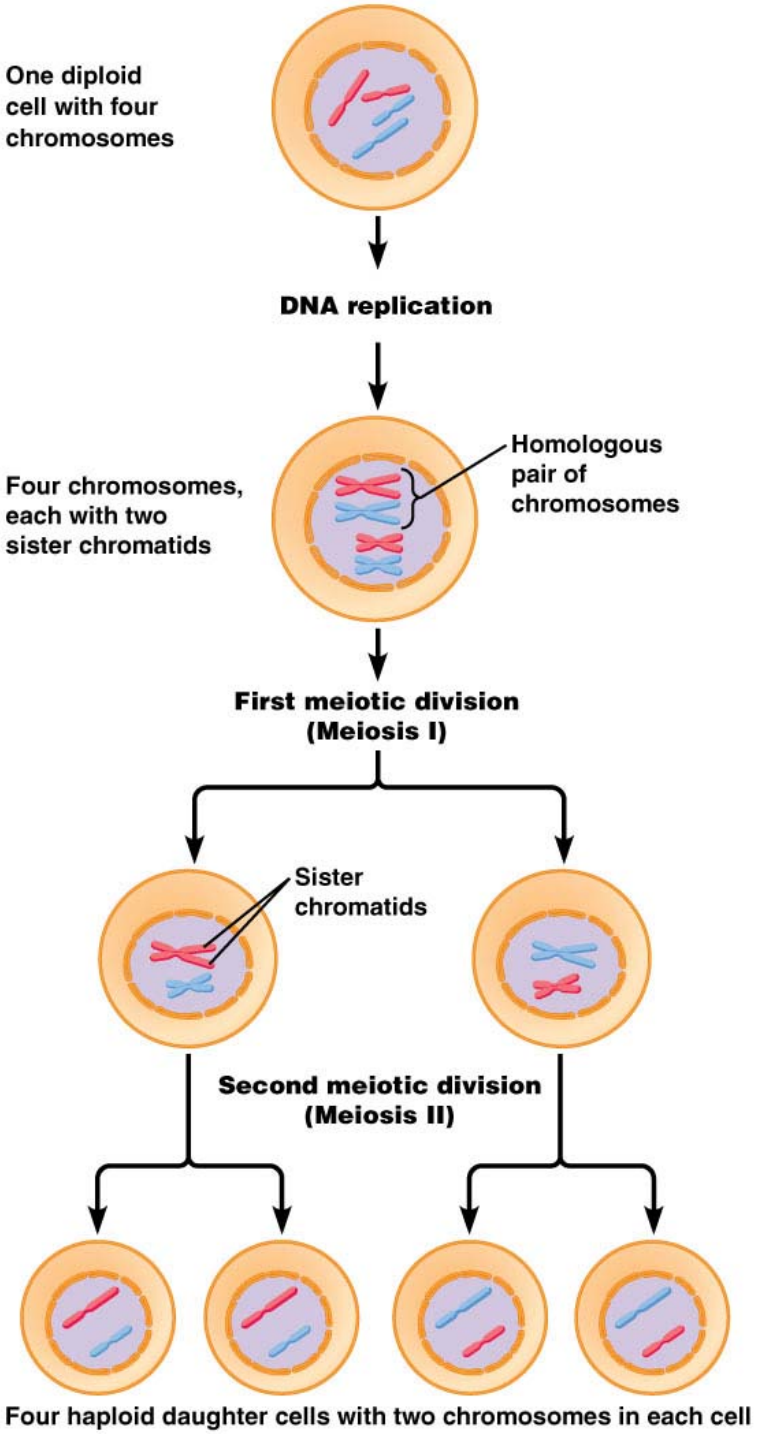
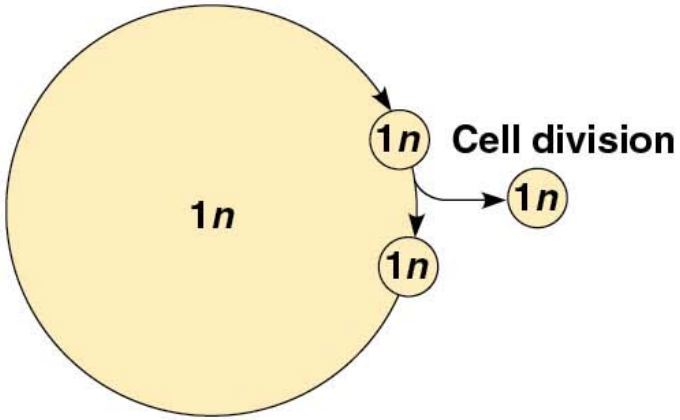
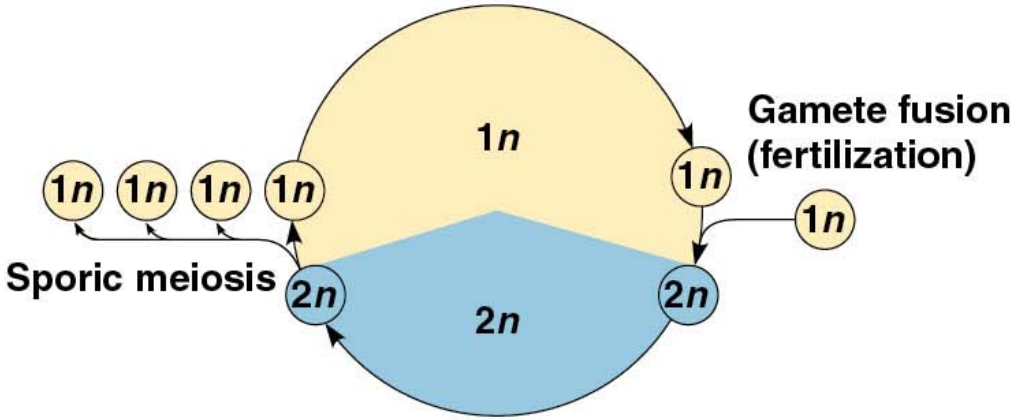
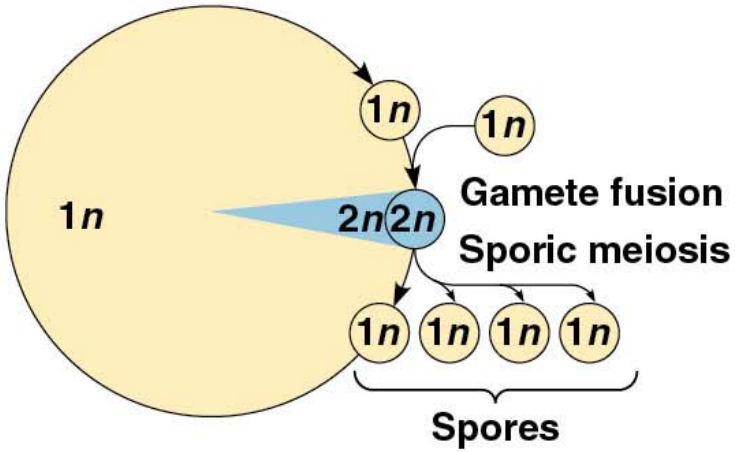




