

Science Takes the Witness Stand

A Play in One Act

HC70A

Genetic Engineering in Medicine, Agriculture & Law

Dr. Bob Goldberg

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Rules and Suggestions:

- This is a serious discussion and you will be evaluated on your ability to put forth and defend your arguments logically. You should have fun with this discussion, but not at the expense of learning and discussing the serious issues raised by this article.
- This script provides only a sketch of the topics you will be covering in discussion. You should write your own dialogue to fill in any gaps. You have A LOT of work to do before you come to discussion. We have written some questions to help you in your study, but you should also develop your own concept questions for the trial.
- You are welcome to make handouts and diagrams to assist you in your discussion of the topics presented in this case.
- There is a time limit for each scene. If you do not adhere to these limits, you will be cut off. Please make your arguments concise and well-thought-out.
- **You should prepare for this play by reading the articles assigned for Week 5 Discussion (“*Science Takes the Witness Stand*,” and “*The DNA Detectives*.”) In addition you should read Chapter 8 (textbook) and consult a genetics text on how to calculate allele frequencies in a population using the Hardy-Weinberg equilibrium.**

Make an effort to prepare for your role. Work in groups, bring costumes and props, and think about what points you want to make before coming to discussion. *This is a unique learning experience.*

TOMO's DISCUSSION

ROLE

Sheila Wong

Vincent Wong

Captain Krunche (Police / Forensic Officer)

Sergeant Monday (Police / Forensic Officer)

Fred Melroy

The Honorable Judge Mills Lane

Jurors

Prosecuting Attorneys

Jon Johnson, J.D.

Laura Kroft, J.D.

Defense Attorneys

Annie Warbucks, J.D.

Peter Neufeld, J.D

Expert Scientific Witnesses

Joe Bruin

Undergraduate Molecular Biology Student

Neville Colman, MD/PhD

Director of Clinical Laboratory - Mount Sinai

Barry "Blotman" Southern

Technician in Santa Monica Forensic Laboratory

Amanda J. Allele, PhD

Professor of Human Genetics - UCLA

Eyewitnesses

Alvin S. Gates

Senior Programmer, TECHNOJARGON.com

Mrs. B. C. Body

Neighbor's Dog

PLAYED BY

TAN, JOCELYNNE

NEWTON, ERIC

MILLIKEN, MICHAEL

LEE, BENJAMIN

CORTEZ, MICHAEL

KAWASHIMA, TOMO

CHEUNG, ANNE

NEWTON, ERIC

TAN, JOCELYNNE

MOBLEY, ERICA

RAMOLA, DIVI

SUDHINARASET, AMY

CRANDALL, JOHN

SCHWEIZER, RENA

HORAK, MONICA

SCHULZ, TIMOTHY

MOBLEY, ERICA

GRABAREK, PATRICIA

RUSSELL, JONATHAN

JORDAN, ANTONIA

RAMOLA, DIVI

SUDHINARASET, AMY

GROUP CHOICE

TOMO's DISCUSSION

The Story

Vincent Wong and Fred Melroy were best friends and co-workers. They shared everything from toothpaste to girlfriends when they were Computer Science majors and roommates during their undergraduate years at UCLA. In fact, Fred was the one who introduced Vincent to the future Mrs. Wong, a woman he had grown up with in a small Amish town in Pennsylvania.

More recently, Vincent and Fred were hired by the same small internet start-up company in Santa Monica. Their cubicles were right next to each other, as were their apartments in a small duplex just outside of Santa Monica's exclusive Amish district. As far as anyone could tell, they were the best of friends, and had been so for quite a long time.

This comfortable picture was shattered one day at work when Vincent and Fred got into a violent struggle at the office. Witnesses overheard Vincent yelling "I'll kill you if you ever come near my house again!" Fred's reply was muffled because of the fight, but several witnesses reportedly heard him moan "Only if I don't kill you first..." Once their coworkers were able to pry them apart, they were taken to separate hospitals to be evaluated, treated, and questioned by the police.

