

CRIME INVESTIGATION LABORATORY CAPITVATES INTEREST OF NON-MAJORS STUDENTS. *Allison D'Costa, Andrew Benson & Diane Dorsett* Georgia Gwinnett College, Lawrenceville, GA 30043



ABSTRACT:

Non-majors biology students often lack both interest and motivation in science survey courses and laboratories. However, these same students have a great level of interest in popular crime dramas airing on television, that involve forensic techniques to investigate murder scenes and identify criminals. In an attempt to captivate students' interest in forensic investigation through a learner-centered environment, a 3 weeklong "crime drama" laboratory module was developed. After reading a narrative describing a murder, each group of students picked one of three potential suspects that they would analyze to either clear or indict as the murderer. During the course of the module, each group tested and collated hair, blood and DNA samples from their suspect, the victim, and murderer using common techniques such as microscopy for hair analysis, ABO blood typing, karyotyping and DNA fingerprinting. Groups compared their data at the end of each lab period in an attempt to eliminate suspects.

The module was designed to demonstrate that while individuals may share similarities in characteristics such as blood group or karyotype, known to be heterogeneous in human populations, it is the highly variable areas in our DNA, the short tandem repeats (STR), that allows for unique identification of individuals. Therefore, students were unable to correctly identify the murderer until DNA analysis was completed on the final day of the module. In order to reinforce concepts learned in lab, instructors assigned additional investigative case studies, which allowed students to analyze real-life scenarios and biological anomalies.

INTRODUCTION

The objective of this lab module is for students to use their technical and analytical skills and "play detective" in a crime investigation. Students are divided into groups of 4. In lecture, they have learned some basics about the structure and composition of the genetic material, but in this lab get a chance to visualize DNA, and understand how a person's DNA fingerprint allows for unique identification of individuals.

The learning outcomes:

- 1) Describe the properties of DNA
- 2) Understand the basic use and concepts behind techniques such as DNA extraction, microscopy, blood-typing, karyotyping and DNA gel electrophoresis
- 3) Ability to gather and analyze data, and use it to eliminate suspects.

TIMELINE

Week 1	DNA extraction, Introduce murder story, Hair analysis
Week 2	Blood typing, Karyotyping, Practice loading gels
Week 3	DNA gel electrophoresis, Case studies

WEEK 1

DNA extraction: Each group completes DNA extraction from wheat germ. As they spool the DNA, they must observe its properties - long strands, solubility in water, and relate it to the its molecular structure.

Murder story: Several students are assigned to read different parts of the story aloud for the class. There are 3 suspects in the murder of Prof. Morra, his wife, a student, and the apartment manager.

Selection of suspect: Each group selects one of three suspects. Their task is to perform a series of tests to determine whether their suspect is guilty of the crime.

Hair Analysis: Various hair samples were obtained from salons, and a few strands from each sample were placed on a microscope slide and cover-slipped for easy view through a compound microscope. Groups compared hair sample from their suspect to hair found at the crime scene (murderer) and to hair from Prof. Morra (the victim). Hair was viewed at 40X, 100X and 400X magnification.

