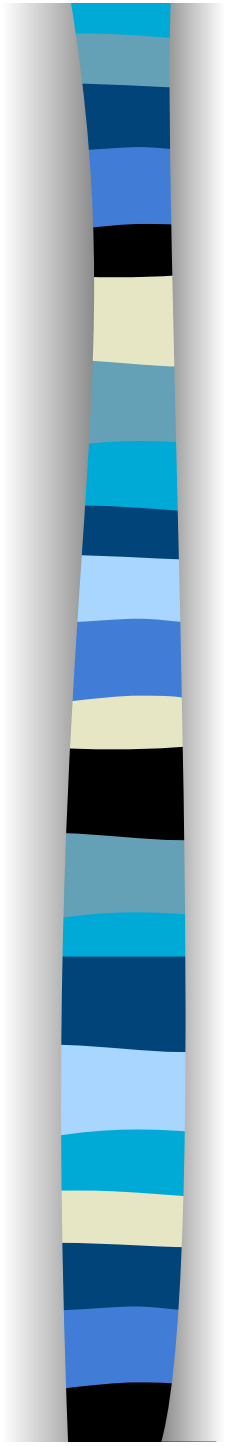


Chapter 16: DNA Structure and Function

- The history of early research leading to discovery of DNA as the genetic material, the structure of DNA, and its method of replication are described.

Genetic Material

- A. Genetic material must have three things:

1. Store information
2. Stable for replication
3. Mutate for variability

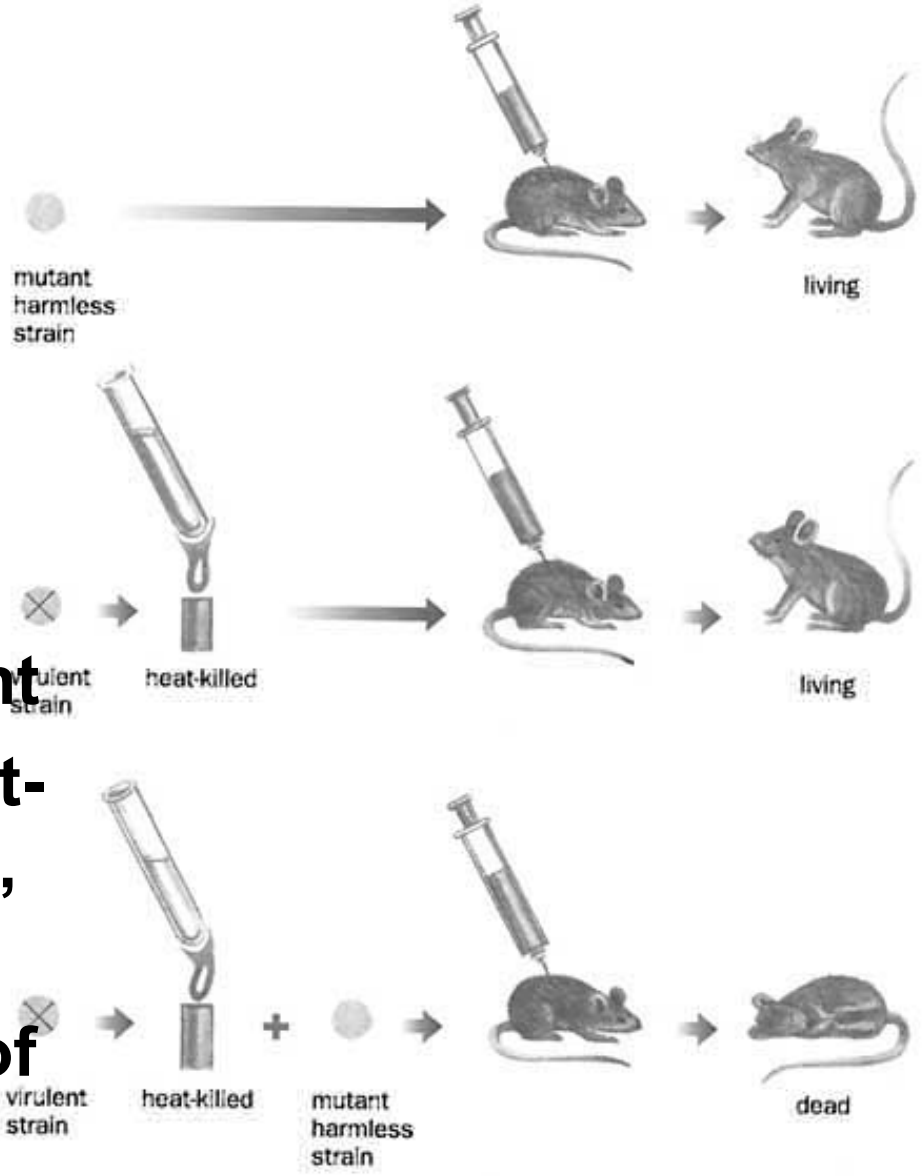
B. Previous Knowledge of DNA

- Needed to know the chemistry

1. Discovery of “nuclein”
2. DNA and RNA discovered
3. Nucleic acids contain 4 types of nucleotides

C. Transformation of Bacteria

1. **1931, Griffith experimented with *Streptococcus pneumoniae.***
2. **Mice injected with (S) strain and (R) strain.**
   - A. **S strain virulent**
   - B. **R strain not virulent**
3. **Injected mice with heat-killed S strain bacteria, mice lived.**
4. **Injected with mixture of heat-killed and R strains.TRANSFORMED**

