



# Protein Modeling Challenge

## Science Olympiad Trial Event

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# Protein Modeling Challenge

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- To compete successfully in the Protein Modeling Challenge, you will:
  - Identify basic features of protein structure
  - Explore protein structure with the computer visualization program RasMol
  - Create physical models using the flexible modeling media, Mini-Toobers

# Web-Based Resources

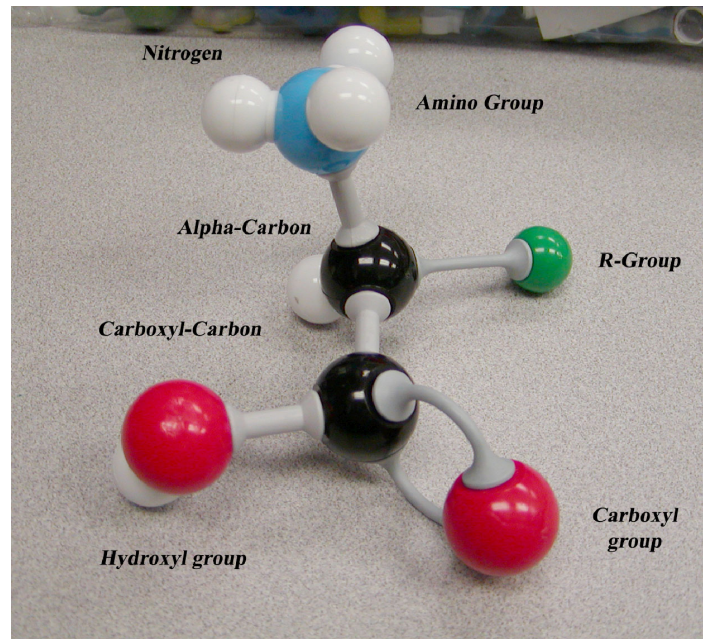
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- This powerpoint presentation will serve as an interactive resource for your team to gain the knowledge they need to be successful in the Protein Modeling Challenge
- You will find links distributed throughout this presentation, indicated by the [blue underlined text](#)
- Follow these links to the appropriate sources
- Good luck and have fun!

# Protein Structure

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- Proteins are macromolecules
- Amino acids are the basic building blocks of proteins



# Protein Structure Resources

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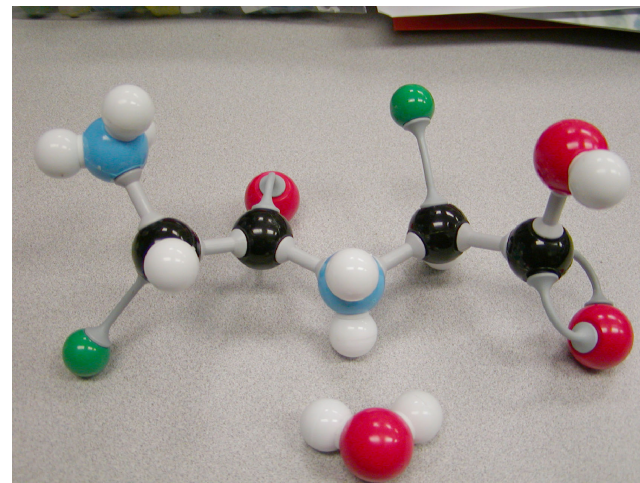
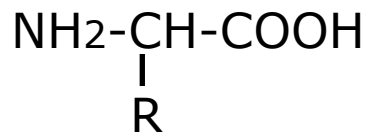
- The following links will serve as tools to help you learn the basic information needed to be successful in this challenge. Please follow these links:
  - Basic Introduction to Protein Structure and Modeling ([pdf](#))
  - Collection of models and activities: **I**ntroduction **T**o **P**rotein **S**tructure (ITOPS) ([www](#))
  - MSOE Model Lending Library ([www](#))