The next morning, Sheila Wong placed a frantic call to the police department. She reported that her husband Vincent had left the house sometime during the night, and had not returned. When the police arrived at the scene, they found Vincent's blood-soaked body hidden in the bushes separating the two sides of the duplex. He had obviously been murdered, and Fred was the only suspect.

TOMO's DISCUSSION

Scene 1:

Front Yard of Vincent & Fred's Duplex

(1 minute)

Sheila Wong meets with police officers in the front yard. They notice that a neighbor's loose Golden Retriever appears preoccupied by something in the bushes separating the two sides of the duplex. After shooing away the dog, a brief search reveals Vincent's blood-soaked body. Sheila screams, whispers the word "Fred!" and passes out, hitting her head on the pavement next to the body as she falls.

Scene 2:

Front Yard of Vincent & Fred's Duplex

(3 minutes)

After Sheila is taken inside to rest in the house, the officers begin to collect evidence at the scene. They are careful to wear gloves and follow sterile procedures. The samples they find include:

1. a blond hair
2. a brown hair
3. blood sample taken from Vincent's body
4. blood sample from the ground near body
5. a piece of white fabric speckled with blood caught on a nearby branch

Scene 3:

LAPD - Santa Monica Precinct Headquarters

(5 minutes)

Officers Krunche and Monday discuss the facts of the case, and recall questioning Vincent after the previous day's fight between the dead man and his friend, Fred Melroy. The officers call Fred, and ask him to come in for questioning. Fred does so voluntarily. During questioning, the officers notice that Fred is behaving as if he's in shock, and that he hasn't changed out of the blood-stained clothes he wore during the fight yesterday. The officers also notice that the tattered white shirt he is wearing matches the fabric found on the branch near the body. The officers decide that they have enough circumstantial evidence to obtain a search warrant for Fred Melroy. They walk down the hall to the Honorable Judge Jodi's office, describe the evidence, and ask for a search warrant so that they may obtain a blood sample from Fred Melroy. The search warrant is granted, and the sample is obtained. They send Fred home with a warning to stay in the area, and send the samples off to the forensics lab.

Scene 4:

LAPD - Santa Monica Precinct Headquarters - 6 weeks later

(1 minute)

Officers Krunche and Monday receive test results back from forensic lab, and decide that they have enough evidence to indict Fred Melroy. They go to Judge Jodi to obtain a warrant for Fred's arrest.

Scene 5:

Santa Monica City Courthouse - 10 weeks later

TOMO's DISCUSSION

(50 minutes)

I. Trial Begins: Opening statements for Prosecution and Defense (3 minutes)

II. Prosecution presents its case

Part A

1. Prosecution calls Alvin Gates to the stand.
 - provides eyewitness account of the fight that occurred at work the day before the murder
 - testifies that he heard the defendant make a death threat toward Vincent
2. Defense cross-examines Mr. Gates
 - determines that, due to the nature of the struggle, it was difficult for an eyewitness to precisely discern what each combatant was saying

Part B

1. Prosecution calls B. C. Body to the stand.
 1. gives eyewitness account of seeing two shadowy figures arguing near the bushes in front of Vincent & Fred's duplex at midnight
2. Defense cross-examines Mrs. Body.
 - determines that Mrs. Body is not able to conclusively identify whether the two figures were Vincent, Fred, or some other person

Part C

1. Prosecution calls Officers Krunche & Monday to the stand
 - the crime scene is diagrammed for the jury, and all relevant pieces of evidence are produced and discussed
2. Defense cross-examines officers
 - officers are challenged to defend the sterility of the techniques used to collect evidence

Part D

1. Prosecution calls first scientific witness, Joe Bruin to the stand
2. Defense OBJECTS to use of this scientific witness as an expert. A heated discussion of the qualifications of expert witnesses ensues.
 - What are the qualifications of this molecular biology student? Does a person associated with the science presented necessarily qualify as an expert witness?
 - What is an "expert witness?" What qualifications must an expert have in order for his/her testimony to be valid in a court of law?
3. Judge sustains objection, and the witness is excused. The trial proceeds.
4. Prosecution calls Dr. Neville Colman, MD/PhD to the stand. Dr. Colman discusses the scientific basis of DNA fingerprinting.
 - What type of analysis has been performed in this case? What is DNA? What is the structure of DNA? How does the DNA of one individual differ from the DNA of another? How can DNA be used to determine whether an individual was present at the scene of a crime?
 - What are VNTRs? Are the same VNTRs found in all human individuals? How do VNTRs vary within a population of individuals?