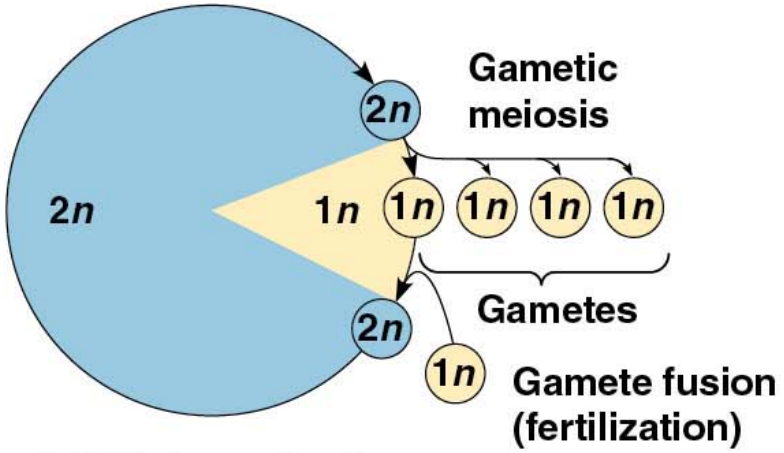
(a) Bacteria



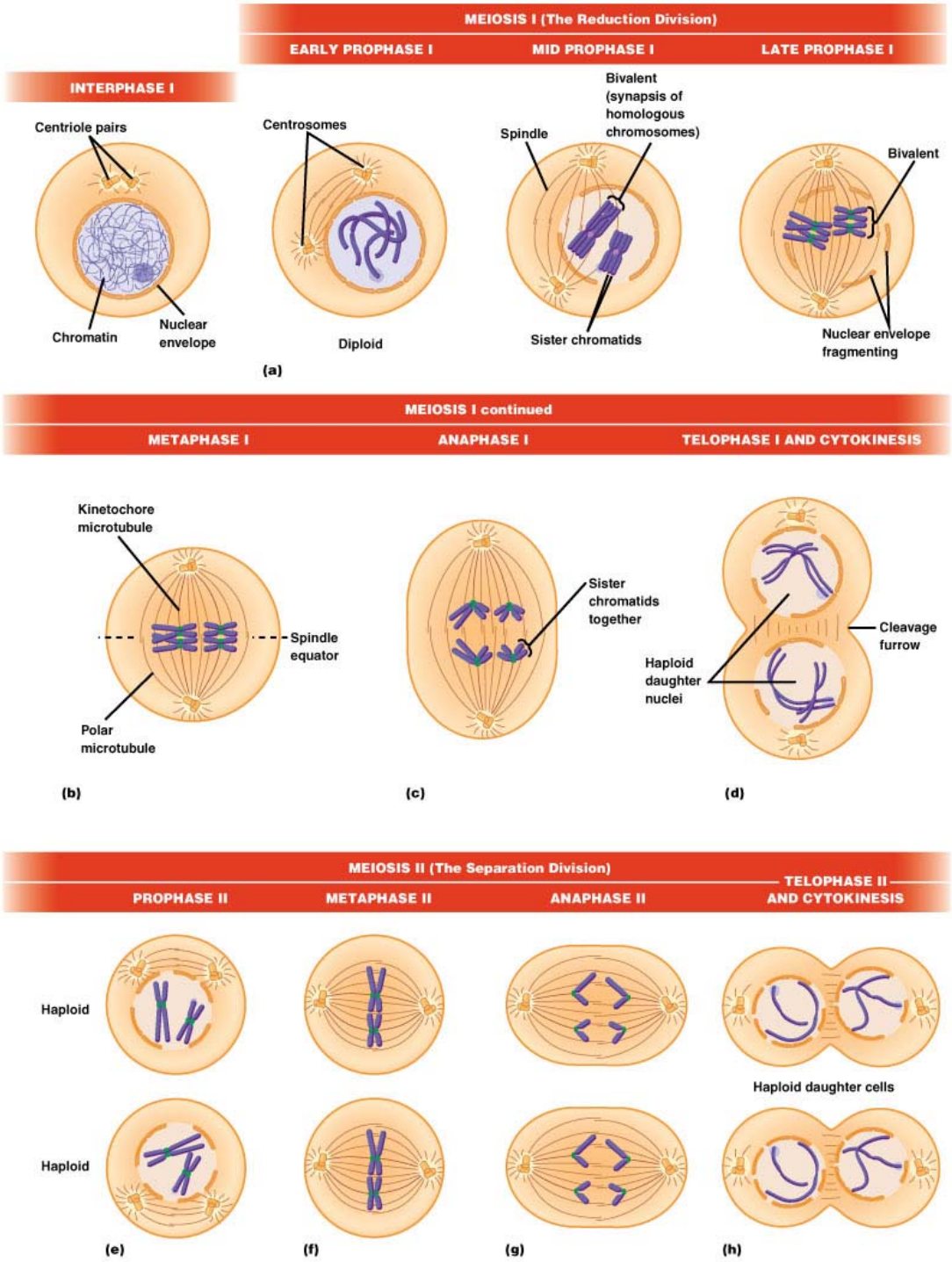
(c) Mosses

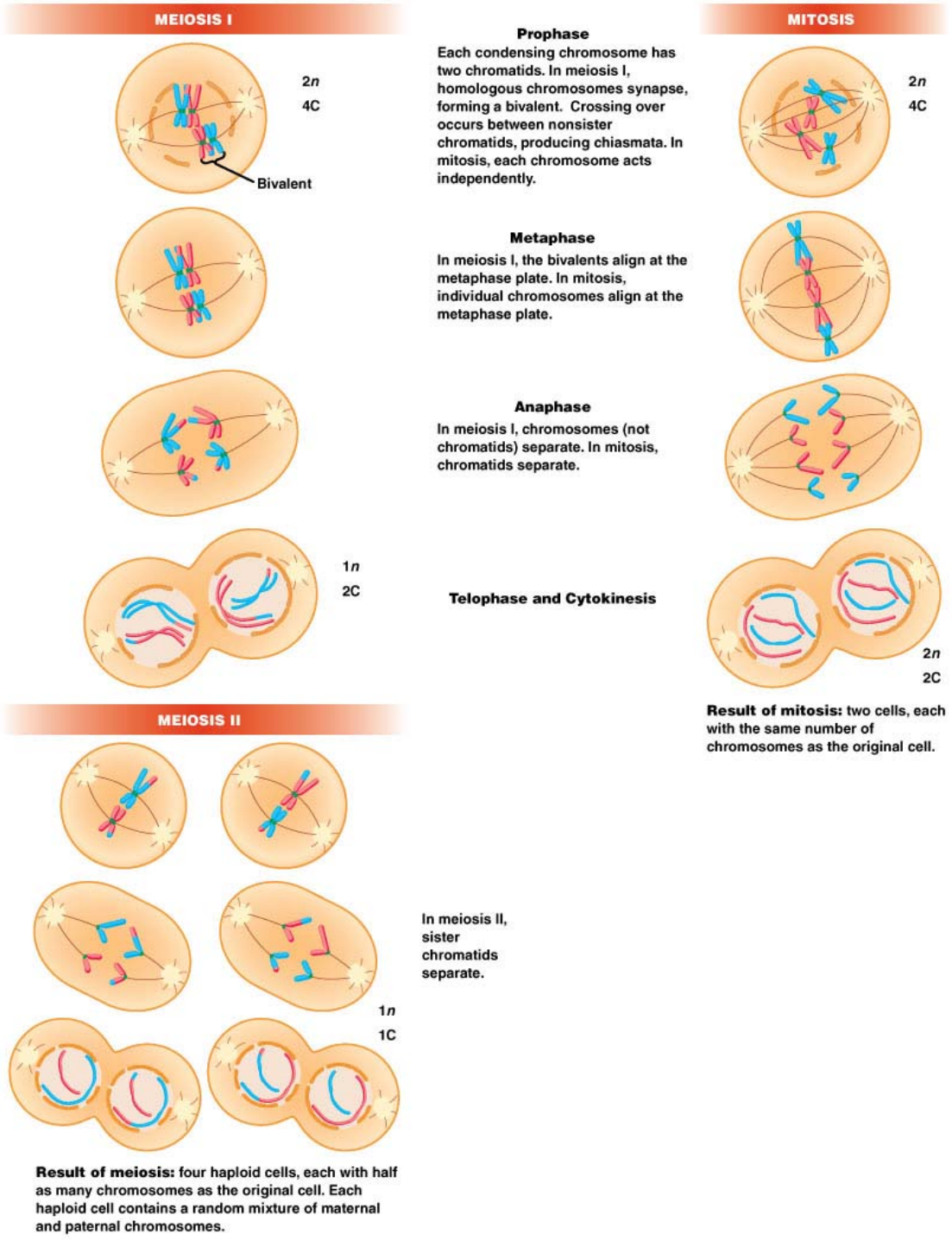


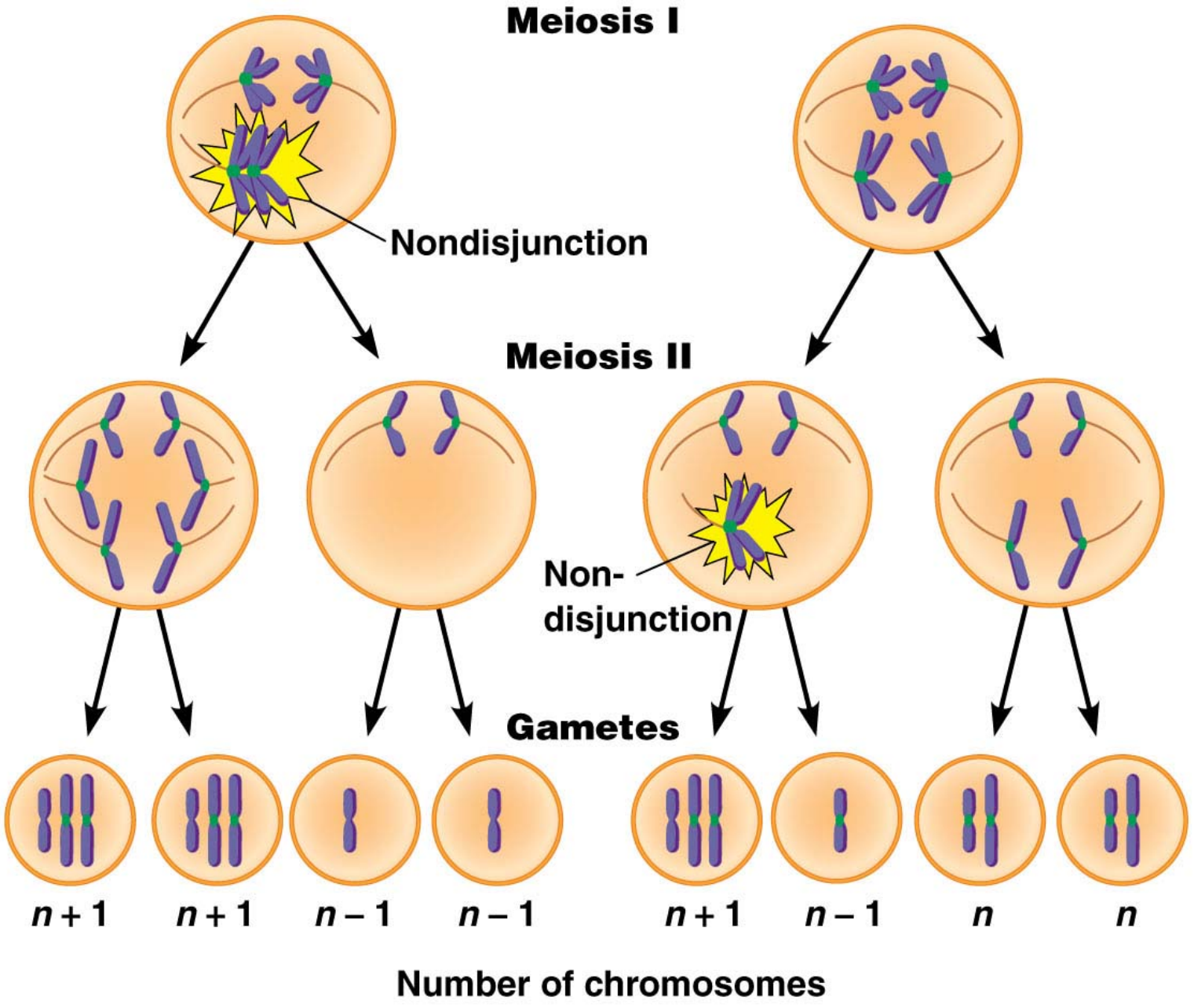
