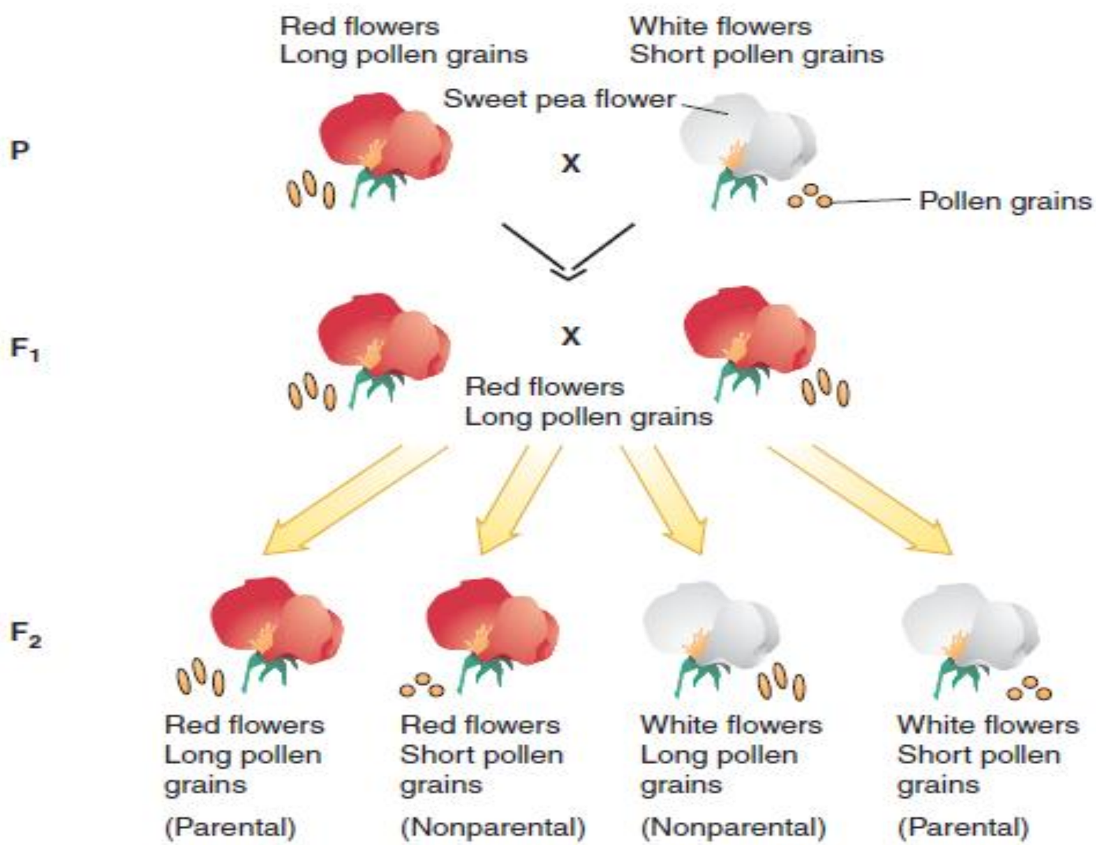
CHANDRA SHEKHAR AZAD UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, KANPUR- 208 002

M.Sc. Semester I
Course : Principles of Genetics (GPB-501)

Lecture by: Sanjana Pathak
Teaching associate
Department of Genetics and Plant Breeding

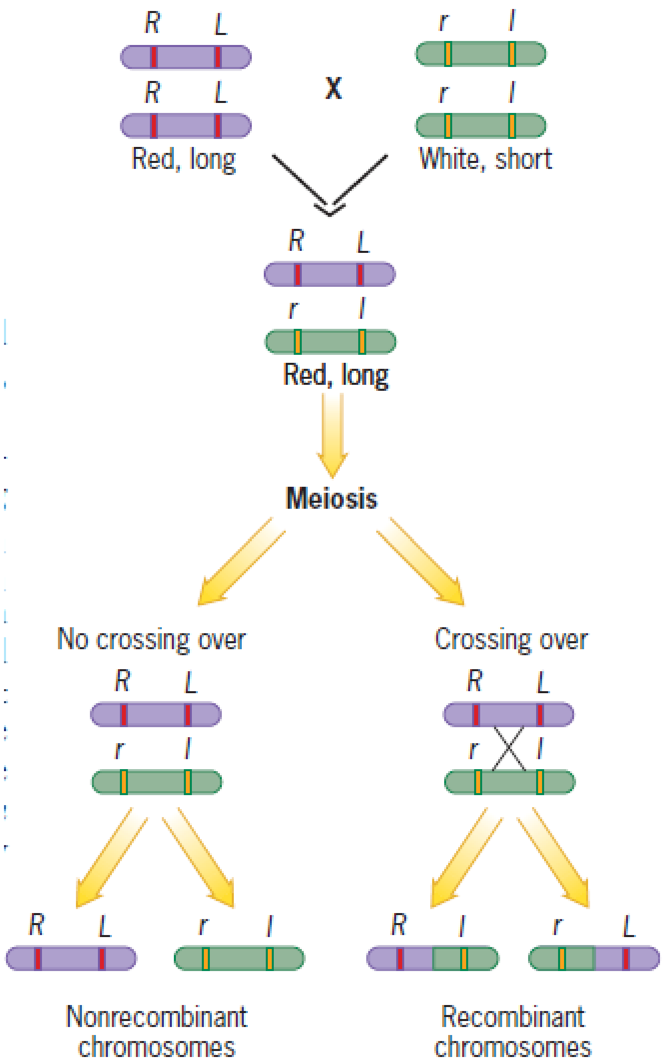
LINKAGE

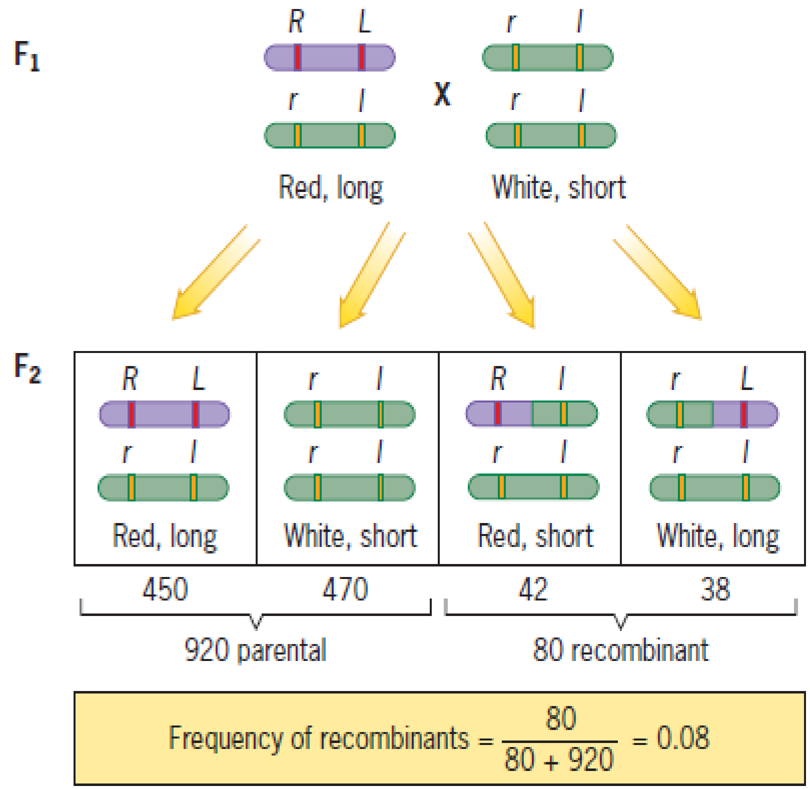


	Red flowers, Long pollen grains (Parental)	Red flowers, Short pollen grains (Nonparental)	White flowers, Long pollen grains (Nonparental)	White flowers, Short pollen grains (Parental)
Observed	583	26	24	170
Expected	451.6	150.6	150.6	50.2

