

First steps

Drs Joseph C Ayoob and Chakra Chennubhotla discuss the University of Pittsburgh's summer **Training and Experimentation in Computational Biology (TECBio)** programme, which provides undergraduates a taste of this nascent discipline and an invaluable insight into research in the field

Could you begin by offering an overview of the TECBio programme, and the catalyst for its creation?

JA: TECBio is a 10 week Research Experience for Undergraduates (REU) programme funded by the National Science Foundation and hosted by the Department of Computational and Systems Biology at the University of Pittsburgh. TECBio provides a challenging graduate-level research experience to undergraduate students. The programme also offers introductory training in topics pertinent to computational biology, and various enrichment activities – research and career seminars, a journal club, training in the responsible conduct of research, professional development opportunities, and various forums for the students to present their research. These events are designed to complement the research projects and help prepare our students for successful careers in science.

CC: Dr Ayoob and I are colleagues in the department. He is an experimental developmental biologist and I am a computational biologist with research interests in computational perception of medical images and computational biophysics. Designing this programme offered us a unique opportunity to creatively merge our scientific backgrounds in biological, physical, and computer sciences.

The students participate in an Ethics Forum. Is an understanding of responsible conduct an increasingly essential facet of biological research? What is discussed at such an event?

JA: Training in the ethical conduct of science is one of the most important aspects of our

programme. We strive to train our students to be successful scientists, and an important part of that is to teach them how to perform their experiments and interact within the scientific community in a responsible and ethical manner. For the Ethics Forum, our students form groups to research cases of fraud or misconduct, and present their analyses to a larger audience of students from other summer programmes. In studying these events, the students can better understand the pitfalls of taking shortcuts and learn how to both perform their research responsibly and interact and collaborate with other scientists ethically and respectfully.

How important is the experience of presenting their work at a Pittsburgh-wide annual research symposium for their future scientific careers? Is it important for them to understand the value of good dissemination?

JA: By the end of each summer programme, our students are all likely sick of us telling them how important it is to hone their scientific communication skills. Especially in today's challenging funding environment, it is important to be able to present your work and ideas clearly. We stress this to our students at every opportunity, and provide guidance to teach them how to be effective communicators. Their presentations at the end of the programme require them to organise their thoughts and data to plan out the story that they want to tell. By assembling both a poster and a research talk, and in conjunction with their written proposals that they produce earlier in the programme, our students gain a wealth of valuable experience in scientific communication.

CC: This symposium may be the first opportunity a student has to present and argue a hypothesis, explain the course of research and convince an audience why the results are justified. These skills are critical in the scientific realm.

With research funding being notoriously difficult to procure, how significant do you believe these training experiences to be for scientific students, and U.S. research in general?

JA: Programmes like TECBio and other REUs serve a very important role in advancing scientific discovery and dissemination. With regard to our programme specifically, which deals with a relatively new and rapidly growing interdisciplinary field, we are able to reach out to and train students who are interested in computational biology research early on in their scientific careers. This not only gives them an important head start in their scientific training, but also allows them to get an experience of graduate school before they commit to it. Moreover, we and our students are helping to develop and promote the new technologies, approaches, and scientific advances that are driving the next wave of scientific research, which we feel is a very significant and critically important endeavour.

CC: I recall reading that, while research until now was looking into space, the next 100 years is about looking within the human body. This requires training budding scientists to formulate a hypothesis, do wet-lab experiments to gather data, write analysis algorithms, verify the hypothesis, and if necessary, revise the hypothesis and repeat the investigation and verification cycle.



Tomorrow's scientists

As part of the continued national and global drive to promote scientific skills, the National Science Foundation has helped implement the [University of Pittsburgh's](#) exciting summer programme for undergraduates

WITH A CONSTANT international drive to encourage people into STEM industries (science, technology, engineering and mathematics), it is important to provide opportunities to young people to gain experience relevant to such careers. The TECBio programme at the University of Pittsburgh is doing just this, giving undergraduates a chance to experience real research in the burgeoning field of computational biology. With only 12 places available each summer, and an average of over 200 applicants, it is clear that such opportunities are well regarded by students. Specifically targeting universities with limited research opportunities and under-represented demographics, the programme is hoping to assist entry into the technical world of scientific endeavour. Chosen from a range of disciplinary backgrounds, each student will have displayed a genuine passion for computational biology's interdisciplinary complexity. Students will have had contact with their Pittsburgh supervisors prior to their arrival at the 10 week intensive programme, and they are expected to be able to begin work on their projects almost immediately.

The academic breadth of the students is matched by that of the 26 mentors, who come from the wide range of scientific disciplines within computational biology. Early communication leads to the students producing a formal written research proposal, giving a clear indication of what will be studied as well as providing an opportunity to practice essential scientific writing skills. Such activities emphasise an essential facet of the course, the drive to instil scientific independence. Since graduate study necessitates

a degree of self-reliance, TECBio seeks to work this into their summer programme, providing training which is necessary for future success. Driven by this goal, the students work with their mentors to put together a poster and quarter of an hour talk on their findings before the end of the summer. The students are able to use their mentors' knowledge of scientific communication and dissemination in order to produce cogent and interesting presentations, and to help make them more effective communicators.

