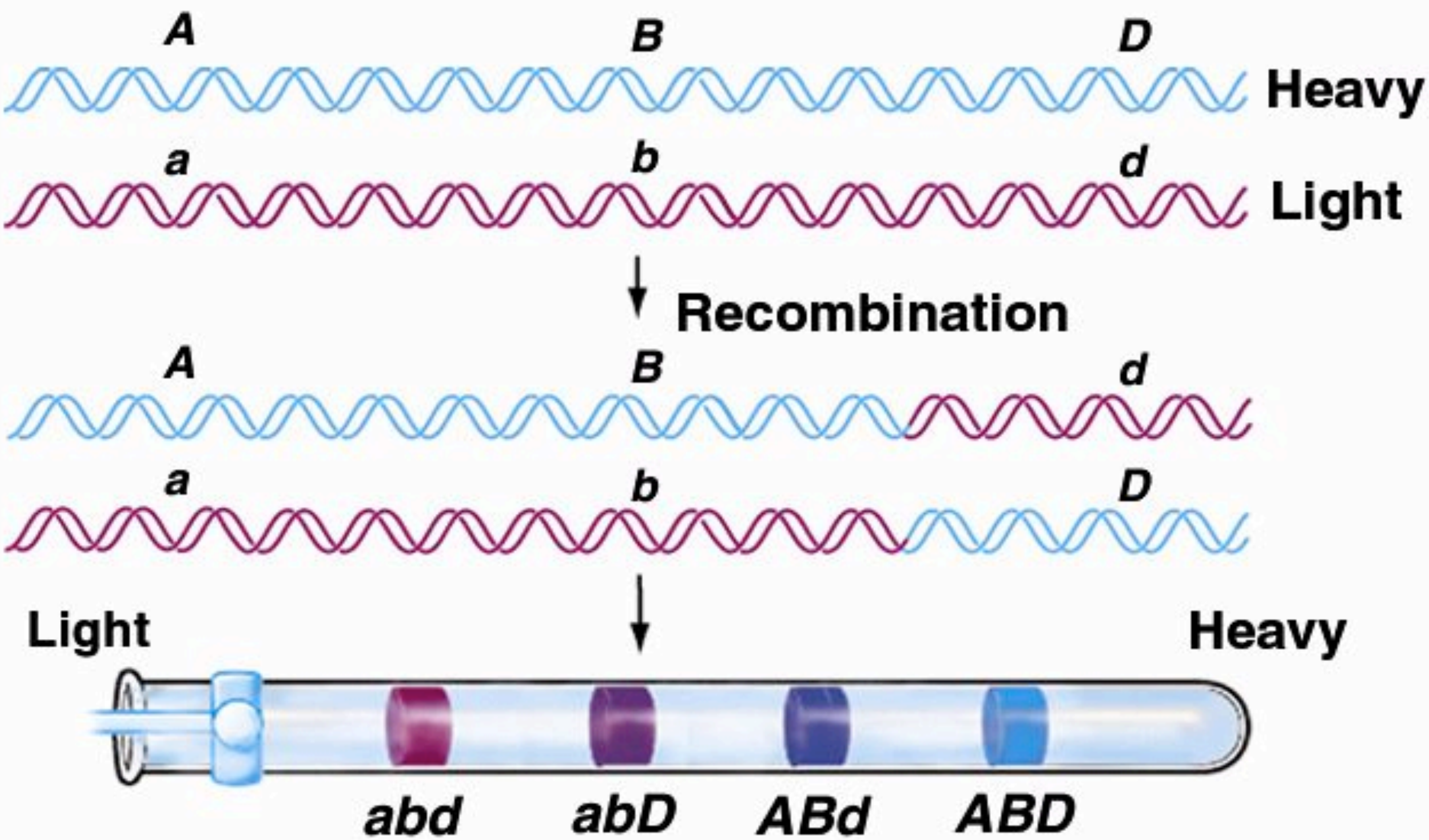
Crossing over or Recombination reshuffles the information content of DNA

- During recombination, DNA molecules break and rejoin
- Meselson and Weigle - Experimental evidence from viral DNA and radioactive isotopes
- Coinfected E. coli with light and heavy strains of virus after allowing time for recombination
- Separated on a CsCl density gradient