# Amino Acids Have Unique Chemical Characteristics

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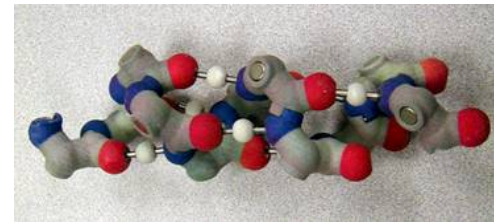
- Each amino acid has the same “backbone” structure, but has different chemical groups (R groups or sidechains) attached
- Construct an amino acid and a dipeptide with a molymod kit (ITOPS) ([www](http://www.itops.com))



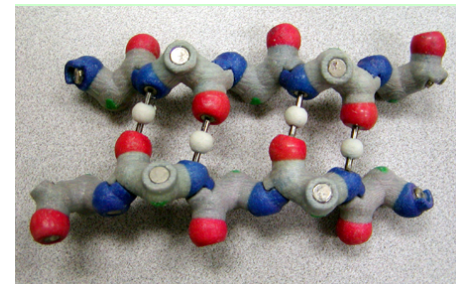
# Proteins Have Secondary Structure

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- A linear chain of amino acids is the protein “primary” structure
- A chain of amino acids will spontaneously form stable “secondary structures”, ie: beta-sheet or alpha-helix
- Construct an alpha-helix and beta-sheet activity (ITOPS, Introduction To Protein Structure)  
([pdf](#))



Alpha Helix

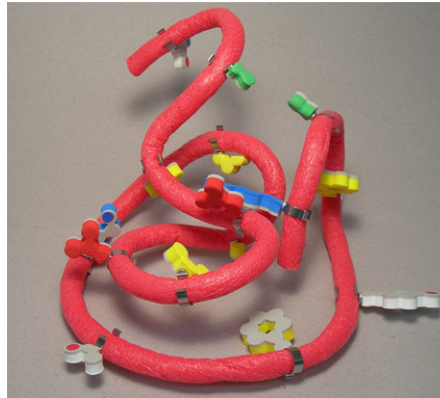


Beta-sheet

# Proteins Fold Into a Tertiary Structure

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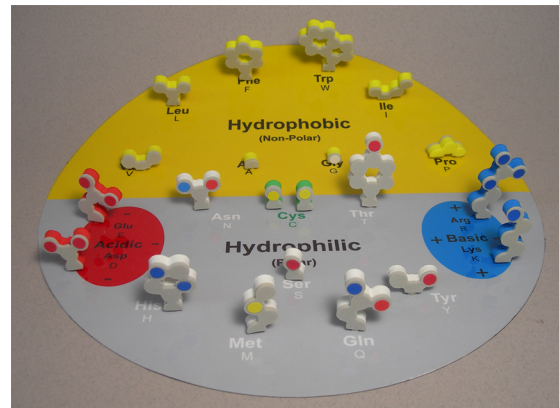
- Proteins spontaneously fold into a specific three dimensional “tertiary” structure that governs a protein’s function





# Proteins Fold Into a Tertiary Structure

- Protein folding is due to the behavior of different chemical groups on amino acids in an aqueous environment
- Explore amino acid sidechain chemistry and protein folding with the Amino Acid Starter Kit Activity (ITOPS, Introduction To Protein Structure) ([WWW](#))



# Defining Protein Structure

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- The 3-dimensional structure of proteins is often determined by x-ray diffraction or NMR analysis
- Each atom in a protein is assigned a specific set of X, Y, Z coordinates in 3D space to create a PDB data file

# Protein Data Bank

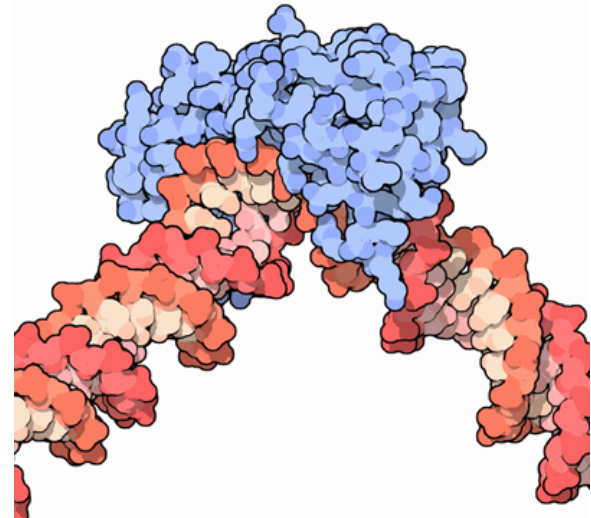
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- PDB file lists the X, Y, Z coordinates for each atom in a protein
- **Protein Data Bank** website is the location to download PDB files ([www](#))
- **PDB Molecule of the Month** features the structure and function of a different protein each month ([www](#))

