

Biotechnology Research Education

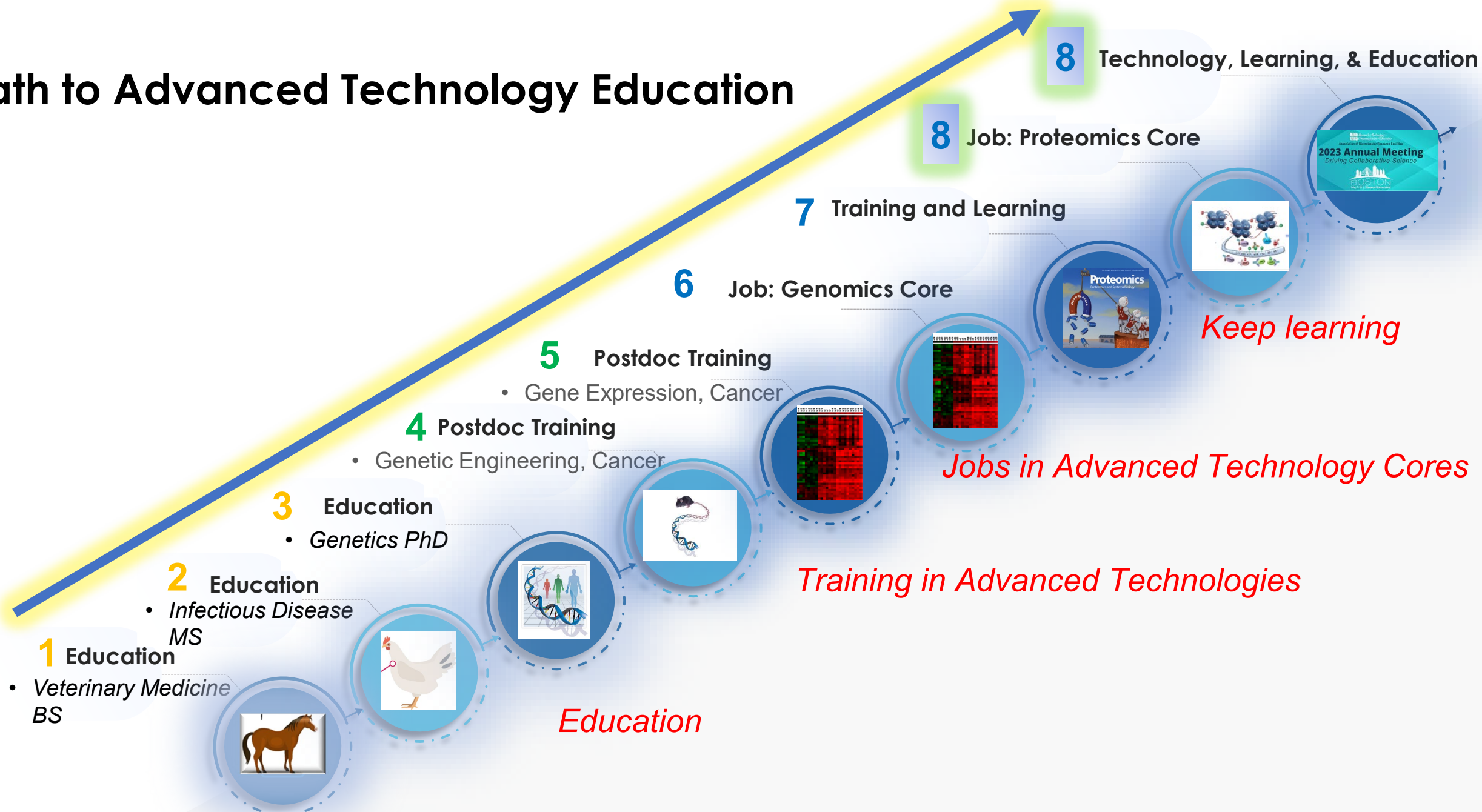
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Professor, Department of Molecular & Cellular Biology
Department of Education, Innovation & Technology

ABRF SC3

October 9, 2024

Path to Advanced Technology Education



Education

Training in Advanced Technologies

Jobs in Advanced Technology Cores

Keep learning

What Do We Do (1)

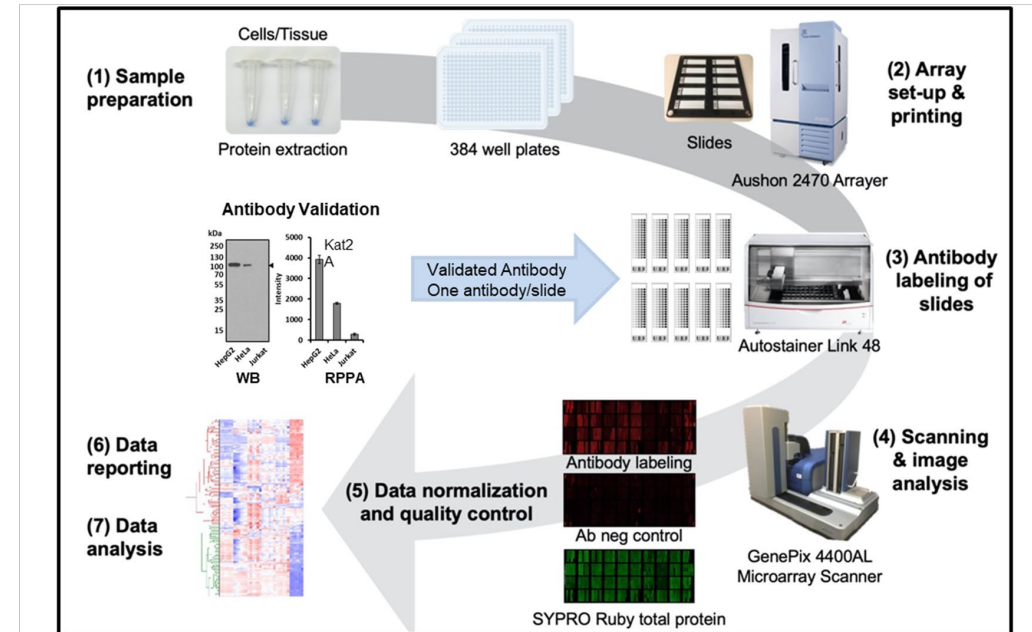
Building a Comprehensive Core Facility and Services

Summary:

- High-throughput antibody-based proteomics platform
- Quantifying hundreds/thousands of samples simultaneously
- Analyzing ~300 validated antibodies
- Core services to researchers around the world

Grant Supports:

- NIH S10 Instrument Award (S10OD028648).
- Cancer Prevention & Research Institute of Texas (CPRIT RP210227)
- NCI Cancer Center Support Grant (P30CA125123)



Coarfa et. al. Reverse-Phase Protein Array: Technology, Application, Data Processing, and Integration. *J Biomol Tech.* 2021 Apr;32(1):15-29. PMID: 34025221; PMCID: PMC7861052.



