

## Bioinformatics game – notes for Teachers

### Introduction

Today there are masses of data being generated in the fields of molecular biology and biochemistry, but a shortage of people with the skills required to manage and analyse it. These people are called bioinformaticians.

*Raiders of the Lost Gene* was developed to expose young students who like computer games, pattern recognition and mathematics to a career path they may not have considered: one in bioinformatics.

The game was developed by a high school teacher and a Year 10 student in collaboration with scientists and bioinformaticians working in the field of plant biotechnology. It was designed to give students at Year 9-10 a 'feel' for what bioinformatics is about. *Please note: the final version of the game is yet to be made publicly available.*

### What is bioinformatics?

Bioinformatics has been described as 'the application of tools of computation and analysis to the capture and interpretation of biological data' (Bayat, 2002). In other words, bioinformatics is the use of computers and software to make biological data meaningful. This 'data' includes DNA sequence as well as amino acid sequence and models of 3-dimensional protein structure. The volumes of data generated in modern biology, including those resulting from the human genome project and sequencing projects in other organisms, can only be managed with the use of computers. The field of bioinformatics continues to develop, therefore, out of necessity.

Bioinformatics has changed the way biologists 'do science'. While 15 years ago molecular biologists spent years determining the sequence of a gene, today they can sequence thousands of kilobases in the space of a few days, combine this information with gene expression profiles and predict the structure of the gene product of a distantly related organism. And the results of this analysis can be shared with a world-wide scientific audience via the internet. Bioinformatics requires thinking that is at once creative, analytical, and collaborative.

### Why teach bioinformatics in the classroom?

Rather than viewing bioinformatics as yet another 'topic' to be incorporated into an already crowded science curriculum, bioinformatics can be used as a basis for developing scientific literacy as well as biology content in the secondary school classroom (Wefer and Sheppard, 2008).



Students are already engaging with the social, political and ethical issues associated with scientific advances that range from genetic testing and privacy to the environmental and health impacts of GM (genetically-modified) foods. Bioinformatics techniques are at the heart of these scientific developments.

With internet access, students can use a range of bioinformatics tools that give them the chance to visualize and manipulate *in silico* the very ideas they are learning about in the classroom. For example, students often find it difficult to understand the relationship between DNA sequence, genes and chromosomes (ref). By using tools such as the Interactive Oregon Wolfe Barley Maps <http://wheat.pw.usda.gov/BarleyTNP/IMap/> students can observe the phenotype that results from a genetic mutation, using bioinformatics tools to 'make the link' between genes, chromosomes and phenotype.

Another example where bioinformatics tools are currently being used in the classroom is in generating phylogenetic trees by comparing DNA or polypeptide sequences (e.g. Dolan DNA Learning Centre's Bioservers website, [www.bioservers.org](http://www.bioservers.org))

How can I incorporate bioinformatics in the classroom?

### **Year 7-10**

In *Raiders of the Lost Gene*, segments of a plant chromosome are represented as a long bar made up of different coloured blocks. Each block represents a gene. The goal of the game is for the player to choose, from the chromosomes at the bottom of the screen, the one that would be generated by recombination between the 'domestic line' chromosome (shown at the top of the screen) and a second parental chromosome containing the 'sy gene'. 'Sy' is a gene that confers a desirable trait to the plant, such as tolerance to the heavy metal Boron. Through conventional breeding practices, plant breeders try to develop plant varieties that contain such 'good genes'.

*Raiders of the Lost Gene* was based on work conducted by bioinformatician Greg Lotto from the Molecular Plant Breeding CRC in Adelaide. The game is a simplified version of his work which focuses on generating accurate chromosomal maps of genetic markers (DNA sequences that are sometimes, but not necessarily, also genes). To date, work is still underway to provide whole genome sequence and physical maps in plants such as wheat and barley. Without the benefit of a complete genome sequence, Greg's job is to collate short stretches of DNA sequence from hundreds of progeny plants and to try and determine the order in which they appear on a chromosome.

*Raiders of the Lost Gene* is not intended to provide the scientific background to chromosomal mapping. Its authors hope that it will be used as a tool of initial engagement, providing the stimulus for students to find their own 'need to know'. In this way, *Raiders of the Lost Gene* provides a platform for



students to practice skills of questioning, problem-solving, collaborative learning and information gathering using the internet. All of these skills are essential for the 'new way of doing science' that bioinformatics is helping to create.

### **Senior Biology**

There are a number of excellent educational websites that teach students about bioinformatics. The best allow students to manipulate and analyse data themselves, as opposed to providing reams of text outlining bioinformatics protocols.

The list of websites below is recommended as a place for teachers to start. From working through these sites, teachers can develop guided classroom activities that suit the needs of their students.

### **Bioinformatics websites**

Interactive Oregon Wolfe Barley Maps is an interactive resource to view barley genome maps with links to information on individual genes and phenotypes.

<http://wheat.pw.usda.gov/BarleyTNP/IMap/>

Bioservers, from the Dolan DNA learning centre, provides tools to launch DNA database searches, statistical analyses, and population modeling from a centralized workspace [www.bioservers.org](http://www.bioservers.org)

Greenomes – laboratory and bioinformatics exercises to introduce students to modern plant genetics and genome research <http://www.greenomes.org/>

### References

Bayat, A. (2002) Bioinformatics. *British Journal of Medicine*, 324: 1018-1022.

Wefer, S. H. and Sheppard, K. (2008) Bioinformatics in high school biology curricula: A study of state science standards. *Life Sciences Education*, 7: 155-162.