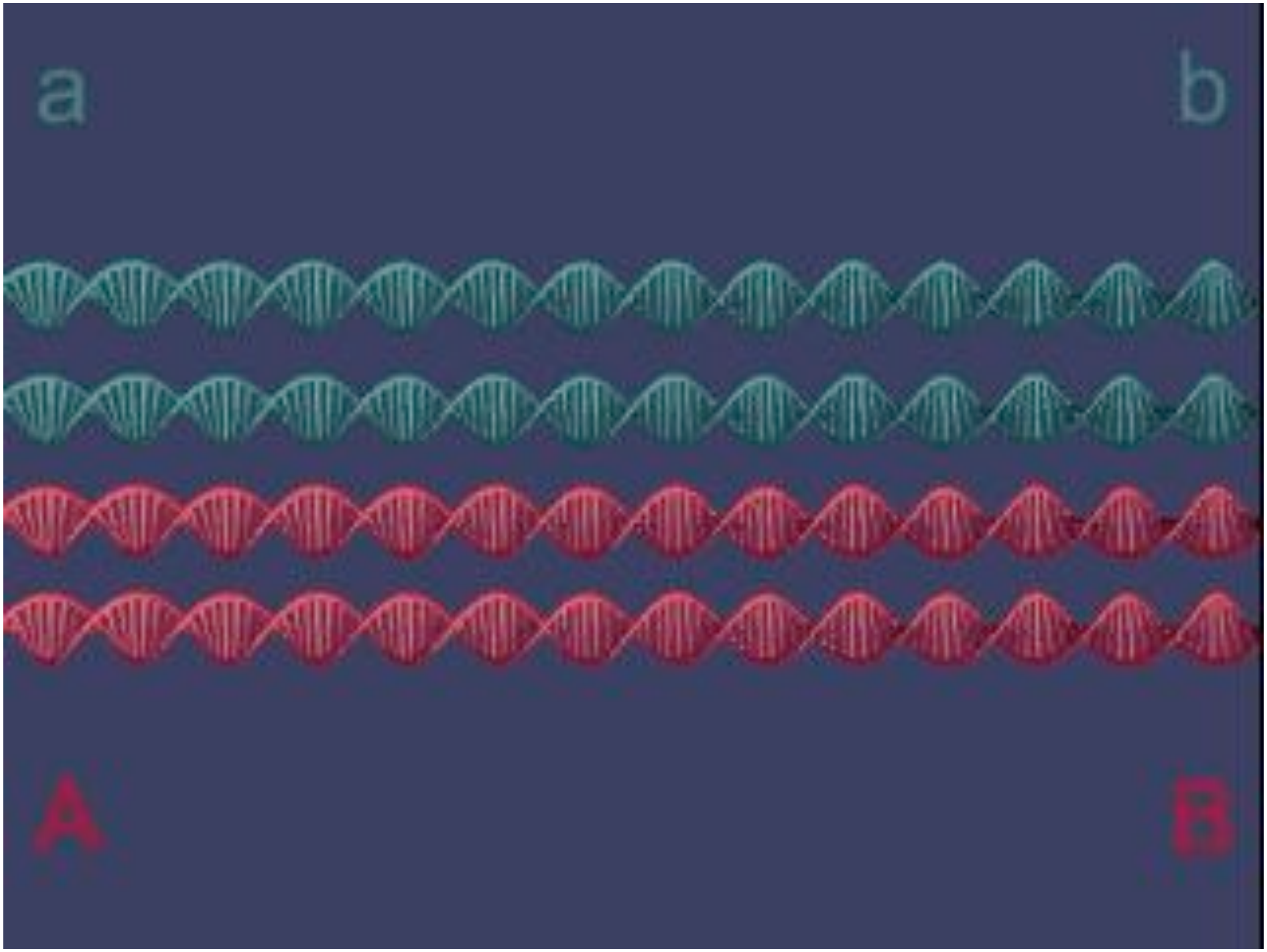
DNA breakage and reunion



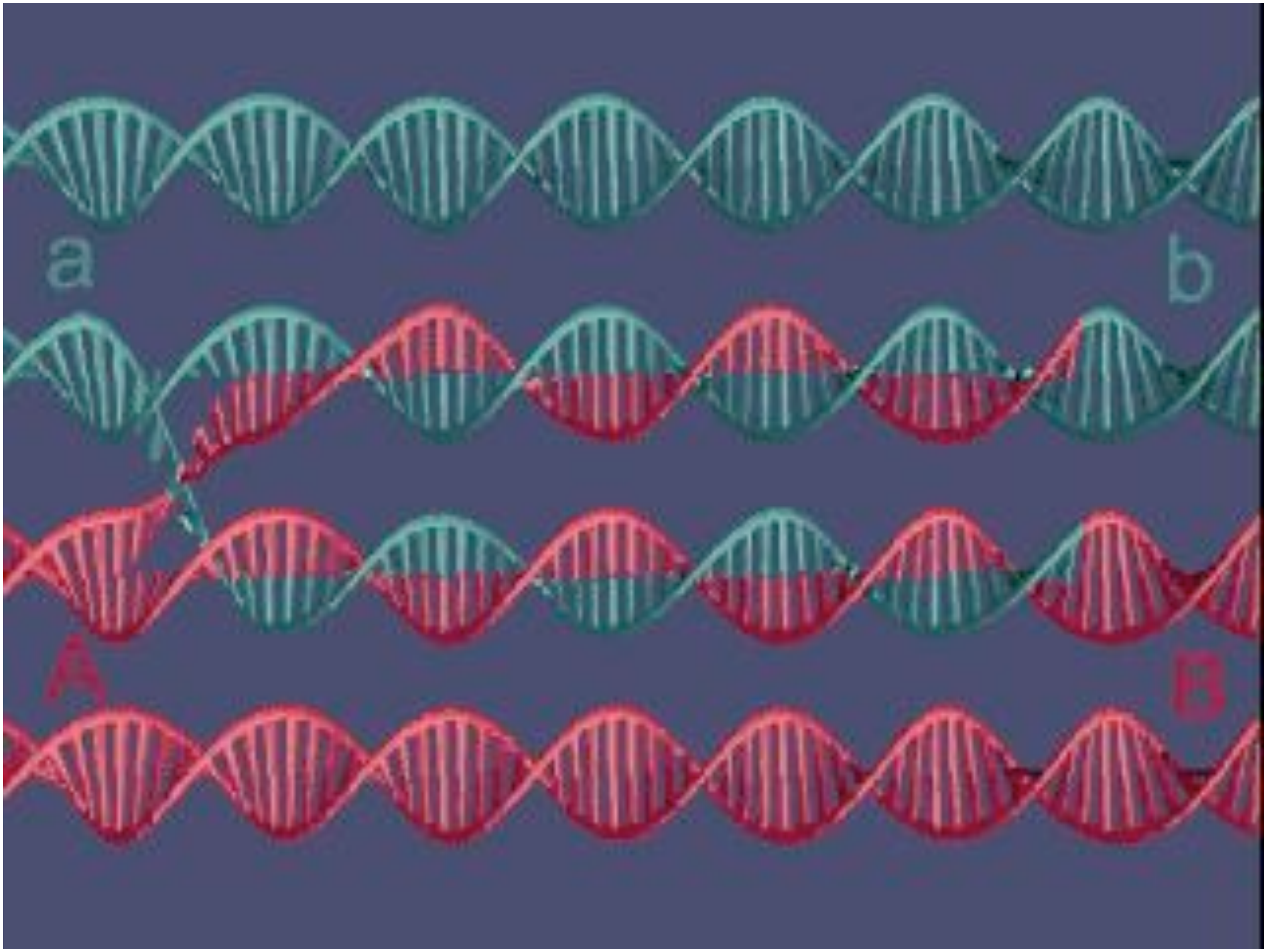
Double stranded break model of meiotic recombination