ADVANCED TECHNOLOGY CORES

Antibody-Based Proteomics

- Bioengineering
- Biostatistics and Informatics Shared Resource
- Core for Advanced Magnetic Resonance Imaging (CAMRI)
- Cell-Based Assay Screening Service (C-BASS)
- Cryo Electron Microscopy (CryoEM)
- Cytometry and Cell Sorting
- Gene Vector
- Genetically Engineered Rodent Models (GERM)
- Genomic & RNA Profiling (GARP)
- Human Tissue Acquisition and Pathology (HTAP)
- Human Stem Cell And Neuronal Differentiation Core (HSCND)
- Integrated Microscopy
- Macromolecular X-Ray Crystallography
- Mass Spectrometry Proteomics
- Metabolomics
- MHC Tetramer
- Mouse Metabolism and Phenotyping Core
- NMR and Drug Metabolism
- Optical Imaging and Vital Microscopy (OIVM)
- Patient-Derived Xenograft and Advanced *In vivo* Models Core
- Population Sciences Biorepository (PSB)
- Protein and Monoclonal Antibody Production
- RNA *in situ* Hybridization
- Single Cell Genomics Core
- Zebrafish
- Core Directory

ANTIBODY-BASED PROTEOMICS

This Core provides customized services for high-throughput protein profiling by antibody-based proteomics platforms. These platforms provide targeted quantitative assays both for validation and protein biomarker discovery research, particularly for low abundance regulatory proteins, activation states of proteins with antibodies to specific phosphorylation sites and epigenetic core histone post-translation modifications. Services provided include reverse phase protein arrays (RPPA), Luminex bead technology for multiplex quantitative analyses of intracellular and extracellular signaling proteins and an Ella Automated Immunoassay System that performs assays similar to ELISA, but with the advantage of requiring smaller sample materials and incorporating automation.

MAJOR EQUIPMENT

- Bio-Plex 200 Luminex bead reader (Bio-Rad)
- Luminex bead washer (Bio-Tek ELx405)
- Ella Automated Immunoassay System (BioTechnique)
- Quanterix 2470 Microarrayer (Quanterix)
- Dako Autostainer Link 48 (Agilent)
- Axon Array Scanner 4200AL and GenePix software (Molecular Devices)
- TissueLyzer II (Qiagen)
- Molecular Devices Spectramax 340PC Plate Reader

SERVICES

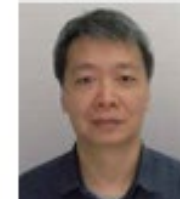
- Consultation and experimental design.
- Protein sample preparation.
- Reverse Phase Protein Array assays. High density microarrays spotted with researchers' protein lysates and probed with validated specific antibodies (>260) to proteins and phosphorylation sites of major protein signaling pathways.
- RPPA epigenetic panel. Profiling of a wide range of histone post-translational modifications (PTMs) and histone and chromatin modifier proteins.
- Luminex bead assays (Luminex xMAP technology) for highly sensitive quantitative measurement with very small protein lysate or serum samples.
- Ella Automated Immunoassay System performs assays similar to ELISA with the advantages of full automation, higher sensitivity and smaller sample materials requirement. The system is suitable for clinical studies and research projects with limited materials or large numbers of samples.
- Image analyses of protein/antibody microarrays.
- Data management and analysis (Q/C, normalization, statistics and differential analysis).



CORE LEADERSHIP



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Biotechnology Research Education

- Secondary School Teacher Training Program
NIH R25 Biotechnology Research Incubator for Teachers (BRITE)
- College Student Summer Research Program
NIH P20 BCM-TSU CURED CREP Program
- High School Student Program and Symposium

WWW.BCM.EDU/BRITE

Biotechnology Research Education

Genomics & Proteomics Technologies & Applications

Technology expertise

Training background



Education & Training Pilot

Internal funding

Establishing programs



NSF or NIH funding

Dreaming...

Support and Grants

➤ Internal funding :

- Dept of Education, Innovation and Technology, BCM
- Huffington Foundation pilot grant
- Lester & Sue Smith Breast Center
- Sealy Center for Environmental Health and Medicine, University of Texas Medical Branch

➤ NSF or NIH grant funding:

- Applying

BRITE History



Teachers Externship	BCM-BRITE Initiation, Dept EIT	Huffington Foundation Dept EIT grant	Fundraising: Breast Center UTMB	NIH grant funding Science Education Partnership Award
2 days virtually In 2 weeks Mentors to teachers Classroom lessons	2 weeks Summer training Lesson plans	3 weeks Summer Training Lesson Plans	3 weeks Summer Training Literature adaptation Lesson Plans	3 weeks summer Year-round Literature adaptation Lesson plans
10 teachers	4 teachers	3 teachers	3 teachers	12-16 teachers

Applying for and receiving the NIH grant



Katherine Harris¹, Beatriz Perez-Sweeney¹, Katie Holtman², Shixia Huang^{1,3}

¹Department of Education, Innovation & Technology, ²Office of Communications and Outreach, ³Advanced Technology Cores
Baylor College of Medicine

Background

Teachers are the most influential determinants of a student's success in life. In STEM+M (Science Technology Engineering, Mathematics and Medicine), teachers foster students' problem solving and critical-thinking skills, and ultimately have the power to unlock students' passions and mentor the next generation of scientific leaders. We observed that most science teachers' scientific experiences were limited. Without opportunities for advanced scientific training and hands-on experience themselves, it is incredibly challenging for these teachers to be expected to provide real-world scientific experiences to adequately prepare students for futures in STEM+M.

Objectives

We started the Teacher Externship this summer, pairing teachers with scientists at BCM and exposing them to cutting-edge research, coupled with collaboration to bring the new knowledge to their students.

The main objectives were:

- Teachers explore cutting-edge research happening in the TMC.
- Scientist mentors work with teachers to design a curricular component that integrates the knowledge or skills learned.

