Bioscience Educator Support & Training (BEST) Program

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Background and Rationale: To bolster and diversify the STEM pipeline and improve K-12 STEM education, we need to provide educators with tools, resources, and training. K-12 students report STEM courses to be difficult, boring, and irrelevant, demonstrating the need for hands-on science and inquiry-based experiences that spark their curiosity and inspire interest in science.[1] Significant barriers must be overcome for this need to be met.[1] Lack of teacher training and support combined with resource deficiencies are prominent barriers in schools with the highest numbers of low socio-economic status and underrepresented (UR) students.[2] Bioscience educators need **1)** professional development and training to develop their content knowledge**, 2)** peer support to build their confidence and self-efficacy in performing molecular biology techniques with students, and **3)** improved access to equipment and materials.[3] The **B**ioscience **E**ducator **S**upport and **T**raining (**BEST**) program will address the barriers educators face in underserved schools by thoughtfully addressing each of these needs. Our goal is to connect the local secondary school bioscience community with the University of Colorado Anschutz Medical Campus (AMC), providing access to higher education resources and expertise. The BEST team will develop a bioscience teacher training program which will include a bioscience equipment and material lending library and provide engaging lesson plans that can be implemented in secondary science classrooms. This collaborative partnership between the AMC, the University of Colorado Cancer Center (UCCC) Cancer Research Training and Education Coordination (CRTEC) Office, and local education communities will benefit both groups, as AMC scientists and graduate students will gain mentoring and teaching experience while teachers and secondary students will gain mentoring, training, and bioscience resources. Through the BEST partnership, a greater understanding of biomedical science and educational pathways in higher education will be fostered in our community. We are requesting $30,000 for resources to develop the BEST program.

Objective: Our goal is to build a symbiotic partnership between AMC and local teachers to transform local bioscience education, foster a greater understanding of biomedical science in our community, and support AMC trainees interested in teaching. The BEST program will promote higher education by building relationships between secondary teachers and students and AMC graduate students and postdoctoral fellows. To achieve this, the BEST program will take a multi-dimensional approach through the following aims (Figure 1).

Aim 1: Develop a bioscience teacher training program supported by a Bioscience Lending Library and curricula.

Aim 2: Mentor and support BEST teachers.

Aim 3: Provide teaching opportunities for AMC scientists.

Figure 1. *BEST Program Aims*

Program Plan

Aim 1: Develop a bioscience teacher training program supported by a Bioscience Lending Library and curricula. Secondary science teachers will participate in high-quality professional development to learn exciting and engaging bioscience labs and activities to implement in their classrooms. The Bioscience Lending Library will provide equipment and lesson plans to teachers, bridging the resource gap that prevents schools from bringing real world science into the classroom.

Teacher Training Program: BEST leadership will collaborate with schools and districts to recruit science teachers for the program and to coordinate training sessions. These required teacher training sessions will be offered free of charge. Professional development sessions for teachers will include safety and ethics practices specific to the bioscience equipment and curricula in the Bioscience Lending Library (Table 1). Teachers will participate in hands-on workshops to learn how to use and troubleshoot kits in their classrooms. BEST teachers will receive documentation of the training sessions they complete, which they can use for their required professional development to renew their professional teaching license with the Colorado Department of Education and apply towards earning their professional Career and Technical Education (CTE) licensure in

Biomedical Sciences. The state provides extra funding to schools for teacher salary and course materials to support CTE programming and licensed teachers are eligible to apply for Perkins V funding to purchase equipment for CTE programs. CTE licensed teachers can teach courses in their schools such as Principles of Biomedical Sciences, Biomedical Innovations, and Introduction to Biotechnology.

