ASCB and Carnegie Deliver Cell Biology in Ghana

This past July 4th eight U.S. and European scientists converged on Korle Bu, Ghana, a suburb of the capital city, Accra. There they met 25 young African scientists for two weeks of intensive work in cell biology with a focus on protozoan parasites. This course, entitled "Learning and Teaching Modern Cell Biology: A Route to Successful Biomedical Research," was designed to provide information and practical experience in cell biology that would be relevant to the needs and interests of African biomedical scientists. It also tried to instruct and model good teaching of these subjects. Through lectures, "tool talks," journal clubs, and practicals, students were exposed to aspects of modern cell biology—including fluorescence microscopy, basic molecular biology and protein biochemistry, bioinformatics, genetic engineering of cells, and live-cell study. They were also introduced to teaching methods that emphasized interactive, conceptual learning and highlighted the uses of animations and other visual materials. The course participants were eager and hard-working; they actively engaged in class discussions; and they also shared many of their personal experiences as African scientists.

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The course was taught by John Cooper of Washington University in St. Louis; Martha Cyert of Stanford University; Kirk Deitsch of the Cornell-Weill Medical School; Markus Engstler of the University of Wuertzburg, Germany; Triscia Hendrickson of Morehouse College; Swapna Kollu from Dartmouth University; as well as Dick McIntosh and Joy Power from the University of Colorado, Boulder. The workshop was enthusiastically hosted by the School of Allied Health Sciences, University of Ghana, and would not have been possible without the tireless efforts of Richard Asmah of that school. Asmah did a remarkable job of drawing interest and support from a wide range of biological science departments; this work minimized the logistical problems that are always part of a course arranged from a distance, particularly one taught in a developing country. The students, who were selected by applications initially screened by Asmah, came from the School of Allied Health Sciences and several other institutions in Ghana and Nigeria. The course was supported by grants to ASCB from the Carnegie Corporation of New York and Carl Zeiss. The latter generously donated an Axioscope with LED fluorescence illuminators and excellent optics. This instrument, together with an electronic camera donated by the University of Colorado, will stay in Ghana to support research at the medical school. It was gratifying to see that this equipment was already in use for research before the end of the course!

Lab Practicals, Workshops, and Journal Clubs

Most afternoons were devoted to lab practicals, which gave participants hands-on experience with many techniques with which they were unfamiliar. Financial constraints in Africa mean that the educational system provides only limited training in experimental procedures. Under Engstler's guidance, participants studied fixed African trypanosomes expressing a GFP-tagged mitochondrial protein, which they also stained with DAPI. This allowed them to compare the use of bright field and phase optical images with two fluorescence images of the same sample. Deitsch and Power worked out microscopic and PCR-based practical exercises to compare *Plasmodium* strains that were sensitive or resistant to chloroquine. Chloroquine was once an important treatment for this pathogen, but it has gone out of use as a result of widespread resistance. Hendrickson and Cooper provided instruction and experience in protein purification as well as a study of flagellum biology in *Chlamydomonas*. Using local materials, i.e., scales from a live fish, Cyert and Power showed students how to visualize pigment granules. They also helped students develop and test their own hypotheses concerning the regulation of granule motility by signaling pathways. Two bioinformatics workshops developed by Engstler and Deitsch introduced students to computer resources they can use to explore the genomes and proteomes of various *Plasmodium* and trypanosome species; they also demonstrated aspects of protein folding into 3D structures.

The course also included five journal clubs that examined papers chosen by one of the instructors to link with a particular lecture topic. These journal clubs encouraged students to examine data logically and critically. This was challenging, given the wide range of topics and methods that the papers represented. It was particularly rewarding to see the students coming to grips with detailed scrutiny of gels, blots, sequences, and images. This occurred as they gained the confidence required to question every aspect of a published paper's substance. This kind of professional skepticism is not a common part of science education in Africa, but it was one of the skills the course helped students develop. For these sessions, the class was divided into groups of five students and two staff, thanks to the presence of Ellis Owusu-Dabo, Karen Duca, and Augustina Annan from the Kwame Nkrumah University for Science and Technology in Kumasi, Ghana. That institution will be the site of next summer's ASCB-Carnegie course in cell biology.

The students' abilities to analyze and interpret data were further challenged near the end of the course by a "Virtual Practical" developed previously by Eva Gluenz and others in Keith Gull's lab at Oxford, UK. (This teaching instrument was described at an Education Initiative Forum during last year's ASCB Annual Meeting.) Students were presented with information about a collection of trypanosomes that had been transfected with a library of RNAi vectors and screened for strains that showed some problems with DNA metabolism. Each student had to understand the vector used for making this library, the way RNAi works in trypanosomes, the screens used to pick likely candidate strains, how the insert in the transforming plasmid could identify the gene that had been knocked down, the Northern and Western blots that showed the efficacy of the knock-down, and, finally, several sets of data on the phenotypes of trypanosomes in which the RNAi was expressed vs. control cells. Virtually all the students seemed to feel a real sense of scientific competence by the end of the course, based on their ability to grapple with these different kinds of data. Each participant was given a USB flash-drive containing the materials for the virtual practical, as well as all the lectures, journal clubs, and laboratory exercises, so these teaching tools are now available to the participants for their future work.

