

CENTER FOR BIOLOGICAL PHYSICS

Math and Science Teaching Fellows 2007

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Introduction

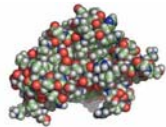
We have spent the past four weeks working within the Center for Biological Physics, specifically working with Director Mike Thorpe, Dr. Banu Ozkan, and Dr. Arjan van der Vaart. Each researcher patiently explained his/her research, conveying higher level physics and math in such a manner that it was comprehensible to three high school math teachers. Through this experience, we all have a renewed humility and appreciation for the quest for knowledge that these scientists carry out on a daily basis. We each attempted to synthesize the information presented to us in a usable and relevant standards-based form for our students. With this poster, we hope to explicitly demonstrate the knowledge we have gained from the research experience, as well as the curricular activities we have developed for our students.

The Research

Summary:

Using computer simulations to study a variety of molecular and large scale situations including:

- Molecular dynamics
- Protein structures
- Protein folding
- Virus structure
- Network rigidity



Research Tools:

- Online database resources for protein structure models.
- Supercomputers and personal computers
- Freeware for running simulations
- Online protein modification software

Selected Research for Curricular Application:

- Structure of proteins and viruses as related to an icosahedral shape.
- Modeling small objects such as molecules
- Modeling large objects such as planets and galaxies.

Algebra Curriculum

Length scales and proportional reasoning:

Students have difficulty understanding the significance of their answers in the context of the problem. We designed a unit to stress these ideas.

Students will:

- Understand scaling in terms of a map.
- Apply the idea of scaling to planets using proportions.
- Design a scale model of the planets in our solar system.
- Apply the idea of scaling from a quark up to a human.
- Compare travel times for various speeds and distances.
- Improve estimation skills.



If we use an inch to represent one mile for the distance from Mesa to Tucson, will that map have a practical size? What would be a better scale for that situation?

If we are representing the distance from the earth to the moon using a whiteboard marker, how many markers would be needed to represent the distance from the earth to the sun?



If you put a grain of sand at the edge of our classroom, that is the relative proportion of a quark to an atom. If a grain of sand represents a quark, then what would represent proportionally to a human?

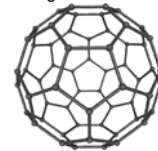
Geometry Curriculum

From Euler's Theorem to Virus Structure

Students have a fundamental understanding of Euler's Formula, but not the application to life systems. We have designed a curriculum to understand complex viruses based on the principles of a simple polyhedron.

Students will:

- Understand fundamental topology of a polyhedron.
- Model the structure of the platonic solids.
- Derive Euler's Formula and the principle of duality from structure models
- Learn what a soccer ball has in common with a virus
- Understand why virus capsids are icosahedral in structure.
- Create a buckyball structure to understand protein packing.



Study the figures you created. Do you notice any relationship between the number of faces, vertices, and edges in each platonic solid? Photo from www.wikipedia.com

Analyze the soccer ball with your group. How many faces, vertices, and edges does it contain? How many pentagons and hexagons? This structure is much like a buckyball.



The virus shown has a triangulation number of 4. If the capsid has 140 triangular regions, how many proteins does the virus contain?

State Standards

Math:

- Solving Equations and Proportions
- Translate among various data representations
- Generate an algebraic sentence to model real-life situations
- Understand the logic of algebraic procedures
- Determine whether a given procedure for solving an equation is valid
- Make a net to represent a 3-dimensional object
- Draw 2-dimensional and 3-dimensional figures with appropriate labels

Science:

- Describe the characteristics, location, and motions of the various kinds of objects in our solar system
- Analyze the relationships among position, velocity, acceleration, and time
- Describe the features and components of the atom



X-ray and FRODA protein strand

Wells/Hespenheide/Menor/mt2005

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