- Homologs physically break, exchange parts, and rejoin.
- Breakage and repair create reciprocal products of recombination
- Recombination events can occur anywhere along the DNA molecule
- Precision in the exchange prevents mutations from occurring during the process
- Gene conversion can give rise to unequal yield of two different alleles.
  - 50% of gene conversions are associated with crossing over of adjacent chromosomal regions,
  - 50% of gene conversions are not associated with crossing over

Double stranded break model of meiotic recombination



Double stranded break model of meiotic recombination



Double stranded break formation

spol protein breaks one chromatid on both strands

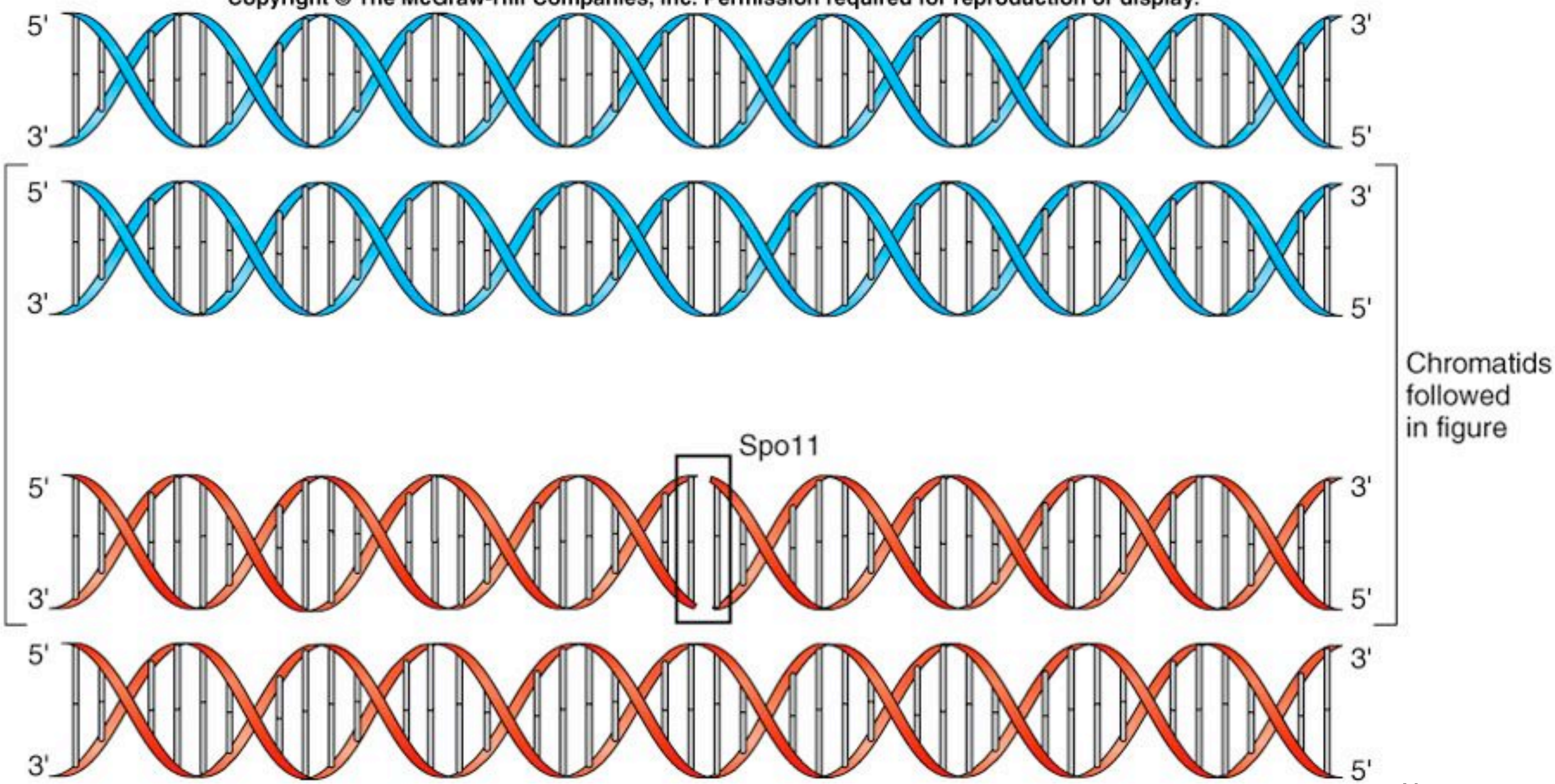
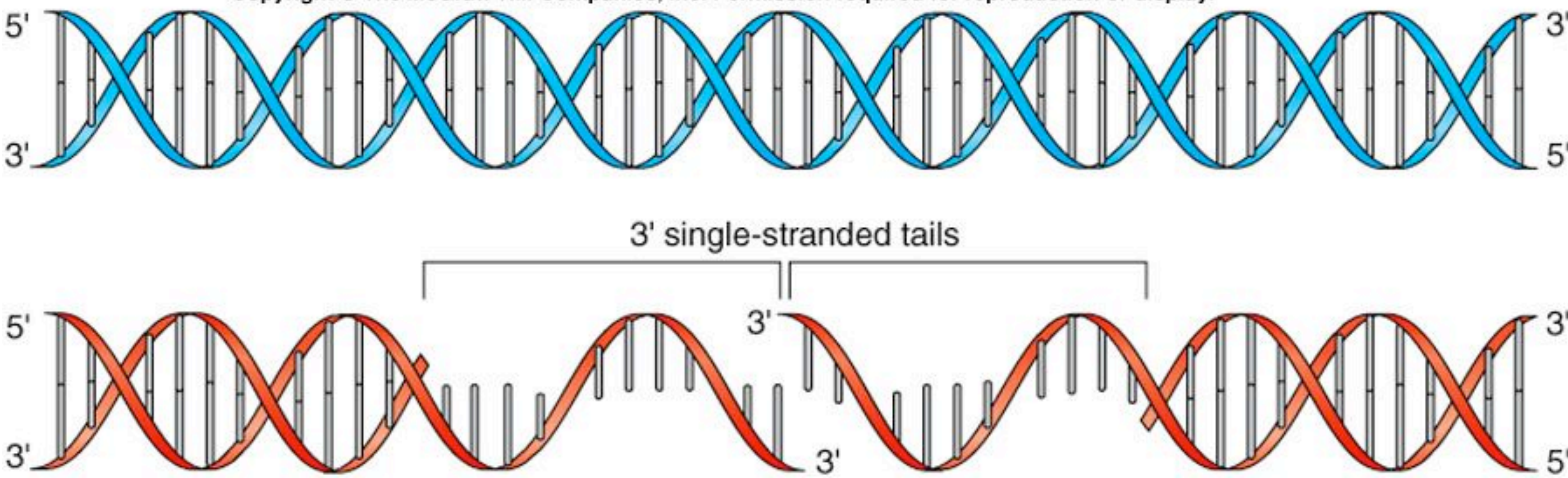