Students loaded PCR products onto an agarose gel to identify strains of Plasmodium *resistant to chloroquine.*

Research Discussions and iBio-Seminars Viewings

The students also discussed original research projects of their own design, usually their ongoing work, in small breakout sessions that were led by a faculty mentor. Some of these proposals were based on laboratory science, quite a few on clinical work, since several of our students were practicing physicians, and some on science pedagogy. The diversity of their projects is nicely represented by a few examples of project titles:

- "Development of a Simple Diagnostic Tool Using Amoeba for the Early Identification of *Mycobacterium ulcerans"*
- "Prevalence of Malaria and Glucose-6-Phosphate Dehydrogenase Deficiency among Pregnant Women: A Case Study at the Central Regional Hospital"
- "Cocoa Antioxidants and Severity of Pathogenesis in Trypanosomiasis"
- "The Effect of Infections on Congenital Hydrocephalus in Ghana"
- "Microvascular Damage in Severe Malaria; the Role of Cytokine"
- "Hormonal and Genetic Biomarkers of Breast Cancers"
- "Human Papillomavirus Infections and Oral Squamous Cell Carcinoma"
- "*Cryptosporidium spp*. in Some Cattle Rearing Areas in Ghana"

On the last day of the course, every student gave a 10-minute PowerPoint presentation describing his or her project, then fielded questions from both fellow students and faculty. Again, this experience seemed very rewarding, in part because of the students' investment in their projects and in part because of their using newly acquired ways of thinking about and presenting science.

Each event-filled day of the course was capped by an informal evening session; these included activities such as viewing of iBioSeminars (see the ASCB website at www.

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Students examined answers received to questions they posed on PlasmoDB, a functional genomic database for malaria parasites.

ascb.org/iac/international-affairs.html for availability and details about these useful teaching tools), discussions of how to read scientific papers, how to apply for grants, and how to get access to further education. Two sessions were devoted to aspects of professional ethics: the professional behavior of scientists and teachers, and issues where scientific progress intersects public opinion, such as genetically modified foods and animal cloning.

A Positive Impact

Immediate feedback indicated that the course had a strong, positive impact on its participants. Comments solicited from both students and instructors on a written questionnaire, completed anonymously at the end of the course, were enthusiastic. In addition, a flood of warmly appreciative emails was sent by participants to each other and their mentors, after the course had ended. These responses included: "It was an absolute privilege for me to have been part of this course in modern cell biology. I am really grateful to the organizers, the faculty, and to all the students, for all the knowledge, fun and encouragement that was shared. I am convinced that it was a landmark event. Our responsibility now is to make the investment pay!" "Honestly, for me this has been an experience with a fresh zeal and passion for research and better ways of teaching. I admire the faculty, interactions and fun we shared together, plus PlasmoDB, as well as making new friends for future collaborative work. Thank you all and let's keep this network active." "I must say that it was really a great workshop, full of practical knowledge that can be applied in all scientific areas. The mentors did a marvelous job. To all students, well done for going through this training successfully. I believe it will transform our research and teaching careers forever."

While it is hard to evaluate the lasting impact of such a course, there are some encouraging signs. A few of this year's students are already discussing how they might collaborate to teach a similar course to Ghanaian scientists who did not attend the ASCB course. Also, reports from students who participated in last year's course in Ghana show that a number are now actively engaged in research, some in PhD programs abroad and some on the very projects they brought to the course for discussions, criticism, and improvement. In the past, we have followed up with a questionnaire at six months, and we plan to do so again. Overall, the feedback we have received indicates that courses like this should be continued.

All members of this year's faculty have expressed their sense that this course was an exciting and valuable experience for them as well as for the students. However, it is an open question whether the effort to put both scientific and pedagogic instruction into a single course is the right way to go. This most recent effort was heavily biased toward science itself, rather than honing methods of teaching. An alternative would be to offer a course for teachers of university undergraduates that provided extensive training in methods for interactive learning. We encourage ASCB members with a serious interest in science pedagogy to develop and present such courses, not only in Africa but in many places around the world that are working to deepen their teaching of modern biology. Such quality instruction could help with the many problems in agriculture, medicine, and animal husbandry that currently limit the quality of life in developing nations. ■

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—Richard McIntosh on behalf of the ASCB Ghana teaching team