TOMO's DISCUSSION

- How are VNTRs used in DNA fingerprinting? What is the reason for using VNTRs instead of genes for DNA fingerprinting?
5. Defense cross-examines Dr. Colman.
- How many different VNTRs must be identified in order to find a unique DNA “fingerprint” of an individual? Could many individuals within a population have the same number of VNTRs at a specific DNA locus?

Part E

1. Prosecution calls second scientific witness, a technician at the Santa Monica Forensic Lab, where all the forensic tests were carried out. Technician discusses the procedure used to visualize VNTR differences between individuals, and how this procedure was used in this case.
- How do you visualize VNTRs? What is Southern Blotting? What are the steps involved in Southern Blotting, and what is the purpose of each step?
 - What restriction enzymes must be used in order to detect differences in fragment length caused by VNTRs? Where does the enzyme need to cleave in order for different alleles of the VNTR to be visualized? How do you separate DNA fragments cleaved by restriction enzymes?
 - How do you detect the presence of a specific VNTR? What type of probe would you use? What is a single locus probe? How does the probe bind to its target VNTRs? How do you visualize the results of hybridization?
 - What results were obtained from the Southern Blot of the DNA samples collected at the crime scene? What DNA evidence supports the prosecution's assertion that Fred was present when Vincent was murdered?
2. Defense cross-examines witness
- What are the potential problems that arise from the collection of DNA samples at a crime scene? What types of damage can DNA specimens sustain during exposure to environmental insults? What other types of sample contamination are frequently found at a crime scene?
 - How do you explain the variations in banding patterns seen on the autoradiograph presented as evidence? What are your hypotheses for the causes of these variations?
 - What is band shifting? What causes band shifting in gels? What other types of markers can be probed in order to find a correction factor for band shift?
 - In what situation would a human VNTR probe not hybridize with digested DNA? How would you explain the presence of this type of DNA sample at the crime scene?
 - What environmental insults lead to the degradation of DNA? How do you visualize a degraded DNA sample on an autoradiograph? Can any useful results be derived from a degraded sample?
 - What could cause a DNA sample to contain more than two alleles of a locus?
 - Is forensic DNA fingerprinting a useful source of evidence, given all these problems with sample quality and testing variables? Can the DNA evidence presented be used to unambiguously indicate Fred's presence at the scene of the crime?

TOMO's DISCUSSION

- What additional data would be useful to unambiguously show that Fred was present at the crime scene?
- Is the use of DNA fingerprinting widely accepted as a precise method of unambiguously identifying the presence of a suspect at a crime scene? Does this method therefore uphold the precedent set by *Frye vs. United States (1923)*? According to this decision, what general guidelines must be met in order for a scientific technique to be allowed in a court of law? Does this test meet these guidelines?

Part F

1. Prosecution calls third scientific witness, Dr. Amanda J. Allele to the stand.
 - What does the banding pattern on the autoradiograph represent? What is an allele? How many alleles exist for a given locus? How many alleles for a locus does each individual carry? Are all alleles equally common within a population?
 - How do you determine the frequency of an allele in a population? What is Hardy-Weinberg Equilibrium? What are the assumptions on which Hardy-Weinberg Equilibrium is based? How would an allelic frequency change from the H-W calculated frequency if these assumptions are not met?
 - How does the frequency of an allele within a population affect the uniqueness of a DNA fingerprint?
 - How do you use allelic frequencies within a population to determine the probability of the occurrence of a specific genotype? Based on the allelic frequency data obtained by the City of Santa Monica Blood Bank, what is the probability that another individual shares the suspect's genotype? Does this figure unambiguously show that Fred was present during the Vincent's murder?
2. Defense cross-examines geneticist
 - Do different populations tend to have different allelic frequencies? What causes these differences in frequency? Can different allelic frequencies affect the probability that another individual shares the suspect's genotype?
 - How were the allelic frequencies within the population of the Amish district calculated? Using Amish allelic frequencies, what is the probability of multiple individuals having the same genotype as Fred?
 - Based on this frequency data, is the DNA fingerprint at all conclusive as to the identity of the murderer? Can a DNA fingerprint unambiguously determine the guilt or innocence of a suspect?
 - Does the probabilistic nature of DNA fingerprint evidence create reasonable doubt?
 - What would be your suggestion for obtaining more conclusive data as to whether Fred was present at the scene of the crime?