(b) Fungi



(d) Higher animals

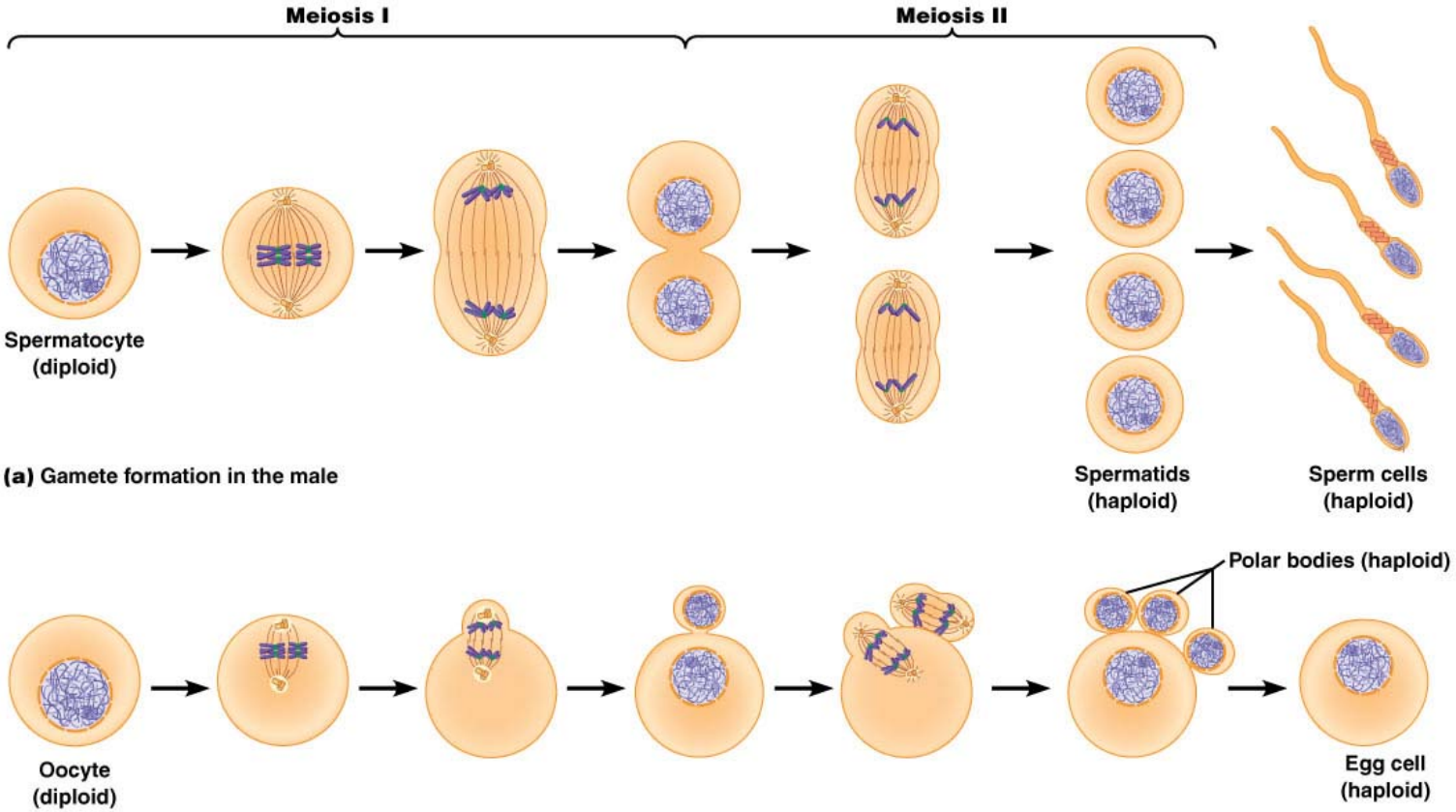






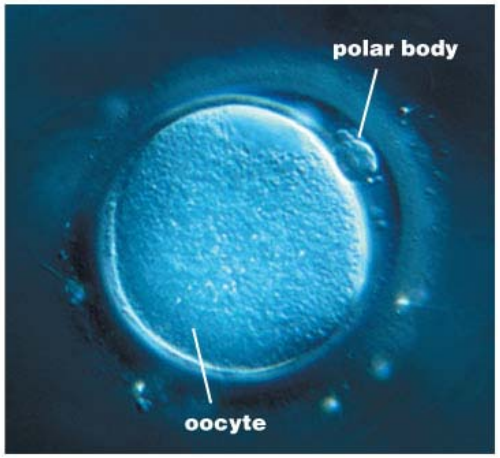
(a) Nondisjunction of homologous chromosomes in meiosis I