# Molecule of the Month (MOM)

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- A monthly PDB feature written by David Goodsell
  - Features a specific molecule
  - Describes protein function
  - Relates structure with function

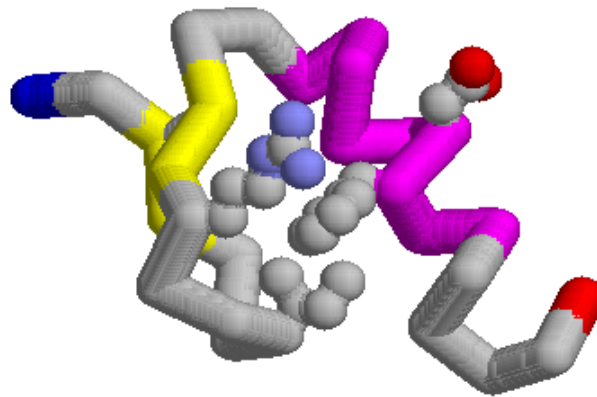


TATA-binding protein  
Aug 2005 MOM  
([www](#))

# RasMol

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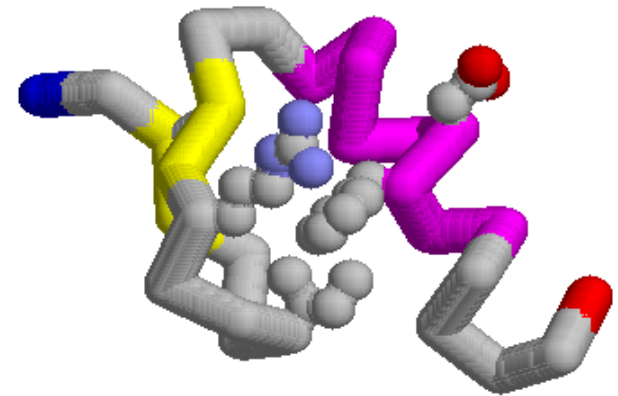
- RasMol is public-domain computer visualization software that displays data from a PDB file as a “3D” image of the molecule on the computer screen



# Exploring Protein Structure with RasMol

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- RasMol allows you to identify elements of protein structure
  - Helix (magenta)
  - Sheet (yellow)
  - N-terminus (blue)
  - C-terminus (red)
  - Amino acid sidechains (CPK)
  - Alpha-carbon backbone model format



# RasMol Resources

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- Use the following resources as tools in learning Rasmol:
  - **RasMol** free download ([www](#))
  - **Science Olympiad Guide to Using RasMol** to explore protein structure ([www](#))
  - **Reference Card of RasMol** commands, condensed ([www](#))

# RasMol Exercises

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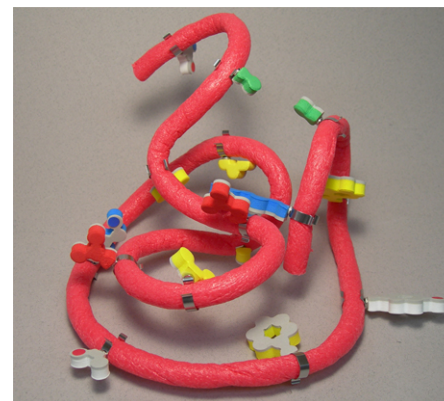
- Explore the structure of a zinc finger domain and beta-globin proteins and practice RasMol
  - Zinc Finger Exercise ([www](#))  
Answers ([www](#))
  - Beta Globin Exercise ([www](#))  
Answers ([www](#))