Fig. 6.22 step 1

Resection

5’ end on each side of break are degraded to produce two 3’ single stranded tails



First strand invasion

RecA binds 3’ tail and double helix allowing invasion and migration

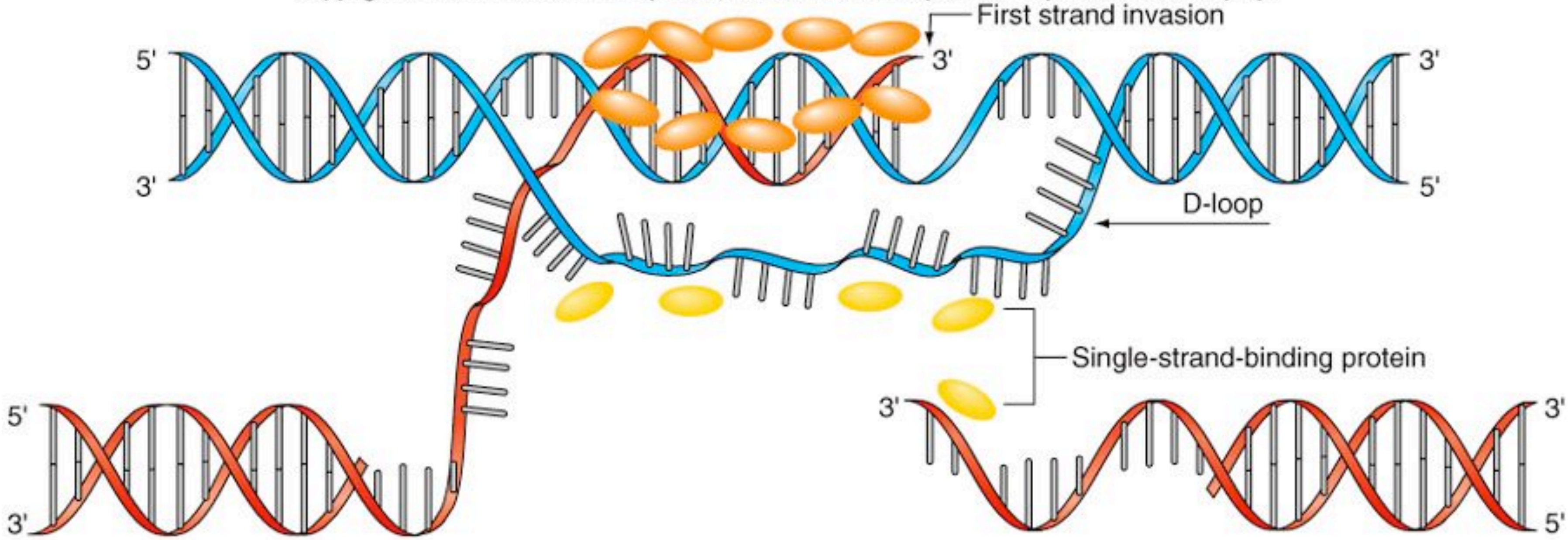
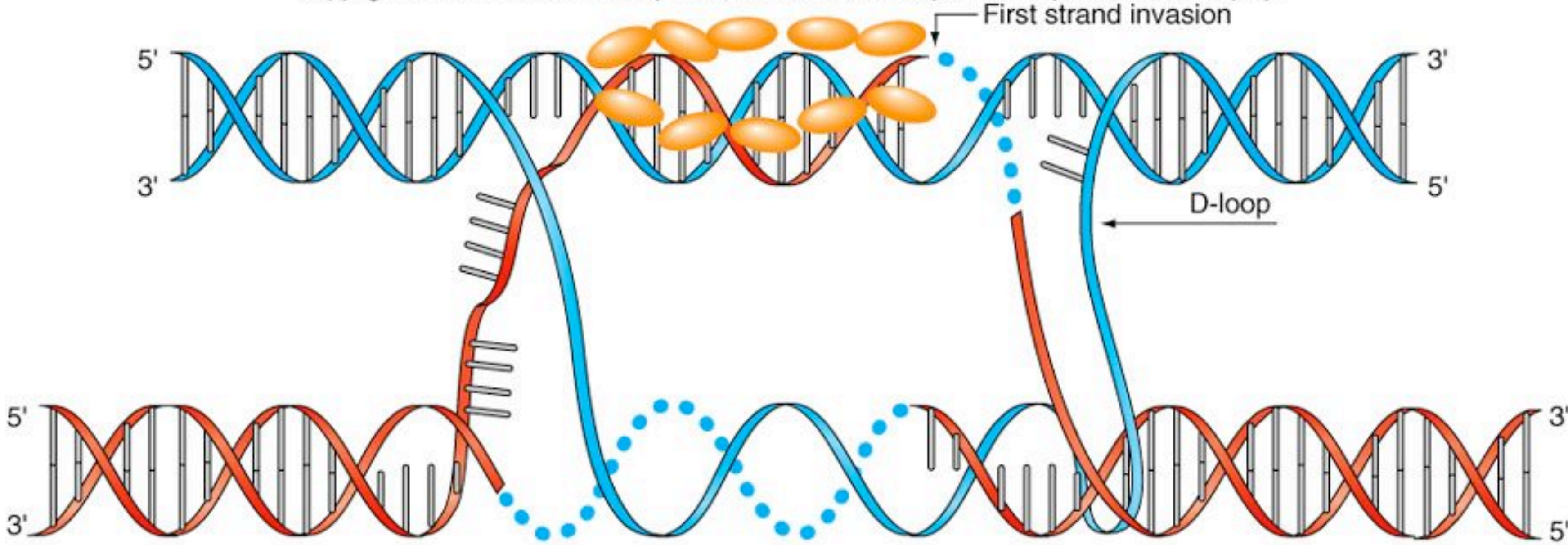


