E1. The results of each succeeding generation depended on the genotypes of the mothers of the preceding generation. For example, if a mother was *dd,* the F_1 offspring were all sinistral. The genotypes of the F_2 mothers were 1 *DD* : 2 *Dd* : 1 *dd.* The *DD* and *Dd* mothers would produce dextral offspring of the F_3 generation and the *dd* mothers would produce sinistral. As expected, the ratio of dextral to sinistral was 3:1, which is derived from the genotypes of the F_2 mothers, which were 1 *DD* + 2 *Dd* : 1 *dd.*

E2. The first type of observation was cytological. The presence of the Barr body in female cells was consistent with the idea that one of the X chromosomes was highly condensed. The second type was genetic. A variegated phenotype that is found only in females is consistent with the idea that certain patches express one allele and other patches express the other allele. This variegated phenotype would occur only if the inactivation happened at an early stage of embryonic development and was inherited permanently thereafter.

E3. A haploid oocyte should only express either the 550- or 375-length mRNA, but not both (because it has only one copy of the gene). The nurse cells, however, can express both mRNAs if the female is heterozygous. Therefore, if we begin with heterozygous females, we could dissect and separate the nurse cells from the oocytes. We would then isolate mRNA from the nurse cells and (in a separate tube) isolate mRNA from oocytes. The mRNA would then be run on a gel, and subjected to Northern blotting, using a probe that is complementary to both the 550- and 375-length mRNA. According to our knowledge of maternal effect genes, we would expect the oocyte to contain both the 550 and 375 mRNAs, because it receives them from the nurse cells. Both forms of the mRNA would also be found in the nurse cells.

E4. The pattern of inheritance is consistent with imprinting. In every cross, the allele that is inherited from the father is expressed in the offspring, while the allele inherited from the mother is not.

E5. Mate the female to a *dd* male. If all the offspring coil to the left, you know the female must be *dd.* If they all coil to the right, she could be either *DD* or *Dd.* If the F_1 offspring coil to the right, you could let them mate with each other to produce an F_2 generation. If the original mother was *Dd,* then half the F_1 female offspring would be *Dd* and half would be *dd.* Therefore, half of the F_2 snails would coil to the right and half to the left. In contrast, if the original mother was *DD,* all the F_1 female offspring would be *Dd.* In this case, all the F_2 snails would coil to the right.

E6. We assume that the snails in the large colony on the second island are true-breeding, *DD.* Let the male snail from the deserted island mate with a female snail from the large colony. Then let the F_1 snails mate with each other to produce an F_2 generation. Then let the F_2 generation mate with each other to produce an F_3 generation. Here are the expected results.

Female *DD* × Male *DD*

All F_1 snails coil to the right.
All F_2 snails coil to the right.
All F_3 snails coil to the right.

Female *DD* × Male *Dd*

All F_1 snails coil to the right.
All F_2 snails coil to the right because all of the F_1 females are *DD* or *Dd*.
15/16 of F_3 snails coil to the right, 1/16 of F_3 snails coil to the left (because 1/16 of the F_2 females are *dd*).

Female *DD* × Male *dd*.

All F_1 snails coil to the right.
All F_2 snails coil to the right because all of the F_1 females are *Dd*.
3/4 of F_3 snails coil to the right, 1/4 of F_3 snails coil to the left (because 1/4 of the F_2 females are *dd*).

E7. A. All the lanes would show the same results. The form of G-6-PD inherited from the mother would be found because the paternal X chromosome would be inactivated.

B. We would find equal amounts of both the fast and slow forms of G-6-PD in all lanes. X inactivation does not occur in this species.

C. We would find equal amounts of both the fast and slow forms of G-6-PD in all lanes. X inactivation does not occur in this species.