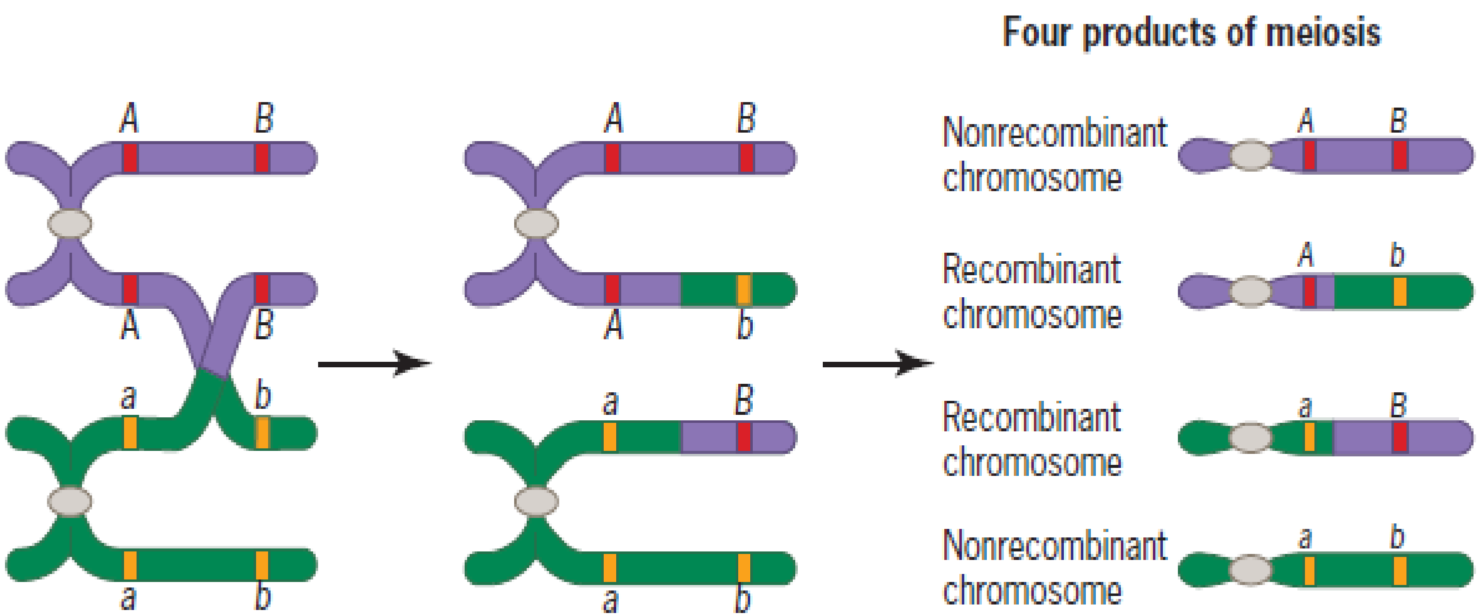
$$\chi^2 = \sum \frac{(\text{Obs.} - \text{Exp.})^2}{\text{Exp.}} = 38.2 + 103.1 + 106.4 + 285.9$$

