products industry and those entering the field from related areas. With its uniquely broad focus on drugs, devices and biologics, our program prepares you for a variety of careers in the regulatory affairs industry, including roles in manufacturing, compliance, marketing and quality assurance.

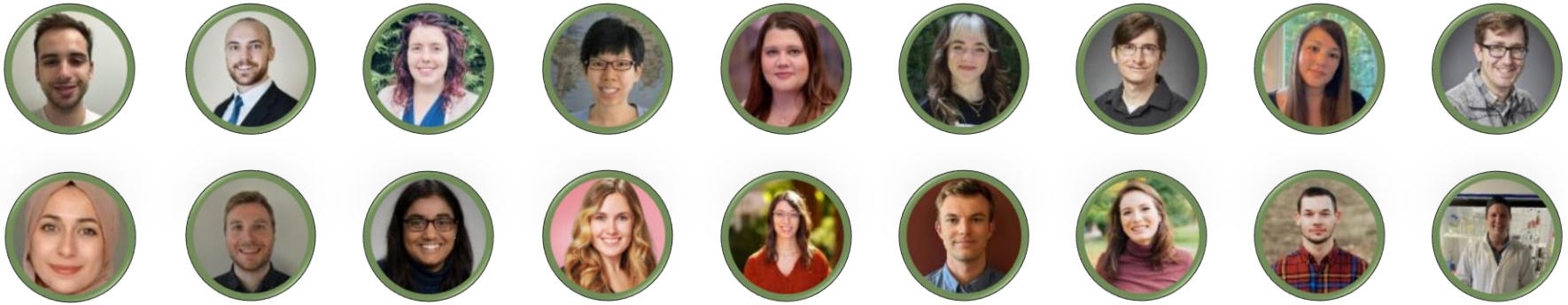
BRAMS offers practical experience.

Sample of Past Student Projects:

- Creation of a Quality System, with focus on the quality manual, as the basis for proof that the product is safe and effective for human use
- Creation of document control system, including the SOP for document control process, SOP for change notice, document and revision numbering procedure, the change order form
- IRB application review and gap analysis
- Preparation of a pediatric study slan for a novel therapeutic monoclonal anitbody
- Planning and preparing a clinical evaluation report for a medical device
- Developing the Risk Management File required for FDA 510(k) submission
- Risk assessment of data security incidents under the EU's General Data Protection Regulation
- Preparation of a European IMPD for a novel Chimeric Antigen Receptor T-cell (CAR-T) therapy
- Investigational New Drug (IND) Application for acetazolamide in the treatment of ataxia symptoms in PMM2-Congenital disorders of glycosylation
- Building a database of all publicly available oncology approvals from US, EU and Canada

ITHS: TL1 Translational Research Training Program

The ITHS TL1 program is a one-year mentored research training program in translational science for predoctoral students. This program creates a cross-disciplinary community of emerging researchers and provides them with specific training, career development opportunities, and team science skills to help them function effectively within translational science teams.



Researcher Training: ITHS Gene and Cell Therapy Lab

The Gene and Cell Therapy Lab (GCTL) provides translational researchers with the infrastructure, training, and technical expertise necessary to develop and manufacture gene-modified cells, vector production, and ex-vivo manipulation of cells for novel gene and cell therapy products under a comprehensive Quality Assurance Program compliant with Good Manufacturing Practices.

Expanding the Pool for the Future

UW Bothell Center for Biotechnology Innovation and Training (CBIT)

The Center for Biotechnology Innovation and Training (CBIT) will serve to increase the number of biotechnology-trained STEM graduates for the growing biotechnology industry in Bothell and the greater Puget Sound region. CBIT will also facilitate collaborative biotechnology research for faculty and students, with industry. CBIT will house a university-wide multidisciplinary core of UWB faculty with expertise in multiple areas of biotechnology, such as chemistry, biology, engineering, physics, computer science, health studies, business, and policy studies. Affiliate faculty from outside UWB, especially from the local biotech industry, will become an integral part of the teaching and training core. UWB students, including those traditionally underrepresented in STEM, will receive specialized hands-on training in biotechnology skill sets required by regional and national industry for both entry level and advanced jobs.

How do we efficiently connect the talent with jobs?

Face the Facts: Industry Pays 2X

They’re going to leave,
so develop efficiencies in
recruiting and training.

Casting a broad net isn't always helpful.