Bioscience Lending Library: We will develop a series of kits which contain lab equipment and materials that our participant teachers can check out for use in their classrooms after completing the required professional development. Having a variety of bioscience kits available will reduce barriers for educators teaching in schools with limited resources. The first kits we will develop for BEST will support the trainings and labs/activities listed in Table 1. Each kit will include the bioscience equipment and materials teachers need to implement the lab with their students in their home classroom. Curricula associated with each kit will align with Next Generation Science Standards and will be differentiated for middle and high school students. High school curricula will also align with the Colorado State Science and CTE Bioscience Standards, which will enable teachers to easily integrate the materials and lessons into their existing curriculum. Ms. Shawndra Fordham, program developer in the CRTEC and former secondary bioscience teacher, has extensive experience developing curricula that align with science teaching standards and will ensure alignment. We will consult with the Office of Diversity, Equity, Inclusion, and Community Engagement to ensure the materials and lesson plans are equitable and inclusive of the populations present in our local secondary schools.

Table 1. Professional Development Training Sessions

Topic	Skill/Knowledge	Example Labs/Activities
Introduction to Bioscience Research	• Bioscience Research and Education at the AMC • Safety Protocols of the Bioscience Lab • Proper Use of Common Bioscience Lab Equipment • Experimental Design	• Micropipette Art • Strawberry DNA Extraction Design Lab
Techniques in Molecular Biology: DNA	• Restriction Digest & Gel Electrophoresis • DNA Extraction, PCR, & Gel Electrophoresis • Quantitative PCR	• DIY Electrophoresis • Restriction Digest Based Labs (Disease Diagnosis, Forensic DNA, Outbreak) • PCR Based Labs (PTC, ALU, ID of GMOs, Detection of Antibiotic Resistance Genes in Soil Bacteria, etc.)
Techniques in Molecular Biology: Protein	• Immunology & ELISA • Gene expression & Proteins • Genetic Engineering • Bacterial Transformation • Protein Structure	• Biobits – Central Dogma • Bacterial Transformation (LacZ, PGlo, or Antibiotic Resistance) • CRISPR Bacterial Transformation • Painting with Bacteria – pFLO plasmids
Translational Science: From Bench to Bedside	• Clinical Trials & Use of Animals in Research • Bioethical Considerations and Responsible Conduct in Research	• Simulated Mouse Studies • Clinical Trial Simulation

Aim 2: Mentor and support BEST teachers. The connections that will be made between the AMC scientists and teachers are a powerful aspect of the BEST program. We will use mentor modeling where BEST teachers will co-teach the labs along with an AMC scientist as they develop confidence in demonstrating, teaching, and troubleshooting the techniques and science associated with each lab. BEST leadership will mentor teachers during training and will initiate a BEST teacher network for sharing experiences, mentoring, and improving curricula.

Developing educators' content knowledge, confidence, and self-efficacy in instructing students and implementing bioscience labs in their classrooms is essential for the success of this program. The BEST program will take a scaffolding approach with teachers to fully support them in developing proficiency with not only performing the skills and using the kits associated with the lessons, but also in teaching these skills to students and implementing these lab activities in their classrooms. Teachers will have professional development, direct classroom support by the BEST team and AMC graduate students and postdocs, and the BEST Teacher Network to aide them in successful use and implementation of the BEST program resources for their students.

A key component of the BEST program is building new relationships between local secondary teachers and AMC scientists. AMC scientists will accompany kits to classrooms to mentor teachers for the first use of the kits. BEST teachers will teach the labs with support from AMC scientist as they develop confidence in demonstrating, teaching, and troubleshooting the techniques and science associated with each lab. The program is committed to continued classroom support for BEST teachers beyond the first use of kits if they need more time to build

confidence and experience. Additional mentoring for teachers will be provided by BEST leadership during teacher training and hands-on activity sessions. We will form the BEST Teacher Network, a peer support network via a social media resource (ie SLACK, TEAMS or similar) and a BEST website supported by CRTEC. BEST teachers will remain connected to each other and share experiences and best practices. BEST teachers will also be supported by BEST leadership and AMC scientists in developing their own lessons that they can share with the BEST Teacher Network.

Aim 3: Provide teaching opportunities for AMC scientist trainees. Graduate students and postdoctoral fellows at AMC lack consistent opportunities to explore education as a future career and to develop skills for effective teaching. BEST will leverage AMC expertise to train graduate students and postdoctoral fellows in effective teaching approaches. AMC scientists will provide teachers with scientific expertise related to equipment and lesson plans from the Bioscience Lending Library. They will observe teachers in the classroom, build a network for future career opportunities, and generate awareness about higher education pathways to bioscience careers.