$$= 533.6$$

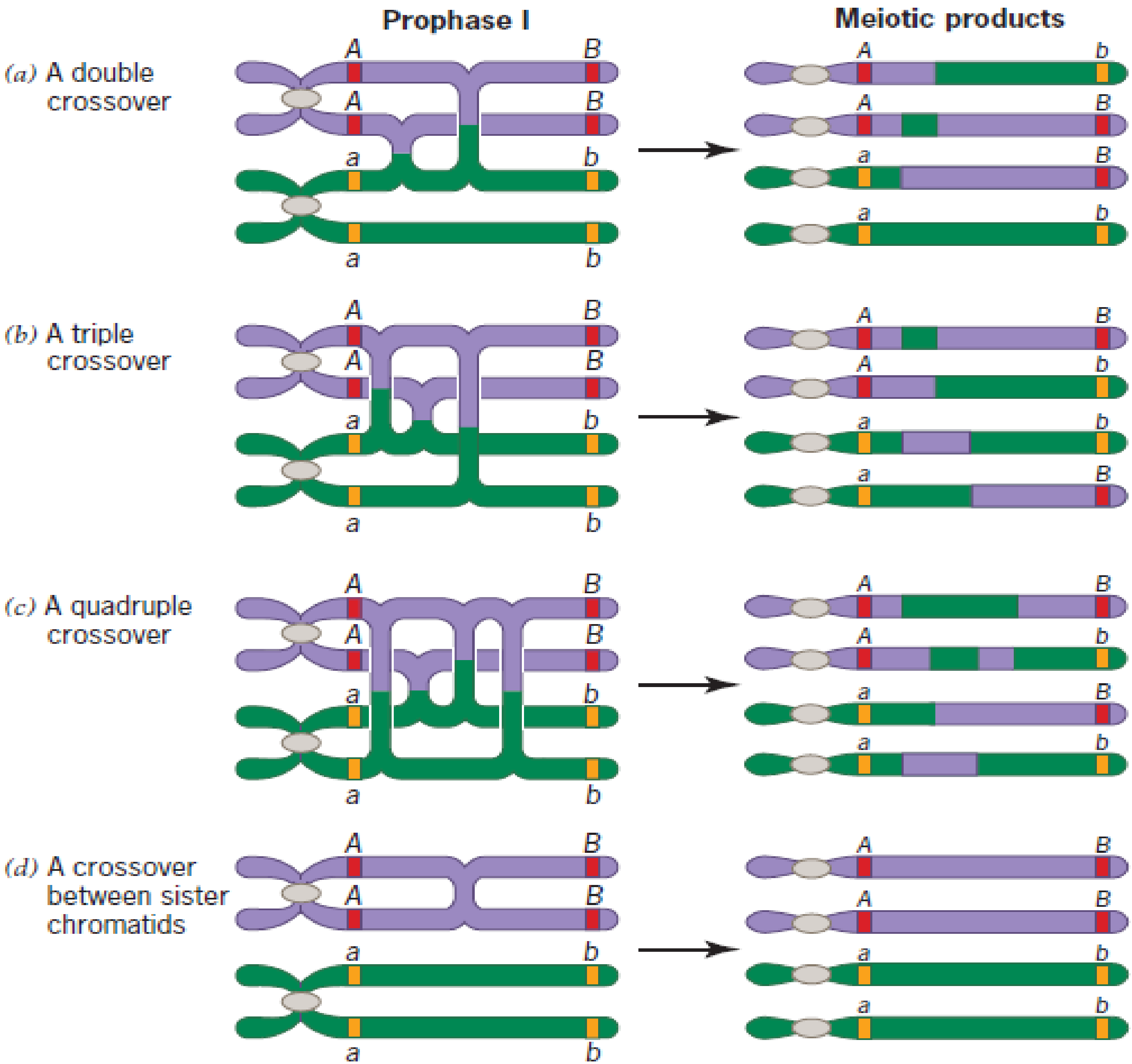




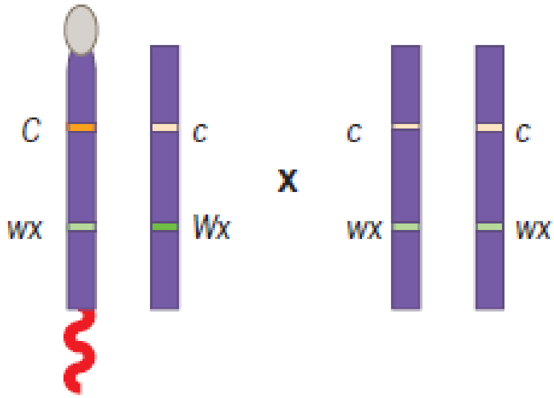
■ **FIGURE 7.4** A testcross for linkage between genes in sweet peas. Because the recombinant progeny in the F_2 are 8 percent of the total, the genes for flower color and pollen length are rather tightly linked.

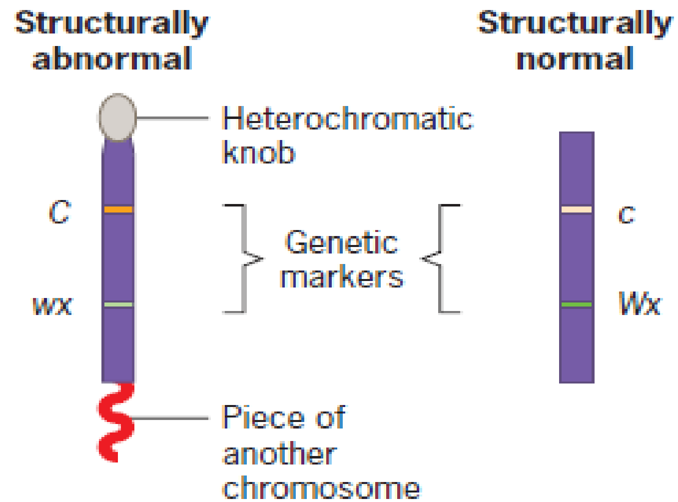


■ **FIGURE 7.6** Crossing over as the basis of recombination between genes. An exchange between paired chromosomes during meiosis produces recombinant chromosomes at the end of meiosis.

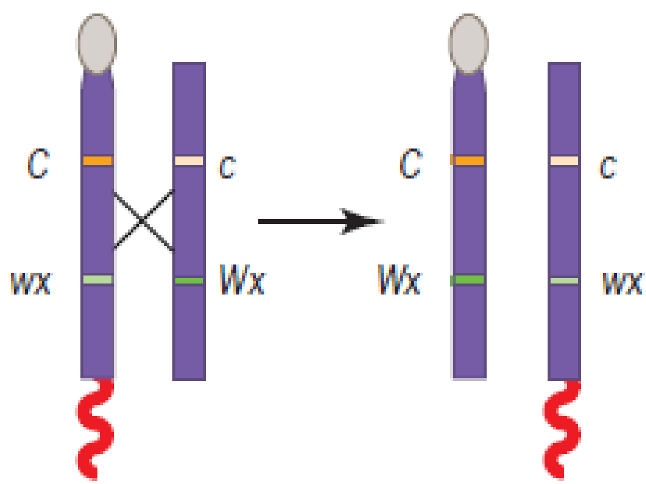


■ **FIGURE 7.7** Consequences of multiple exchanges between chromosomes and exchange between sister chromatids during prophase I of meiosis.

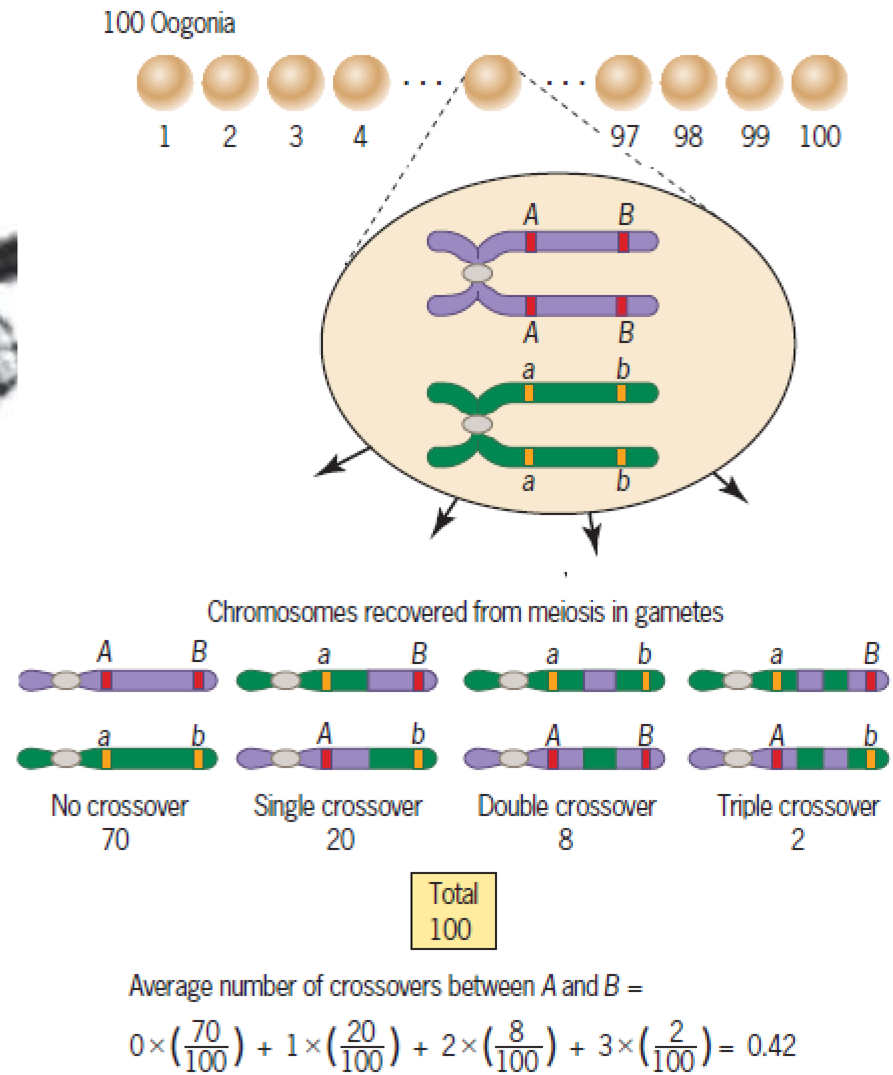




■ **FIGURE 7.8** Two forms of chromosome 9 in maize used in the experiments of Creighton and McClintock.