AI without human intervention is like…

…shrimp "bycatch."

Sharing “Secrets”

50 BEST FISHING SPOTS IN SEATTLE AND KING COUNTY (2023 UPDATE)

by Eric Apalategui

Photo by Alabastro Photography, courtesy of Seattle Southside Regional Tourism Authority

Paving Paths

Positive experiences with BRAMS students has led to lasting relationships with Seattle Genetics, Genentech, and more. Regulatory HR would be happy to fill all positions with BRAMS students.

Remember: Representation Matters to Future Generations!

Questions?

Visit ITHS
Technology Development Center

https://www.iths.org/technology-development-center/

Teddy Johnson
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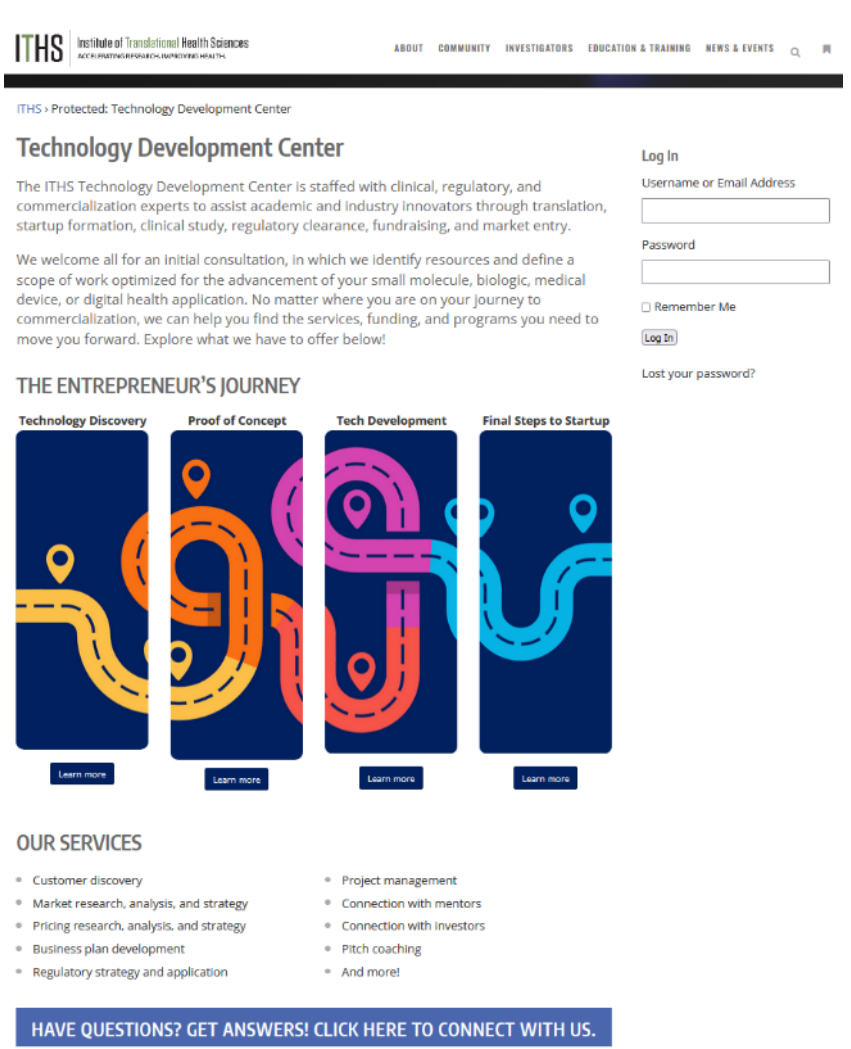
ACCELERATING RESEARCH. IMPROVING HEALTH.



Innovation, Partnerships, and Future Planning at Shoreline Community College

Shoreline
COMMUNITY COLLEGE
Engage. Achieve.