AMC offers excellent research training for graduate students and postdoctoral fellows, however, trainees interested in a career that includes teaching have few opportunities to practice skills on our campus. As many as 30% of graduate students and postdoctoral fellows may be considering careers in secondary education, so it is critical to offer experiences that support interest in teaching.[4] We will train AMC scientists who are graduate students and postdoctoral fellows to use equipment and kits from the Bioscience Lending Library and to teach the associated curricula. The AMC Academy of Medical Educators is an outstanding resource for learning general teaching skills, with workshops such as How Learning Styles Impact the Way you Teach and Learn, Teaching to a Large Group, and Giving Effective Feedback. We will engage educators from the Academy to deliver sessions targeted to skill development for graduate students and postdoctoral fellows. Ms. Shawndra Fordham will lead additional training specific to supporting scientific inquiry in secondary school classrooms. AMC scientists will also engage in training for working with minors and implicit bias. Once trained, AMC scientists will visit classrooms to work with trained BEST teachers in delivering curricula and Bioscience Lending Library kit activities. They may support teachers by providing background or context for scientific concepts, troubleshooting techniques, presenting pieces of the lesson plan, or working with students to complete activities. Participating AMC scientists will be compensated by CRTEC.

Impact: We anticipate training ten secondary teachers in year one and expect each teacher to deliver labs at least twice a year. On average, secondary science teachers teach between 150-180 students a year. As the program continues and we add an additional ten teachers each year, the direct impact will grow to approximately 10,000 students after three years (Figure 2). We anticipate BEST teachers will share their experiences with their internal and external school networks, growing the pool of teachers interested in BEST training and significantly expanding the number of students impacted. We estimate that we can train ten teachers each year, but once the program is established, we expect to streamline processes and if there is teacher interest, we can increase the number of teachers trained each year. Similar programs across the country, have reached between 5,000 – 10,000 students annually.[5] We anticipate training 8-10 graduate students or postdoctoral fellows to support teachers in the first year of the BEST program and expect to train 1-2 more each year as needed. Trainees who elect to pursue teaching careers will have teaching experience to draw from and a network of advisors and job opportunities in secondary science education.

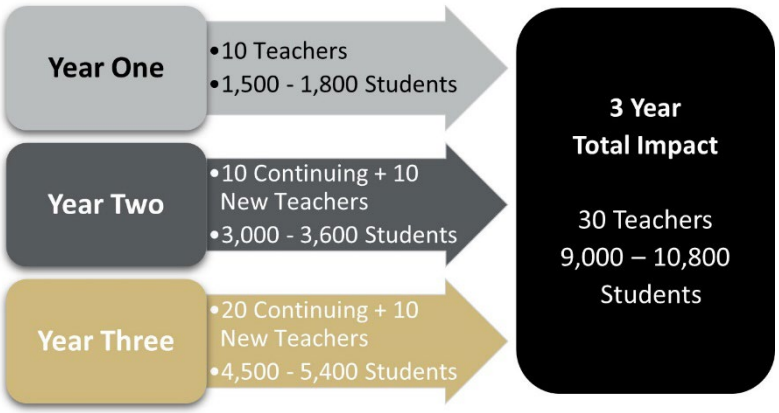

Figure 2. *BEST Program Teacher and Student Impact*

Sustainability and Potential for Growth: The UCCC CRTEC office will support the BEST program with in-kind contributions of 5% time for Dr. Adela Cota-Gomez and Ms. Shawndra Fordham and will provide $5,000/year for teacher training and consumable materials. This constitutes a commitment of $8,800/year for salaries and $5,000/year for materials indefinitely. Dr. Tennis' time is supported by the Division of Pulmonary Science and Critical Care Medicine in the School of Medicine. CTREC will also provide infrastructure for the BEST teacher online networking program and graduate student and postdoctoral fellow compensation. At six months and at

year one, BEST program leadership will submit reports to funders and the CRTEC Steering Committee for evaluation and feedback. As the program grows, we plan to develop additional curricula to explore model organisms or more advanced analysis of nucleic acids and proteins. We will also expand the program to include elementary schools after consulting with local elementary teachers to develop age-appropriate kits and lesson plans for their classrooms.