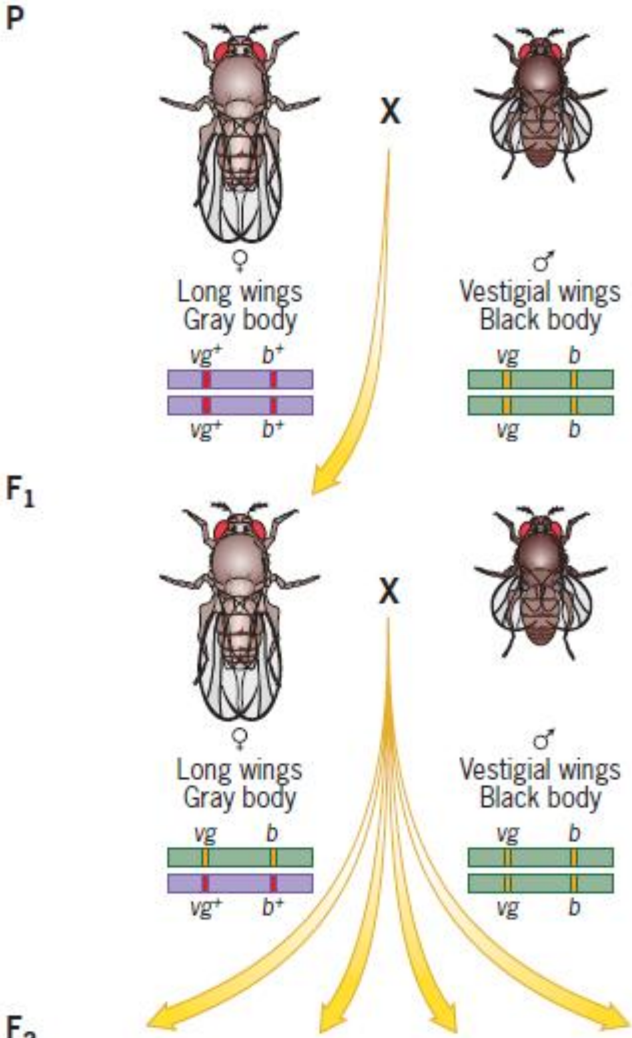


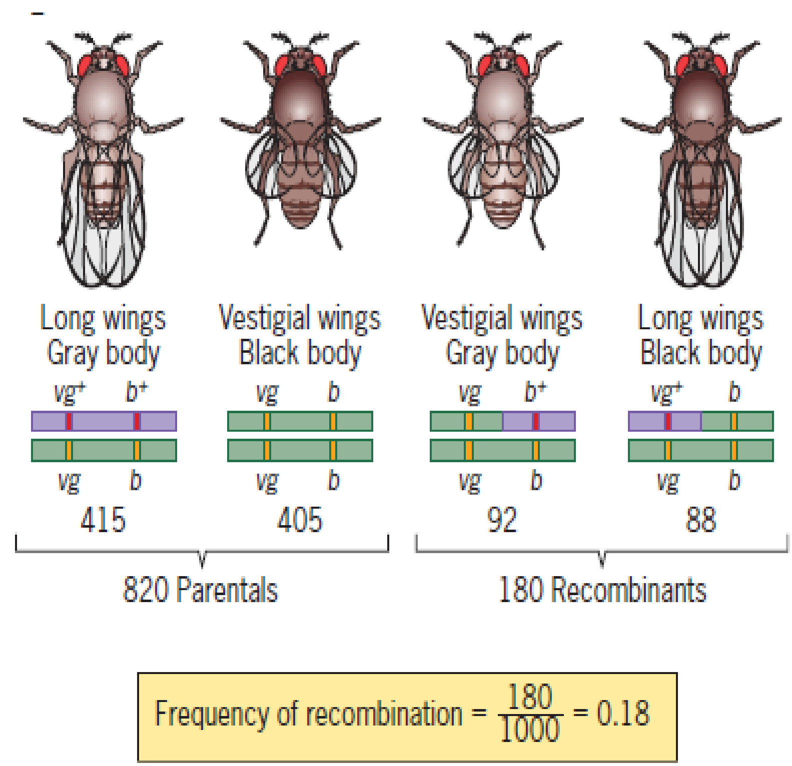
■ **FIGURE 7.9** Diplonema of male meiosis in the grasshopper *Chorthippus parallelus*. There are eight autosomal bivalents and an X-chromosome univalent. The four smaller bivalents each have one chiasma. The remaining bivalents have two to five chiasmata.



■ **FIGURE 7.10** Calculating the average number of crossovers between genes on chromosomes recovered from meiosis.

