



CATALASE: A BIOINFORMATICS CASE STUDY

Title of Lesson: Catalase: A bioinformatics case study

Designed by:

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Background:

This activity is a webquest that guides students through various bioinformatics tools on the internet including the protein database at NCBI, Cn3D protein viewer, and ClustalW. Students will focus on a specific protein and gain a better understanding of its 3D structure as well as its primary amino acid structure. They will also compare protein sequences from different organisms and use this to investigate evolutionary relationships.

Description of Audience:

This biotechnology/bioinformatics activity is designed for use in a high school Biology, AP Biology, Biotechnology, or equivalent course.

State Standards:

This biotechnology/bioinformatics activity fulfills the following State of California Science Standards:

Biology

- Grades 9-12: 1b, 1d, 1h, 4e, 4f, 5a, 8f

Investigation and Experimentation

- Grades 9-12: 1d, 1l

National Standards:

This biotechnology/bioinformatics project-based multimedia learning activity fulfills the following National Science Standards:

- Content Standard A: Science as Inquiry
- Content Standard C: Life Science
- Content Standard E: Science and Technology

STEM Connection:

Bioinformatics is being used increasingly in many aspects of research science. Tools such as the ones here can be used in research fields as varied as pharmaceuticals, medicine, marine science, agricultural science, molecular biology, epidemiology, and taxonomy.

Goals(s):

The goal of this lesson is to (List overall goals. What do YOU, as the teacher, set up for students to learn?):

- expose students to bioinformatics tools and technology on the web.
- allow students to visualize and manipulate the 3D structure of a protein.
- reinforce the connection between protein structure and function.
- clarify the similarities and differences between the structure of similarly functioning proteins in different organisms.
- show students how differences at the molecular level can be used to infer evolutionary relationships.

Learning Objective(s):

Upon completion of this lesson, students will be able to:

- use NCBI to find protein structure files and protein sequences.
- use Cn3D to visualize and manipulate protein files.
- acquire protein sequences from various organisms and align them using ClustalW.
- explain the difference between primary, secondary, tertiary, and quaternary structure in proteins using visuals.
- explain how and why proteins with the same function may differ in structure in different organisms.
- explain how organisms with dissimilar protein sequences are more distantly related than organisms with more similar protein sequences.

Purpose/Rationale:

I am teaching this lesson using a webquest so all students have hands-on access to technology and experience walking through the process of using bioinformatics tools. As students answer the accompanying questions, they are required to research information on the web with the teacher as a coach and not a disseminator of information. Since bioinformatics is becoming more prevalent in scientific research, it is important for students to be exposed early on to web databases and tools such as the ones used in this lesson.

Materials/Resources:

In order to complete this lesson, the following materials are needed:

- Student access to computers with internet (ideally, 1 computer per student)
- The following websites: <http://www.ncbi.nlm.nih.gov/>, <http://align.genome.jp>
- Bioinformatics Questions Handout

Prior Teacher Preparation:

Before this lesson, the teacher should test out all the websites to make sure they are still accessible. Since NCBI is a dynamic database, the searches that students do may not always result in the exact pictures that are in the directions. There is a lot of information in the database, and a general familiarity with how the databases work and are used will be especially helpful when students ask questions.

This lesson assumes that students already have a basic understanding of protein structure, amino acid codes, and the relation of protein structure to protein function. It will also be helpful if they already have some knowledge of general classification and how to interpret a phylogenetic tree.

3-Step Procedure:

#1 Introduction:

- Reference back to what students already know about protein structure and function.
- Ask students what proteins do and why proteins work best only under certain temperature and pH conditions.
- Ask students what holds proteins together and why protein shape is important.
- Give a quick tutorial to explain to students how to access computer and internet.
- Remind students to work on the accompanying questions as they navigate through the various websites.

#2 Exploration:

- Students will be working relatively individually following the directions on the webquest and answering the questions that go along with it. They are welcome to work together, but must submit their own paper.

#3 Application:

- The last part of the student worksheet requires students to do outside web research to expand on the significance of the bioinformatics tools and/or the scientific importance of the protein they studied. This directly ties in to real-life application of these tools especially in the realm of scientific research.
- With some knowledge of bioinformatics, students will have more familiarity with NCBI in the future if the teacher decides to incorporate BLAST, ORF finder, or other tools available on the website.

Assessment:

- The teacher can collect their questions, examine their compiled sequences, and phylogenetic tree. These all give feedback as to whether they were able to follow directions and understand what they were doing.
- If desired, teachers can ask students to do the same activity investigating another protein that they're interested in.

Teachers' Self Evaluation:

- *Incomplete*