Participants

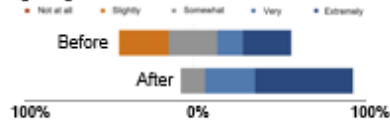
- Eight teachers participated in the BCM Teacher Externship experience.
- 3 Teachers from DeBakey High School for Health Professions
- 5 Teachers from the Baylor College of Medicine Biotech Academy at Rusk
- Seven scientists served as mentors from Baylor College of Medicine

Methods

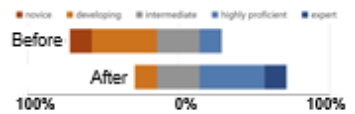
1. Planning – brainstorming program components
2. Recruiting – interested teachers at BCM affiliate Houston ISD schools, scientist mentors from BCM
3. Matching teachers with mentors – based on teaching assignment and scientists' expertise
4. Summer externship program – teachers working with scientist mentors, keynote speakers, panel discussions focused on STEM+M pipeline programs
5. Further development & implementation of projects in teachers' classrooms
 - Teacher visits to scientists' labs; scientist visits to schools
 - Innovative programs currently under development will be implemented throughout the 2021-2022 school year
6. Program Evaluation – Survey teachers at the conclusion of the summer program and again at the end of the school year

Results

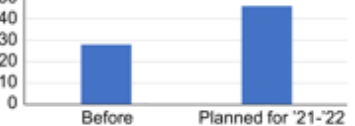
Teacher perception of teachers' level of comfort integrating health science content into their classroom:



Teacher perception of their ability to communicate current health science research to their students:



STEM+M Strategies Used by Teachers Before and After



Summaries & Conclusions

- Teacher participants gained comfort in incorporating knowledge and skills
- Teachers gained confidence in their ability to communicate knowledge of current health science research.
- 7 out of the 8 teachers plan to continue collaborating with mentors to bring real-world scientific experiences to students.
- Development of research enrichment class at Rusk Middle School this year.
- Lesson design on randomized controlled trial for student internship program.

Future Direction

Biotechnology Research Incubator for Teachers (BCM-BRITE)



Acknowledgements

Mentor scientists and keynote speakers include Dr. Jeffrey Yau, Dr. Ricardo Nulia, Dr. Andrew Childress, Dr. Shixia Huang, Dr. Jimmy Wu, Dr. Anil Panigrahi, Dr. Robia Pautler, Dr. Rayne Rouce, Dr. Aimee Gardner, and Dr. Nancy Moreno. BCM Pipeline student panel comprised of current and former students of BCMA Ryan, BCMA Rusk, DeBakey HS, and Baylor College of Medicine.

Teacher participants

- **Gained comfort** in incorporating knowledge and skills
- **Gained confidence** in their ability to communicate knowledge of current health science research.
- **7 out of the 8** teachers plan to continue collaborating with mentors to bring real-world scientific experiences to students.
- **Development of research enrichment class** – for COVID Vaccine.

BRITE History



2021	2022	2023	2024	2025
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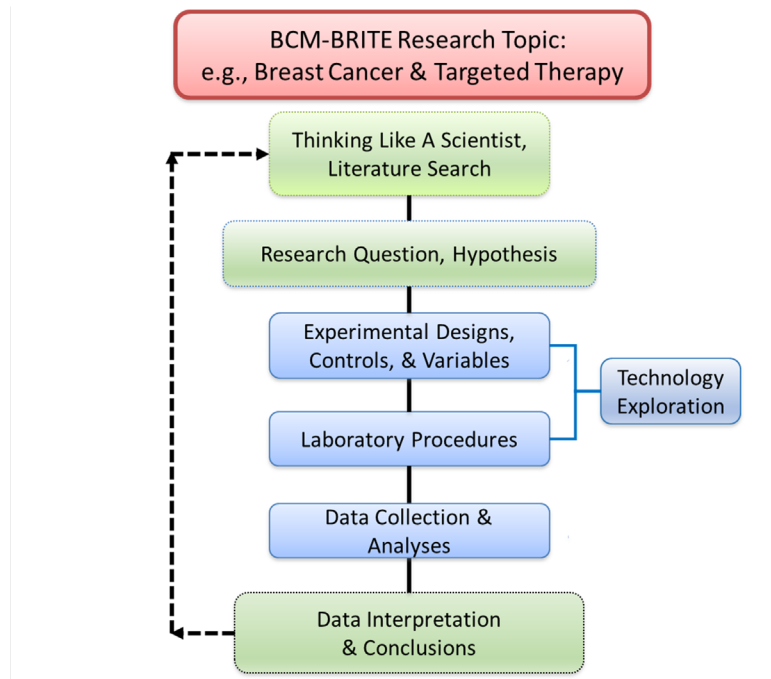
Applying for and receiving the NIH grant

METHODS

Before Summer:

- Recruit 4 teachers and match with lab mentors
- Teacher Summer Pre-survey

Summer research experience:
2 weeks working with scientists and STEM specialists



End of Summer:

- Teacher Summer Post-evaluation

Module 1: Workshops and Discussions

- Cancer biology and genomics & proteomics
- Breast cancer & targeted therapy
- Genomics and Next Generation Sequencing
- Antibody-based Proteomics and Cancer
- Mass Spectrometry Proteomics
- Flow Cytometry Technology and Applications
- Big Data and Multiomic Analysis
- Breast Cancer and Bone Metastasis
- Vaccine Development and Research

Module 2: Core Facility Hands-On Training

- Project design and experimental controls
- Cells and Cell Culture
- Next Generation Sequencing
- Flow Cytometry Technology
- Breast Cancer Progression
- Reverse Phase Protein Array (RPPA)
- Data Analyses & Visualization
- Public Data Mining

Module 3: Literature and Lesson Plans

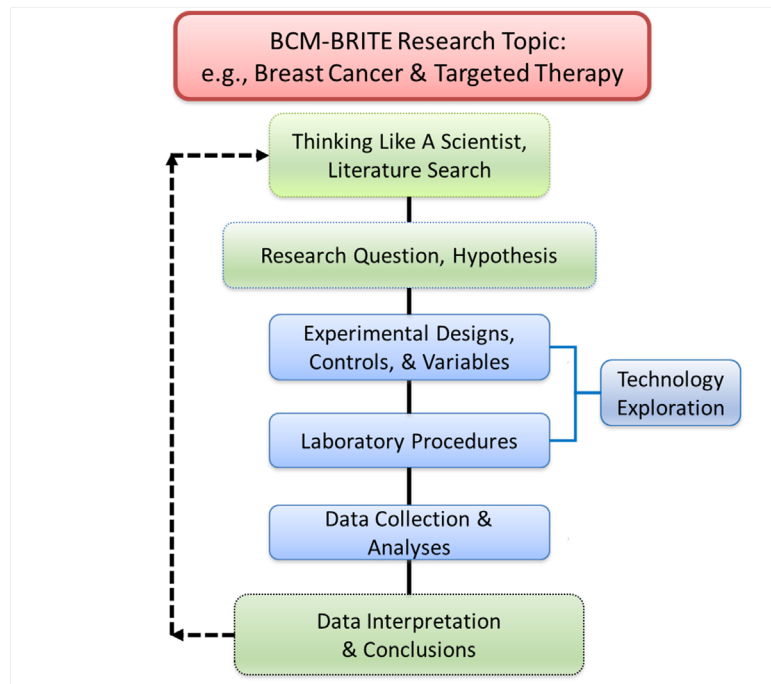
- Reading Scientific Literature
- Thinking Like a Scientist
- STEMM Lesson Plans
- Guided Primary Scientific Literature comprehension
- Final Presentation