Shoreline Industry Partnerships – Automotive

- Toyota, GM, Honda, Chrysler
  - Students alternate between on campus coursework and co-op learning in dealerships. 1-2 year programs
  - Student recruited from High School Programs and from dealerships
  - Program outcomes linked to internationally recognized industry certifications
  - Dealerships reimburse students for tuition and tools

Innovative Partnership – Tesla Electric Vehicle Training Program

- Multiple pathways for student recruitment from Shoreline programs, nationally and internationally - Tesla leads student recruitment process
- 16-week full time training program
- Students hired and paid as interns while taking Shoreline courses and working in Tesla Service Center – located on the Shoreline
- 97% conversion rate for students in the program – nationwide job placement

Innovative Biotechnology and Biomanufacturing Partnerships

- Multiple regional employers expanding in the Biomanufacturing sector have identified this as a critical workforce need
- Specific educational programs developed for adult learners and High School school students

Essentials of Biomanufacturing Training program

- Entry level Biomanufacturing associates Training program
- Course outcomes and assessment methods developed in partnership with Bristol Meyers Squibb, Seagen and AGC Biologics
- Low math and science requirements to begin the program
- Work with High School partners to develop courses accessible to running start students
- Create multiple on-ramps for the training program

On Ramps for Biomanufacturing Training

High Schoolers

- Essentials of Biomanufacturing Certificate
- Biotech Lab Technician Training Program

Adult Learners

- 10-Week Essentials of Biomanufacturing Certificate

(1) Essentials of Biomanufacturing Training program – High School track

- Developed in partnership with AGC Biologics and Edmonds School District – formerly “BioPath” program
- High school juniors recruited using extensive High School teacher network develop through Biotech outreach program
- Looking for students not necessarily interested in a 4-year STEM degree
- Students enroll via running start in one 3 credit Biomanufacturing Lab course per quarter – NO need to rearrange a full senior year schedule of classes

(1) Essentials of Biomanufacturing Training program – High School track

- Courses held at the AGC Biologics Biomanufacturing training site
- Industry Partners - Parse Bioscience, NovoNordisk, Fred Hutch, Nanostring, AGC Biologics provide:
  - Industry mentors for the length of the program
  - Career Panels, Facility Tours
- Students earn Basics of Biomanufacturing Certificate and credits towards the Biotech Lab Technician AAAS degree

(2) 10 Week Essentials of Biomanufacturing Training program

- Entry level Training program for adult learners
- Recruiting with CBOs supporting underrepresented populations, Health Occupations Training Programs
- Accelerated version of the the year-long high school program - 10 weeks (1 quarter)
- No degree or science background required
- Paired with a paid internship with regional biomanufacturing company

Bristol Myers Squibb™

Seagen®

(2) 10 Week Essentials Course Sequence

Course	Description	Modality	Length	Credits
First five weeks of quarter				
BIOL 248	Intro to Regulatory Affairs	Online	5 weeks	2
BIOL 245	Intro to Aseptic Technique	In Person	5 weeks	2
Second five weeks of quarter				
BIOL 246	Intro to Bioreactors & Cleanroom Dynamics	Hybrid	5 weeks	2
BIOL 247	Quality Control & Quality Assurance	Online	5 weeks	2

(3) Biotech Technician Training Program– High School track (launch 2023)

- Developed in partnership with Fred Hutch and Shoreline School District
- Students will Complete a 1-year Biotech Technician certificate program at Shoreline
- Graduates would receive required training to work in any of the Fred Hutch Basic Sciences divisions as an entry level Lab Technician

(3) Biotech Technician Training Program– High School track (launch 2023)

Year			Certificate Activity
2023	**Junior Year**	**Summer**	Fred Hutch Internship 1
2023-2024	**Senior Year**	**Academic year**	Principles of Biomanufacturing @ SCC • 9 college credits (Running Start) • 1 course per quarter (Sept-June)
	Senior Year	**Summer**	Fred Hutch Internship 2
2024-2025	**Post High School**	**Sept-Aug**	Full-time classes @ SCC • 13-15 credits per quarter • Classes articulate to AAAS Biotech Degree

(3) Biotech Technician Training Program– Courses taught at shoreline

Quarter	Courses
Fall	College success, Cell Biology, Statistics, Solution and media prep
Winter	Molecular biology, microbiology, business studies – computer applications
Spring	Cell culture, recombinant DNA techniques, Business communications
Summer	Two of – Bioinformatics, protein biochemistry, flow cytometry, molecular medical diagnostics

Building Training Pathways to Industry

- *Dedicated student support for recruitment, outreach, and program success – Program Navigators*
- Develop relationships with aligned high school programs
- Design lower credit courses college course that function as an onramp to a credential or degree
- Work with CBOs that support underrepresented populations
- Engage with industry to design course outcomes and assessments
- Involve industry HR, College Foundation, Marketing and Outreach in process