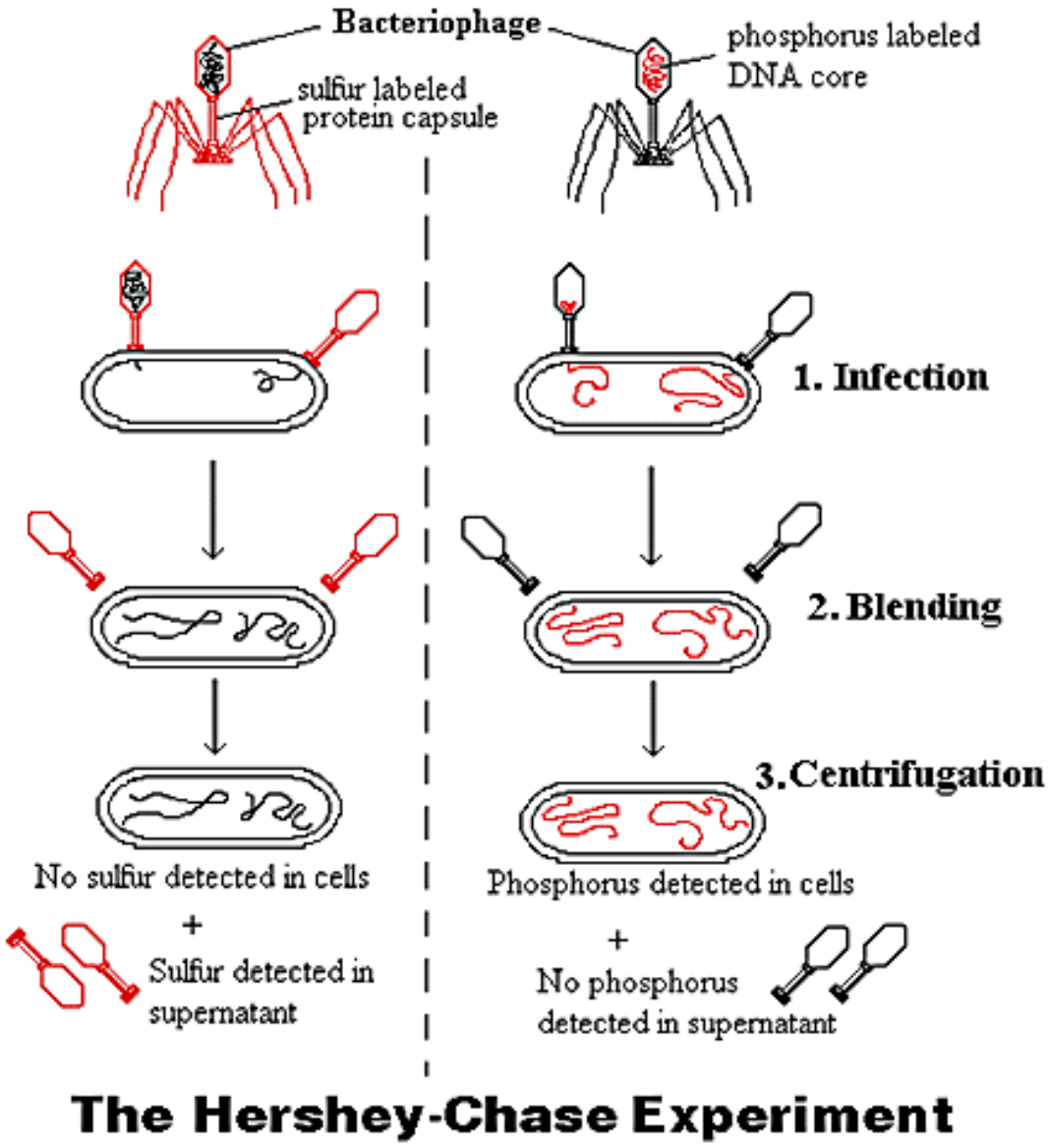


D. DNA: The Transforming Substance

1. Avery said transforming substance was DNA
   - A. DNA from S strain causes R strain to transform.
   - B. Protein degrading enzymes do not stop transformations
   - C. DNA digesting enzymes prevent transformations.
2. Bacteria can take up DNA.

E. Reproduction of Viruses

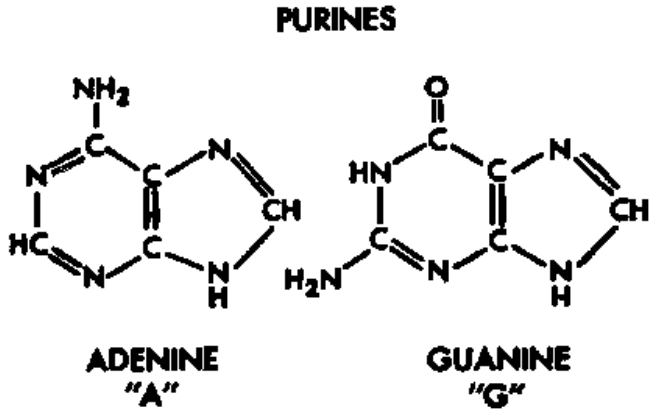
1. Bacteriophage = virus infecting bacteria
2. Bacteriophage T2 infects *e.coli.*
3. 1952, Hershey and Chase use Bacteriophage T2
   A. Purpose was to determine if protein coat or DNA entered bacterial cells.

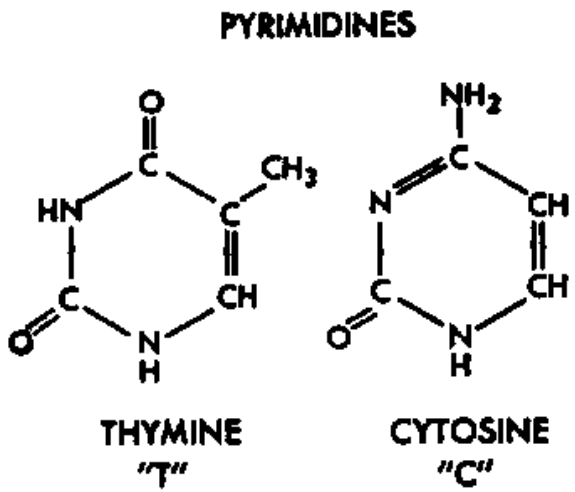


14.2 Structure of DNA

A. Nucleotide Data

1. 1940's, Chargaff analyzed base of DNA:
   A. Purine = adenine and guanine.
   B. Pyrimidine = thymine and cytosine.
2. Chargaff Rules:
   A. G, C, A, and T in DNA varies
   B. A=T and G=C



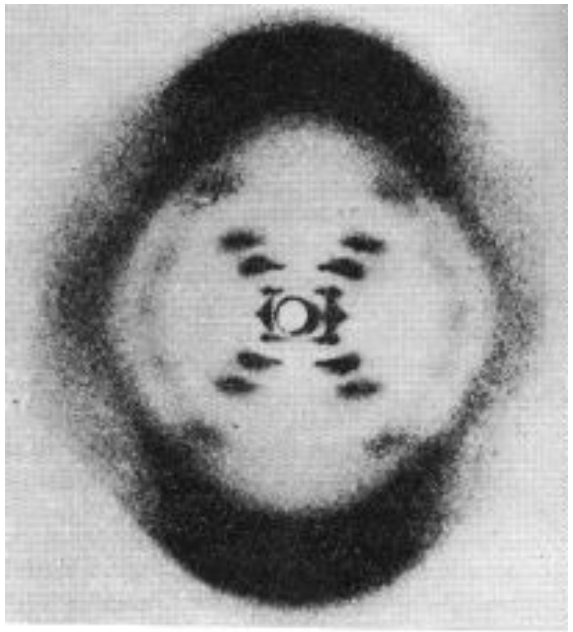


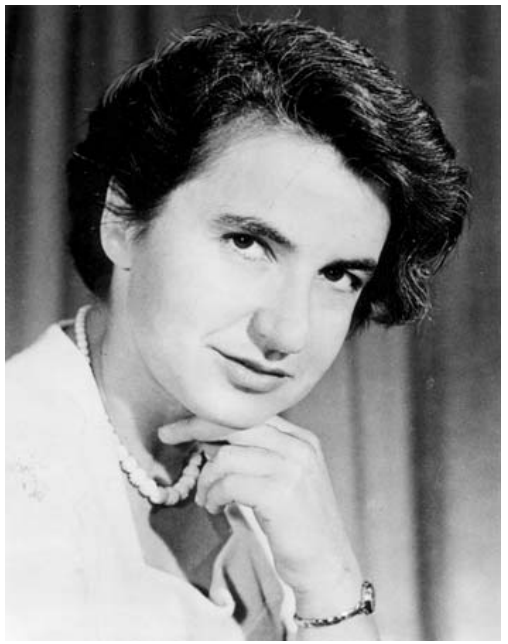
B. Diffraction Data

1 Franklin produced X-Ray diffraction photographs.

A. DNA is a helix.

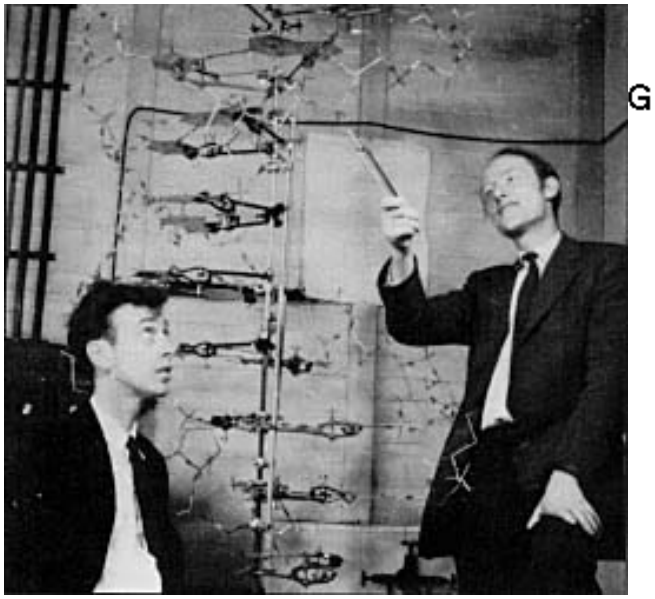
B. One part of helix is repeated.