METHODS

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Module 2: Core Facility Hands-On Training

- Project design and experimental controls
- **Cells and Cell Culture**
- Next Generation Sequencing
- Flow Cytometry Technology
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Module 3: Literature and Lesson Plans

- Reading Scientific Literature
- Thinking Like a Scientist
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Example: General Technology

Session 7 Cell & Cell Culture

Introduction

...Primary cell culture: The cells of interest are isolated from living tissue, and then they can subsequently be maintained under carefully controlled conditions. ...[Read More](#)

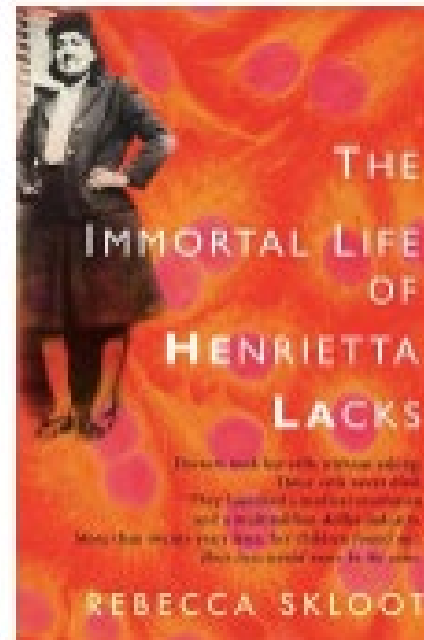
1. Cell Structure



2. Cell Culture Basics



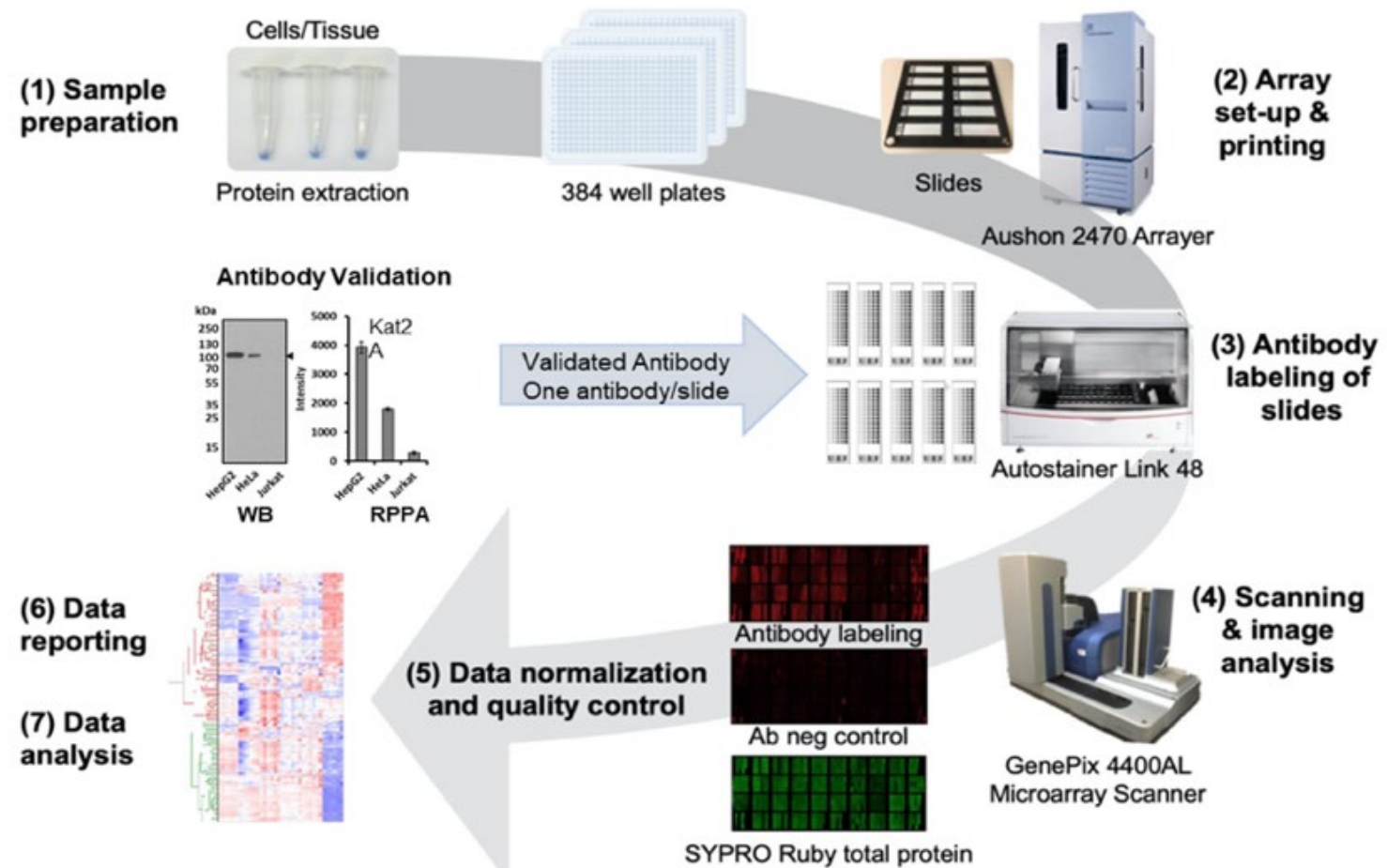
3. Reading



Example: Advanced Technology in Cancer Research

Session 10. Reverse Phase Protein Array (RPPA) Technology

Introduction: RPPA is a high-throughput antibody-based targeted proteomics technology that can quantify hundreds of proteins in thousands of protein extracts[Read More](#)