# Mini-Toober Models

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- Mini-Toobers are a flexible modeling media
- Developed by **3D Molecular Designs (3DMD)** with a Small Business Initiative Research grant (SBIR) from the National Science Foundation (NSF) ([www](http://www.3dmd.com))



# Create Physical Mini-Toober Models

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- Identify protein structural features with RasMol (ie: helix, sheet, amino acid sidechains)
- Create a protein folding map ([www](#))



# Mini-Toober Models (cont.)

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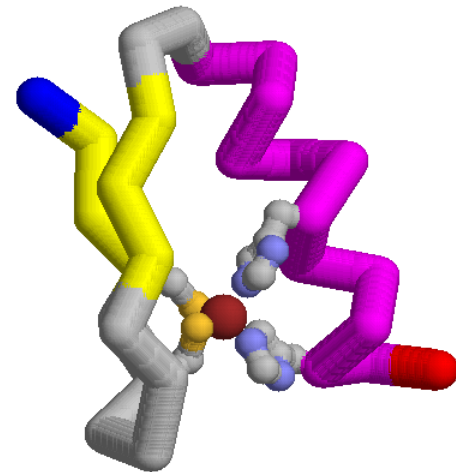
- Mark location of structures on Mini-Toober
- Fold Mini-Toober into a 3D model representing protein



# Zinc Finger Protein

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- Zinc finger proteins bind DNA
- A zinc finger domain contains a short alpha-helix, 2 beta-strands and conserved Cys, His amino acids that bind a molecule of zinc



# Zinc Finger Folding Exercise

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- Zinc Finger Folding Kit is available from MSOE Lending Library - Introduction to Protein Structure-ITOPS ([www](#))
- **Challenge:** Download the 1ZAA pdb file, create an image in RasMol, identify key structural features, and fold a Mini-Toober model ([www](#))

# Protein Modeling Challenge

## Science Olympiad Trial Event

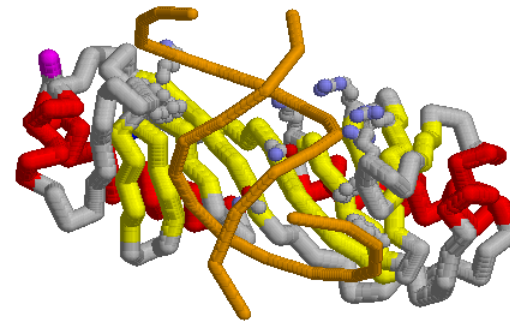
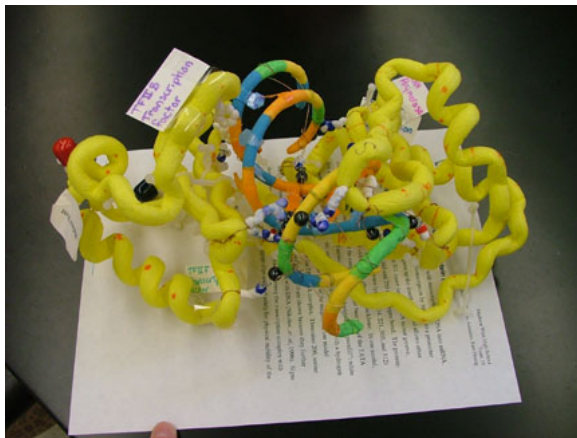
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- 2006 Event Rules ([www](#))
- Pre-built model and written description (40%)
- On-site Model challenge (30%)
- Written exam (30%)

# Pre-Built Model 2006

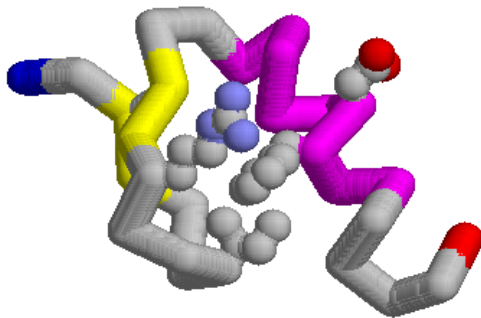
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- TATA-binding protein and written description based on August 2005 Molecule Of the Month ([www](#))
  - Impound prior to competition
  - 40% team score