(b) Nondisjunction of sister chromatids in meiosis II

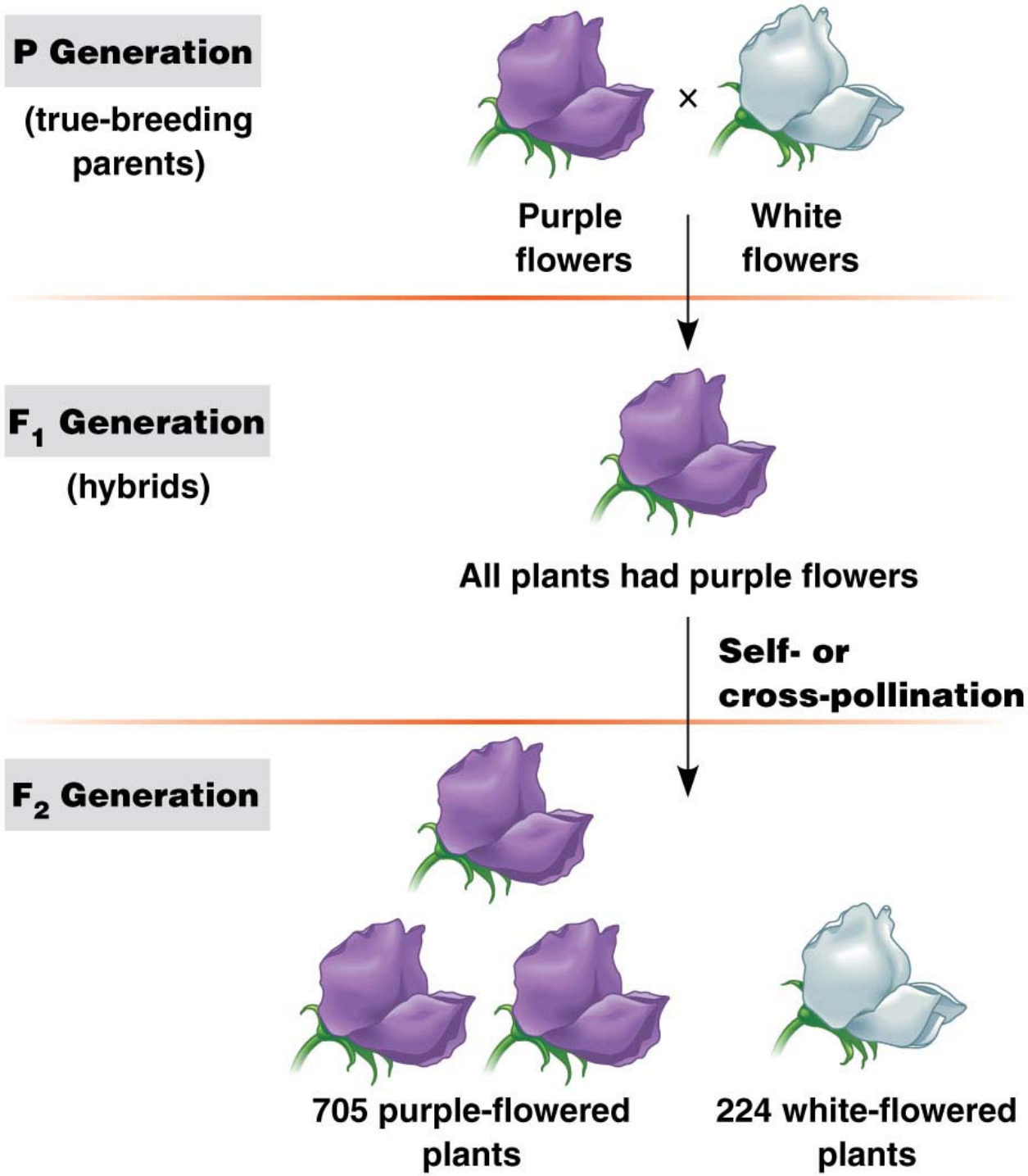


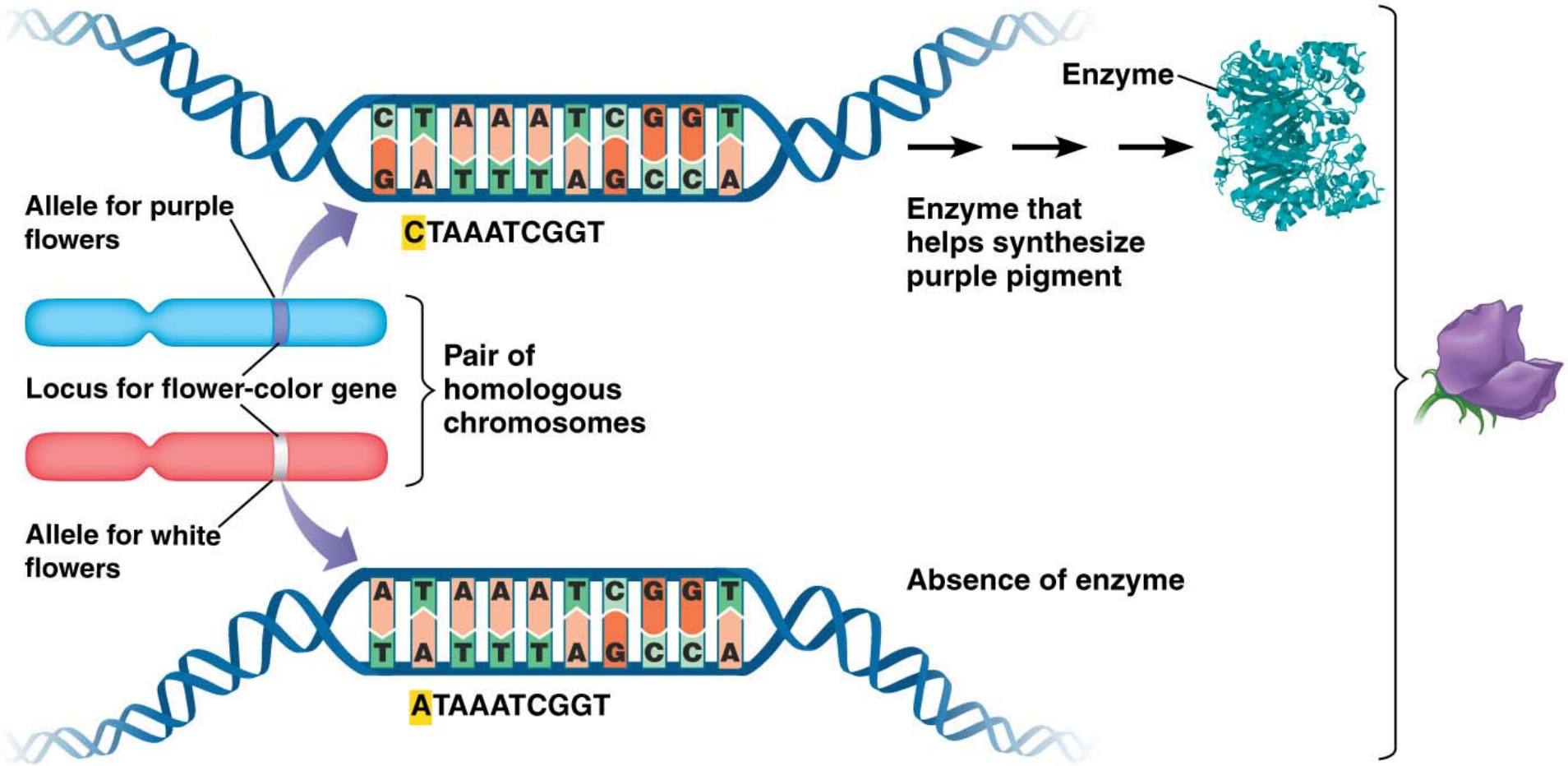
(a) Gamete formation in the male

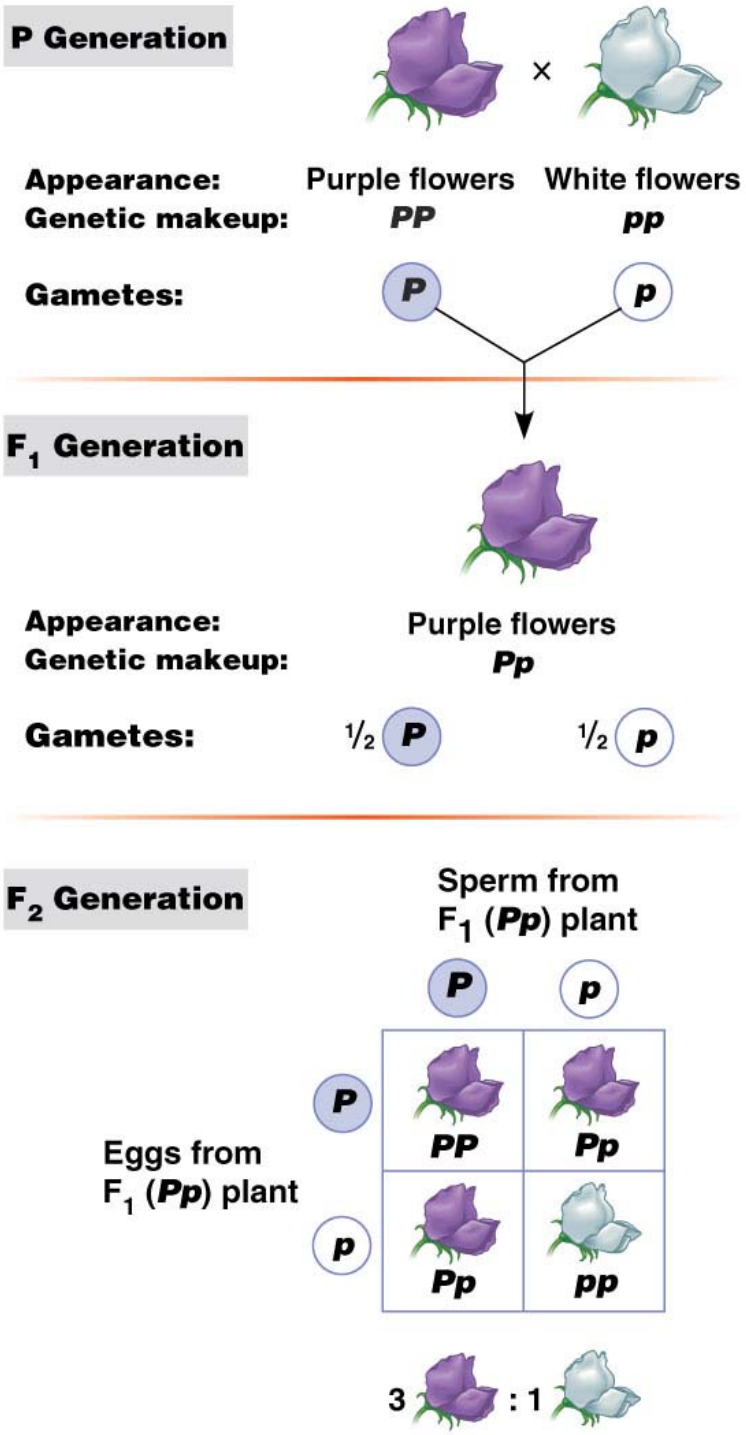