Fig. 6.22 step 3

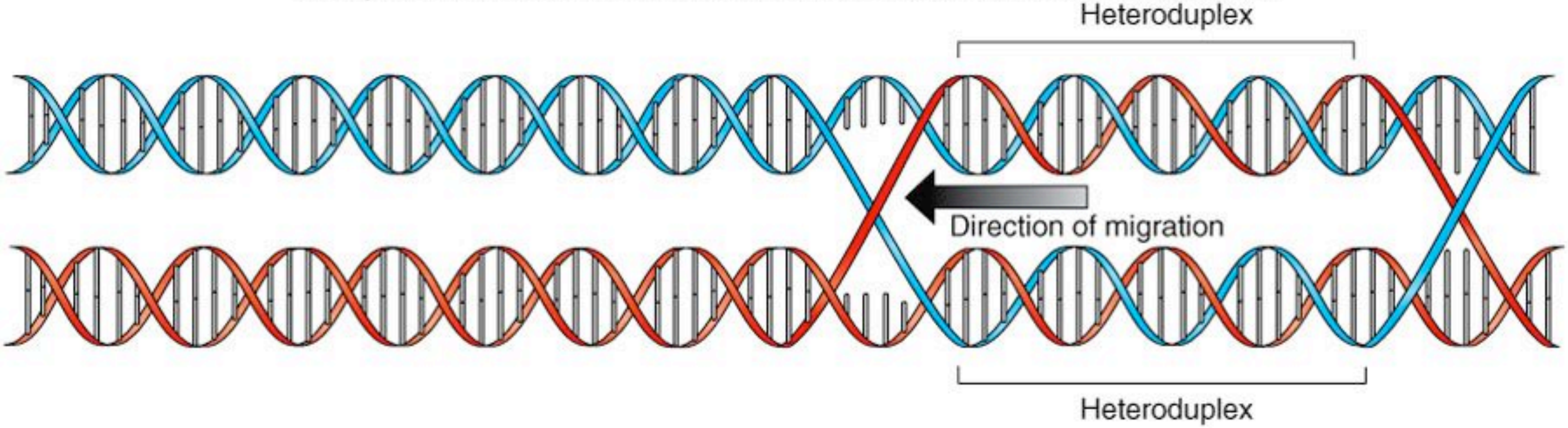
Formation of Holliday junctions

New DNA synthesis forms two X structures called Holliday junctions



Branch migration

Both invading strands zip up and migrate while newly created heteroduplex molecules rewind behind.



The Holliday intermediate

Interlocked nonsister chromatids disengage.