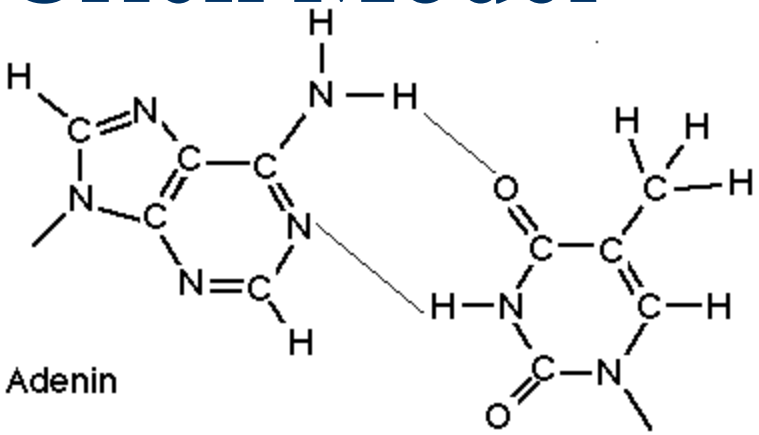


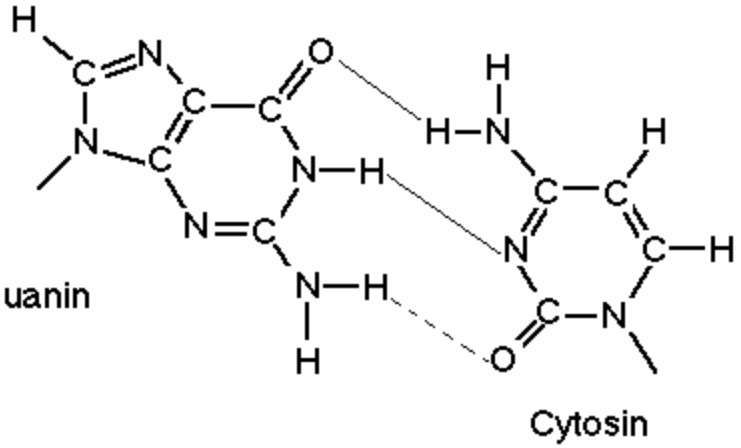


C. The Watson and Crick Model

1. Using info. from Chargaff and Franklin, Watson & Crick built a DNA double helix model.
2. Model used complementary base pairing.







14.3 Replication of DNA

A . Copy DNA molecule

1 Unwinding by helicase.

2 Complementary Base Pairing catalyzed by DNA polymerase.

3 Joining.

4 DNA replication must be done before a cell divides.

B. Replication is Semiconservative

1. One parental strand and one new strand.
2. Meselson & Stahl confirmation of DNA replication
   A. Results = 1/2 DNA light, 1/2 hybrid
3. Exact expected results with semiconservative replication.

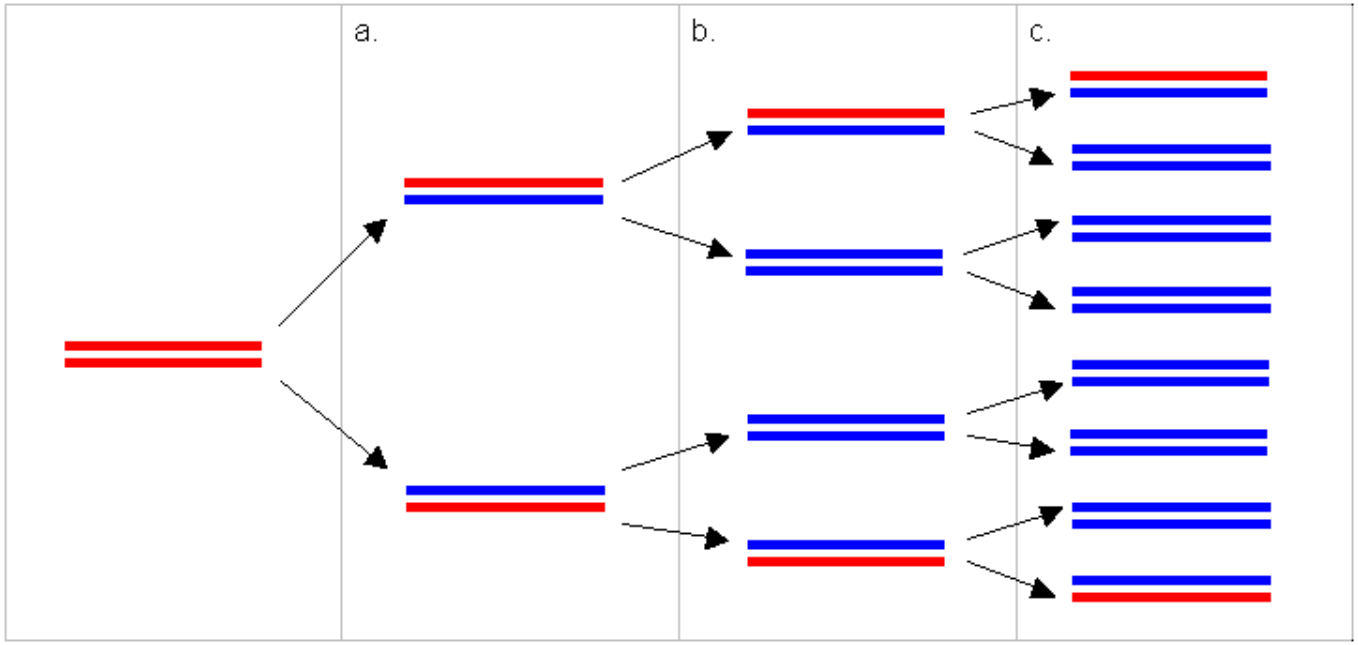
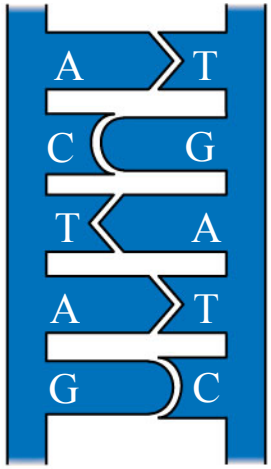
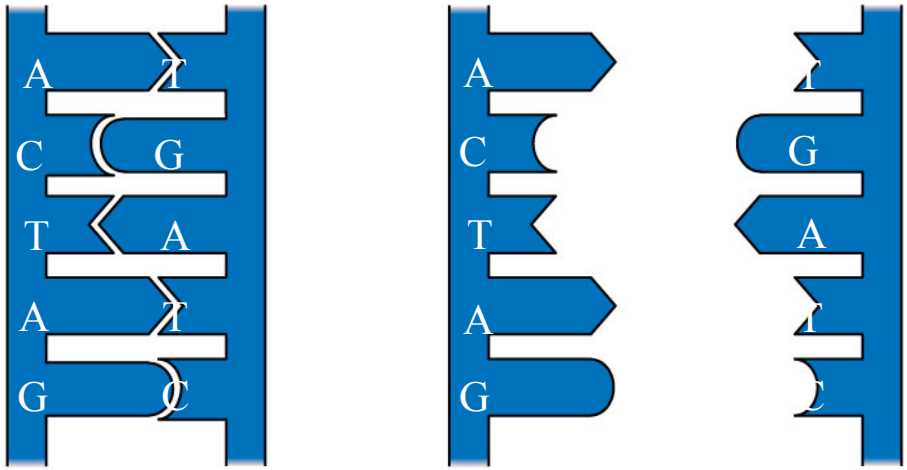