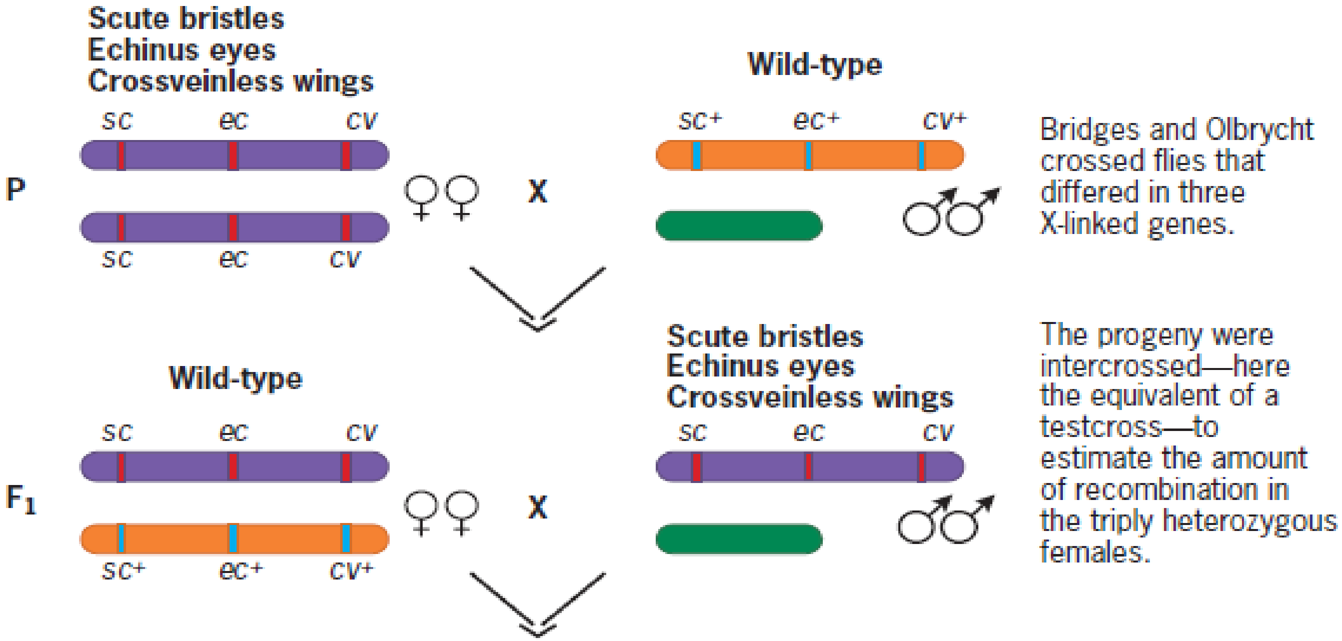
Sturtevant's fundamental insight was to estimate the distance between points on a chromosome by counting the number of crossovers between them. Points that are far apart should have more crossovers between them than points that are close together. However, the number of crossovers must be understood in a statistical sense. In any particular cell, the chance that a crossover will occur between two points may be low, but in a large population of cells, this crossover will probably occur several times simply because there are so many independent opportunities for it. Thus, the quantity that we really need to measure is the *average* number of crossovers in a particular chromosome region. Genetic map distances are, in fact, based on such averages. This idea is sufficiently important to justify a formal definition: *The distance between two points on the genetic map of a chromosome is the average number of crossovers between them.*





■ **FIGURE 7.11** An experiment involving two linked genes, *vg* (*vestigial* wings) and *b* (*black* body), in *Drosophila*.

This simple analysis indicates that, on average, 18 out of 100 chromosomes recovered from meiosis had a crossover between *vg* and *b*. Thus, *vg* and *b* are separated by 18 units on the genetic map. Sometimes geneticists call a map unit a **centiMorgan,** abbreviated cM, in honor of T. H. Morgan; 100 centiMorgans equal one Morgan (M). We can therefore say that *vg* and *b* are 18 cM (or 0.18 M) apart. Notice that the map distance is equal to the frequency of recombination, written as a percentage. Later we will see that when the frequency of recombination approaches 0.5, it underestimates the map distance. To test



F_2

Class	*Phenotype*	*Genotype of maternally inherited X chromosome*			*Number observed*
1	Scute, echinus, crossveinless	*sc*	*ec*	*cv*	1158
2	Wild-type	sc^+	ec^+	cv^+	1455
3	Scute	*sc*	ec^+	cv^+	163
4	Echinus, crossveinless	sc^+	*ec*	*cv*	130
5	Scute, echinus	*sc*	*ec*	cv^+	192
6	Crossveinless	sc^+	ec^+	*cv*	148
7	Scute, crossveinless	*sc*	ec^+	*cv*	1
8	Echinus	sc^+	*ec*	cv^+	1
				Total:	3248

■ **FIGURE 7.12** Bridges and Olbrycht's three-point cross with the X-linked genes *sc* (*scute* bristles), *ec* (*echinus* eyes), and *cv* (*crossveinless* wings) in *Drosophila*. Data from Bridges, C. B., and Olbrycht, T. M., 1926. *Genetics* 11: 41.

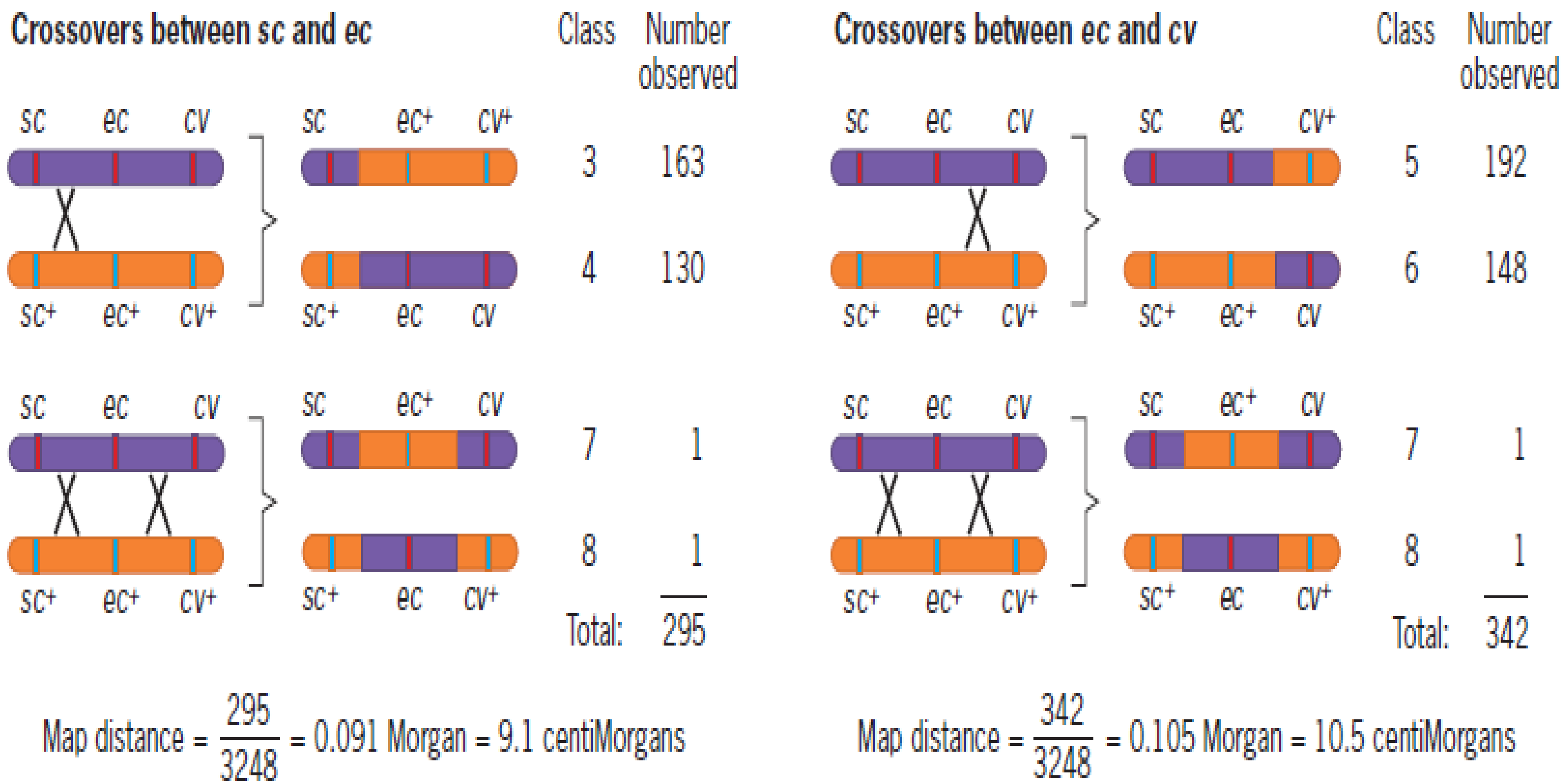


FIGURE 7.13 Calculation of genetic map distances from Bridges and Olbrycht's data. The distance between each pair of genes is obtained by estimating the average number of crossovers.