Two resolutions are possible

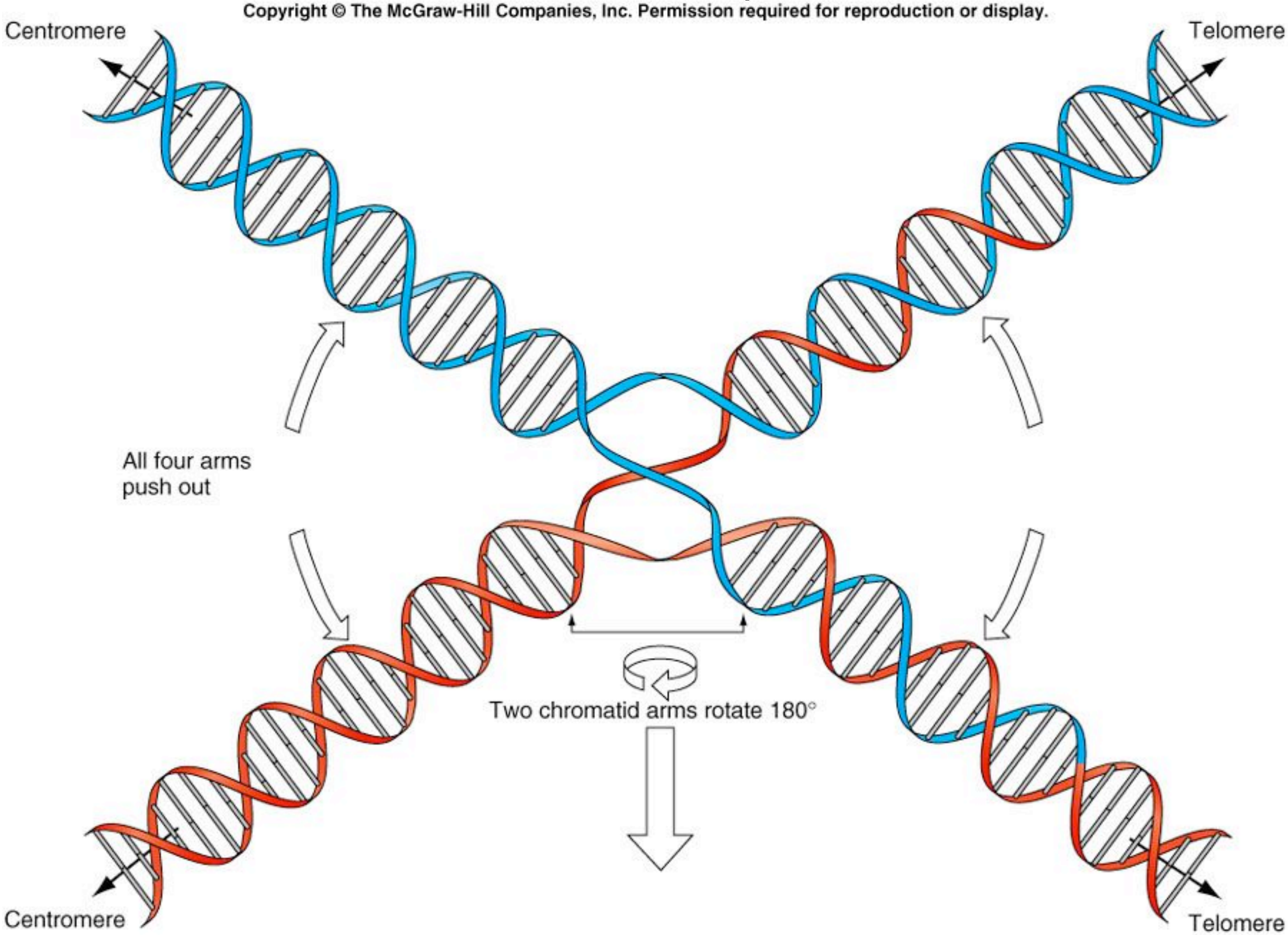
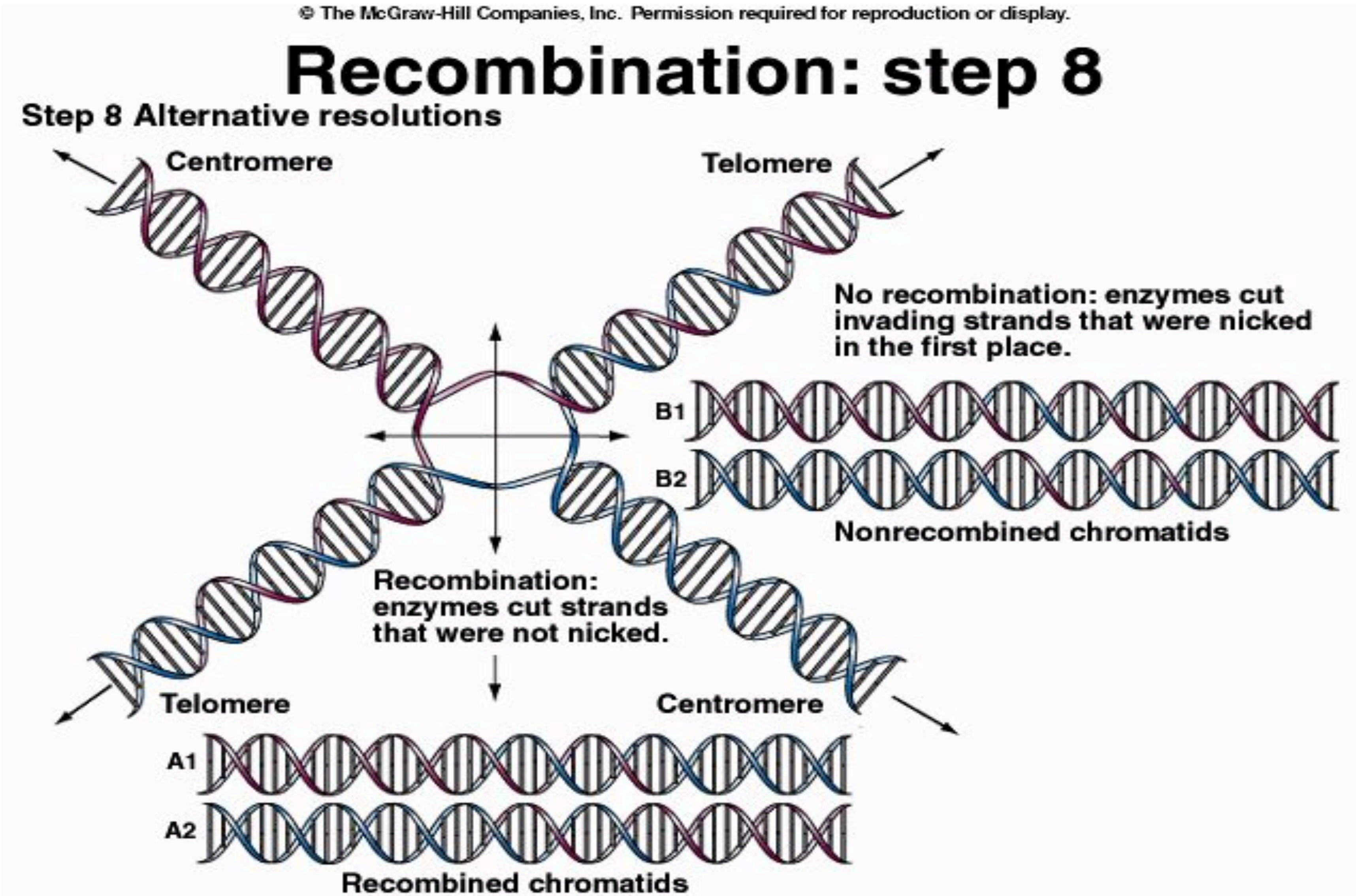