Program Development

Module 1: Workshops and Discussions

- Cancer biology and genomics & proteomics
- Breast cancer & targeted therapy
- Genomics and Next Generation Sequencing
- Antibody-based Proteomics and Cancer
- Mass Spectrometry Proteomics
- Flow Cytometry Technology and Applications
- Big Data and Multiomic Analysis
- Breast Cancer and Bone Metastasis
- Vaccine Development and Research

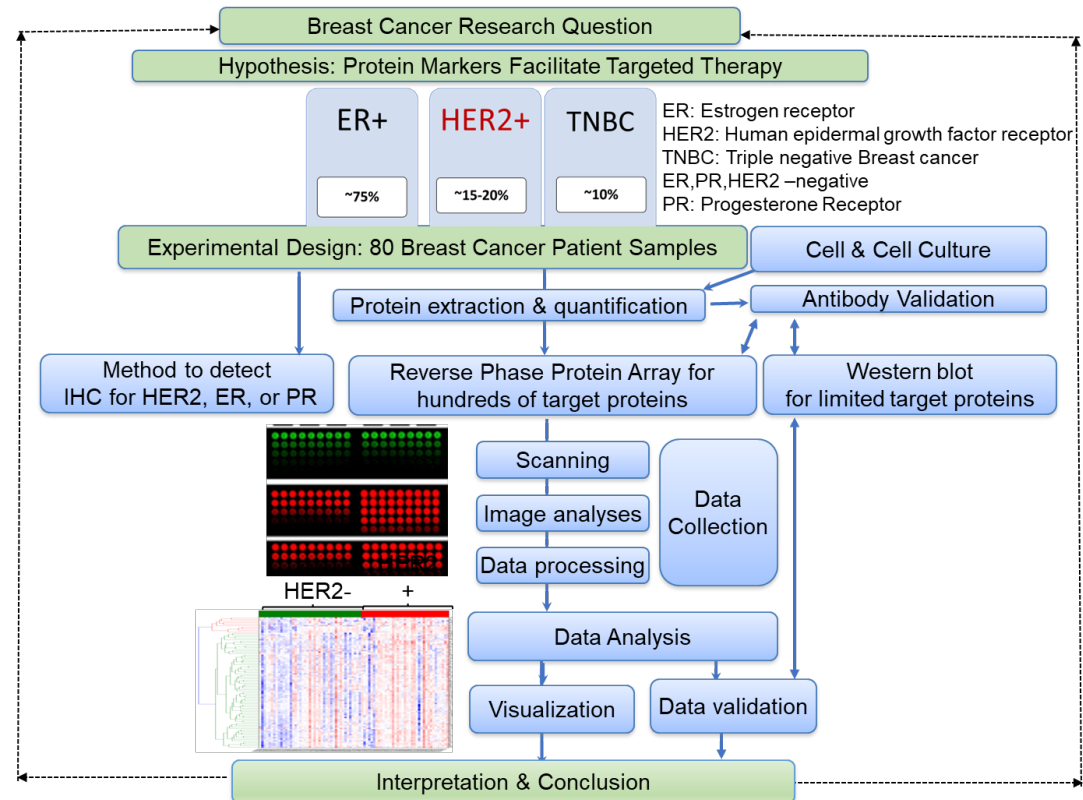
Module 2: Core Facility Hands-On Training

- Project design and experimental controls
- Cell Culture and protein extraction
- Next Generation Sequencing
- Flow Cytometry Technology
- Breast Cancer Progression
- **Reverse Phase Protein Array (RPPA)**
- Data Analyses & Visualization
- Public Data Mining