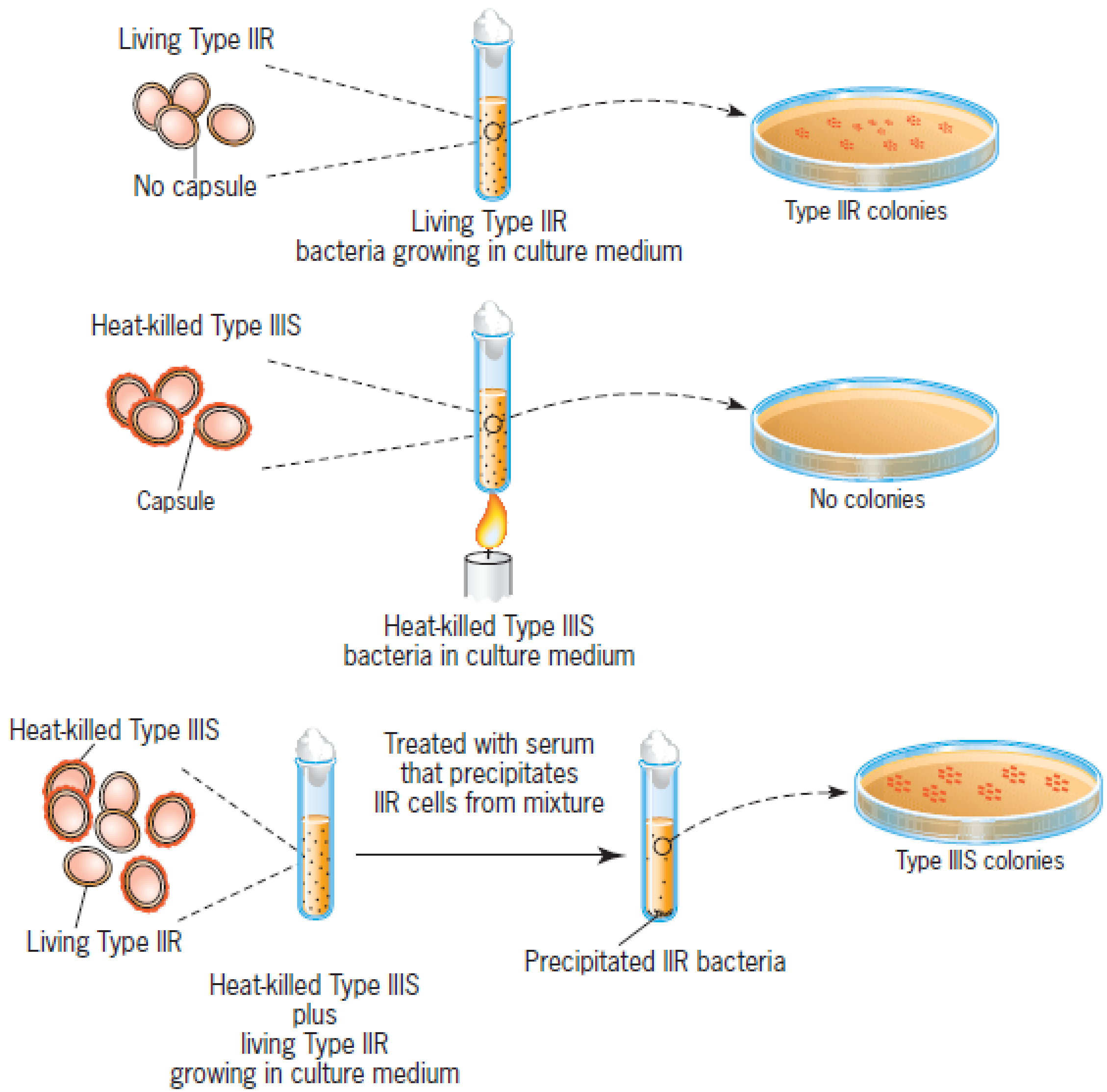


FIGURE 9.1 Sia and Dawson's demonstration of transformation in *Streptococcus pneumoniae in vitro*.