Fig. 6.22
step 6

Alternative resolutions

Endonuclease cuts Holliday intermediate



Heteroduplexes mark the spot of recombination

- Homologs physically break, exchange parts and rejoin.
- Products of recombination are always in exact register:
  - not a single base pair is lost or gained
- Two strands do not break and rejoin at the same location;
  - often they are hundreds of base pairs apart
- Region between break points is called heteroduplex
- **Heteroduplex formation**:
  - the two strands of DNA may not break at precisely the same point,
  - it may be a bit staggered,
  - resulting in a portion of the DNA where each strand comes from a different origin: heteroduplex

Heteroduplex region

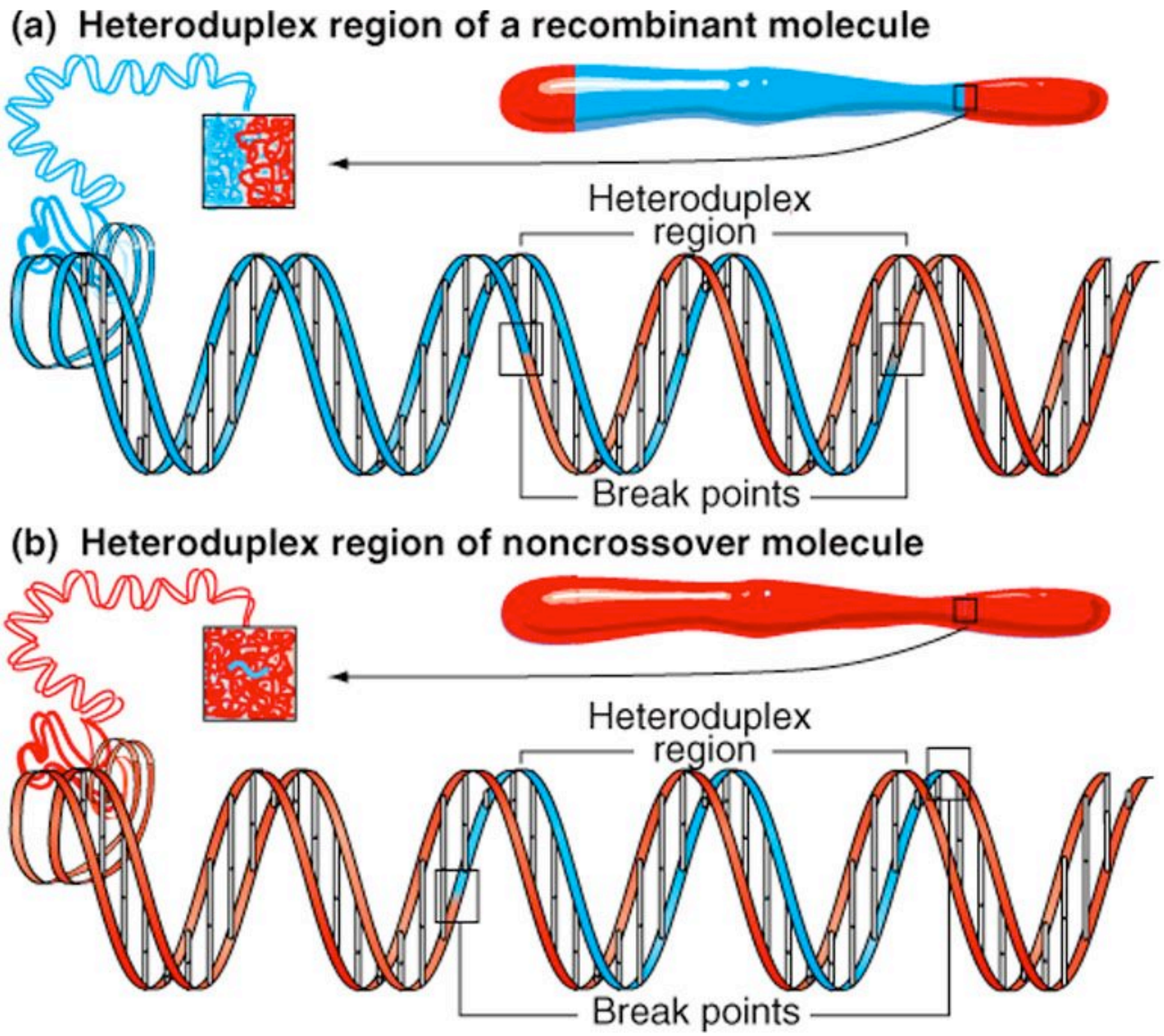


Fig .6.20

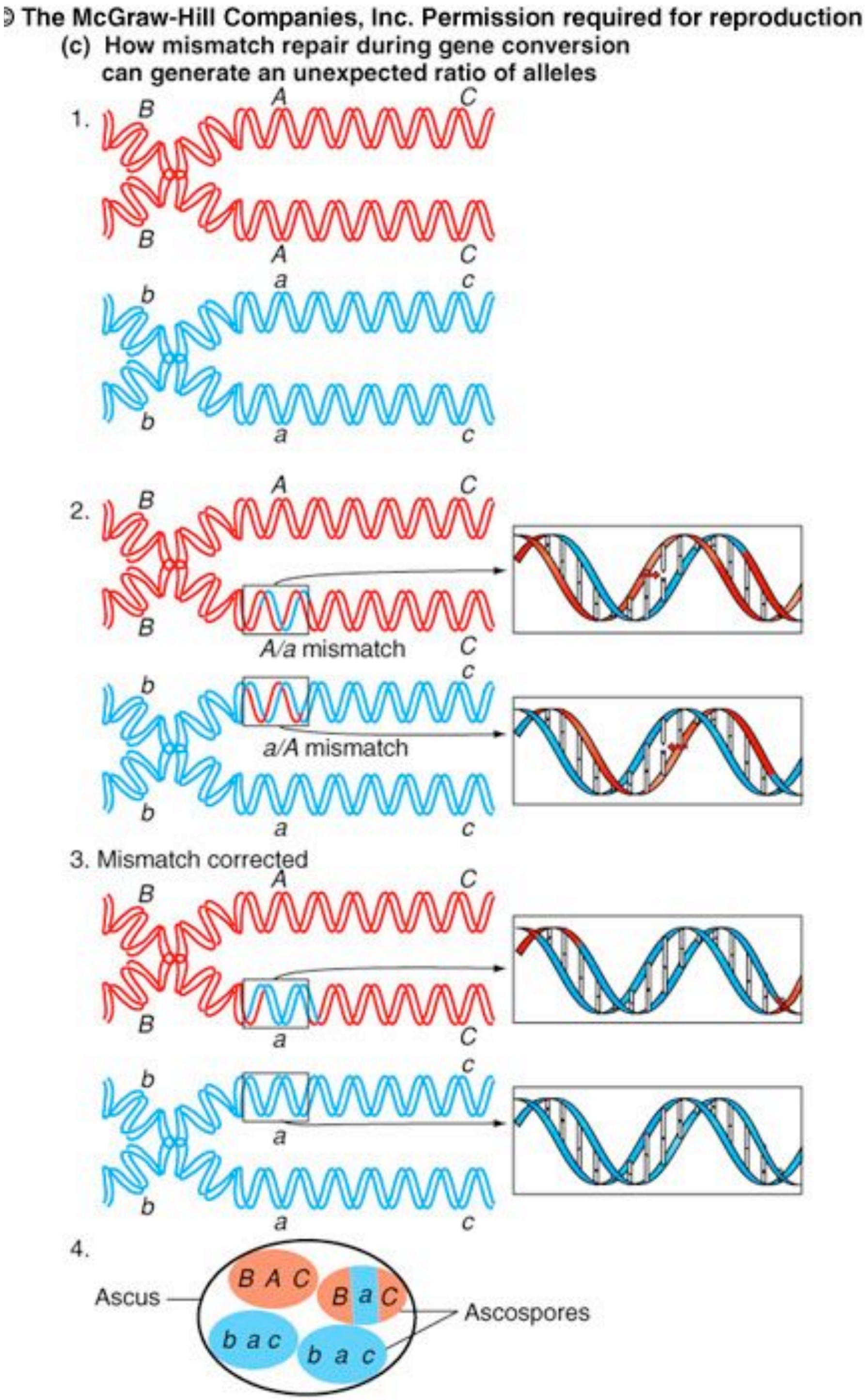
Recombination

- Recombination can occur anywhere along the DNA molecule.
- **Precision:** there is no gain or loss of nucleotides
- **Gene conversion:**
  - when recombination occurs within a gene such that each strand of the resulting heteroduplex does not have complementary bases and conveys a different message,
  - one of the strands has to be converted so that the two strands convey the same message.

Heteroduplexes

- In heterozygotes, mismatches within heteroduplexes must be repaired

- Gene conversion –
  - a deviation from expected 2:2 segregation of alleles due to mismatch repair.



Gene conversion in yeast

Mismatch leads to 3:1 ratio of a:A.

Ratio of B:b and C:c which lie outside of heteroduplex are both 2:2, as expected.

Fig. 6.20 c

Homework Problems

- Chapter 11

- # 30

- DON’T forget to take the online QUIZ!!
- DON’T forget to submit the online iActivity
  - “Unraveling”