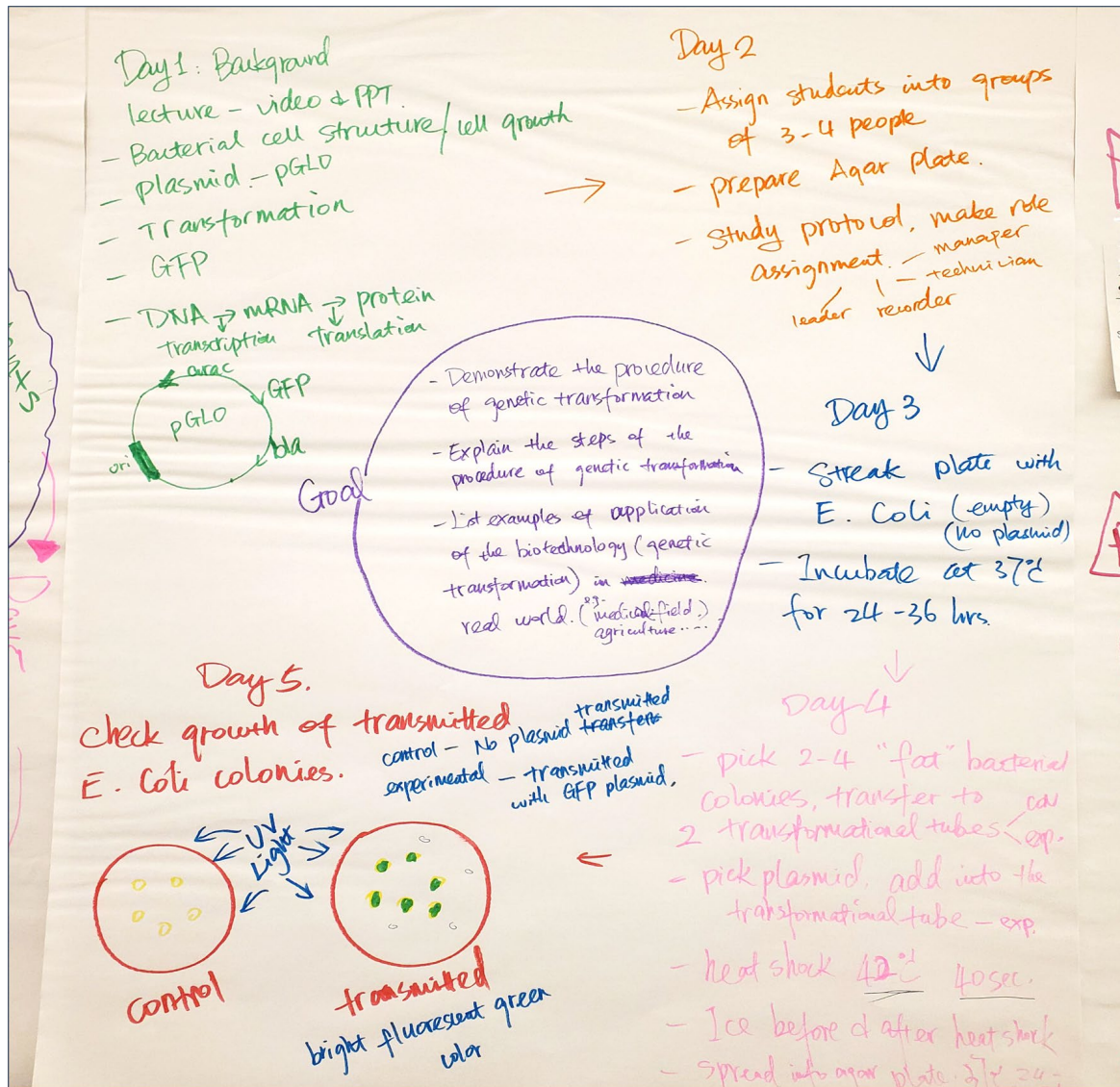
Module 3: Literature and Lesson Plans

- Reading Scientific Literature
- Thinking Like a Scientist
- STEMM Lesson Plans
- Guided Primary Scientific Literature comprehension
- Final Presentation

Advanced Technology Core Hands-On Training



Breast Cancer Patient Sample analyses: representative hands-on training on advanced technologies: experimental planning, sample preparation, data generation, and data analysis using informatic tools

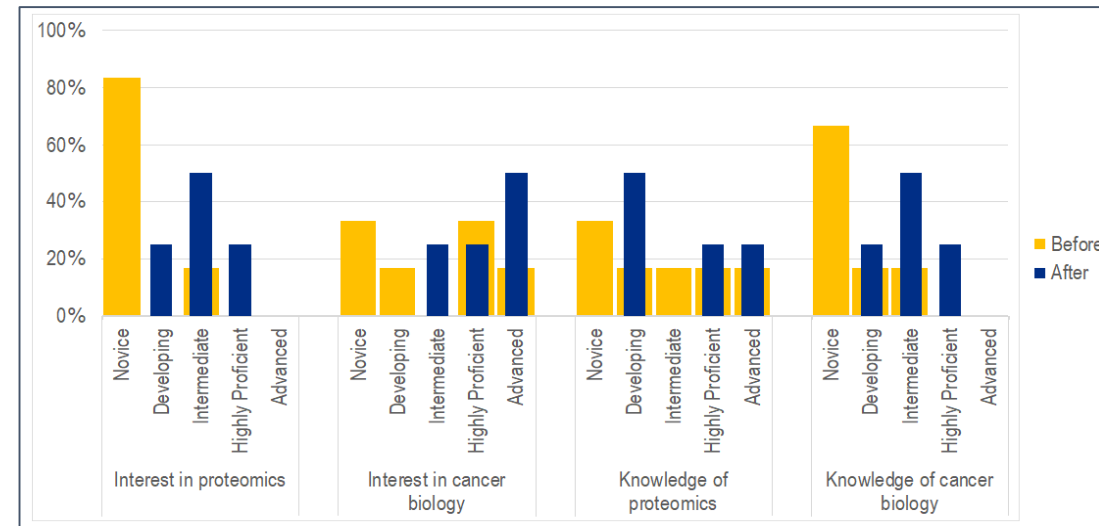
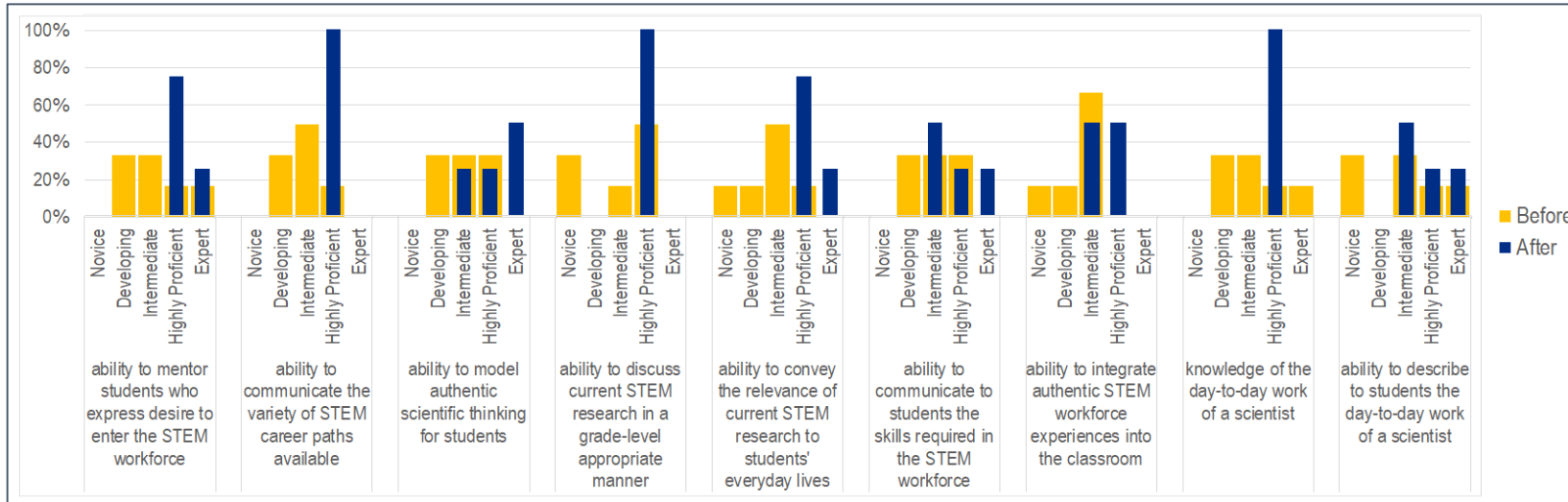


“I was able to incorporate what I learned from BCM-BRITE into my lesson plan. It started with working with my colleagues to decide on the new labs, order the right material, design and plan the material, hand-out, and pacing, demonstrate the activities, and supervise the activities and collect student data, and reteach.”

– one participant’s end of the year post-evaluation comment

Example of a teacher draft lesson plan.

