Practice problems

1. Calico cats have patches of black and orange fur, and are heterozygous for the orange and black alleles of a coat color gene. A calico cat named Furball had a father with black fur.

What sex chromosome did Furball inherit from its father? Explain your reasoning.

Describe the mechanism that results in Furball’s patches of black and orange fur.

Much to your surprise, Furball’s karyotype reveals that it is XXY. How would this finding affect the answers to the previous questions?

If you know that Furball inherited two X chromosomes from mom, can you predict the fur phenotype of Furball’s mother?

2. DNA polymorphisms on the Y chromosome and on mtDNA have been used extensively to study the history in humans. Describe some of the advantages that these chromosomes have over autosomes for these types of studies.

3. Androgen insensitivity is an X-linked trait that results from the inability to respond to testosterone and dihydroxytestosterone. Describe the karyotypic sex (which sex chromosomes they have) and the sexual phenotypes of the gonads and external genitalia of individuals with this trait.

4. Explain how analysis of variation in mtDNA among different groups of people led Allan Wilson and his colleagues to conclude that humans originated in Africa.

5. Two human populations have been isolated on islands since their ancestors first arrived. The mtDNAs of the people on one of the islands is more varied in sequence than the other. From this information which island would you predict was populated earlier and why?

6. A woman claims that her two children, a two year old boy and a 6 month old girl, were fathered by a man named Mr. Roamer. Mr. Roamer claims he is not the childrens’ father and has his X and Y chromosomes, as well as those of his potential children, tested by PCR. Amplification of a sequence on the X chromosome produces a band of 200 base pairs in length, and amplification of a sequence on his Y chromosome produces a band of 150 base pairs. Amplification of a sequence on the X chromosome of his potential son produces a band of 180 base pairs, and amplification of a sequence on the boy’s Y chromosome produces a band of 150 base pairs. Amplification of a sequence on the X chromosome of his potential daughter produces bands of 170 and 180 base pairs. Could Mr. Roamer have fathered the two children?
7. In the 18th century, a young boy suffered from a skin condition that included thickening of the skin and the formation of loose spines that were periodically sloughed off. This “porcupine man” married and had six sons, all of whom had the same condition. He also had several daughters, all of whom were unaffected. What might you theorize about the location of the abnormal gene?

8. The Argentinean Army executed the son of a man named Francisco. At the same time, Francisco’s grandson disappeared. Francisco believes that his missing grandson has been raised by a former army general and his wife. The former general claims that he is wrong because he has documents that he and his wife are the biological parents. Francisco wants to have his mitochondrial DNA and the mitochondrial DNA of the man he thinks is his grandson to be tested. Do you think that this could prove that the man is his missing grandson and not the son of the general? If not, what might you suggest.

9. Mrs. Klein (41 years old) and her husband have an amniocentesis for advanced maternal age. They already have two healthy children, a girl and a boy. They receive results indicating a 46, XX karyotype. However, the doctor noted a penis on the prenatal ultrasound before the amniocentesis is performed. What is the most likely explanation of this unusual phenotype? (No, mixing up amniotic fluid samples is NOT an option). How many Barr bodies will be found in each somatic cell?

10. Mrs. Smith (40 years old) and her husband have an amniocentesis for advanced maternal age. They already have four healthy children. They receive results indicating a 47, XXY karyotype. What is the phenotypic sex of the fetus? How many Barr bodies will be found in each somatic cell?