Table 1 : Hair Analysis

Hair Sample	Color	Thickness	Texture
Prof. Morra			
Murderer			
Your suspect			

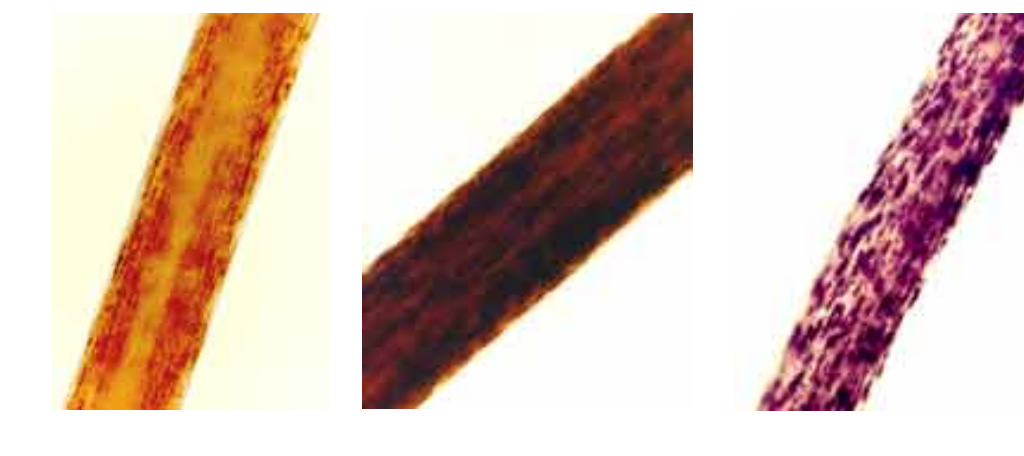


Figure 1: Hair samples from FBI files
(<http://www.fbi.gov/hq/lab/fsc/backissu/july2000/deedrie1.htm>)

WEEK 2

Blood typing: Students learned how the presence of A, B and Rh antigens on red blood cells determines the blood type of the individual. They are also taught how blood type can be detected by agglutination with anti-sera. Artificial blood typing kits from Carolina Biologicals (www.Carolina.com) were used.

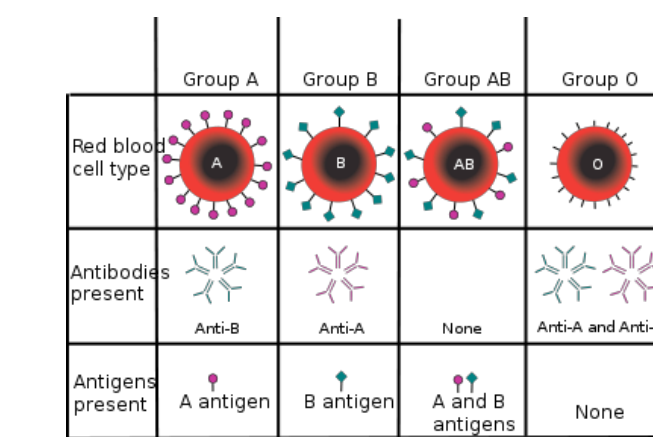


Figure 2: Blood Groups
(http://en.wikipedia.org/wiki/Blood_type)

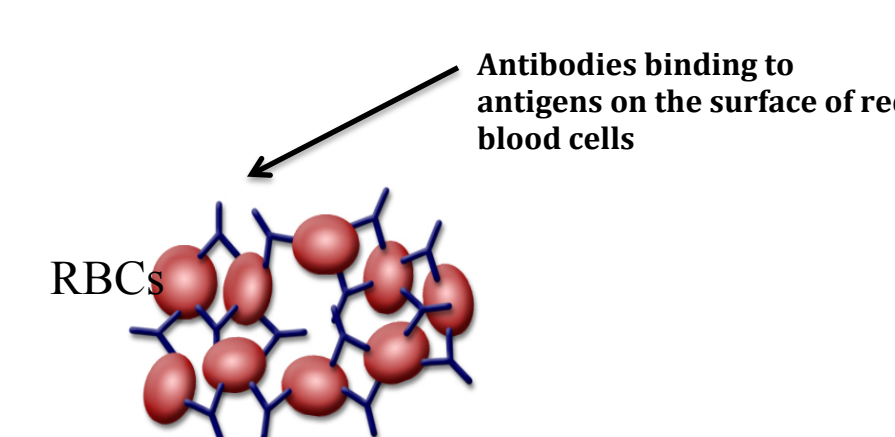


Figure 3: Agglutination

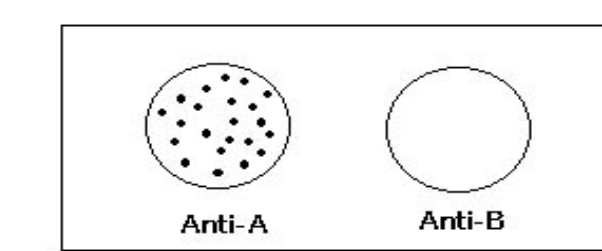


Figure 4: Agglutination reaction for type A blood

Table 2 : Blood-type Analysis

Write "yes" or "no" for the agglutination reaction in the boxes and then identify the person's blood type.

