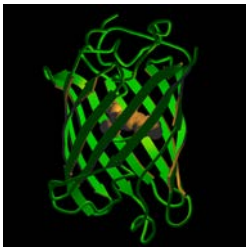
AP Biology Term 2 Project

Spider silk

Protein Project

"Almost all aspects of life are engineered at the molecular level, and without understanding molecules we can only have a very sketchy understanding of life itself."
- Francis Crick



Green fluorescent protein

Introduction:
The genomes of many species are being sequenced and deciphered. The field of genomics is now moving into a more complex field – proteomics, the study of protein structure and function. Unlike DNA, which is a linear molecule, proteins vary tremendously in their composition. The search for potentially useful proteins in nature, revealing their structure & function, and devising new applications for them is a major focus for many biotechnology companies today.

Purpose: You have recently been hired by a proteomics company to work with a *bioprospector* to investigate naturally occurring proteins and propose novel uses for them.

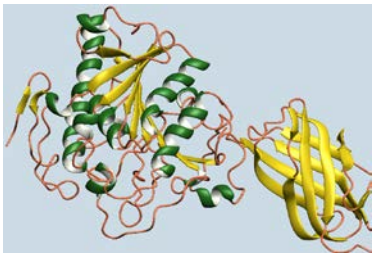
Procedure Overview:

A) Bioprospecting:
Work with your lab partners to research proteins from a variety of organisms. Identify a protein that you think has practical applications.

B) Biochemistry:
Identify the protein's chemical structure and how it functions at a molecular level.

C) Bioengineering:
Describe applications for this protein. Specifically, how is it or how might it be useful in medicine, industry, research, etc.?

D) Presentation:
Present information about your protein with a poster board or electronically.



Lipase

Telomerase

Bioprospecting – *The sampling of diverse organisms for genes, gene products and other compounds that are of value to humans* (www.nature.com/nrg/journal/v4/n8/glossary/nrg1128_glossary.html).

Objectives:

- From what type of organism is the protein found?
- How does the protein help the organism survive in its environment?
- Describe the history of when people first discovered the protein.

Procedure:
Work with laptops in groups at school and individually at home to investigate websites provided on the list of protein examples. Website can be easily accessed at the AP Bio Moodle site - http://ab.thinkingdistance.org/login/index.php (Login with your username or as a guest).

Biochemisty - *The chemistry of living things, including the structure and function of biological molecules and the mechanism and products of their reactions* (http://antoine.frostburg.edu/chem/senese/101/glossary/b.shtml).

Objectives:

- Describe the hydrophobic, hydrophilic, negative, and positive amino acids that make-up the protein.
- How do the secondary structures (example: alpha helices, beta-pleated sheets) and tertiary bonds (example: hydrogen bonds, disulfide bridges, etc.) influence the shape of the protein?
- Explain how the protein's molecular shape and charge influence its (bio)chemical function

Procedure:

1) Learn the basics of protein chemistry by following the guided activities at **Molecular Workbench** - http://mw.concord.org/modeler/index.html Select and explore "Proteins and Nucleic Acids." Specifically, you will follow parts 1 – 6 in the table of contents. Begin with an "Introduction to Proteins" and the tutorial will advance you to the next steps. You are not likely to finish this online study in class and are expected to work on these activities at home over the next few weeks.

2) Study more advanced protein chemistry using the next three websites:

   - Michigan State University's Peptides and Proteins - http://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/protein2.htm#aacd10b

   - Proteopedia - http://proteopedia.org/wiki/index.php/Structural_templates

   - foldit - http://fold.it/portal/info/science

   These three sites are very in-depth and are meant to provide you with explanations of your protein's chemistry. The serve as *references* - you are not expected to master the material. Refer the 'Objectives' section (above) to see what level of chemical detail you are expected to know for your protein.

3) At this point you can study the chemical properties of your protein using "Jmol," software that will enable you to analyze a molecule in 3D. Begin by locating Internet Explorer or some other browser on your laptop and go to Protein Data Bank - http://www.pdb.org/pdb/home/home.do This website will bring you to the "Biological Macromolecule Resource." In the 'search' window, type the name of your protein (ex. Antifreeze Protein or Melittin). Select the protein under 'Molecule Name' or 'Molecule of the

Month.' You may need to click the image of one of the displayed proteins. When you see a description for viewing in "Jmol" select this option. The Jmol software will now open and once you see your enlarged protein in 3D, right click it to highlight a menu. You might select "spin" and click "On." Your molecule will now rotate. Next select – "display selected only." This command will allow you to dissect your protein piece-by-piece. For instance, if you select "Protein" you can highlight the hydrophobic or hydrophilic regions of the protein. Refer to a handout of the chemical properties of amino acid side chains. Consider which amino acids would comprise the hydrophobic or hydrophilic domains of the protein. Are the hydrophobic regions on the inside or outside of the protein? Why do you think it is arranged this way? How might this structure influence how it functions?

4) Jmol takes practice to develop moderate skill. This next site will help you build those skills: *Yet Another Tutorial for Jmol* - http://www.bluffton.edu/~bergerd/classes/jmol.html

   If you want to download Jmol on your computers at home so you can analyze your protein outside of class, go to Download Jmol - http://jmol.sourceforge.net/download/

Bioengineering - *Using the principles of engineering to develop solutions for health-related products and techniques that improve the quality of life* (http://www.worldwidelearn.com/online-education-guide/engineering/bioengineering-major.htm).

Objectives:
- Describe how researchers are using the protein for practical applications.
- Using your own ideas, propose other possible uses for the protein.

Procedure:
- Work with laptops in groups at school and individually at home to investigate websites that describe practical applications for the protein.

Presentation – Present information about your protein with a poster board (see class examples).

