

# Forensic Genetics

Module 15 – Section 6 Answers

# Exercise 1a: Formulating Propositions

An individual is discovered looking into a house one night. The police are called and find a single cigarette butt under the window where the incident occurred. No one in the family smokes. The police have a person of interest captured on a neighbor's CCTV.

A single-source profile is obtained from the cigarette butt and the reference profile of a person of interest (POI) matches.

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$H_p$  : The evidence came from the POI.

$H_d$  : The evidence came from an unknown person.

Or, for simplicity:

$H_p$  : POI

$H_d$  : Unknown (U)

## Exercise 1b: Formulating Propositions

A complainant calls 911 to report a sexual assault in her home. She is taken to a hospital where an intimate swab is collected.

A POI is identified from the investigation and the obtained profile from the swab is fully explained by a mixture of the complainant (K) and the POI.

# Exercise 1b: Formulating Propositions

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$$H_p : K + \text{POI}$$

$$H_d : K + U$$

## Exercise 1c: Formulating Propositions

A complainant is cut with a knife during an altercation. Based upon eyewitness testimony, a POI is identified.

A stain on the clothing of the POI is tested for blood, and a DNA profile is developed that is consisted with a mixture of the POI and the complainant.

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$$H_p : \text{POI} + \text{K}$$

$$H_d : \text{POI} + \text{U}$$

Note how the direction of transfer provides important information.

# Exercise 1d: Formulating Propositions

Molotov cocktails have been thrown at random cars. An unexploded container is found in the street, and a 2 person mixture is developed from the evidence.

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$$H_p : \text{POI 1} + \text{POI 2}$$

$$H_{d1} : \text{POI 1} + \text{U}$$

$$H_{d2} : \text{POI 2} + \text{U}$$

$$H_{d3} : 2\text{U}$$

What if circumstances indicate that they cannot both be present?

# Exercise 1e: Formulating Propositions

A complainant walking through a city park is attacked from behind and is sexually assaulted on a blanket. She didn't get a good look at the perpetrator. The police recognize the blanket as possibly belonging to a vagrant known to live near the park.

A profile obtained from the blanket is fully explained by mixing of K and POI's DNA.

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A profile obtained from the blanket is fully explained by mixing of K and POI's DNA.

$$H_p : K + \text{POI}$$

$$H_{d1} : \text{POI} + U$$

$$H_{d2} : K + U$$

$$H_{d3} : 2U$$

## Exercise 2: Base Rate Fallacy

- Of the women complaining of painful hardening of the breast, 1% have a malignant tumor:  $\Pr(C) = 0.01$ .
- The accuracy (+ or -) of a mammography is 90%:  
 $\Pr(+|C) = \Pr(-|C') = 0.9$ .
- Estimate  $\Pr(C|+)$  to decide whether or not to order a biopsy.

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$$\Pr(C|+) = \frac{\Pr(+|C) \Pr(C)}{\Pr(+|C) \Pr(C) + \Pr(+|C') \Pr(C')} = 0.0833.$$

Representativeness leads people to neglect the base rate, by assessing a conditional probability by the 'degree of similarity' ( $\Pr(A|B) \neq \Pr(B|A)$ ). This is known as the *base rate fallacy*.

## Exercise 2: Base Rate Fallacy

Using the odds form of Bayes' theorem:

$$\frac{\Pr(C)}{\Pr(C')} = \frac{1}{99}$$

$$\frac{\Pr(+|C)}{\Pr(+|C')} = \frac{0.9}{0.1} = 9$$

Even though the LR  $> 1$ , the prior odds (i.e. the base rate) is relatively small. The posterior odds are  $\frac{1}{11}$ , such that  $\Pr(C|+) = \frac{1}{12} = 0.0833$ .

## Exercise 3a: Prosecutor's Fallacy

Do you think these statements are correct/incorrect/ambiguous?

- The evidence is much more likely if the DNA profile came from the suspect than if someone else left the sample.

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Correct, standard phrasing of the likelihood ratio.

## Exercise 3b: Prosecutor's Fallacy

Do you think these statements are correct/incorrect/ambiguous?

- The probability of this DNA profile if it came from someone other than the suspect is very low.

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Conditioning on the hypothesis is clear by the word 'if', but no explicit mentioning of both hypotheses.

## Exercise 3c: Prosecutor's Fallacy

Do you think these statements are correct/incorrect/ambiguous?

- The probability that this DNA profile came from someone other than the suspect is very low.

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Do you think these statements are correct/incorrect/ambiguous?

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Prosecutor's fallacy: statement about the proposition instead of the evidence.

## Exercise 3d: Prosecutor's Fallacy

Do you think these statements are correct/incorrect/ambiguous?

- The probability of someone other than the suspect having this DNA profile is very low.

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Do you think these statements are correct/incorrect/ambiguous?

- The probability of someone other than the suspect having this DNA profile is very low.

Not clearly worded, and no explicit mentioning of both hypotheses.

## Exercise 3e: Prosecutor's Fallacy

Do you think these statements are correct/incorrect/ambiguous?

- The probability of someone other than the suspect leaving this DNA profile is very low.

## Exercise 3e: Prosecutor's Fallacy

Do you think these statements are correct/incorrect/ambiguous?

- The probability of someone other than the suspect leaving this DNA profile is very low.

Similar as the previous example, but even more ambiguous because of the use of the word 'leaving', which may imply an activity level.

## Exercise 3f: Prosecutor's Fallacy

Do you think these statements are correct/incorrect/ambiguous?

- The evidence strongly supports the hypothesis that the DNA profile came from the suspect over the hypothesis that someone else left the sample.

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Technically correct, but not clearly worded as it goes beyond the LR while not considering prior probabilities. If the prior is very low, combined with the evidence, we may not come to the same conclusion.