The BEST Program Team

The BEST program team is comprised of leaders with a wealth of experience developing and implementing bioscience lessons for secondary science students. Drs. Tennis and Cota-Gomez and Ms. Fordham have collaborated on several educational outreach projects through CRTEC and are excited to work together on this new endeavor.

Meredith Tennis, PhD: Dr. Tennis is an Associate Professor in the Division of Pulmonary Science and Critical Care Medicine at AMC. She will oversee BEST programming, develop training plans for AMC graduate students and postdoctoral fellows, develop curricula for the Bioscience Lending Library, prepare progress reports and disseminate program outcomes. Dr. Tennis developed and directs CU Science Discovery (CUSD) at AMC, which includes summer science camps for middle and high school students and a 4-week mentored summer research experience and research education for 11th and 12th grade students. Dr. Tennis is on the Aurora Science & Tech Middle and High School Advisory Committee, where she helps school leaders expose students to a higher education environment. In formal education roles, Dr. Tennis revised and directed the Cancer Biology Graduate Program course in grant-writing for cancer biology for two years and is a Co-Director for the SOM research education course for senior medical students.

Adela Cota-Gomez, PhD: Dr. Adela Cota-Gomez is the UCCC Assistant Director. She will manage award finances, support teacher training programming, and develop training plans for AMC graduate students and postdoctoral fellows. Dr. Cota-Gomez has been involved in research training for students from historically underrepresented (HUR) groups at AMC for over 20 years. As manager and Multi-PI of the National Heart Blood and Lung Institute (NHLBI) Graduate Experience for Multicultural Students (GEMS), Dr. Cota-Gomez has worked with undergraduate populations that feed into AMC and their families and community. In the UCCC, Dr. Cota-Gomez has directed the development of numerous training programs, running the gamut from middle school to junior faculty. As an immigrant Latina, Dr. Cota-Gomez has experienced first-hand the barriers to education that HURs face and understands best practices to knocking down these barriers.

Shawndra Fordham, MEd*:* Ms. Fordham serves as a program coordinator and developer for CRTEC. She will develop and lead teacher training and professional development, develop curricula for the Bioscience Lending Library, and manage the BEST Teacher Network. Prior to working at UCCC, Ms. Fordham was a secondary school bioscience instructor and adjunct professor for 22 years, during which time she developed and implemented a state-of-the-art biotechnology and bioscience research program for high school students. Ms. Fordham holds a professional teaching license in secondary science education, a professional Career and Technical Education (CTE) license in Biotechnology Research and Development and is accredited by College Board to serve as a concurrent enrollment bioscience instructor. She has earned two master's degrees in education (in Educational Leadership and in Education and Human Resource Studies) and is currently earning her Doctor of Education in Leadership for Educational Equity – Science Education. She has mentored numerous pre-service and in-service teachers and has developed and facilitated teacher workshops and professional development sessions. Ms. Fordham will serve as a secondary education expert and will be an invaluable resource for participants.

Budget

Item		**Estimated Costs**
General Lab Equipment	micropipettes, vortex mixers, microcentrifuges, tube racks, ice containers, lab glassware, pipette aid, scales, safety goggles, hot water baths.	$10,000
Kit Lab Equipment	gel and protein electrophoresis equipment and imaging systems, thermocyclers, plate reader, incubator, lung/skin cancer models, simulation materials.	$11,500
Consumable Materials	micropipette tips, disposable transfer pipettes, petri dishes, gloves, reagents, well plates/strips, tubes, inoculating loops.	$7,000
Other Program Expenses	teacher training materials, program promotion, shipping/travel costs for kit delivery.	$1,500
Total Cost		$30,000

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