



The Biological Database Explorer

A web-based teaching tool to introduce pharmacogenetics and bioinformatics to high school students

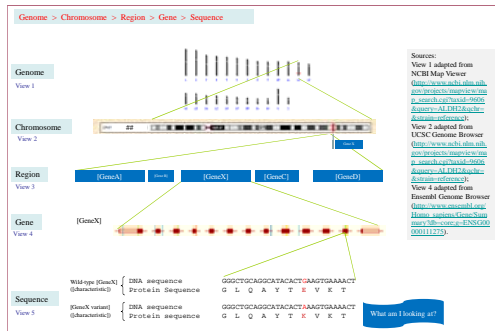
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Abstract

We are creating the **Biological Database Explorer (BDE)**, a web-based tool targeted at high school students, to teach pharmacogenetics concepts and introduce biological databases through hands-on experience. The recent completion of the sequencing of the 3 billion bases that comprise the human genome has ushered in a new scientific era in which vast amounts of genetic data are generated. The field of bioinformatics has emerged in tandem with major biological databases to store, process, and analyze this explosion of data. Students need to be aware of this new paradigm for scientific research and to understand current genetics-related topics. We are designing lessons drawing upon pharmacogenetics, the study of the role of human genetic variation in drug treatment outcomes. The rich information in the Pharmacogenetics and Pharmacogenomics Knowledge Base (PharmGKB; www.pharmgkb.org) serves as the inspiration for the BDE.

Figure 1



Based on the genome browsers used by researchers, the Chromosome Cruiser depicts different levels at which genetic information can be visualized. Students will be able to navigate from one view to another and will better understand the relationships between them.

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Education Challenge

Provide the experience of using a real biological database with distilled content that is interesting and comprehensible.

We are adapting features of existing biological databases and supplementing scientific content with visualizations, animations, and explanations.

Project Design

Phase 1

- Department of Genetics and School of Education project members hold brainstorming sessions
- Create prototypes and generic content templates with visual representation sequences for key concepts

Phase 2

- Construct web-based BDE, drawing on Phase 1 materials
- Develop accompanying instruction methodologies and presentation mechanisms

Phase 3

- Pilot-test BDE instructional unit with high-school students using a combination of instructor-led guidance and hands-on exploration by students

Project Goals

- Create a visual, interactive, web-based teaching module to introduce pharmacogenetics concepts and biological databases to high school students
- Reinforce California Science Content Standards for genetics through real-life examples in humans

California Science Content Standards reinforced in the BDE:

- Life Sciences/Genetics**
- ✓4b. Students know how to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA.
 - ✓4c. Students know how mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein.
 - ✓4e. Students know proteins can differ from one another in the number and sequence of amino acids.
 - ✓5a. Students know the general structures and functions of DNA, RNA, and protein.
 - ✓5b. Students know how to apply base-pairing rules to explain precise copying of DNA during semiconservative replication and transcription of information from DNA into mRNA.
- Investigation and Experimentation**
- ✓1a. Select and use appropriate tools and technology... to perform tests, collect data, analyze relationships, and display data.
- Source: <http://www.cde.ca.gov/be/st/ss/>, 1/26/2009

Results To Date

- We have prototyped two pharmacogenetics lessons showcasing the relationship between a genetic variant and drug response:
 1. ALDH2 variants and response to alcohol ingestion
 2. ADRB2 variants and response to the asthma medication albuterol
- We have developed visual representation series for scientific concepts related to pharmacogenetics, including:
 1. Chromosome Cruiser (Figure 1)
 2. Pathway Portal (Figure 2)

Plans For 2009

- Design generic visual representation templates for pharmacogenetics content
- Enhance the templates with animations of important, complex material (e.g., pathway animations)
- Create a website with database-style interface based on graphical templates
- Pilot-test web-based instructional unit with high-school students
- Evaluate pilot-test results

Impact and Future Directions

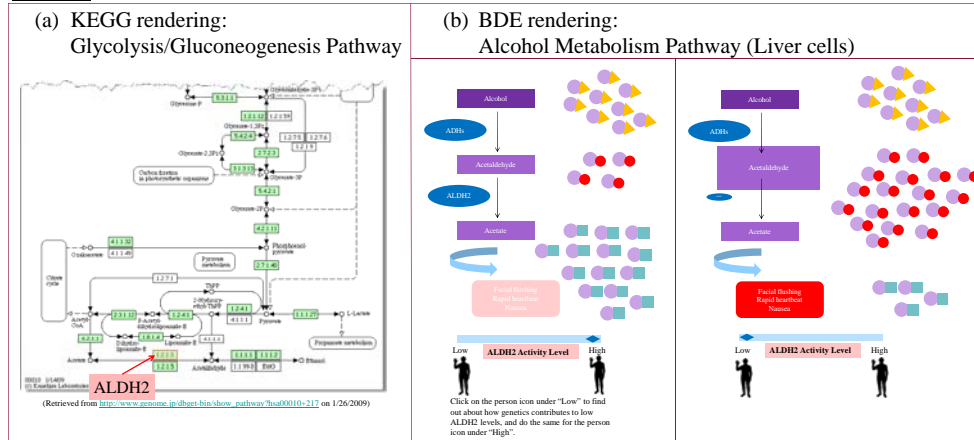
Impact:

- Students will gain an appreciation of recent advances in human genetics
- Students will become aware that available genetic tests can help predict response to certain drugs
- The BDE will introduce students to the existence, structure, and content of biological databases

Future directions:

- Increase the number of gene-drug-phenotype relationships in the BDE to provide extensive coverage of important scenarios
- Add module investigating Ethical, Legal, and Social Issues (ELSI) in pharmacogenetics

Figure 2



The BDE illustrates a portion of the biochemical pathway for alcohol metabolism through the use of visuals. Panel (a) shows the biochemical pathway, as represented in the KEGG biological database. The BDE representation is in Panel (b). Animation will be incorporated for further clarification.