Protein Crystals in Space Program

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Background

- Dr. Alexander McPherson has been selected under a NASA Research Announcement to perform eight (8) microgravity missions with the Enhanced Dewar Flight Hardware.
- The Enhanced Dewar Hardware affords a very high volume of protein crystallization experiments.
- High School students and teachers can be qualified to prepare and load flight samples.
- We use the flight opportunity as a hook to introduce, and gain interest, in the field of structural biology.

Science Overview

- Proteins are a class of chemical compounds found universally in all living creatures.
- Different sections of DNA molecules cause the production of thousands of different proteins, which perform a myriad of essential functions.
- Proteins are associated with disease and illness. One way to control or suppress a disease is to interfere with the function of an associated protein.
- One of the best methods to obtain chemical and structural data on protein molecules is by x-ray crystallography.
- Currently, the ability to obtain good quality crystals of proteins is the limiting step for x-ray crystallography.

Sequence of Events for Protein Research

Isolate and purify a specific gene sequence of DNA →	Purification through gel-electrophoresis. The DNA can also be sequenced to determine the order and types of base pairs that give it its unique genetic code
Multiple copies of a DNA sequence can be produced by cloning →	DNA sequences can be cloned using several techniques including insertion into bacteria and the Polymerase Chain Reaction (PCR)
Specific DNA gene sequences can be inserted into bacteria to produce mRNA that will subsequently translate the desired amino acid sequence producing a protein →	DNA sequences can be inserted into a bacteria plasmid (circular recombinant DNA) and the bacteria can then produce the protein being studied
Isolate and purify the specific protein being used for research →	Once the bacteria has made the protein, it must be removed from the bacteria and the substances not being studied must be removed, usually through gel-electrophoresis
Protein crystallization using purified protein →	Perfect crystals are needed for research
X-ray diffraction using the protein crystals formed earlier →	X-ray beams scatter according to placement of atoms within a crystal to produce a diffraction pattern
Data from the diffraction pattern of the protein crystal is used to compute the 3-dimensional structure of the protein →	Points from the diffraction pattern are inputted into a computer that uses the physics of diffraction angles to compute the 3D structure of the protein
The computer generated 3D structure of the protein is used to study the binding interactions of the protein's →	Interactions with the binding pocket can be studied and used to develop drugs to help fight disease. Proteins that cause disease through being overactive, underactive, and or non-functioning can also be studied

Status

- UCI in collaboration with Alabama Space Grant and UAH, has initiated a pilot program to demonstrate the feasibility of the program.
- Currently, 150 samples from 80 classrooms in Alabama, Florida, Tennessee, and California are orbiting the earth as part of the first experiment conducted on the International Space Station.
- Activities are underway to include student samples from Texas, Michigan, Florida, California, and Alabama on the January 18, 2001 launch of Atlantis.
- Held 20 workshops training teachers and Space Grant Representatives from over 35 States.
- Developed a standard class experiment kit for crystal growth.

Steps for Participation

1. Identify and train teachers - Brief introduction to structural biology plus demonstration of class experiment. (Typically a 2 hour in-service).
2. Distribute classroom experiment kits - ($150, each kit serves 3 classes)
3. Solicit student essays/projects - Open on any topic related to structural biology. Students often key in on a disease with a personal connection.
4. Select students for sample loading - (Typically up to 24 per workshop)
5. Students attend a workshop and prepare samples - (Typically 2 days)
6. Students attend the launch and receive VIP status at KSC.

Wrap-up

- Opportunities exist for any interested Space Grant Organization to participate in the Enhanced Dewar Program.
- NASA plans to fly the Dewar twice a year. (12/5/2002 is next manifested flight)
- Students are involved in a current science experiment with potentially publishable results.