RESULTS

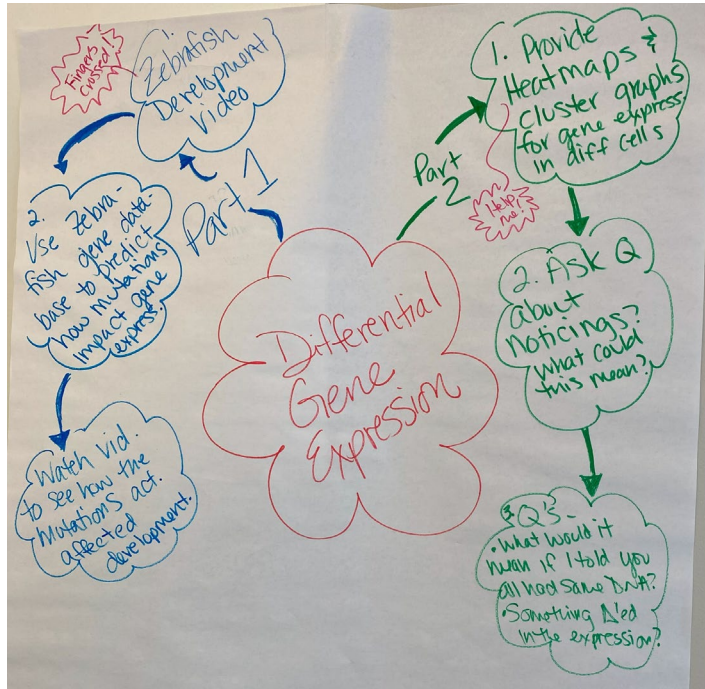


RESULTS

Participating teachers

- Increased confidence in their knowledge and abilities
- Enhanced understanding of scientific research