Prosecution Rests.

III. Defense presents its case.

Part A

1. Defense calls Sheila to the stand.

TOMO's DISCUSSION

- Defense asks Sheila if she has a witness to verify her alibi that she was home in bed all night after Vincent left the house.
 - Defense implies that Sheila might have killed her husband Vincent.
2. Prosecution cross-examines Sheila.
 - Prosecution asks Sheila if she voluntarily gave a blood sample for DNA testing.
 - Prosecution asks Sheila to point to her DNA sample on the DNA gel blot.

Part B

1. Defense calls Fred to the stand.
 - Fred produces personal evidence showing how much he loved his friend, and tearfully denies that he could have killed Vincent.
2. Prosecution cross-examines Fred.
 - Determines that Fred's only alibi is that he was at the hospital recovering from the morning's fight until 11pm. It is also determined that the hospital is a 30 minute drive from Fred's duplex.

III. Closing Statements for Prosecution and Defense

IV. Jury leaves to deliberate.

Scene 6:

Santa Monica City Courthouse

(5 minutes)

Jury returns from deliberation, gives verdict and explains reasoning for verdict.

1. How does the blot and genotype frequency evidence assist you with your decision?
2. Has the evidence presented convinced you beyond a reasonable doubt that Fred murdered Vincent?

Court is adjourned.

Scene 7:

Post-Trial Discussion

(20 minutes)

1. Can DNA fingerprint evidence unambiguously convict someone of a crime?
2. What kind of regulations should be enacted to ensure that samples are preserved?
3. How should crime labs be regulated to ensure quality of DNA testing? Who should perform this regulation?
4. What does the US Constitution say about DNA testing used as evidence in a court of law? Can police obtain samples of DNA from suspects without their consent? Under what circumstances is consent unnecessary?
5. Can police obtain DNA samples from every individual in a neighborhood in order to identify suspects for a crime that occurred in that area? Should all convicted criminals be required to give DNA samples in order to keep their genetic profiles in a