Figure 16.9-1



(a) Parent molecule

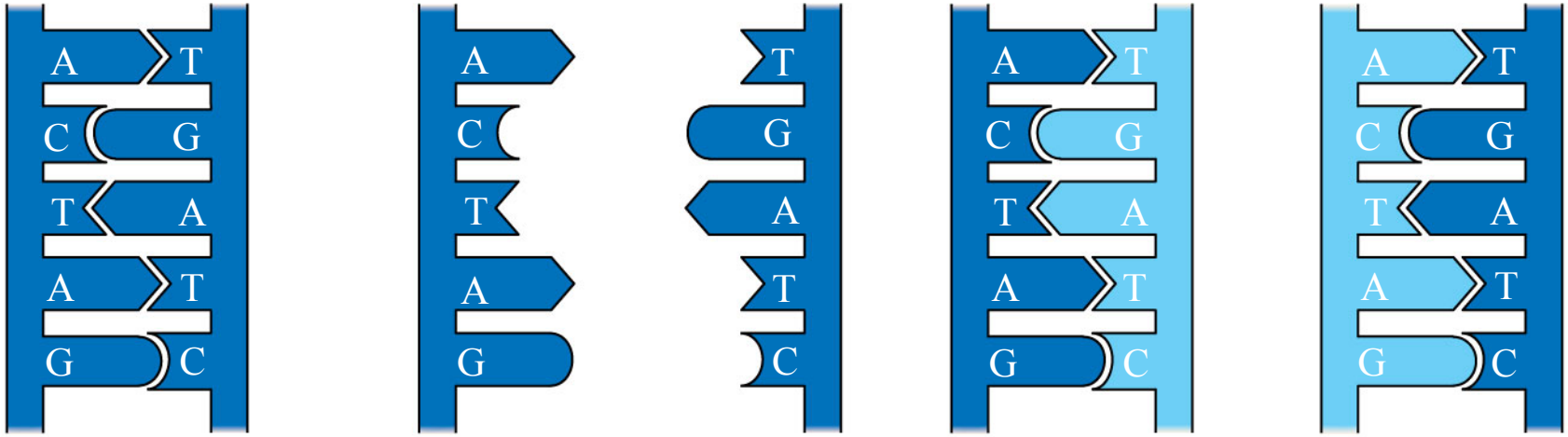
Figure 16.9-2



(a) Parent molecule

(b) Separation of strands

Figure 16.9-3



(a) Parent molecule

(b) Separation of strands

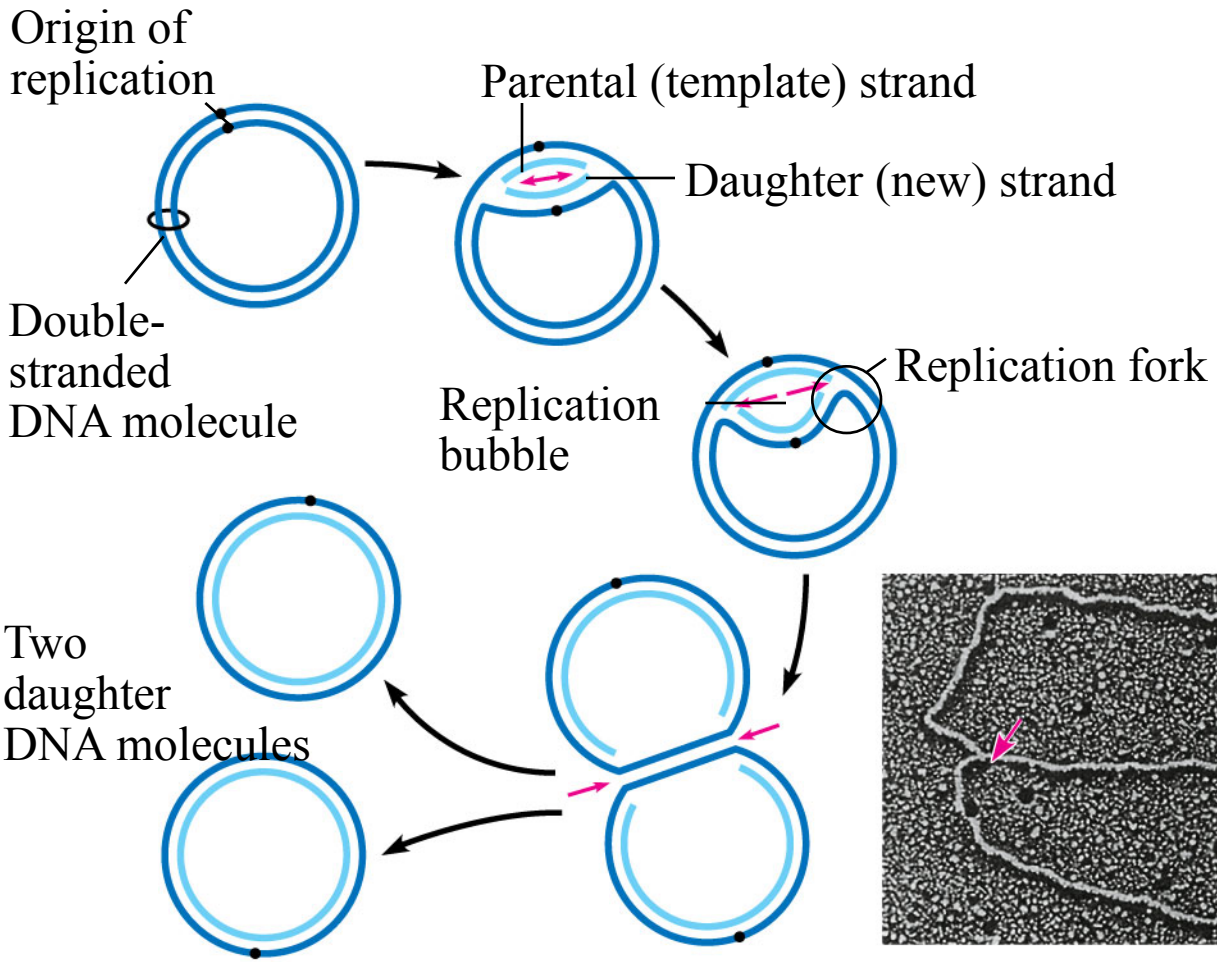
(c) "Daughter" DNA molecules, each consisting of one parental strand and one new strand