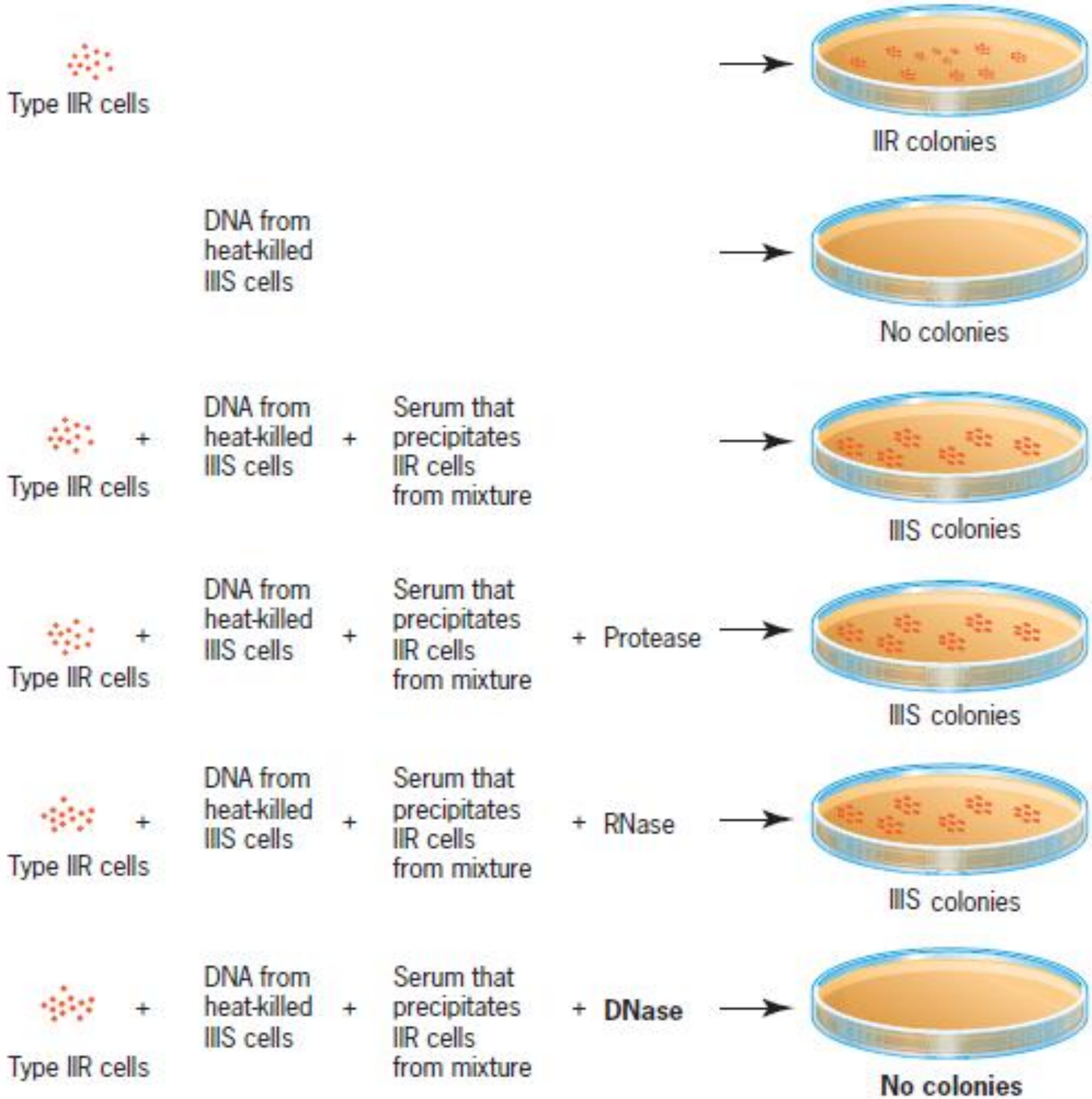
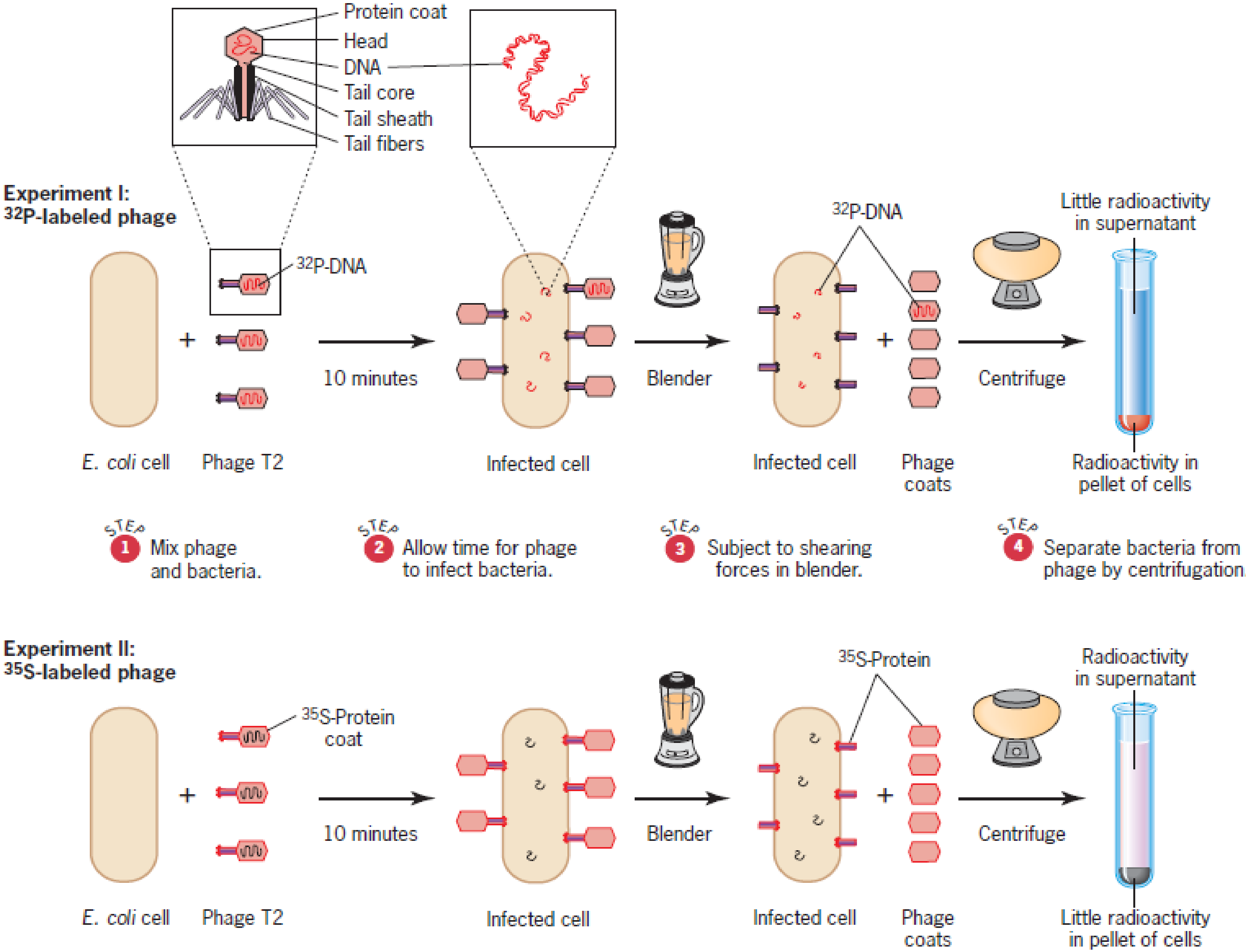


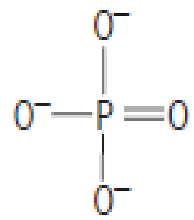
FIGURE 9.2 Avery, MacLeod, and McCarty's proof that the "transforming principle" is DNA.



■ **FIGURE 9.3** Hershey and Chase's demonstration that the genetic information of bacteriophage T2 resides in its DNA.

Nucleic acids are composed of repeating subunits called nucleotides. Each nucleotide is composed of three units.

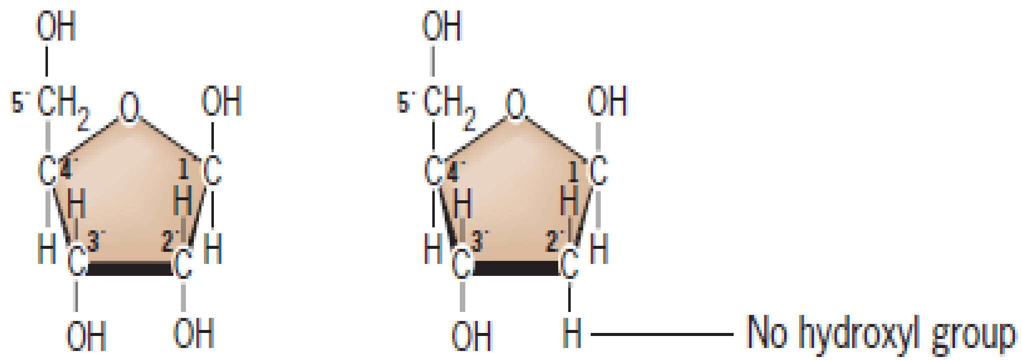
(1) A phosphate group:



(2) A five-carbon sugar or pentose:

(a) In RNA: Ribose

(b) In DNA: 2-Deoxyribose

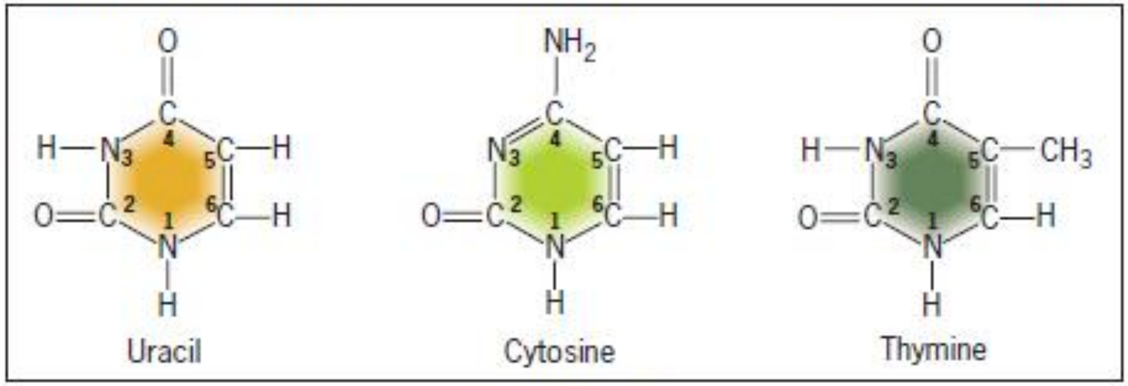


(3)
A
cyclic,
nitrogen-
containing
base:

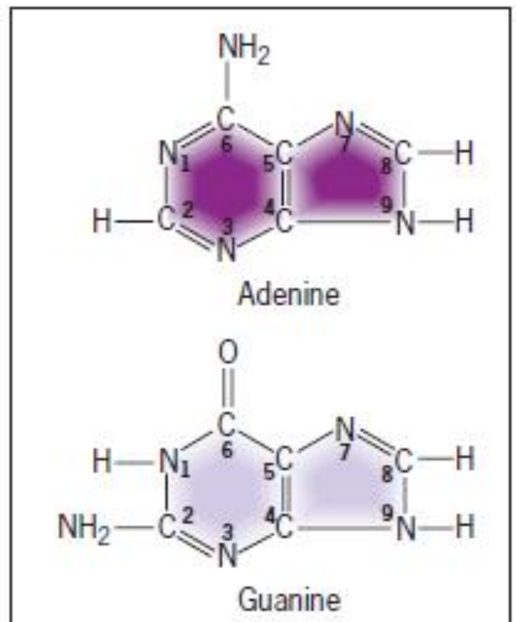
(a) In RNA only (with rare exceptions):

(b) In both RNA and DNA:

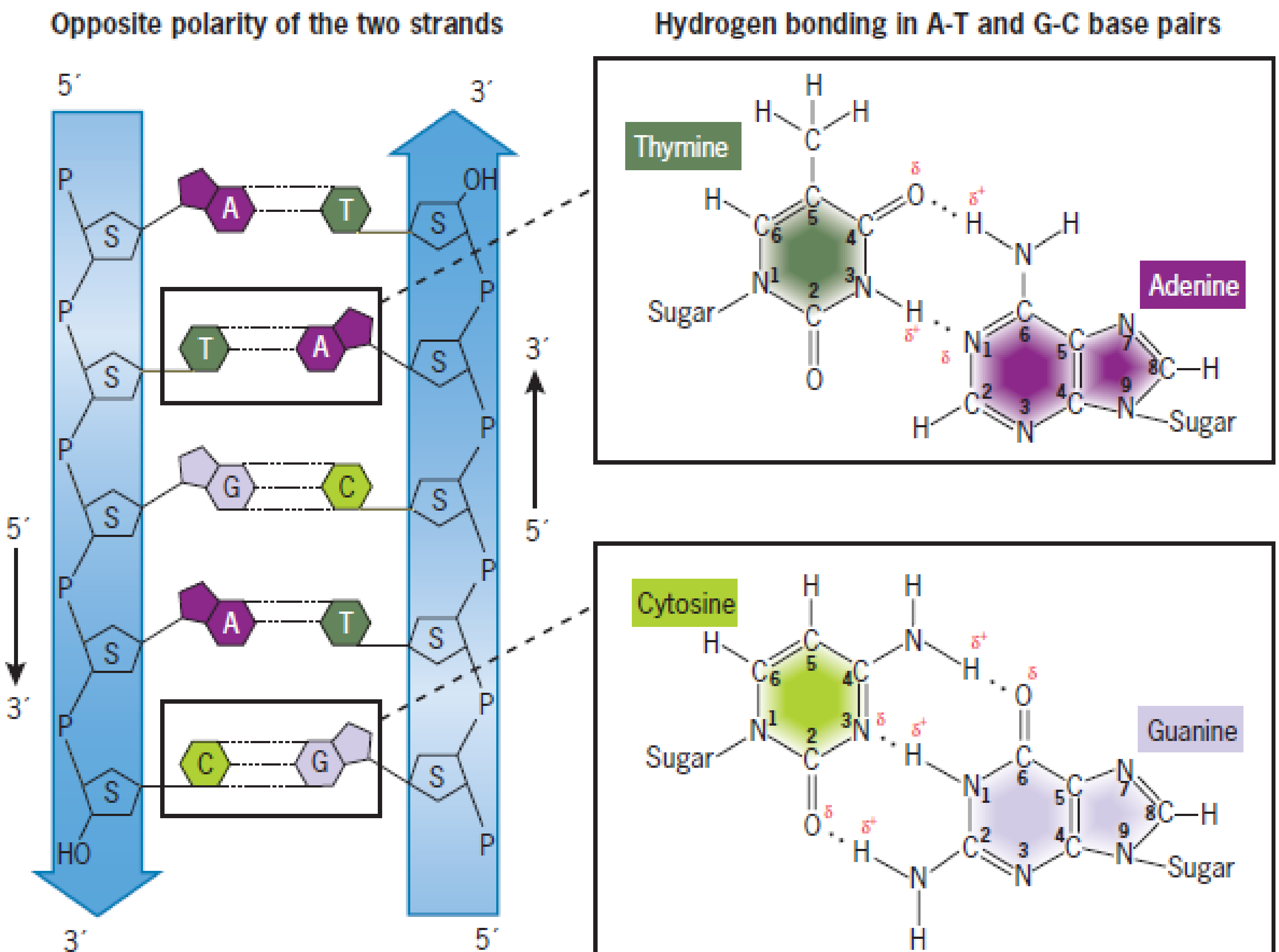
(c) In DNA only (with rare exceptions):



Pyrimidines



Purines


Opposite polarity of the two strands
Hydrogen bonding in A-T and G-C base pairs
5′
3′
OH
HO
P
S
A
T
G
C
Thymine
Adenine
Cytosine
Guanine
Sugar
δ
δ+