(b) Gamete formation in the female

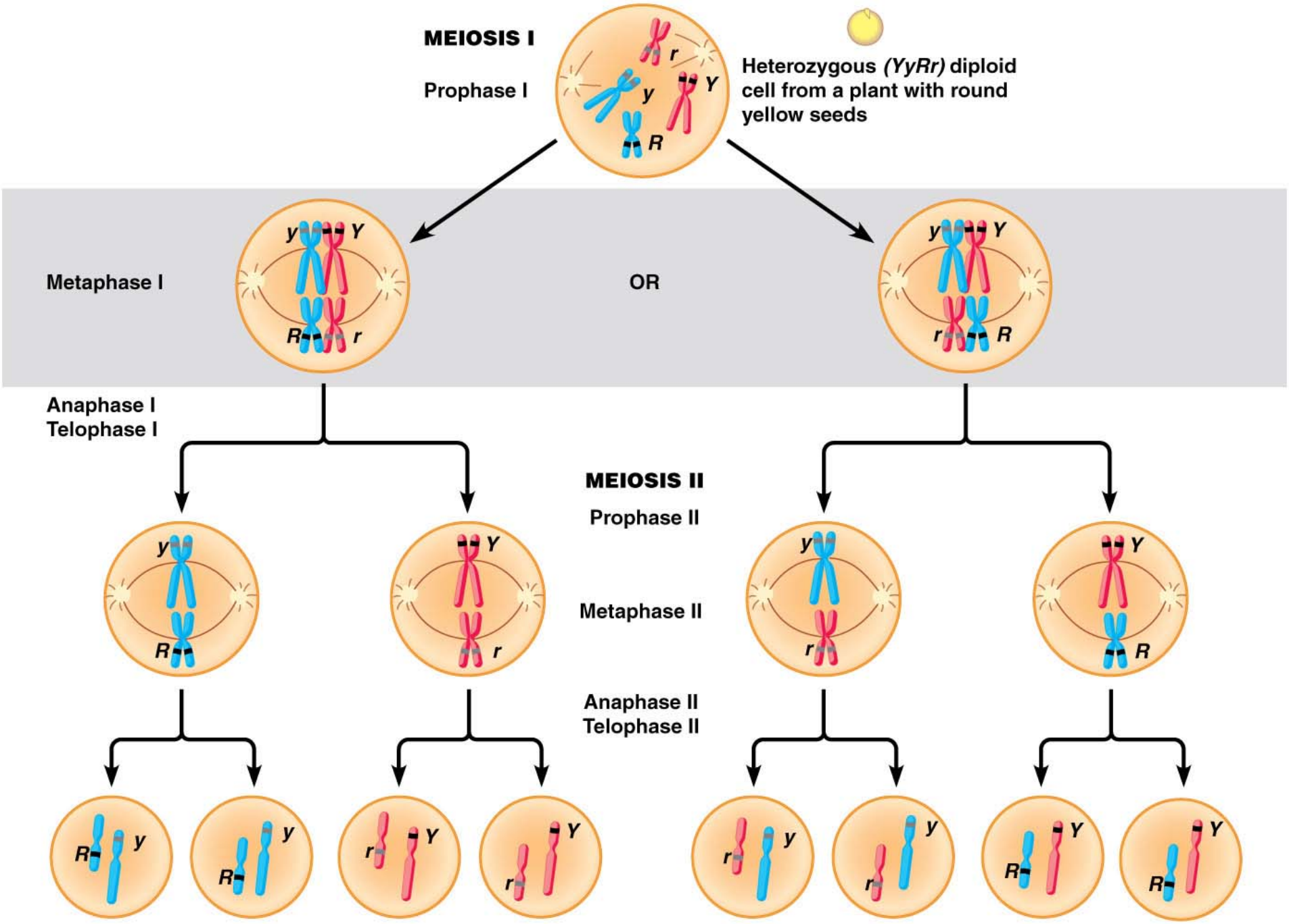


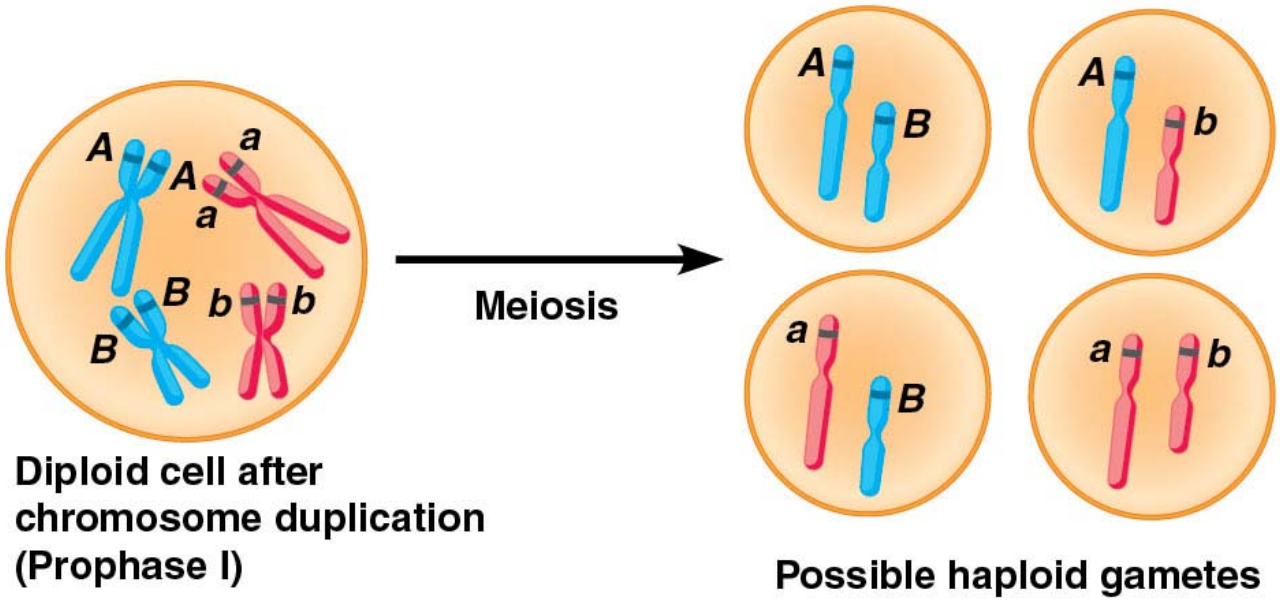
(c) Polar body formation in a human secondary oocyte



