SWITCHED AT BIRTH?

INTRODUCTION

Note: This case is based on the *New York Times* piece "The Mixed-Up Brothers of Bogotá" http://www.nytimes.com/2015/07/12/magazine/the-mixed-up-brothers-of-bogota.html?_r=0. However, the DNA profiles provided do not represent those of the actual individuals.

In 1988, two sets of twin boys were born in Bogotá, Columbia, on the same day and in the same hospital. Carlos and Jorge grew up in the city, while William and Wilber grew up in the country. Twenty-five years later, they were all living in Bogotá. One day, Jorge's coworker went into a butcher shop to buy some meat and was surprised to find Jorge behind the counter—only it wasn't Jorge, it was William. The two men looked exactly alike, and the coworker couldn't believe the similarities. Even more amazing, Jorge and William's respective twin brothers also looked exactly alike.

To understand what was going on, the men visited their doctor, who collected blood samples from them. He sent the samples to a lab, where scientists isolated DNA and then used the polymerase chain reaction (PCR) to isolate and amplify the 13 core STRs in each sample.

You will now use the reference data provided to solve the case!

PROCEDURE

Complete the calculations and answer the questions below. To make the results easier to read, only three STRs are shown: D8S1179, D18S51, and TPOX. A complete profile, however, would include 10 additional STRs.

1. Look at the data tables. Do you see any matches? Explain your findings below.

2. Follow the steps and use the formulas below to calculate the probability of a resident of Bogotá having the partial genetic fingerprints of two of the twins (Carlos and Jorge).

   Calculate the probability of a given genotype using the formulas below. Show your work.

   Heterozygous genotype frequency = 2*pq*, where ***p*** is the frequency of the first allele and ***q*** is the frequency of the second allele

   Homozygous genotype frequency = p^2, where ***p*** is the frequency of the allele

   a. Probability of having Carlos's genotype for the individual loci:

      D8S1179: _____ D18S51: _____ TPOX: _____

   b. Probability of having Jorge's genotype for the individual loci:

      D8S1179: _____ D18S51: _____ TPOX: _____

To calculate the probability of having a given genetic fingerprint, the probabilities of having each STR genotype are multiplied.

c. Calculate the probability of having Carlos's partial profile. Show your work.

d. Calculate the probability of having Jorge's partial profile. Show your work.

3. Were the sets of twins switched at birth? Explain your answer using evidence from their partial genetic fingerprints and calculations.

4. Explain why DNA fingerprints are a more reliable method of determining family relationships than blood typing. *Hint:* How many different blood types are there? How many different possible DNA fingerprints?

5. Can you think of a way that this discovery of identical twins switched at birth would provide scientists with an opportunity to see how certain traits are affected by the environment?

Switched at Birth Data

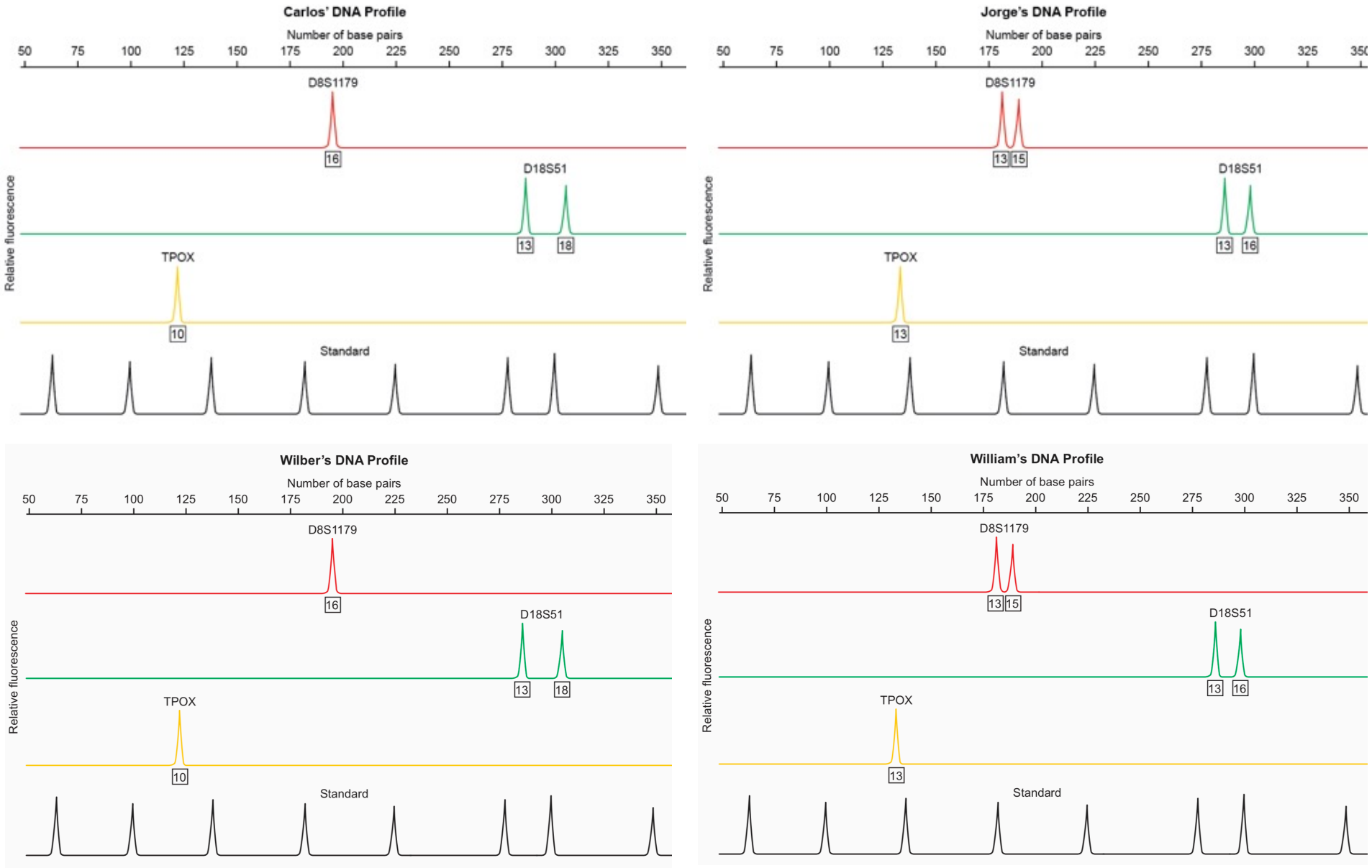

Figure 1. Mock DNA Profiles of the "Mixed-Up Brothers of Bogotá." Only three STRs are shown: D8S1179, D18S51, and TPOX. A complete profile, however, would include additional STRs.

Table 1. Frequencies for each STR allele present in the profiles are shown in the table below.

STR allele present in the DNA profiles above	Frequency in the population of Bogotá
D8S1179 allele #13	0.346
D8S1179 allele #15	0.105
D8S1179 allele #16	0.029
D18S51 allele #13	0.116
D18S51 allele #16	0.112
D18S51 allele #18	0.048
TPOX allele #10	0.036
TPOX allele #13	0.008

(Data source: Rey *et al.* "Allele frequencies for 13 STR's from two Colombian populations: Bogotá and Boyacá." 2003. *Forensic Science International* 136:81–85.)