CHAPTER 15: THE CHROMOSOMAL BASIS OF INHERITANCE

■ INTERACTIVE QUESTIONS

15.1

F_2 Generation

ova \ sperm	w^+	Y
w^+	w^+w^+	w^+Y
w	w^+w	wY

Phenotype			
red-eyed female	red-eyed female	red-eyed male	white-eyed male
Genotype			
w^+w^+	w^+w	w^+Y	wY

15.2 **a.** tall, purple-flowered and dwarf, white-flowered
b. tall, white-flowered and dwarf, purple-flowered

15.3 If linked genes have their loci close together on the same chromosome, they travel together during meiosis and more parental offspring are produced. Recombinants are the result of crossing over between nonsister chromatids of homologous chromosomes.

15.4 Solving a linkage problem is often a matter of trial and error. Sometimes it helps to lay out the loci with the greatest distance between them and fit the other genes between or on either side by adding or substracting map unit distances.

——— 15 ———

m —— 9 —— j —— 6 —— l —— 6 —— k

——— 12 ———

15.5 The gene is sex-linked, so a good notation is X^C, X^c, and Y so that you will remember that the Y does not carry the gene. Capital *C* indicates normal sight. Genotypes are:

1. X^CY
2. X^CX^c
3. X^CX^C or X^CX^c (probably X^CX^C since 4 sons are X^CY)
4. X^CX^c
5. X^CY
6. X^cY
7. X^CX^c

15.6 **a.** A trisomic organism ($2n + 1$) has an extra copy of one chromosome, usually caused by a nondisjunction during meiosis. A triploid organism ($3n$) has an extra set of chromosomes, possibly caused by a total nondisjunction in gamete formation.

b. The genetic balance of a trisomic organism would be more disrupted than that of an organism with a complete extra set of chromosomes.

15.7 translocation, deletion, and inversion

15.8 Aneuploidies of sex chromosomes appear to upset genetic balance less, perhaps because relatively few genes are located on the Y chromosome and extra X chromosomes are inactivated as Barr bodies.

SUGGESTED ANSWERS TO STRUCTURE YOUR KNOWLEDGE

1. Genes that are not linked assort independently, and the ratio of offspring from a testcross with a dihybrid heterozygote should be 1:1:1:1 (*AaBb* × *aabb* gives *AaBb*, *Aabb*, *aaBb*, *aabb* offspring and a frequency of recombination frequency of 50%). Genes that are linked and do not cross over should produce a 1:1 ratio in this testcross (*AaBb* and *aabb* because a heterozygote derived from a parental cross of *AABB* × *aabb* produces only *AB* and *ab* gametes). If crossovers between distant genes always occur, the heterozygote will produce equal quantities of *AB*, *Ab*, *aB*, and *ab* gametes, and the genotype ratio of offspring will be 1:1:1:1, the same as it is for unlinked genes. Because each 1% recombination frequency is equal to 1 map unit, this measurement ceases to be meaningful at relative distances of 50 or more map units. However, crosses with intermediate genes on the chromosome could establish both that the genes *A* and *B* are on the same chromosome and that they are a certain map unit distance apart.

2. A cross between a mutant female fly and a normal male should produce all normal females (who get a wild-type allele from their father) and all mutant male flies (who get the mutant allele on the X chromosome from their mother). $X^mX^m \times X^+Y$ produces X^+X^m and X^mY offspring (normal females and mutant males).

3. The serious phenotypic effects that are associated with these chromosomal alterations indicate that normal development and functioning is dependent on genetic balance. Most genes appear to be vital to an organismís existence, and extra copies of genes upset genetic balance. Inversions and translocations, which do not disrupt the balance of genes, can alter phenotype because of effects on gene functioning from neighboring genes.

Chapter 15

ANSWERS TO GENETICS PROBLEMS

a. The trait is recessive and probably sex-linked. Two sets of unaffected parents in the second generation have offspring with the trait, indicating that it must be recessive. More males than females display the trait. Females #3 and #5 must be carriers since their father has the trait, and they each pass it on to a son.

b. Using the symbols X^T for the dominant allele and X^t for the recessive:

1. X^tY	5. X^TX^t
2. X^TX^t	6. X^TX^t or X^TX^T
3. X^TX^t	7. X^TX^t
4. X^TY	

c. Individual #6 has a brother who has the trait and her mother's father had the trait, so her mother must be a carrier of the trait, meaning there is a ½ probability that #6 is a carrier. Since she is mated to a phenotypically normal male, none of her daughters will show the trait (0 probability). Her sons have a ½ chance of having the trait if she is a carrier. ½ × ½ = ¼ probability that her sons will have the trait. There is a ½ chance that a child would be male, so the probability of an affected child is ½ × ¼, or ⅛.

2. c, a, b, d

The genes appear to be linked because the parental types appear most frequently in the offspring. Recombinant offspring represent 10 out of 40 total offspring for a recombination frequency of 25%, indicating that the genes are 25 map units apart.

4. One of the mother's X chromosomes carries the recessive lethal allele. One-half of male fetuses would be expected to inherit that chromosome and spontaneously abort. Assuming an equal sex ratio at conception, the ratio of girl to boy children would be 2:1, or 6 girls and 3 boys.

5. a. For female chicks to be black, they must have received a recessive allele from the male parent. If all female chicks are black, the male parent must have been Z^bZ^b. If the male parent was homozygous recessive, then all male offspring will receive a recessive allele, and the female parent would have to be Z^BW to produce all barred males.

b. For female chicks to be both black and barred, the male parent must have been Z^BZ^b. If the female parent were Z^BW, only barred male chicks would be produced. To get an equal number of black and barred male chicks, the female parent must have been Z^bW.

ANSWERS TO TEST YOUR KNOWLEDGE

Multiple Choice:

1. e	5. a	9. a	13. c	17. e
2. a	6. e	10. e	14. a	18. d
3. b	7. b	11. d	15. e	19. c
4. d	8. c	12. b	16. d	20. d