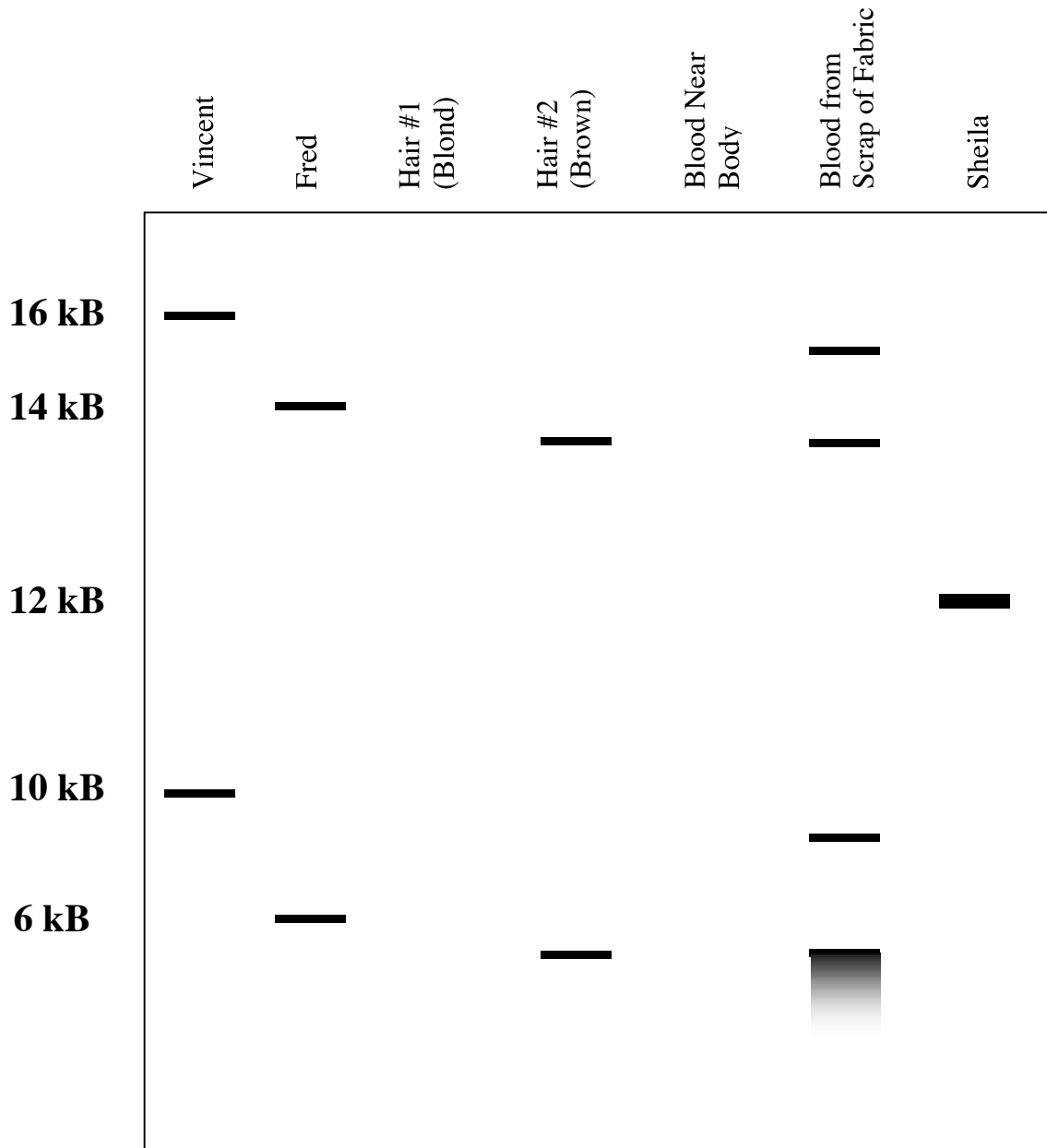
TOMO's DISCUSSION

database? Should any individual arrested for a crime (regardless of conviction or not) be required to give a DNA sample?

6. Should DNA profiles of convicted criminals be sorted by racial/ethnic background in order to speed searches through criminal databases?
7. Should DNA profiles be obtained from all individuals from birth in order to assist law enforcement officials in catching criminals?

TOMO's DISCUSSION

Gel Blot of DNA Sample

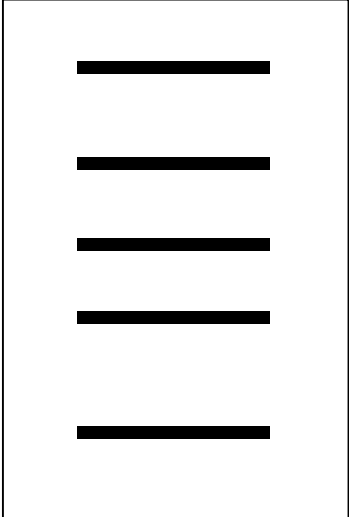


TOMO's DISCUSSION

Allele Frequencies of RFLPs Tested

Data obtained from the City of Santa Monica Blood Bank, from examination of a random sample of individuals THROUGHOUT SANTA MONICA.

How are these allele frequencies determined?

	<u>Size</u>	<u>Allele Frequency</u>
	16 kB	A1 = 0.36
	14 kB	A2 = 0.00009
	12 kB	A5 = 0.14
	10 kB	A3 = 0.26
	6 kB	A4 = 0.000001

Population of Santa Monica = 600,000

What is the **PROBABILITY** of finding someone in the population with the suspect's genotype?