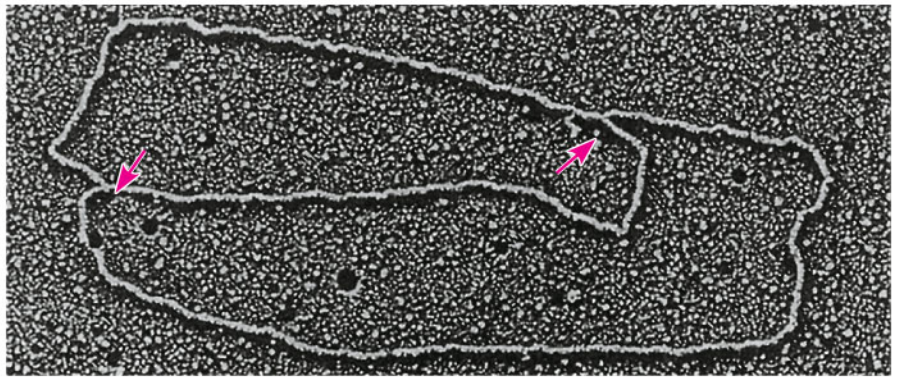
C. Prokaryote Vs. Eukaryote

1. Prokaryotic Replication
   - A. Bacteria single loop of DNA.
   - B. Replication proceeds from 5’ to 3’
   - C. DNA replicated in 40 minutes.

Figure 16.12a

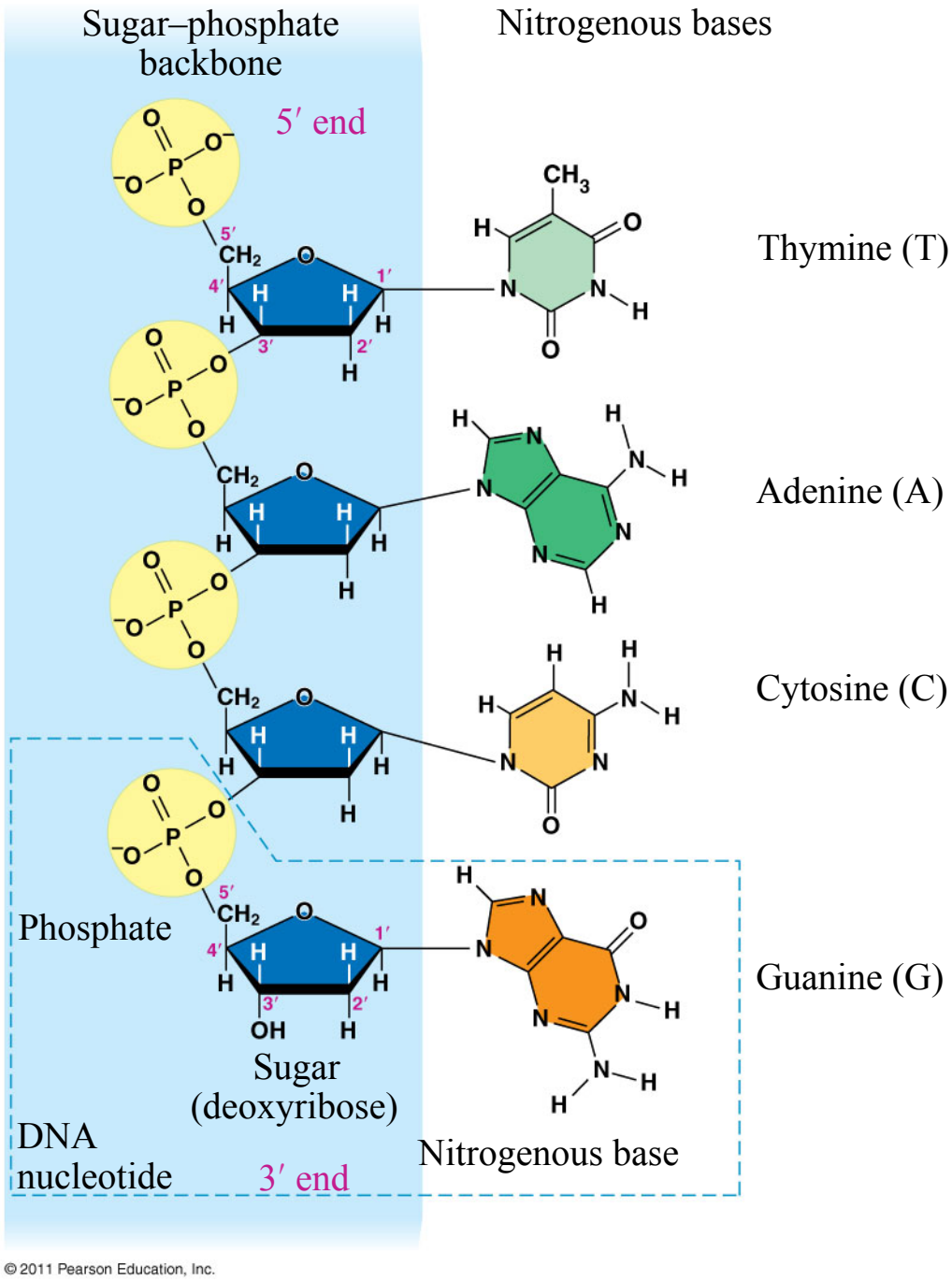
(a) Origin of replication in an *E. coli* cell