Results & Conclusions



Example of a teacher draft lesson plan

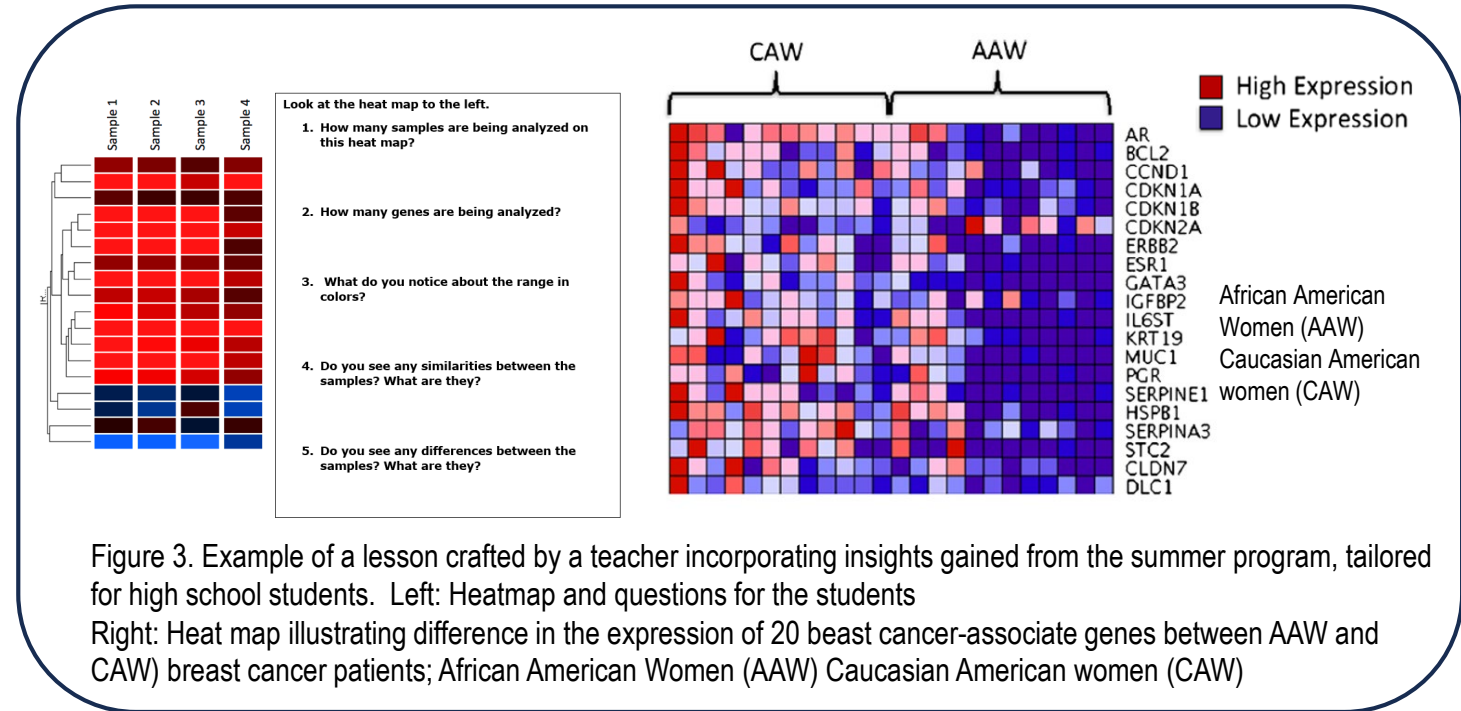


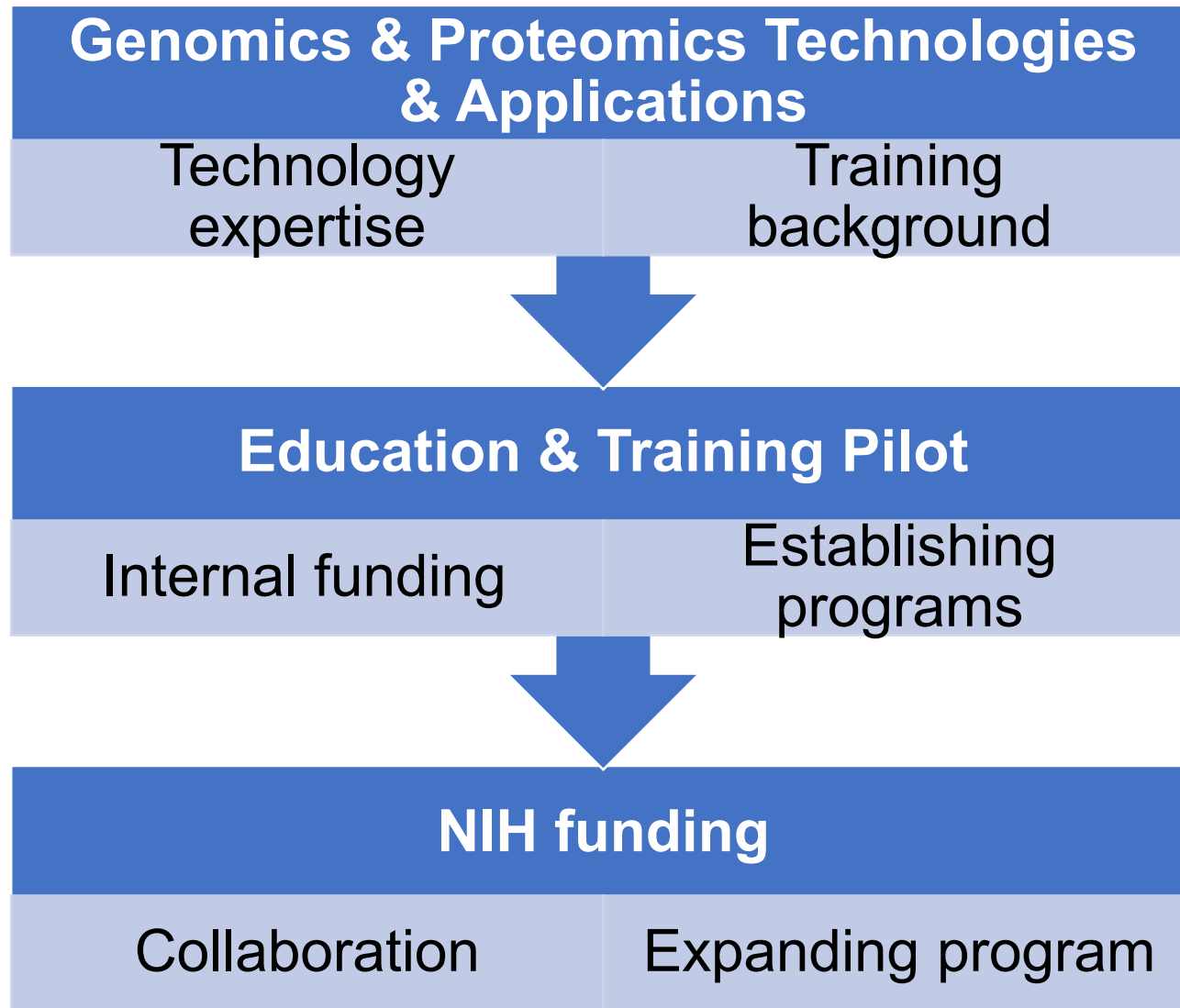
Figure 3. Example of a lesson crafted by a teacher incorporating insights gained from the summer program, tailored for high school students. Left: Heatmap and questions for the students Right: Heat map illustrating difference in the expression of 20 breast cancer-associate genes between AAW and CAW) breast cancer patients; African American Women (AAW) Caucasian American women (CAW)

CONCLUSIONS

Participating teachers

- Identified concrete approaches to incorporate real-world science into lesson plans
- 3 out of 7 teachers designed comprehensive lesson units

Biotechnology Research Education



Support and Grants

➤ Internal funding :

- Huffington Foundation pilot grant
- Dept of Education, Innovation and Technology, BCM
- Lester & Sue Smith Breast Center
- Sealy Center for Environmental Health and Medicine, University of Texas Medical Branch





➤ NIH grant funding:

- NIH R25 Science Education Partnership Award (SEPA, PI).
- NIH P20 BCM-TSU CURED Cancer Research Education Program (CREP, project PI)

Biotechnology Research Education

- **Secondary School Teacher Training Program: BRITE**
 - Started with 3-4 teachers per summer
 - 2-3 week program
 - NIH grant will fund 12-16 teachers per summer
 - 3 week program
 - Lab research and technology training
 - Lesson plans for teachers
- **College Student Summer Research Program: NIH P20 BCM-TSU CURED Cancer Research Education Program**
 - 8 weeks summer program
 - 20 students from Texas Southern University (a public historically black university in Houston, Texas)
 - 1 week in Advanced Technology Cores
 - End of the program symposium
 - Year-long community outreach program
- **High School Student Program and Symposium**
 - Scientific symposium
 - Literature adaptation

Biotechnology Research Incubator for Teachers and Students (BRITE)



BCM BRITE HIGH SCHOOL SYMPOSIUM FOR 2024
DATE: AUGUST 14, 2024
Celebrate
Science
Innovation

BRITE 2024 High School Symposium
[Learn More](#)

BCM-TSU CURED Cancer Research Education Program (C-REP)
[Learn More](#)

BRITE 2024 Teacher's Training Workshop

Advanced Technology Cores

WWW.BCM.EDU/BRITE

Acknowledgements

Antibody-based Proteomics Core Staff:

- Zhongcheng Shi, PhD
- Michael Nguyen, MS
- Yuan Yao, PhD

BCM Multi-omics Core:

- Cristian Coafa, PhD
- Tanmay Gandhi, MS
- Sandy Grimm, PhD
- Kimal Rajapakshe, PhD
- Dimuthu Perera, MS

BCM Collaborators:

- Yi LI, PhD
- Wen Bu, PhD
- Chris Man, PhD
- Rachel Egler, PhD

- Dean P. Edwards, PhD, :
Executive Director, ATC Cores

Past:

- Xuan Wang, PhD
- Myra Costello, BS
- Kimberley Holloway, PhD
- Fuli Jia, MS
- Danli Wu, PhD
- Carlos Ramos, BS
- Cindy Lu, PhD

Grant support

- NIH S10 award (S10OD028648)
- CPRIT (Cancer Research and Prevention Institute of Texas)
 - Core Facility Award (RP210227 & RP170005)
- NCI P30 Cancer Center Support Grant (CA123125)
- NIH R25 Science Education Partnership Award (SEPA, PI).
- NIH P20 BCM-TSU CURED Cancer Research Education Program (CREP, project PI)

Huffington Foundation & Dept of Education, Innovation and Technology
Lester & Sue Smith Center
University of Texas Medical Branch

Biotechnology Research Education

- Zhongcheng Shi, PhD
- Michael Nguyen, MS
- Yuan Yao, PhD

BRITE Teacher's Training:

- Katherine Harris, MS
- Alana Newell, PhD
- Fred Pereira, PhD
- Cynthia Claire Hallmark, PhD
- Nancy Moreno, PhD
- Mentors
- Core directors and staff

High School Student Program:

- Zanique Bullock
- Sara Adio
- Sophie Zhang
- Crystal Shin, PhD
- Guowei Guo, PhD
- Xiang Zhang, PhD
- Mentors and collaborators

CURED-CREP:

- Rayne Rounce, MD
- Veronica Ajewole, PharmD
- Huan Xie, PhD
- Debra Murray, PhD
- Flora Estes, PhD
- Mentors and core directors



A Cancer Center Designated by the
National Cancer Institute



Thank You!

Questions?