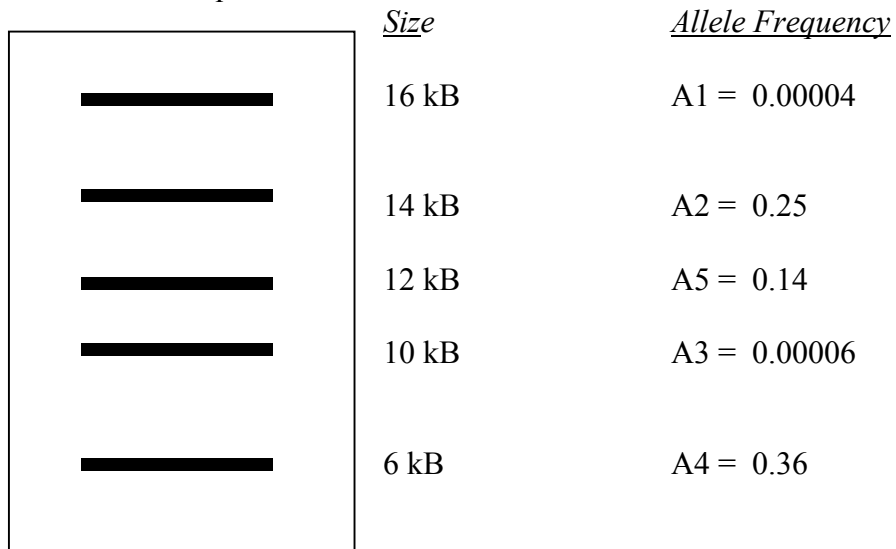
How many individuals in Santa Monica share this genotype with the suspect?

TOMO's DISCUSSION

Allele Frequencies of RFLPs Tested

Data obtained from the Amish Blood Bank of Pennsylvania, from examination of a random sample of AMISH individuals.

How are these allele frequencies determined?

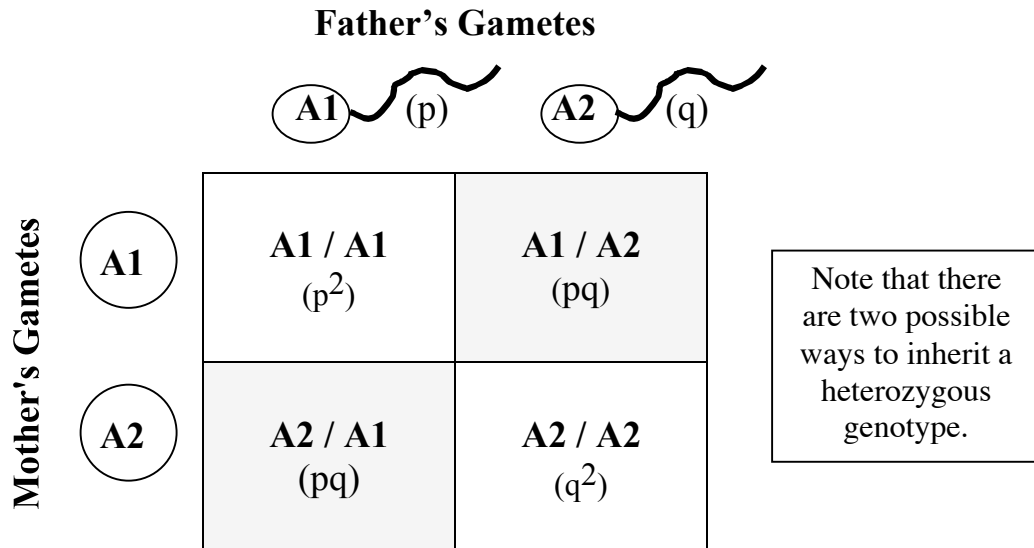


Population of Community = 10,000

What is the **PROBABILITY** of finding someone in the population with the suspect's genotype?

How many individuals in the Amish population share this genotype with the suspect?

Determining the Frequency of a Genotype



p = the frequency of the A1 allele in a population
q = the frequency of the A2 allele in a population

p² = the frequency of the homozygous A1 genotype
q² = the frequency of the homozygous A2 genotype
2pq = the frequency of the heterozygous A1/A2 genotype