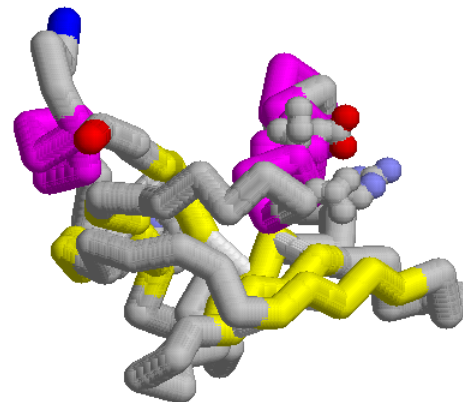


# On-Site Protein Challenge 2006

- **Regional:** Designer Proteins, Molecule Of the Month, September 2005, 1PSV pdb file ([www](#))
- **State:** Cholera Toxin Molecule Of the Month September 2005, 1XTC pdb file ([www](#))
- 30% team score



1PSV



1XTC



# Written Exam 2006

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- Exam covers material in PDB file, Molecule of the Month, RasMol, as well as basic concepts in protein structure and function
- 30% team score
- Wisconsin State 2006 Written Exam ([www](#))

# Scoring Rubrics 2006

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- TATA Binding Protein model ([www](#))
- TATA Binding Protein written description ([www](#))
- Protein folding map ([www](#))
- Cholera toxin model ([www](#))
- WI State written exam ([www](#))

# New Jersey Protein Modeling Challenge 2006

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- Sandy Buleza, NJ Co-director, [sbuleza@comcast.net](mailto:sbuleza@comcast.net)
- Christine Zardecki, Event Supervisor
- New Jersey Science Olympiad website ([www](http://www.njsolympiad.org))
- PDB Science Olympiad website ([www](http://www.pdb.org))



# Kansas Protein Modeling Challenge 2006

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- Greg Novacek, State Director, [Greg.novacek@wichita.edu](mailto:Greg.novacek@wichita.edu)
- Carol Willimason, Event Supervisor, [williamc@olatheschools.com](mailto:williamc@olatheschools.com)
- Kansas SO website ([www](http://www))



# Wisconsin Protein Modeling Challenge 2005, 2006

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- Steven Schultz, State Director, [schultz@wi.tds.net](mailto:schultz@wi.tds.net)
- Gary Graper, Event Supervisor, [gjgraper@facstaff.wisc.edu](mailto:gjgraper@facstaff.wisc.edu)
- Wisconsin Science Olympiad website ([www](http://www.wisconsin-scienceolympiad.org))



# Cost of Materials

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- Materials for pre-built model, regional, and state competitions are approximately \$50-60 per team (all materials provided at cost by 3D Molecular Designs)
- Wisconsin (2005 and 2006) sponsored by 3D Molecular Designs ([www](#)) and MSOE ([www](#))
- New Jersey (2006) sponsored by the Protein Data Bank ([www](#))
- Kansas (2006) sponsored by 3DMD, MSOE, Kansas Science Olympiad committee

# Future Support

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- 3D Molecular Designs and MSOE are committed to sponsor the first National Science Olympiad Protein Modeling Challenge
- Center for BioMolecular Modeling, CBM, will work with each State Event Supervisor to identify corporate sponsors
- Other options: fee to each team, inclusion of cost in team registration fee, grants

# Protein Modeling Challenge With National Science Content Standards

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- Science and Technology
  - Abilities of Technological Design
  - Understandings about Science and Technology
- Life Science
  - The Cell
- Science as Inquiry
  - Abilities Necessary to do Scientific Inquiry
- Physical Science
  - Structure and Properties of Matter
  - Chemical Reactions
- Detailed Alignment ([www](#))



# PDB Education Corner Features Protein Modeling Challenge

- PDB Newsletter, No. 26 Summer 2005  
([www](http://www.pdb.org))
- By Gary Graper, Event Supervisor



