GK-12: A Multi-Disciplinary Research and Teaching Program in Biomedical Engineering for Discovery and Understanding of Cell Communication

Colorado State University
Fort Collins, CO

Tom Chen, Ph.D.
chen@engr.colostate.edu
Michael A de Miranda, Ph.D.
mdemira@engr.colostate.edu
Stuart Tobet, Ph.D.
Stuart.tobet@colostate.edu
Aaron Benally, Project Coordinator
abenally@engr.colostate.edu

Project Abstract

This inventive program is designed to train a new generation of scientists in biomedical science and engineering who are inter- and multi-disciplinary in their training, better equipped for multilevel communication across ages (GK-12) and fields (engineering, biology, and chemistry), and finally prepared to take leadership roles for scientific inquiry and progress into the 21st century. The research component consists of activities in silicon nano scale sensor design, modeling, and understanding how molecules move and the functions of multi-cellular tissues and organ systems in response to external chemical and physical stimuli through intercellular communication. The research is critical for continued understanding and advances in some of the fundamental questions facing biology and medicine, and ultimately our society for better quality of life. The educational component consists of activities to advance biomedical engineering and to provide innovative changes to graduate education by developing a new generation of scientists with transferrable skills in global culture and diversity, leadership, civic and public engagement, innovation, ethics, and communication. The graduate fellows and doctoral advisors collaborate with K-12 teachers to make new STEM content using engineering approaches accessible to K-12 STEM education. The participation of industry partners provides practical experiences for graduate fellows, teachers, and K-12 students in the program.

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Project Goals

Five goals have been identified for the proposed project:

1. To provide a unique interdisciplinary and cutting-edge graduate research program to cultivate world class scientists and engineers in bioengineering. Such an interdisciplinary program promotes a culture of scholarly research environment that will be evaluated by both quantitative and qualitative assessment of graduate fellows' academic progress and scholarly development through publications, presentations, and dissemination efforts.
2. To equip future scientists and practicing engineers with communication skills that allow them to communicate with their fellow researchers and engineers, and more importantly, to communicate effectively with the general public and with K-12 teachers and students in particular. Fellows' ability and their skills to communicate the research contents to K-12 teachers and students will greatly improve the quality of K-12 education and attract more participation from K-12 students in science and engineering.
3. To provide graduate fellows with additional training of important transferrable skills in global culture and diversity, leadership, civic and public engagement, innovation, and ethics, in addition to communication skills. Such transferrable skills are essential ingredients of effective STEM leaders of the future.
4. To build knowledge and content capacity for K-12 teachers and to develop new content for K-12 STEM education by incorporating research contents into K-12 curriculum that address the state and national STEM standards and extend their relevance towards challenging K-12 students to engage in inquiry and discovery.
5. To create and to strengthen the partnerships between STEM departments at CSU, STEM departments at regional K-12 school districts, and private sector companies involved in the electronics and bioscience industry. Such partnerships are essential to making changes in graduate education and K-12 STEM education relevant to societal needs and essential to sustainability of the proposed changes.

Connection and Support of K12 STEM Education

Sample of Project Activities and High School Level Content Standards Addressed

	State of Colorado Model Content Standards		National Standards
GK-12 Activity	Standards	Benchmarks: Grades 9-12	Content Standards: 9-12
Science	Std 1: Scientific method and processes of scientific investigations	#2: Use of appropriate technology #5: Constructing scientific models and explanations #6: Communications of results	Content Standard A: Science as Inquiry -- Ability to do and understand scientific inquiry
	Std 2: Physical sciences	#3: Use of physical & chemical properties for comparisons	Content Standard B: Physical Science -- Understanding of matter and energy and their interaction
	Std 3: Life sciences	#4: Energy used in life systems #5: Human body functioning through systems	Content Standard C: Life Science -- Understanding of matter, energy and organization of living systems.
Mathematics	Std 2: Algebraic methods	#1: Real-world modeling of functions	Content Standard: Algebra
	Std 3: Data collection and analysis	#4: Draw conclusions from data	Content Standard: Measurement
	Std 5: Use of tools to communicate results	#1: Measurement of quantities indirectly #3: Determine accuracy of measures	Process Standard: Representations, Connections and Communications
Engineering and Technology	Std. 14: Understand, select, and use medical technologies	#M: Science of biochemistry and molecular biology	Process Standard: Applied molecular research and diagnostics to disease states and predispositions
	Std. 9: Understanding and applying the engineering design process	#I: Evaluate design principles #K; Design modeling #L: Design factors; reliability, economics, safety, quality control, environmental, ergonomics	Process Standard: Engineering design process. Problem I.D., Data collection, analysis, modeling, prediction, optimization, testing, specifications
Note and Sources: Science -- Colorado Department of Education, (2007a); Mathematics -- Colorado Department of Education, (2005); Science -- National Academy of Sciences, (1996); Mathematics -- National Council of Teachers of Mathematics, (1989), Standards for Technological Literacy: Content for the study of technology – International Technology Education Association (2000).			