Graduate study is never far from the consciousness within TECBio, and the students receive a great deal of coaching towards this end. The students gain a lot from the interaction with their primary research adviser, but are able to gain additional perspectives from other levels of mentoring within the scheme. This diversity enables the students to begin to grasp the breadth of computational biology as a discipline. This is further reinforced in the weekly research and career seminars that are organised specifically for the students. After each of these events, students are able to informally meet the speaker, giving the chance to discuss pertinent topics, learn more about each speaker's career path, and network. Finally, a workshop in the second year of the programme provided advice on getting into and being successful in graduate school, which was followed up by a detailed discussion addressing the students' questions and concerns about the process of applying to graduate school. Each of these activities provided the participants with an introduction to the skills which will be required of them if they want a successful

career in computational biology or other STEM-related fields.

STUDENT SUCCESS

Starting just two years ago, it is difficult to accurately measure the degree of success that TECBio has had. However, there are a number of notable student successes, which imply that the work which has been completed has been extremely useful.

Kimberly Schneider attended the 2010 programme from Carlow University. After TECBio, Schneider received a travel award from The American Society for Cell Biology to present her findings at the 50th annual meeting in Philadelphia. Schneider was able to continue her work because of the proximity of Carlow and Pittsburgh universities, and she has since received a National Science Foundation REU Supplemental award with her mentor, a 2011 Summer Research Fellowship from the Endocrine Society, and a travel fellowship to attend ENDO 2011, the Society's 93rd annual meeting in Boston. This external support has facilitated the continuation of her research, which was included in a recent manuscript submitted for publication. Schneider is currently working with a biotech company while she prepares for the start of her graduate education at the University of Pittsburgh.

Other student successes include Yagmur Muftuoglu, who attended the programme in 2010 from Johns Hopkins University. She has now entered a medical research scholar's programme at Yale University, but before that

INTELLIGENCE

TECBIO

TRAINING AND EXPERIMENTATION IN COMPUTATIONAL BIOLOGY

OBJECTIVES

10-week summer programme that provides a challenging and fulfilling graduate-level research experience to undergraduate students, offering a wide variety of theoretical and experimental research projects. In addition to performing cutting-edge research, TECBio students will also participate in other academic activities, such as classes, seminars, and discussions.

KEY COLLABORATORS

Dr Chakra Chennubhotla

FUNDING

National Science Foundation – contract no. 1004555

CONTACT

Dr Joseph C AyooB

Assistant Professor

Department of Computational and Systems Biology
University of Pittsburgh
3053 Biomedical Science Tower 3
3501 Fifth Avenue
Pittsburgh
PA 15213
USA

T +1 412 648 8646

E jayooB@pitt.edu

www.tecbioreu.pitt.edu

DR JOSEPH C AYOOB is an Assistant Professor in the Department of Computational and Systems Biology at the University of Pittsburgh. His research focuses on the molecular-genetic mechanisms of developmentally-regulated cell death. Dr AyooB also directs educational outreach and mentoring endeavours at the graduate, undergraduate, and high school levels.

DR S CHAKRA CHENNUBHOTLA is an Assistant Professor in the Department of Computational and Systems Biology at the University of Pittsburgh. His group works in building algorithms for computational perception of medical images and statistical inference in biophysics.

her results from the summer programme were published in a first-author paper, Muftuoglu and Mustata 2010, Pharmacophore modelling strategies for the development of novel nonsteroidal inhibitors of human aromatase (CYP19). As well as this, she received a travel grant to present her findings in an oral presentation at the 24th Annual Symposium of the Protein Society in San Diego. Muftuoglu has since published another first-author paper, demonstrating how providing opportunities for students can lead to useful new research.

Since graduate study necessitates a degree of self-reliance, TECBio seeks to work this into their summer programme, providing training which is necessary for future success

Whilst these are particularly successful students, the fact that the programme is so young means that the benefits have not yet had time to be fully realised. It is hoped that more students will begin notable careers because of their experience at TECBio.

DEPARTMENTAL DEDICATION

The success of TECBio has been driven by the vision of Professor Ivet Bahar, the chair of the Department of Computational and Systems Biology at the University of Pittsburgh. Bahar has been able to establish a rich tradition of training students at graduate, undergraduate and high school levels, something which has been thoroughly instilled across the department. Such a focus has meant that the involvement in

the TECBio programme has been enthusiastic and wide ranging, something which can be seen in the successes which it has already been able to produce. This focus within Pittsburgh has been matched by the National Science Foundation, without which TECBio would not exist. The National Science Foundation funds 10 of the 12 places on the programme, and their dedication to scientific outreach and education has been a driver for the programmes at Pittsburgh. Their Research Experiences for Undergraduates programme have had the involvement of thousands of students across the United States and the globe. The national commitment to providing immediate and comprehensive research experience to young scientists has facilitated the work at Pittsburgh, providing excellent opportunities to tomorrow's scientists.

EXPANDING OPPORTUNITIES

The programme has been such a success that plans to expand the provisions have already begun. Last summer the Department of Computational and Systems Biology working in conjunction with the Department of Biomedical Informatics started the Computational and Systems Biology/Biomedical Informatics (CoSBBi) Summer Academy for high school students. Acting under the umbrella of the University of Pittsburgh Cancer Institute, the Summer Academy was able to run in parallel with the TECBio programme, with older students providing advice to their young counterparts on preparing themselves for their undergraduate studies. Local students from both programmes have been able to return to continue their project over the academic year, and the work has been considered extremely successful. In fact, the university has now created an Office of Science Education Outreach, which is augmenting the ongoing educational efforts of the University of Pittsburgh as a whole. It is projected that as well as lending support to existing programmes, this will help to drive additional initiatives, providing opportunities for young scientists to flourish.



Students from the 2011 TECBio REU @ Pitt programme pose for a picture and proudly display the T-shirts that they designed.