# Protein Modeling Supports Science Olympiad Mission

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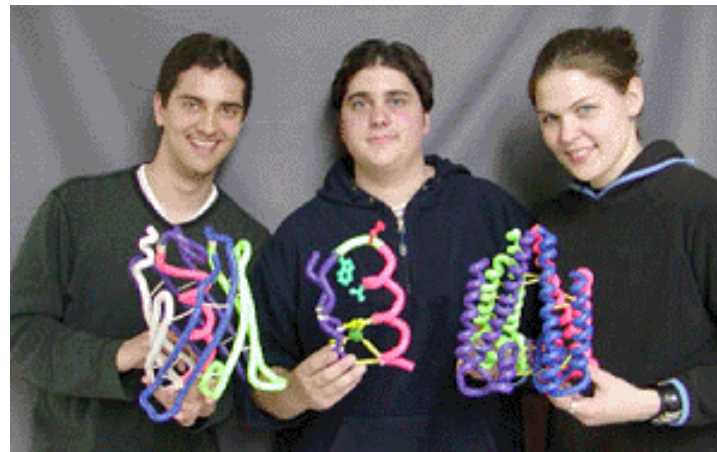
- Emphasis on teamwork



# Protein Modeling Supports Science Olympiad Mission

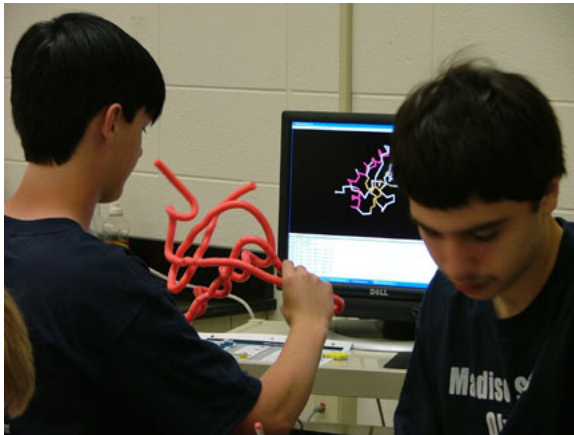
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- Provides curriculum training workshops and web based distribution of materials from the MSOE Center for BioMolecular Modeling web site ([www](http://www.msou.edu/~msoe/bmm))



# Protein Modeling Supports Science Olympiad Mission

- Brings science to life, shows how science works, emphasizes problem solving aspects and understanding of concepts



# Protein Modeling Supports Science Olympiad Mission

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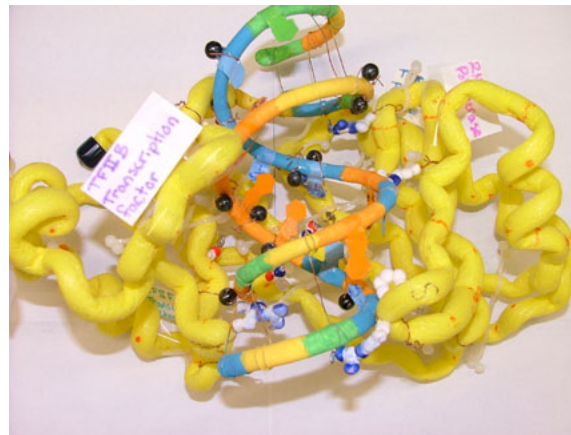
- Promotes partnerships among community, businesses, industry, and education





# Protein Modeling Supports Science Olympiad Mission

- Promotes high level of achievement and demonstrates students can perform at levels approaching practicing scientists



# CBM Programs

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- Teacher Professional Development ([www](#))
  - Genes, Schemes, Molecular Machines
  - Modeling the Molecular World
  - Molecular Stories of Research-Based Health Care
- SMART Teams (Students Modeling A Research Topic) ([www](#))
- MSOE Model Lending Library ([www](#))
- Science Olympiad Protein Modeling Challenge ([www](#))

# Additional Information

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- Please contact either:
  - Gary Graper, [gjgraper@facstaff.wisc.edu](mailto:gjgraper@facstaff.wisc.edu)
  - Shannon Colton, Ph.D., [colton@msoe.edu](mailto:colton@msoe.edu) or 414-277-2824





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Center for  
BioMolecular  
Modeling

*...where teachers come first*

<http://www.rpc.msoe.edu/cbm>