A simulation on using DNA banding patterns to access relatedness

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Introduction

A wev simulation is being developed that will generate DNA fingerprints for a group of imaginary organisms whose relationships are unknown (since the mating system may vary). Students need to extend and apply what they have leaned about biotechnology to be able to work with the data generated to explain the constitution of the observed social groups.

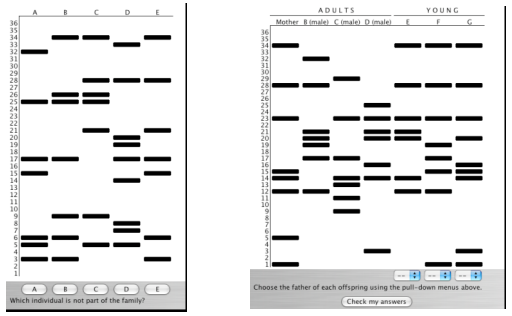


Figure 1: Two types of DNA evidence generated by the simulation using imaginary creatures resembling lemurs.

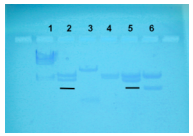
The scenario:

The organisms used are Innorts, imaginary creatures resembling modern day lemurs. Modern species vary in social group constitution. Males may or may not forage with a number of females who may have mated with one or several males that season. The young in any band of individuals than may or may not be related to the accompanying male. In some species, social group composition may change with season or some other ecological agent. Students must relay than on the DNA evidence simulated and cannot assume any degree of relatedness exists between young, males and females found together. Initial visitors to the web site will help determine important aspects of biology of innorts and so the details of the "field study" tacked by students.

http://www.ncsu.edu/project/interactivebiology/

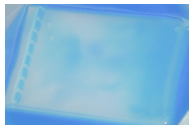
Justification: A realistic extension of the lab experience:

The DNA fingerprinting simulation provides students with ample opportunity to test their understanding of the techniques used to provide evidence as to relatedness or guilt versus innocence in our court rooms. Simplification of such protocols to fit three hour laboratory periods can actually promote misunderstanding although the intend is only to illustrate. In most laboratory situations students simply match overall banding patterns, each consisting of one or two bands. Frequently there is an evidence-banding pattern that is matched against that of three or four subjects. Students who separate two to three bands per sample (and given their inexperience often not well) by electrophoresis sometimes feel that having one band that "matches" with evidence for a suspect can mean the difference between prison and freedom.



A "good" gel on the left.
Note small number of bands.

Unfortunately, many students on their first try obtain a gel like that on the right.



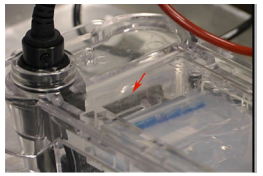
The simulation also asks students to access relatedness among a band of individuals.. To access relatedness however students must first determine the expected number of bands different individuals must share (which will differ given how bands are inherited with the band phenotype of the potential parents). Students work with groups of adults and try to determine if they are family groups or will as often is the case in our modern court room deal with paternity issues. Students will be offered the opportunity to work with relatively easier or harder banding patterns to analyze. For example in the diagram below, students can work with groups in which fathers of the young are always present (easy) or groups in which fathers of the young whose paternity is in question might be absent

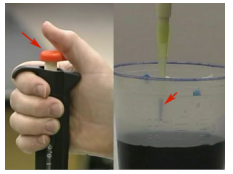
Father is always present in the group represented by the first gel, may be absent in second

The simulation truly extends the laboratory experience, while serving as a better test and for a deeper level of understanding of basic concepts than most lab exercises can provide,

Advantage of a web site

The additional advantage of a web simulation is that it may be linked to other material on the web site that will help students review any underlying concepts or simply provide the motivation to examine additional material in hopes of expanding understanding and building retention. Students attempting the DNA exercise will be able to access material on the website that will explain the science behind DNA fingerprinting that ensures its accuracy. Important techniques such as PCR and electrophoresis will be illustrated by appropriate animations or interactive movies.

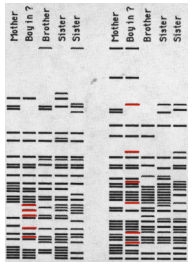




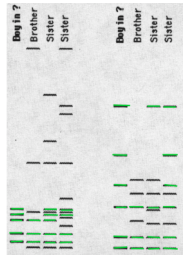
A. In a movie describing electrophoresis, students are told that bubbles and a hissing sound herald the start of a run.
B. Students are shown how the "first stop" results in drawing liquid into the pipette.

All the choices available to practitioners will be explained. More importantly, students will also be able to review why the type of DNA targeted generates unique individual pattern and practice before tackling the simulation by a tutored analysis of the first DNA fingerprints used in a courtroom to solve a question of paternity.

Identify all bands that had to come from DAD.



Determine if boy in question could be a true sib, have the same father as the other children.



In addition, links will be provided to information and websites that can further engage and stimulate self-inquiry. As part of these activities, downloadable materials such as reports that may be requested by an instructor to be printed or emailed will be provided.