Person	Anti-A serum	Anti-B serum	Anti-Rh serum	Blood type
Prof. Morra				
Murderer				
Your suspect				

Blood sample	Type
Prof. Morra	O+
Murderer	A+
Student	A+
Wife	AB+
Apt. Manager	A+

Blood typing will rule out the wife. The apartment manager and student will still be suspects.

Karyotyping: This is a quick and easy exercise for the students. It also brings up the opportunity to discuss chromosomal aberrations. There will be three uncut pictures of chromosomes representing the two remaining suspects (apartment manager and student) and Prof. Morra. Each group should cut out the chromosomes and arrange a karyotype for each individual. After the students have constructed karyotypes for their suspect and Prof. Morra, they are handed the murderer's karyotype that was created from evidence at the scene of the crime.

Results of karyotype analysis:

Murderer	Male XY
Student	Male XY
Apt. Manager	Male XY
Prof. Morra	Super male XYY

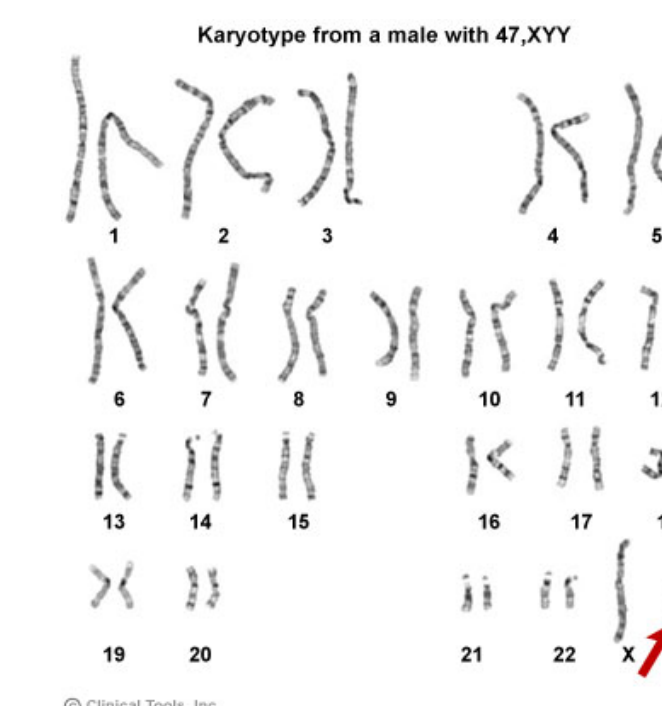


Figure 5: Prof Morra's karyotype

(<http://ahsmidiacenter.pbworks.com/f/XYY.jpg>)