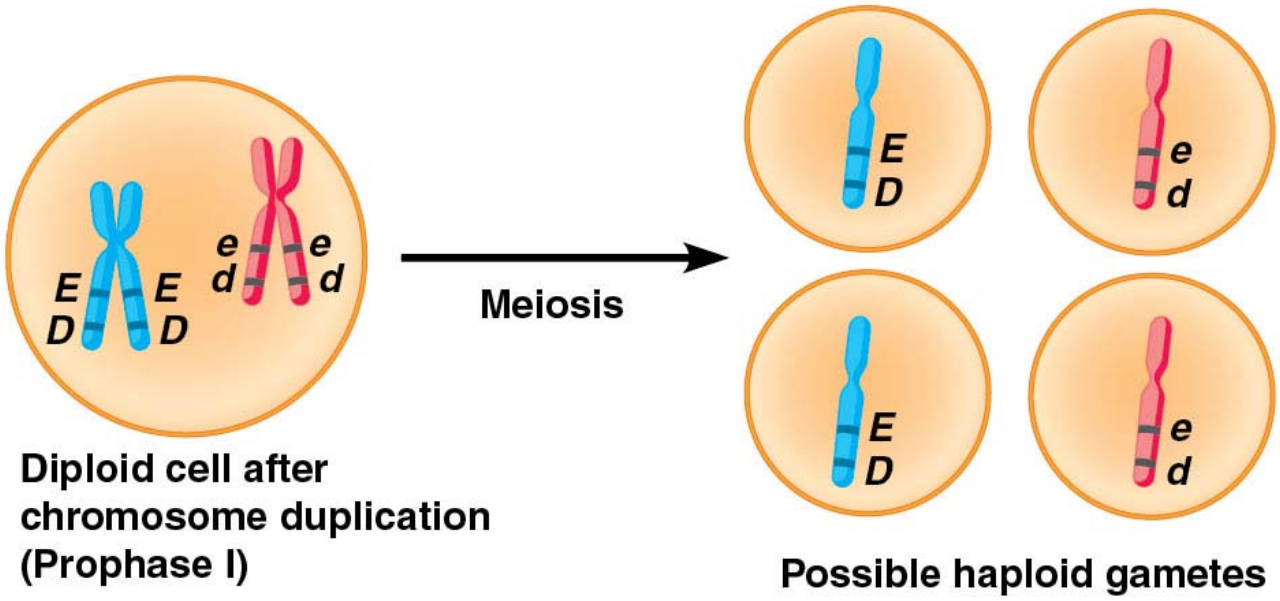




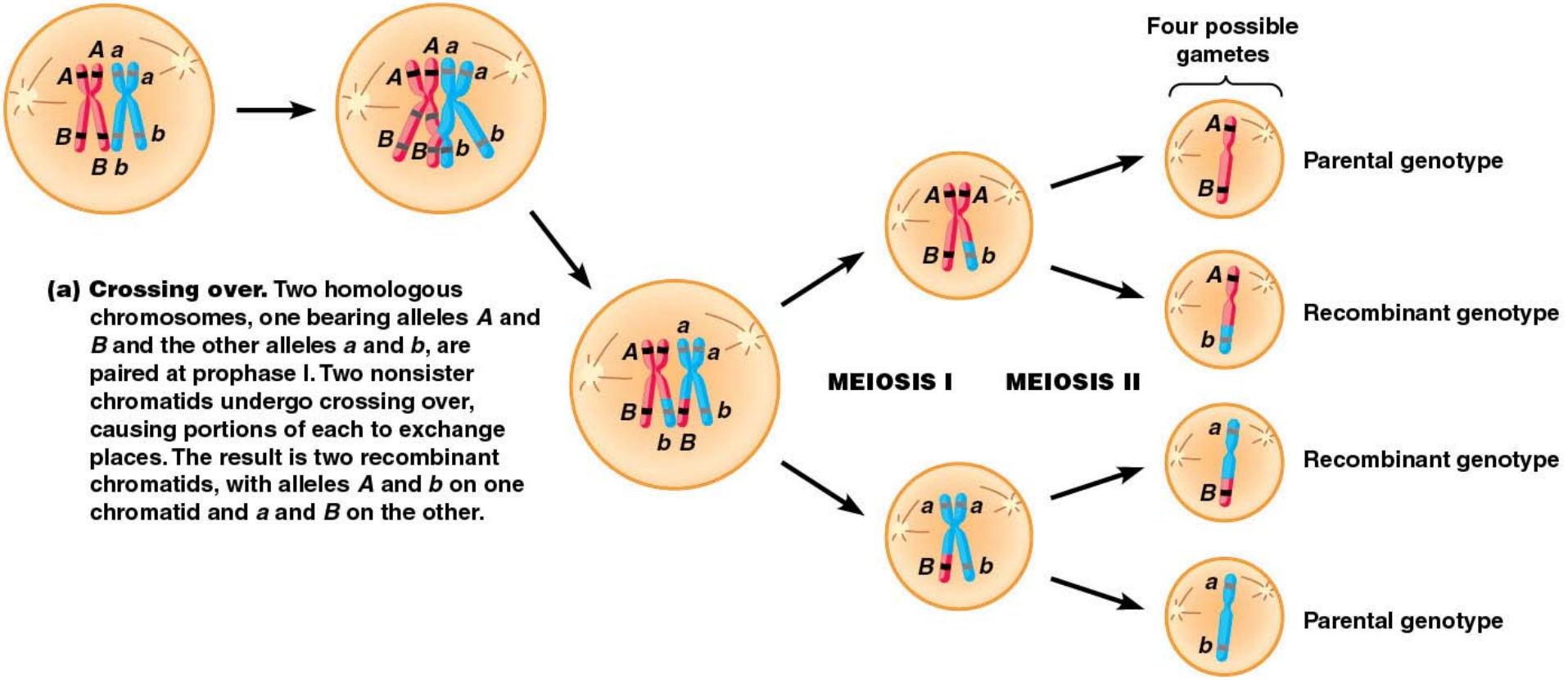




(a) Unlinked genes assort independently