Provide several visuals, including a 3D model of the protein. See example of spider silk protein discussed in class and featured on the AP Biology Moodle site.

Protein Project – Grading Criteria

Period:____ Team Members: _____

Directions: Use the rubric below to interview a representative from a team as they explain why and how they chose to market their protein. Information from the interview and poster or website, Glogseter, etc. will be used to score the presenter in the grading criteria below. Team grades will be the sum of student + teacher marks.

Bioprospecting:
Team investigated multiple sources and provided a list of website references (20%)

Excellent (20 pts):	The organism is described in the context of how the protein helps it survive in its environment. A historical account of the protein's discovery is provided. Descriptions are well-written, clear, and provide sufficient depth. Multiple sources are used and websites are cited.
Good (15 pts):	The organism is described in the context of how the protein helps it survive in its environment. A historical account of the protein's discovery is provided. Descriptions are either not well-written, clear, or do not provide sufficient depth. Multiple sources are used and websites are cited.
Fair (10 pts):	The organism is not described in the context of how the protein helps it survive in its environment. A historical account of the protein's discovery is provided. Descriptions are either not well-written, clear, or do not provide sufficient depth. Multiple sources are used and websites are cited.
Poor (5 pts):	The organism is not described in the context of how the protein helps it survive in its environment. A historical account of the protein's discovery is not provided. Descriptions are not well-written, not clear, and do not provide sufficient depth. Multiple sources are not used and websites are not cited.

Biochemistry:
The chemical structure and function of the protein is detailed and correct (20%)

Excellent (20 pts):	Hydrophobic, hydrophilic, negative, and positive amino acids are highlighted. The secondary structures (example: alpha helices, beta-pleated sheets) and tertiary bonds (example: hydrogen bonds, disulfide bridges, etc.) are described. An explanation of the protein's molecular shape and charge influencing its biochemical function is provided.
Good (15 pts):	Hydrophobic, hydrophilic, negative, and positive amino acids are highlighted. The secondary structures (example: alpha helices, beta-pleated sheets) and tertiary bonds (example: hydrogen bonds, disulfide bridges, etc.) are described. An explanation of the protein's molecular shape and charge influencing its biochemical function is not provided.
Fair (10 pts):	Hydrophobic, hydrophilic, negative, and positive amino acids are highlighted. The secondary structures (example: alpha helices, beta-pleated sheets) and tertiary bonds (example: hydrogen bonds, disulfide bridges, etc.) are not described. An explanation of the protein's molecular shape and charge influencing its biochemical function is not provided.
Poor (5 pts):	Hydrophobic, hydrophilic, negative, and positive amino acids are not highlighted. The secondary structures (example: alpha helices, beta-pleated sheets) and tertiary bonds (example: hydrogen bonds, disulfide bridges, etc.) are not described. An explanation of the protein's molecular shape and charge influencing its biochemical function is not provided.

Bioengineering:
Team investigated multiple sources and provided a list of website references (20%)

Excellent (20 pts):	A description of how researchers are using the protein for practical applications is provided. The proposed ideas for other possible uses for the protein are novel yet plausible. At least one source is provided and website(s) references are given.
Good (15 pts):	A description of how researchers are using the protein for practical applications is provided. The proposed ideas for other possible uses for the protein are novel yet not plausible. At least one source is provided and website(s) references are given.
Fair (10 pts):	A description of how researchers are using the protein for practical applications is provided. The proposed ideas for other possible uses for the protein are not novel and not plausible. At least one source is provided and website(s) references are given.
Poor (5 pts):	A description of how researchers are using the protein for practical applications is not provided. The proposed ideas for other possible uses for the protein are not novel and not plausible. At least one source is provided and website(s) references are not given.

Presentation:
Presentation is neat, clear, and well-formated (20%)

Excellent (20 pts):	The topics, 'Bioprospecting,' 'Biochemistry,' and 'Bioengineering,' are clearly titled. Several visuals, including a 3D model of the protein, are provided. The presentation is well organized and professional looking.
Good (15 pts):	The topics, 'Bioprospecting,' 'Biochemistry,' and 'Bioengineering,' are clearly titled. Several visuals, including a 3D model of the protein, are not provided. The presentation is well organized and professional looking.
Fair (10 pts):	The topics, 'Bioprospecting,' 'Biochemistry,' and 'Bioengineering,' are clearly titled. Several visuals, including a 3D model of the protein, are not provided. The presentation is not well organized and professional looking.
Poor (5 pts):	The topics, 'Bioprospecting,' 'Biochemistry,' and 'Bioengineering,' are not clearly titled. Several visuals, including a 3D model of the protein, are not provided. The presentation is not well organized and professional looking.

→ rubric continued on reverse side

Protein Project – Individual Grading Criteria

Period:____ Team Members: _____

Directions: 80% of your grade for the protein project is based on a sum of your class peers' + the teacher's grades. Now you must also consider individual participation. Use the criteria below to mark if you thought people in your group equally pulled their weight. If someone obviously did not do work, write their name in the space provided to deduct points.

Teamwork:
Did everyone in your team contribute to each of these steps? (20%)

Yes - (20 pts): (everyone participated in each component)	Bioprospecting, biochemistry, and bioengineering research, poster design & production.
No - (15 pts): (_____ did not participate in **one** component)	Bioprospecting, biochemistry, and bioengineering research, poster design & production.
No - (10 pts): (_____ did not participate in **two** components)	Bioprospecting, biochemistry, and bioengineering research, poster design & production.
No - (5 pts): (_____ did not participate in **three** components)	Bioprospecting, biochemistry, and bioengineering research, poster design & production.

Comment if your teammate did not participate. Please provide additional detail.