How did you apply the dollars you were awarded?

The Illinois Mathematics and Science Academy (IMSA) supports the United Nations Sustainable Development Goals, and goal number three is to "ensure healthy lives and promote well-being for all at all ages." Target 3.3 is "By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases." IMSA's scientific inquiries in research (SIR) program provides opportunities for students to perform research either on or off campus. In an attempt to offer more opportunities for on campus SIRs, two research projects began in January; one involving malaria and the other tuberculosis. In the malaria research, the enzyme HGXPRT from *Plasmodium falciparum*, a parasite that causes malaria, was chosen as a drug target, because of its importance in de novo DNA synthesis. In the tuberculosis research, the enzyme isocitrate lyase from *Mycobacterium tuberculosis* was chosen as a target because this enzyme is important for tuberculosis to be able to survive inside of white blood cells.

The dollars were used to purchase a ThermoScientific MaxQ 6000 stackable incubated and refrigerated shaker which was crucial for expressing these two drug targets. *E. coli* cells harboring genes for these enzymes were grown in the incubator overnight to produce a starter culture. This culture was used to inoculate larger cultures the next day. The cultures were grown to an optimal density and induced to start the enzyme production. The HGXPRT enzyme is toxic to the cells, so it was especially important for this enzyme that once enzyme production commenced that the enzyme was produced slowly to minimize damage to the cells. This is done by lowering the temperature. The refrigerated shaker incubator allowed for this possibility. In addition, some of the subsequent protein purification steps were performed inside the incubator to keep the protein refrigerated. Examples include resuspension of the cell pellets in cell lysis buffer and incubation with the resin used for the purification.

Plans for this year also included stabilization of Rubisco activase. Rubisco activase is a plant enzyme that is essential for plant growth, and stabilization of this enzyme could lead to higher crop yields. The gene for Rubisco activase has been cloned into an expression vector and is ready for protein production in *E. coli* using the refrigerated incubator, and this work will be done next school year. Next year other new projects will begin, in particular the preparation of drug targets for other neglected tropical diseases such as mycetoma. Mycetoma is a chronic, destructive, inflammatory disease, usually of the foot, but any part of the body can be affected. It is referred to as the neglected of the neglected diseases.

How many people did your project impact?

At the beginning of the year there were 65 students interested in conducting on campus research. Six of those students chose to work on the malaria and tuberculosis drug targets. Although this work just began in January, these six students were successful in producing and characterizing the enzymes HGXPRT from the malaria parasite and isocitrate lyase from the tuberculosis bacterium. SIR has ended for this school year, but both of these projects will continue next year. Fresh protein will be prepared, and a library of over 800 compounds will be tested for biological activity against these targets.

As of today, there are currently over 100 students who will participate in on campus SIR next year, and that number is growing. New research groups will be supporting students doing research in protein engineering, glioblastoma, virus discovery, and clean water. The drug discovery SIR research group is

also growing. There are currently 12 out of 100 students committed to working on protein targets for drug discovery, so the number of students doing research using this particular piece of equipment next year has already doubled.

Please provide an example of a success story, or testimonial, from a participant.

Admission to IMSA is determined by a highly competitive process that incorporates classroom performance, participation in extracurricular activities, and leadership history with more traditional indicators of talent such as test scores and grades. The mission of IMSA is to ignite and nurture creative, ethical, scientific minds that advance the human condition, through a system distinguished by profound questions, collaborative relationships, personalized experiential learning, global networking, generative use of technology, and outreach.

IMSA students are not just bright, but most are naturally curious. In addition to using this new equipment for research in protein engineering and medicine, it will be used next year in the curriculum. A new lab will be implemented next fall in the biochemistry course where students will grow their own cell cultures to express protein using the refrigerated shaker. The protein will be purified and drug binding assays will be performed in the classroom. Exposing the students to real world research experiences in the classroom will hopefully ignite an interest and passion to get involved doing their own research. Next year there are three sections of biochemistry offered with around 20 students per section. This curricular change will expose 60 new students to research opportunities. The hope is that these students will go on to advance the human condition in very tangible ways.