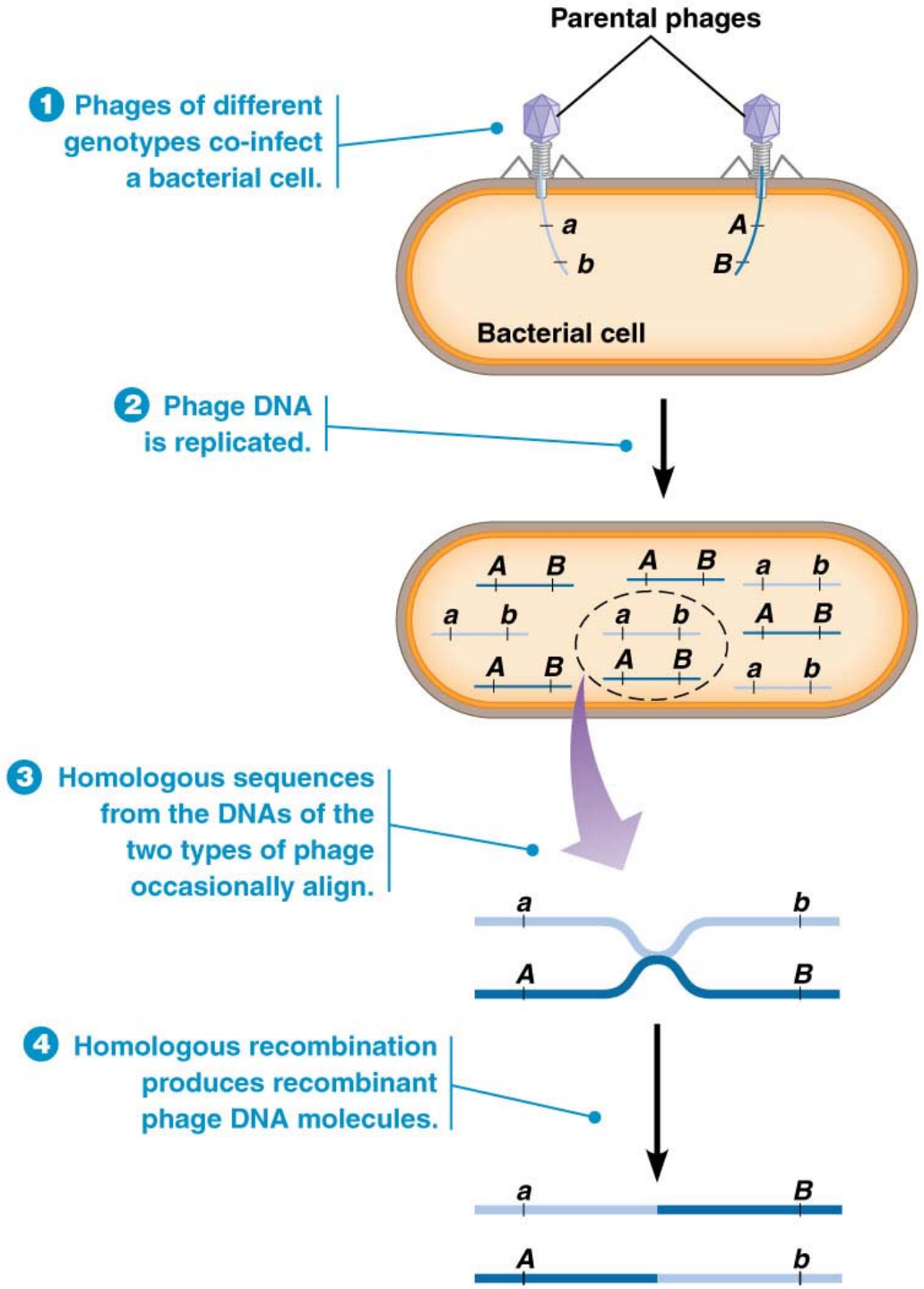


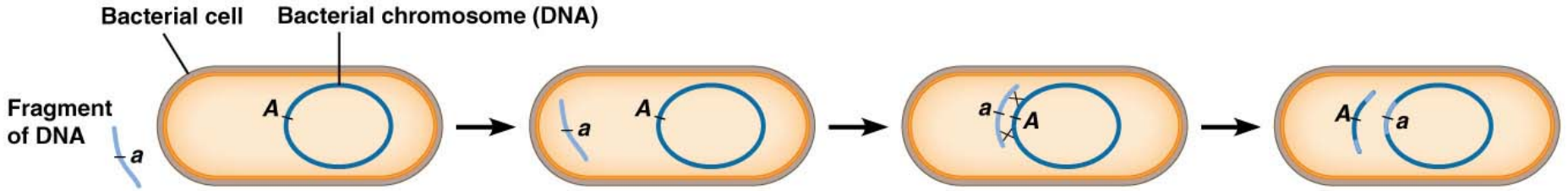
(b) Linked genes end up together in the absence of crossing over