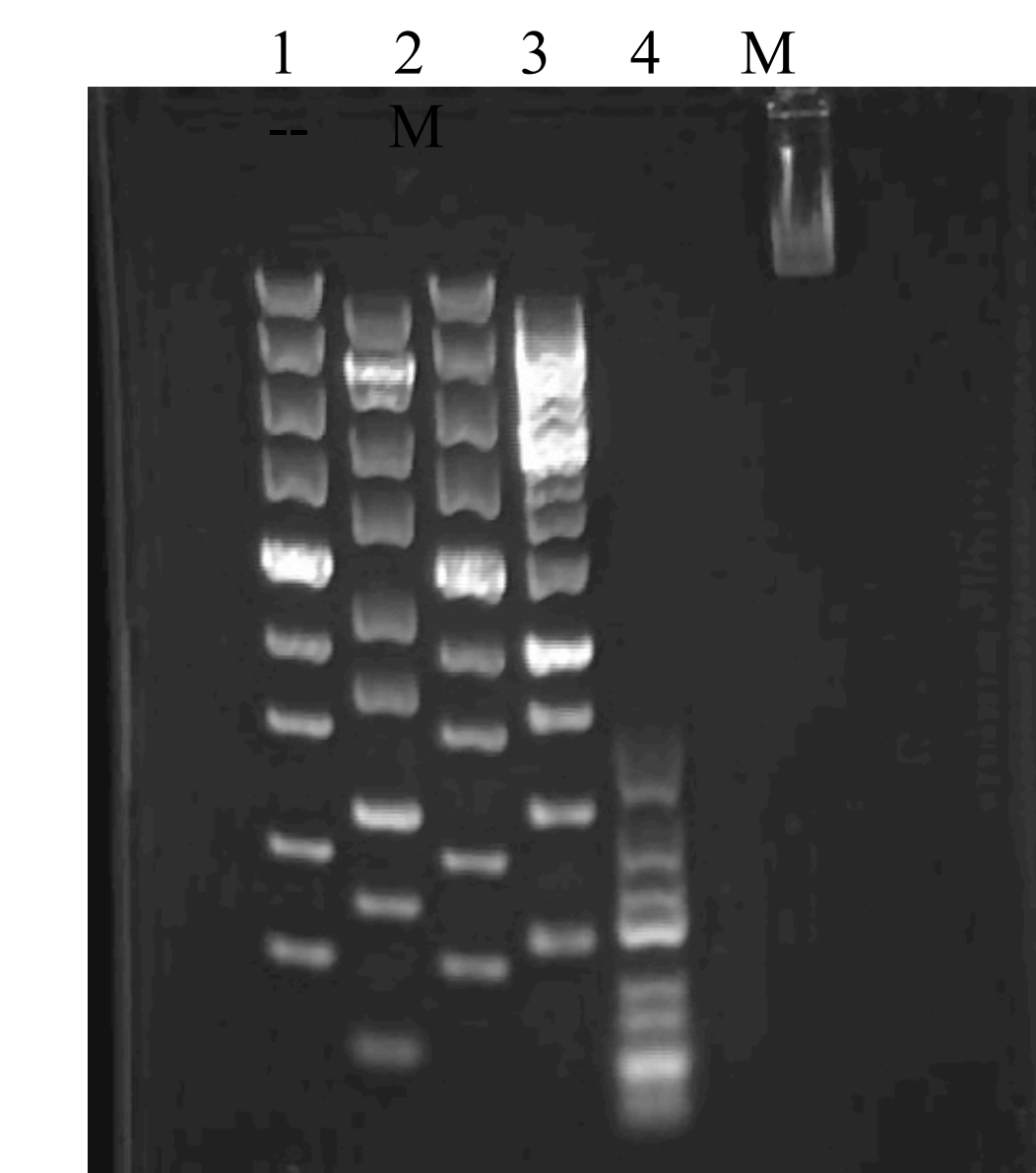
Karyotyping does not rule out any suspects, but it does allow the introduction of trisomies and other karyotype abnormalities in the class, as Prof. Morra is found to be XYY. After this exercise, two suspects remain, both male and blood type A+

Practice loading gels: Students practice on fake gels ("Practice Pipetting Station Kit" from Carolina Biologicals).

WEEK 3

DNA analysis: Agarose gels containing SYBR green are precast for each group and are ready for loading. DNA markers/ ladders are used as a substitute for each individual's fingerprint. The multiple fragments could represent several Variable Number of Tandem Repeats (VNTRs) obtained by PCR from many chromosomal regions and run on a gel. For students at this level, these techniques will not be discussed.

Students load their own gels. While the gel is running, the instructor can discuss the technique of gel electrophoresis, show some gel pictures of forensic analysis from an actual crime scene, and carry out a few case studies. The case studies used ranged from the bizarre, Lydia Fairchild chimera, to crimes conducted by one of two identical twins. Cases are easy to find online, and the students enjoy connecting what they have done in the lab with real cases.



1. Student
2. Prof. Morra
3. Murderer
4. Apt. Manager
- M. Markers

Analysis of the lanes reveals identical bands between the DNA of the murderer and student will lead to the conclusion that the murderer is... Samuel Massey, the student.

STUDENT EVALUATION DATA

Students were asked to complete a short survey to determine the success of the lab module. A 100% of students felt that they understood the basic concepts of DNA forensic analysis.

