Garriga Problem Set 1 answers

1. You cross a male mouse with light colored fur, which is caused by a recessive mutation in an X-linked gene, to a female mouse with dark fur that is homozygous for the wild-type fur gene and heterozygous for a mutation that removes the function of the Xist gene.

a) What are the phenotypes and genotypes of the female progeny?

Xist- C+/ Xist+ c: dark fur
Xist+ C+/ Xist+ c: variegated, patches of dark and light fur

You cross the same male mouse with light colored fur, to a female mouse with dark fur that is homozygous for the wild-type fur gene and heterozygous for a mutation that removes the function of the Tsix gene.

b) What are the phenotypes and genotypes of the female progeny?

Tsix- C+/Tsix+ c: light fur
Tsix+ C+/ Tsix+ c: variegated

2. You have a triploid watermelon, which is sterile.

a) How was the triploid watermelon generated?

diploid x tetraploid to produce triploid

b) You find a rare seed in your triploid watermelon. You plant the seed and find that it grows into a fertile watermelon (one with seeds). What might have happened?

Gametes containing a complete set (1x) or two sets (2x) of chromosomes are generated during meiosis. The 1x sets fuse or the 2x sets fuse.

c) What do you think is the ploidy of the fertile watermelon?

2x and 4x

3. A woman has a daughter with Turners syndrome (X0). The father has hemophilia because of a defect in an X-linked clotting factor gene.

Explain how the Turners daughter could have been produced if she has hemophilia. Be specific.

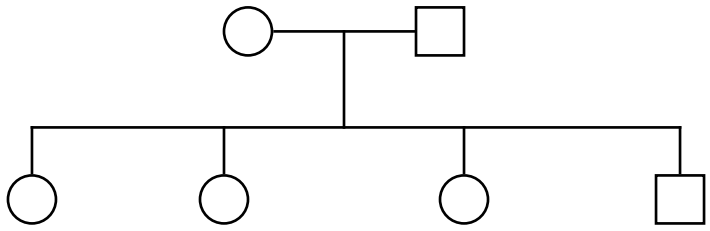
Inherit X from father
Nondisjunction in meiosis I or II in mother generates nullo X egg (no X chromosome) fertilized by sperm with father's X.

Explain how the Turners daughter could have been produced if she does not have hemophilia. Be specific.

Inherit X from mother
Nondisjunction in meiosis I or II in father generates nullo X sperm that fertilizes egg with mother's X.

4. (a tough one) You want to study dosage compensation in kangaroos. Marsupial sex is determined in the same way as in mammals, XX leads to female development and XY leads to male development. Female marsupials have Barr bodies, but males do not. You begin by cloning several genes, and you search for genes that contain polymorphisms in the kangaroo population that can be detected in both both RNA and genomic DNA. You find RNA/DNA polymorphisms for two of the genes located on the X chromosome (X1 and X2), and one of the genes located on an autosome (A1). a indicates one allele and b indicates the other allele. You head to the local zoo and analyze the DNA and RNA extracted from blood samples of a known kangaroo pedigree.

DNA	X1a/X1b	X1b/Y
	X2a/X2b	X2b/Y
	A1a/A1a	A1b/A1b
RNA	X1a	X1b
	X2a	X2b
	A1a	A1b



DNA	X1a/X1b	X1a/X1b	X1b/X1b	X1b/Y
	X2a/X2b	X2b/X2b	X2a/X2b	X2b/Y
	A1a/A1b	A1a/A1b	A1a/A1b	A1a/A1b
RNA	X1a	X1a	X1b	X1b
	X2a	X2b	X2a	X2b
	A1a and A1b	A1a and A1b	A1a and A1b	A1a and A1b

From the results shown above what would you conclude about kangaroo dosage compensation?

First note that while the females can be heterozygous at a particular locus, they will only express RNA containing one allele. The F1 mother, for example, has one X chromosome containing the a allele of X1 and the other X containing the b allele, yet she only expresses the X1a allele. You can conclude that kangaroos employ dosage compensation by inactivating one of the females X chromosomes. This itself is a little surprising since you would expect blood to contain cells that have not only the X1b allele inactivated, but also cells with the a allele inactivated.

The next thing to notice is that when you look at the females in the F1, like their mother, they only express one X allele. The interesting thing is that for some of the F1 females you can tell that they inherited the X1b or X2b allele from the father because they have an X1a or X2a allele that had to come from their mother. The F1 female on the left, for example, is heterozygous for both the X1 and X2 loci. Yet for each locus, only the maternal allele is expressed.

The presence of the RNA product of a single X allele in the blood and the expression of only the maternal X genes shows that the paternal X chromosome is preferentially inactivated in female kangaroos.