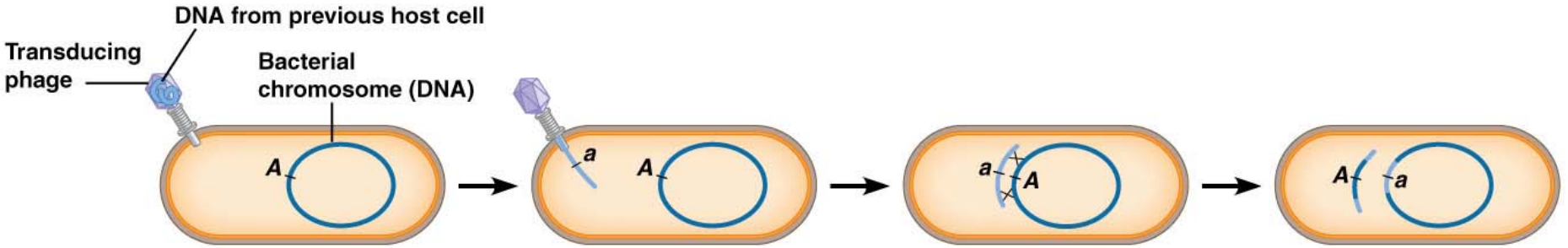
(a) Crossing over. Two homologous chromosomes, one bearing alleles *A* and *B* and the other alleles *a* and *b*, are paired at prophase I. Two nonsister chromatids undergo crossing over, causing portions of each to exchange places. The result is two recombinant chromatids, with alleles *A* and *b* on one chromatid and *a* and *B* on the other.

(b) Results of crossing over. Each chromatid ends up in a separate gamete, two of which have the parental genotypes (*AB* and *ab*) and two the recombinant genotypes (*Ab* and *aB*).

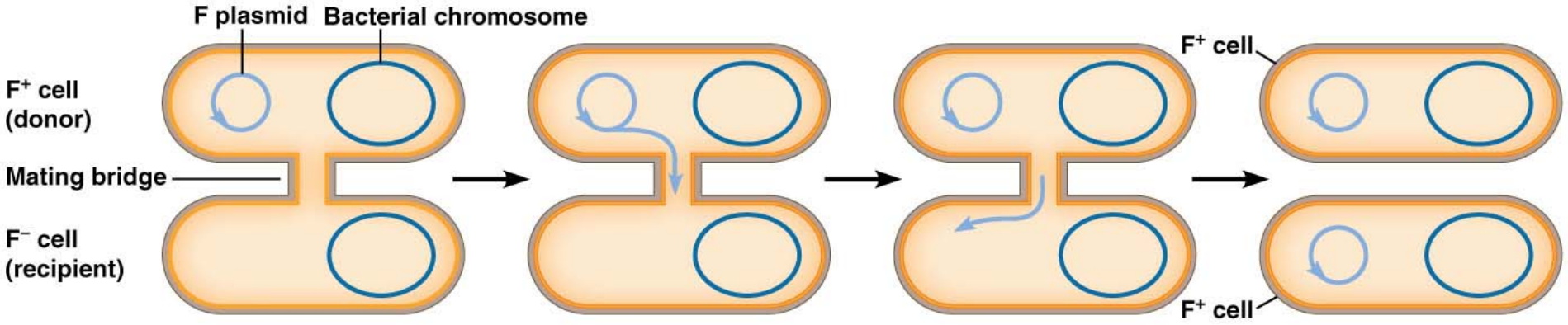




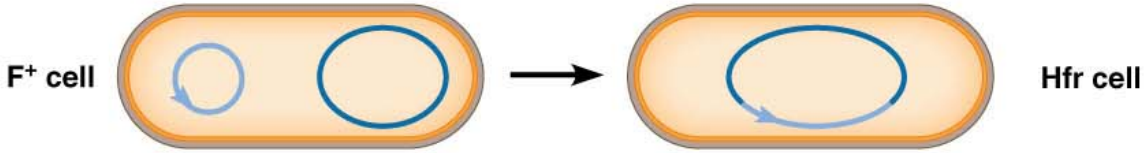
(a) Transformation. Transformation involves uptake by the bacterial cell of exogenous DNA, which occasionally becomes integrated into the bacterial genome by two crossover events (indicated by X's). The exogenous DNA will be detectable in progeny cells only if integrated into the bacterial chromosome because the fragment of DNA initially taken up does not normally have the capacity to replicate itself autonomously in the cell. (The main exception is an intact plasmid.)



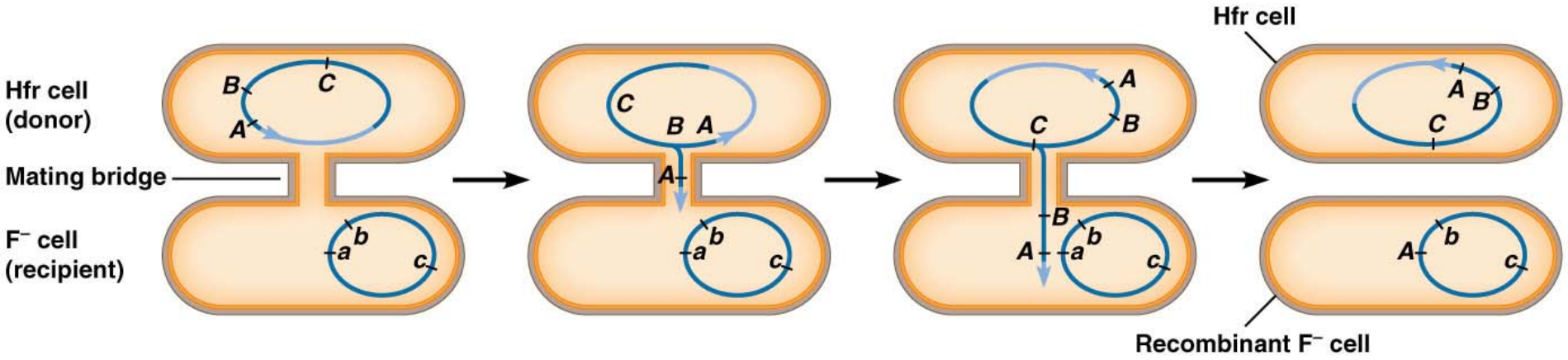
(b) Transduction. Transduction involves the introduction of exogenous DNA into a bacterial cell by a phage. Once injected into the host cell, the DNA can become integrated into the bacterial genome in the same manner as in transformation. In both cases, linear fragments of DNA that end up outside the bacterial chromosome are eventually degraded by nucleases.



(a) Conjugation between F⁺ and F⁻ cells. The transfer of a copy of the F factor plasmid from an F⁺ donor bacterium to an F⁻ recipient converts the F⁻ cell into an F⁺ cell. Plasmid transfer occurs through a mating bridge and begins at the F factor's origin of transfer, indicated by the arrowhead.



(b) Conversion of an F⁺ cell into an Hfr cell. Integration of the F factor into the bacterial chromosome converts an F⁺ cell into an Hfr cell.



(c) Conjugation between an Hfr cell and an F⁻ cell. Transferring a copy of the Hfr genome into an F⁻ cell begins with the origin of transfer on the integrated F factor. Cells rarely remain in contact long enough for the entire bacterial chromosome to be transferred. Once inside the F⁻ cell, parts of the Hfr DNA recombine with the DNA of the F⁻ cell. Uppercase letters represent alleles carried by the Hfr; lowercase letters represent corresponding alleles in the F⁻ cell. In the last step, allele *A* from the Hfr is recombined into the F⁻ cell's DNA in place of its *a* allele.