0.5 μm

Figure 16.5



2. Eukaryotic Replication

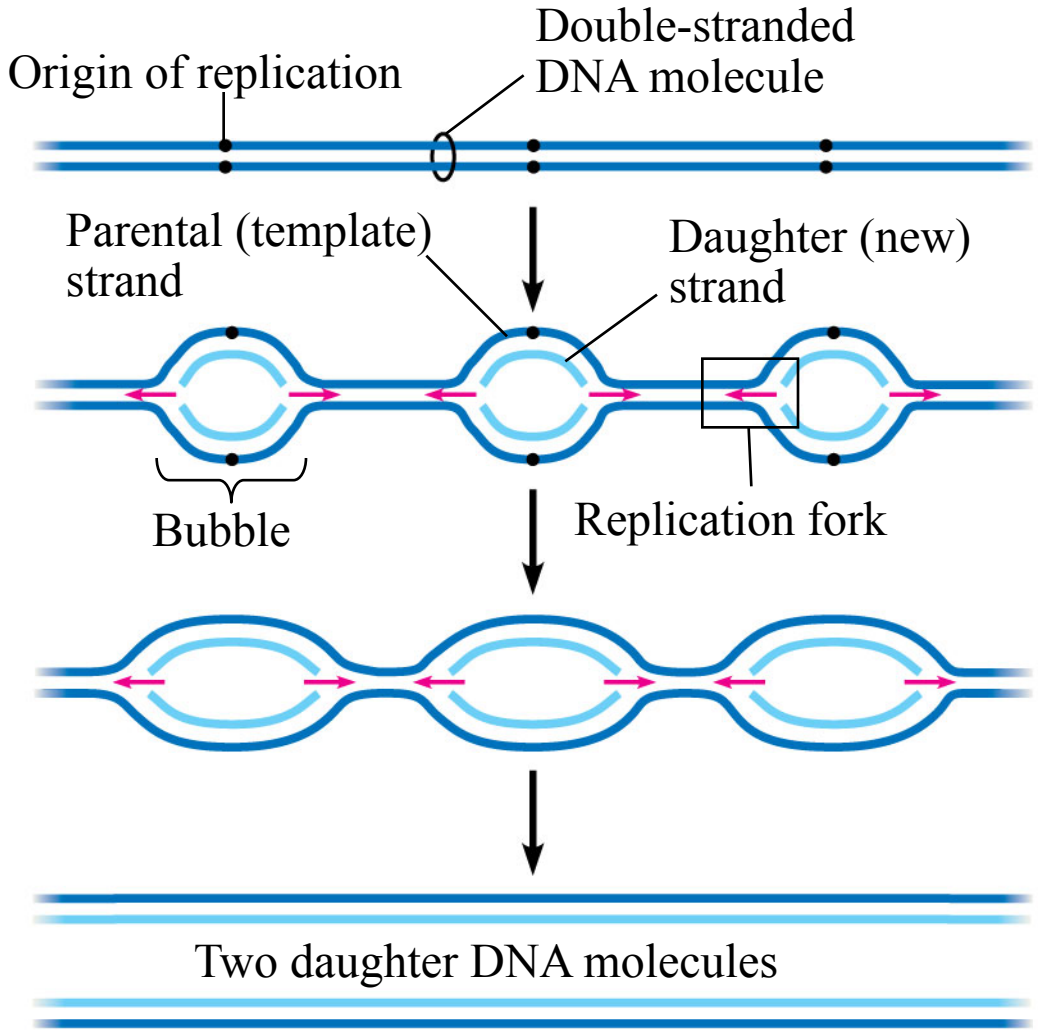
A. Many points of origin.

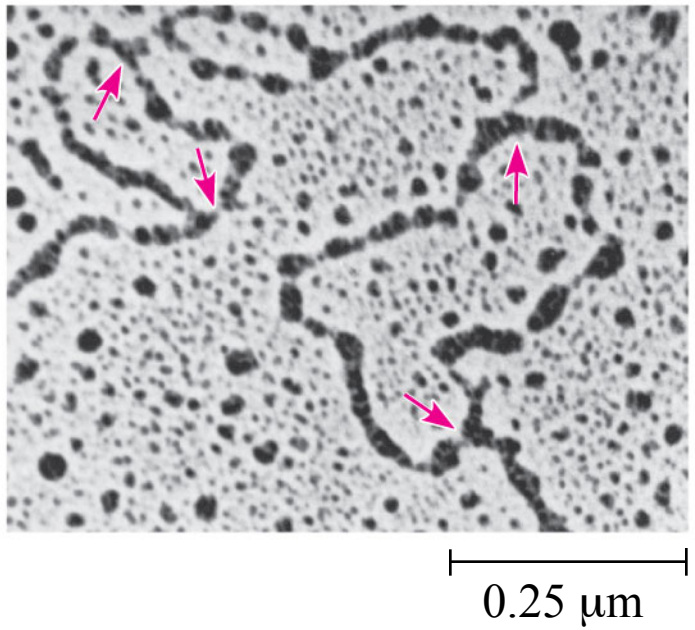
B. Replication Forks.

C. DNA replicated in several hours.

Figure 16.12b

(b) Origins of replication in a eukaryotic cell



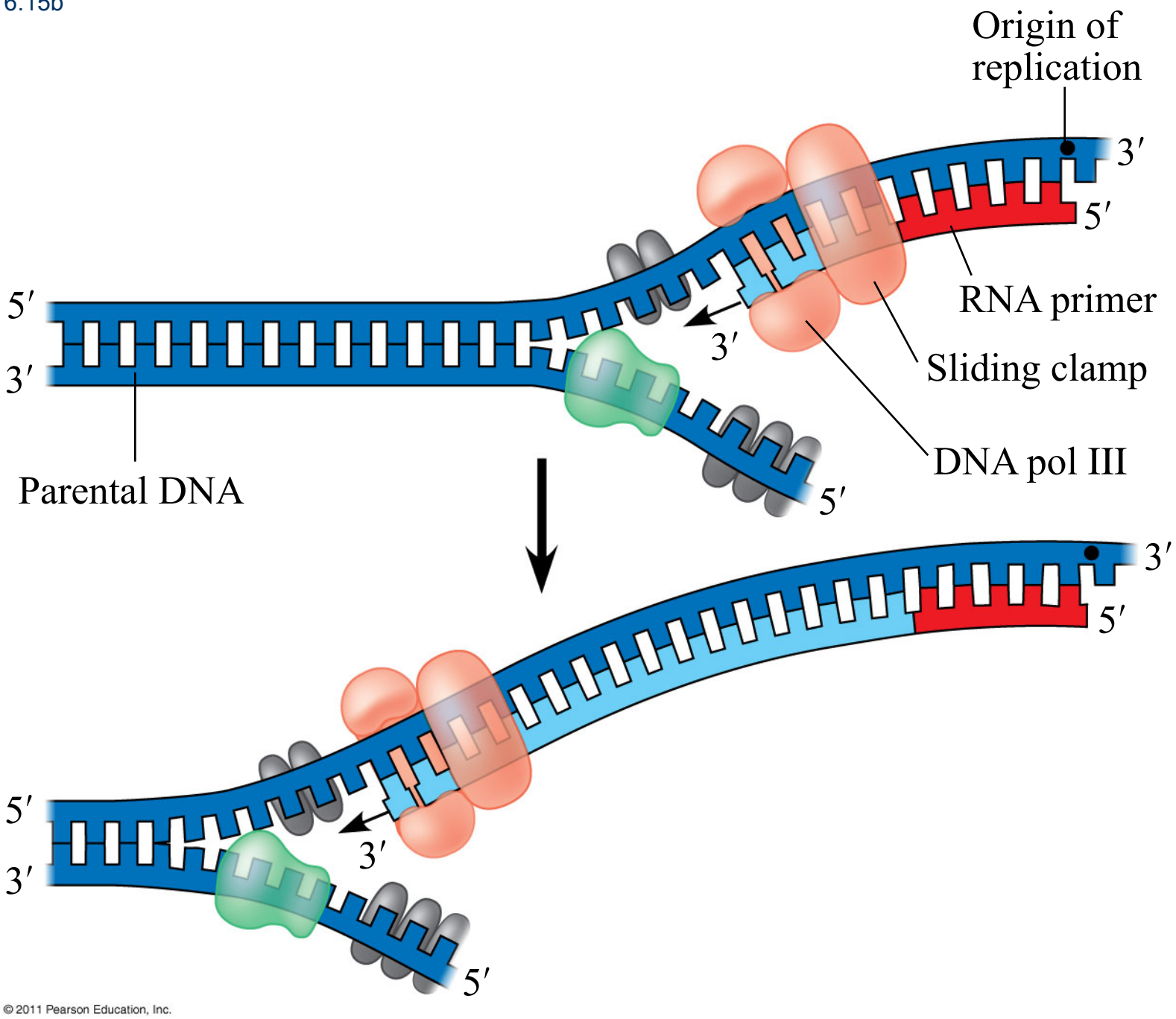


Getting Started

- Replication begins at particular sites called **origins of replication**, where the two DNA strands are separated, opening up a replication "bubble"
- A eukaryotic chromosome may have hundreds or even thousands of origins of replication
- Replication proceeds in both directions from each origin, until the entire molecule is copied