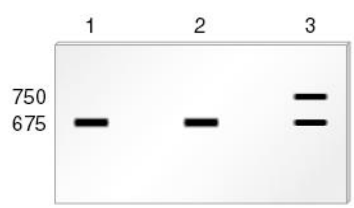
E8. Let's first consider the genotypes of male A and male B. Male A must have two normal copies of the *Igf-2* gene. We know this because male A's mother was *Igf-2 Igf-2;* the father of male A must have been a heterozygote *Igf-2 Igf-2m* because half of the litter that contained male A also contained dwarf offspring. But since male A was not dwarf, it must have inherited the normal allele from its father. Therefore, male A must be *Igf-2 Igf-2.* We cannot be completely sure of the genotype of male B. It must have inherited the normal *Igf-2* allele from its father because male B is phenotypically normal. We do not know the genotype of male B's mother, but she could be either *Igf-2m Igf-2m* or *Igf-2 Igf-2m.* In either case, the mother of male B could pass the *Igf-2m* allele to an offspring, but we do not know for sure if she did. So, male B could be either *Igf-2 Igf-2m* or *Igf-2 Igf-2.*

For the *Igf-2* gene, we know that the maternal allele is inactivated. Therefore, the genotypes and phenotypes of females A and B are irrelevant. The phenotype of the offspring is determined only by the allele that is inherited from the father. Since we know that male A has to be *Igf-2 Igf-2,* we know that it can produce only normal offspring. Since both females A and B both produced dwarf offspring, male A cannot be the father. In contrast, male B could be either *Igf-2 Igf-2* or *Igf-2 Igf-2m.* Because both females gave birth to dwarf babies (and since male A and male B were the only two male mice in the cage), we conclude that male B must be *Igf-2 Igf-2m* and is the father of both litters.

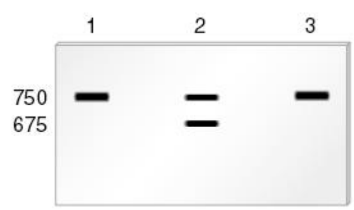
E9. A clone only produces one type of G-6-PD enzyme because X inactivation has already occurred and it is inherited permanently in subsequent cell divisions. If a biopsy was taken in early embryonic development, prior to X inactivation, then a clone could express both copies of the *G-6-PD* alleles. The biopsy described in the experiment of Figure 7.6 must have been varied enough so that not all the tissue was derived from the same embryonic cell. Only if a small biopsy was taken, and all the tissue was derived from the same embryonic cell in which X inactivation had already occurred, would the cells from that biopsy produce only one of the two *G-6-PD* alleles.

E10. In mice, one of the two X chromosomes is inactivated; that is why females and males produce the same total amount of mRNA for most X-linked genes. In fruit flies, the expression of a male's X-linked genes is turned up twofold. In *C. elegans,* the expression of hermaphrodite X-linked genes is turned down twofold. Overall, the total amount of expression of X-linked genes is the same in males and females (or hermaphrodites) of these three species. In fruit flies and *C. elegans,* heterozygous females and hermaphrodites express 50% of each allele compared to a homozygous male, so that heterozygous females and hermaphrodites produce the same total amount of mRNA from X-linked genes compared to males. Note: In heterozygous females of mice, fruit flies, and worms, there is 50% of each gene product (compared to hemizygous males and homozygous females).

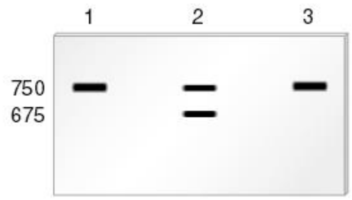
A.



B.



C.



E11. Based on these results, it may be cytoplasmic inheritance involving plastids. In most cases, plastids follow a maternal inheritance pattern, but a low percentage of the time, paternal leakage does occur.

E12. In the absence of UV light, we would expect all sm^r offspring. With UV light, we would expect a greater percentage of sm^S offspring.

E13. If you examined them under the microscope, the neutral petites would lack nucleoids in their mitochondria, or their nucleoids would be very small. In contrast, suppressive petites would have fairly normal-looking nucleoids in their mitochondria. Another approach might be to isolate mitochondria from neutral and suppressive petites, extract the DNA, and determine the amount of DNA (e.g., with a spectrophotometer or by gel electrophoresis and staining with ethidium bromide).