Animation: Origins of Replication

Figure 16.15b

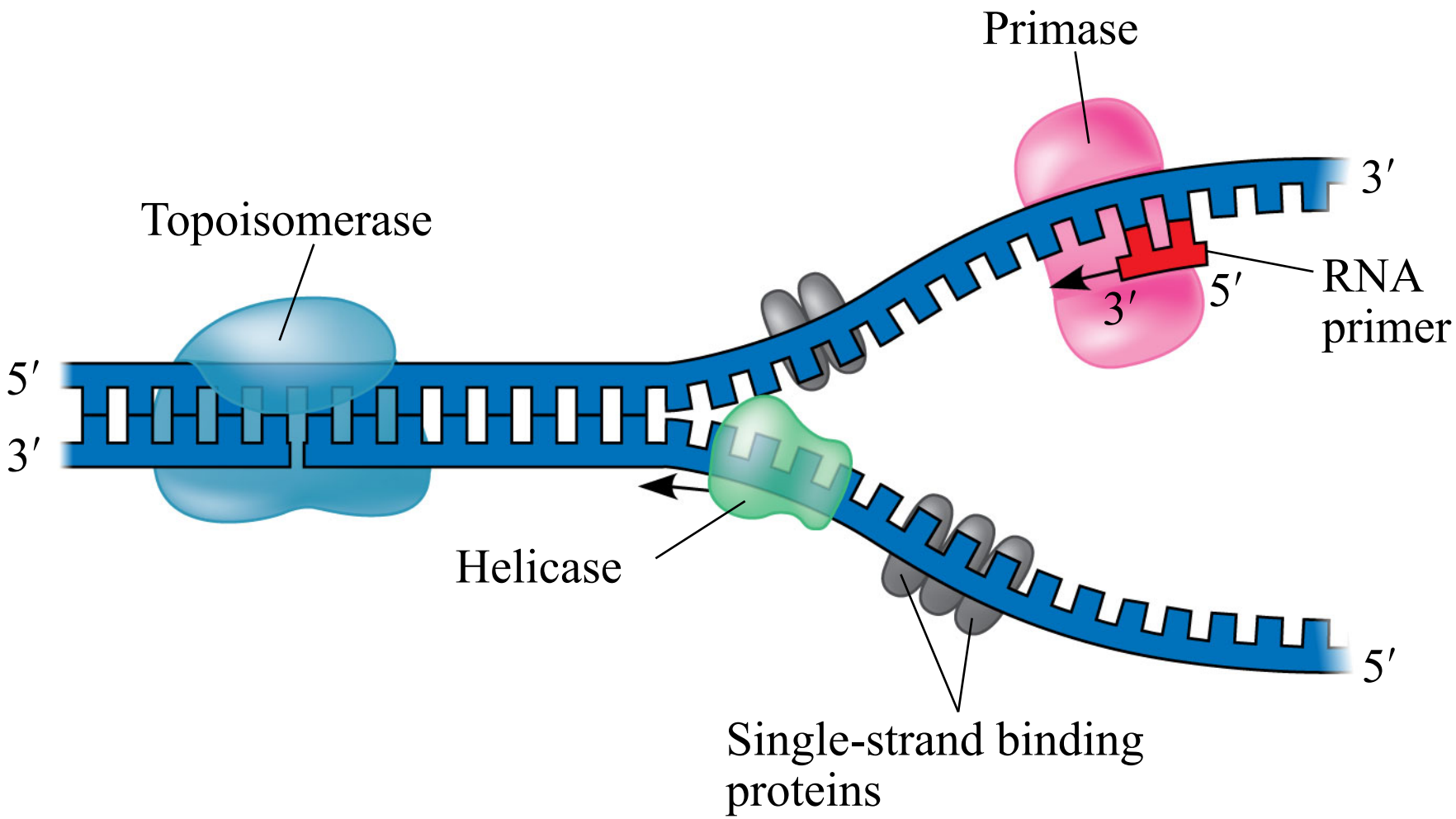


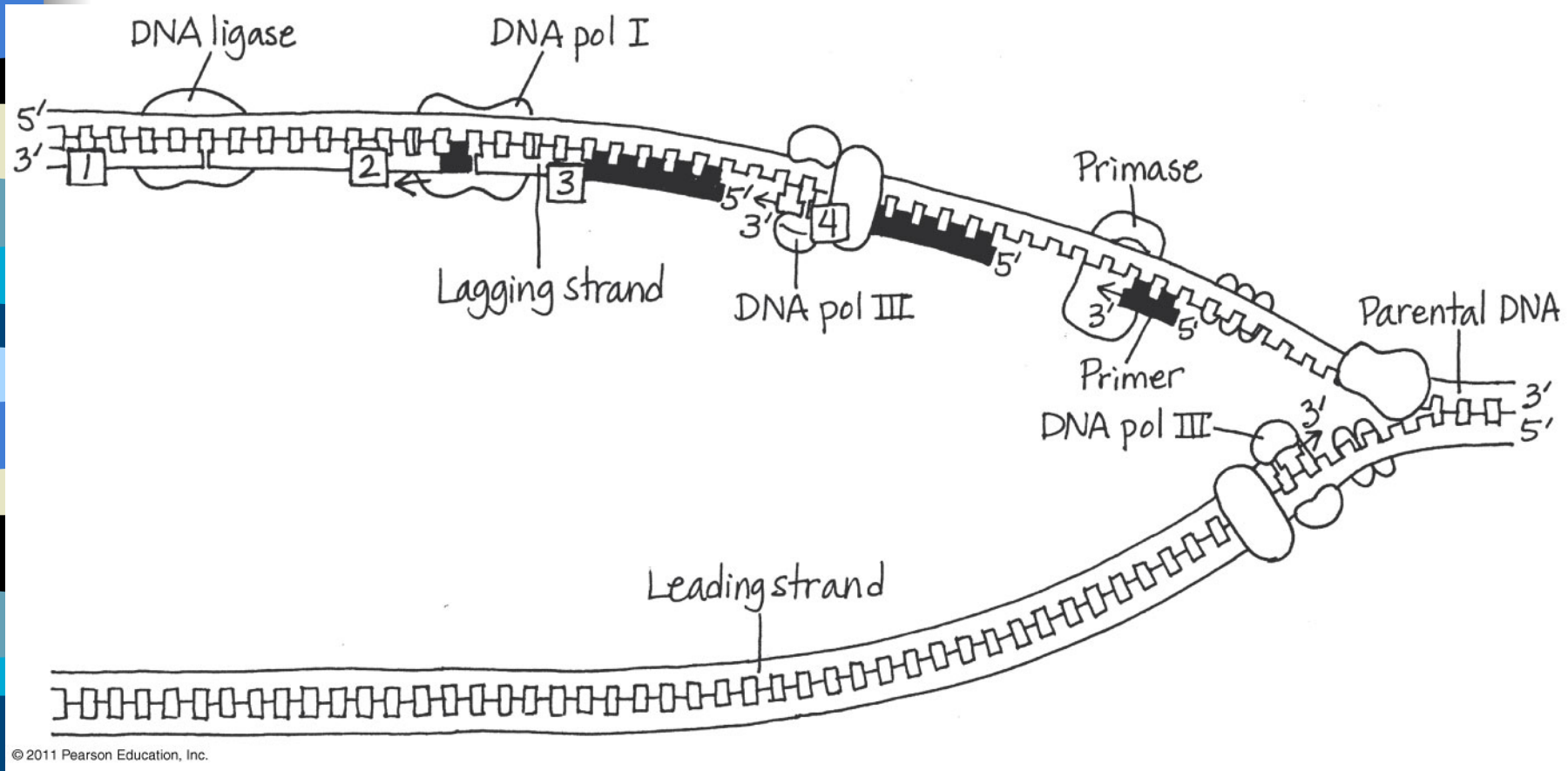
- At the end of each replication bubble is a **replication fork**, a Y-shaped region where new DNA strands are elongating
- **Helicases** are enzymes that untwist the double helix at the replication forks
- **Single-strand binding proteins** bind to and stabilize single-stranded DNA
- **Topoisomerase** corrects "overwinding" ahead of replication forks by breaking, swiveling, and rejoining DNA strands

Leading strand and lagging strand animation

- DNA polymerases cannot initiate synthesis of a polynucleotide; they can only add nucleotides to the 3′ end
- The initial nucleotide strand is a short RNA **primer**
- An enzyme called **primase** can start an RNA chain from scratch and adds RNA nucleotides one at a time using the parental DNA as a template
- The primer is short (5–10 nucleotides long), and the 3′ end serves as the starting point for the new DNA strand

Figure 16.13





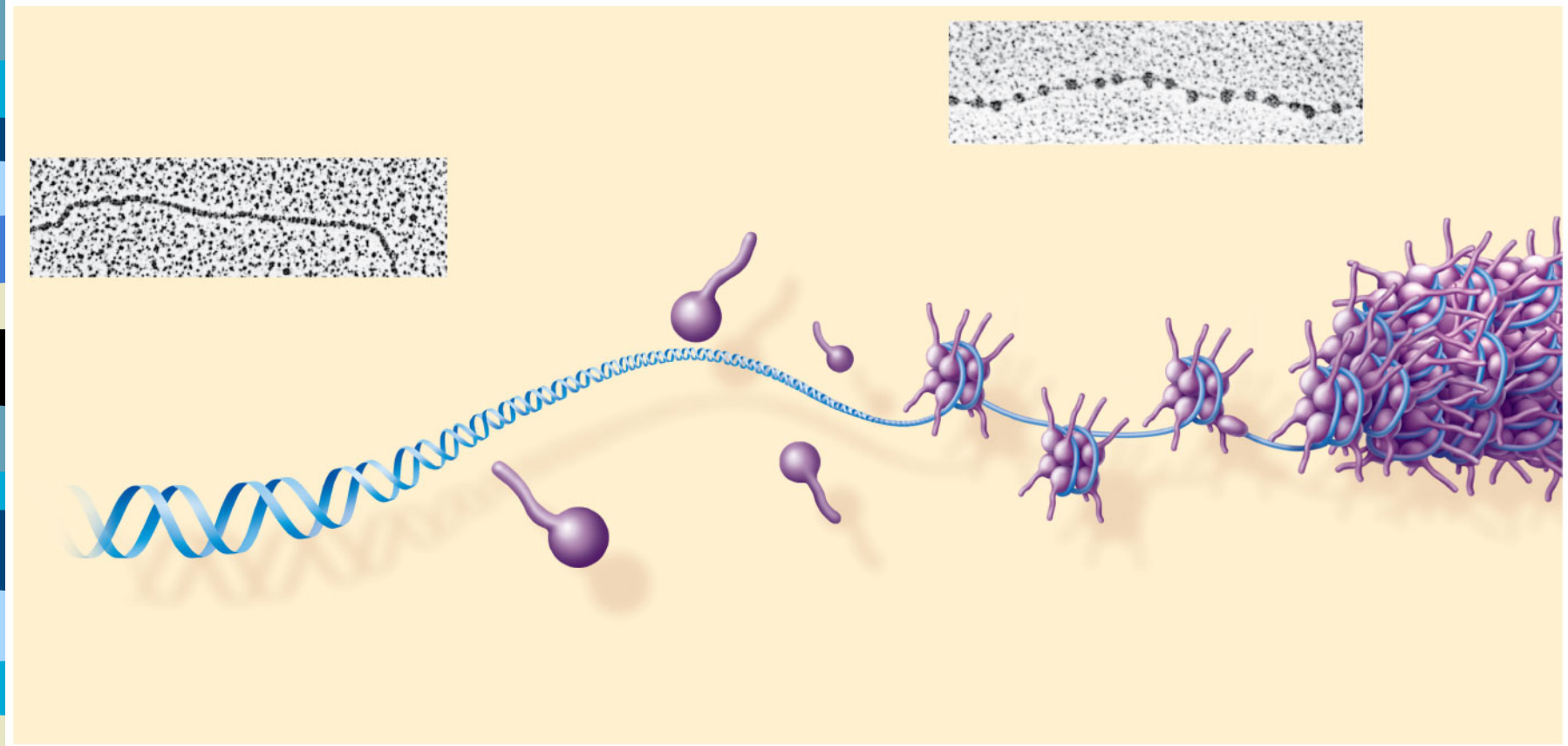
D. Replication Errors

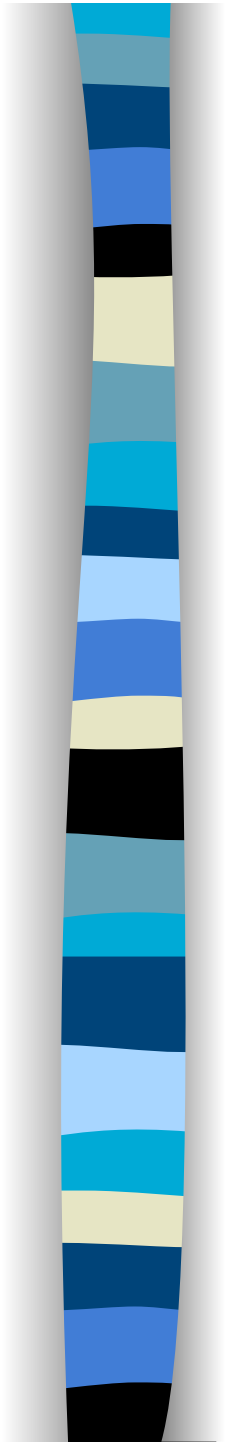
1. Mutations are permanent changes in base sequences.
2. Base changes causes mutations.
3. Mismatched nucleotides (1 in 100,000 base pairs) cause pause in replication.
4. DNA repair enzymes.

Replicating the ends of chromosomes

- Limitations of DNA polymerase create problems for the linear DNA of eukaryotic chromosomes
- The usual replication machinery provides no way to complete the 5′ ends
- Eukaryotic chromosomal DNA molecules have special nucleotide sequences at their ends called **telomeres**

The structure of a Eukaryotic chromosome





Chromatin

- Most chromatin is loosely packed in the nucleus during interphase and condenses prior to mitosis
- Loosely packed chromatin is called **euchromatin**
- During interphase a few regions of chromatin (centromeres and telomeres) are highly condensed into **heterochromatin**
- Dense packing of the heterochromatin makes it difficult for the cell to express genetic information coded in these regions