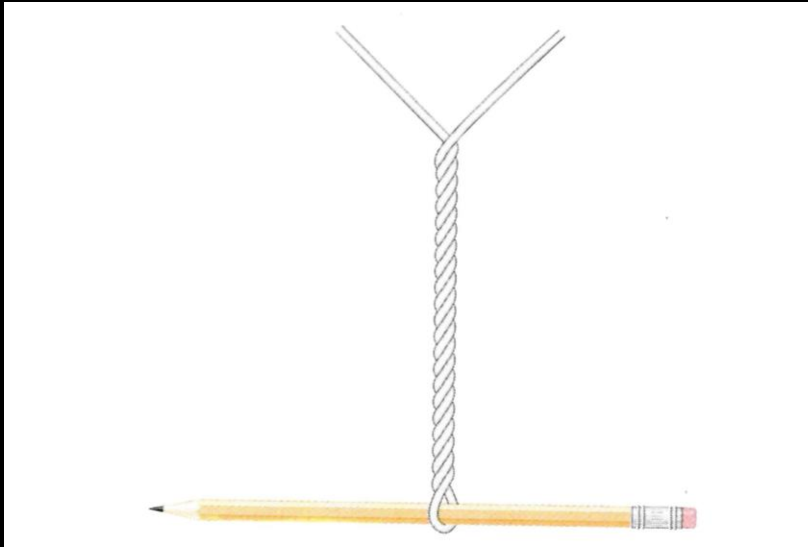
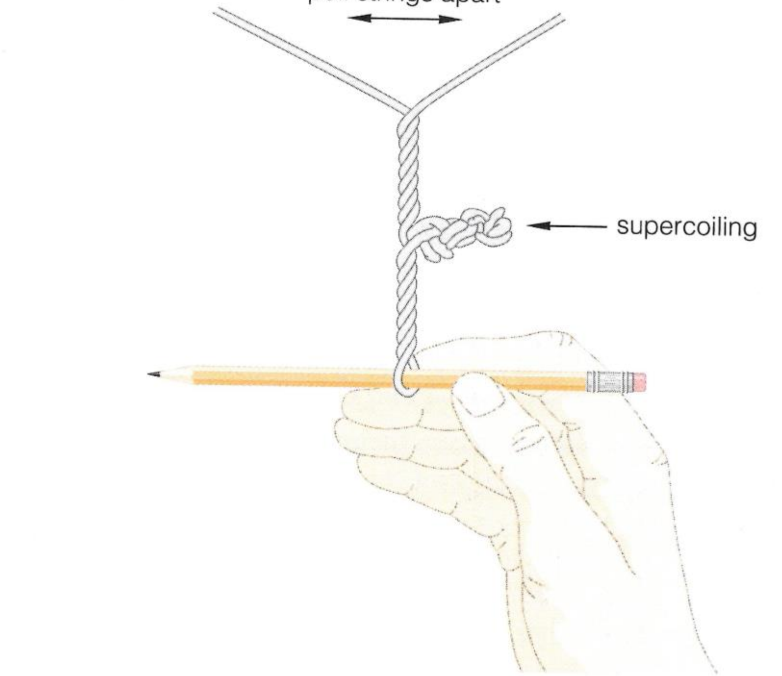
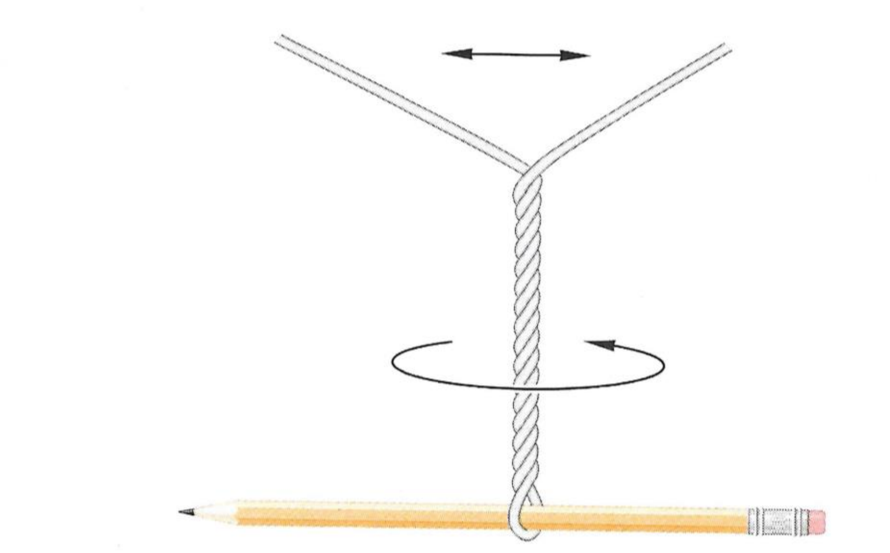
Demonstration of Supercoiling



a The string looped around a pencil and twisted represents a double helix without supercoils.

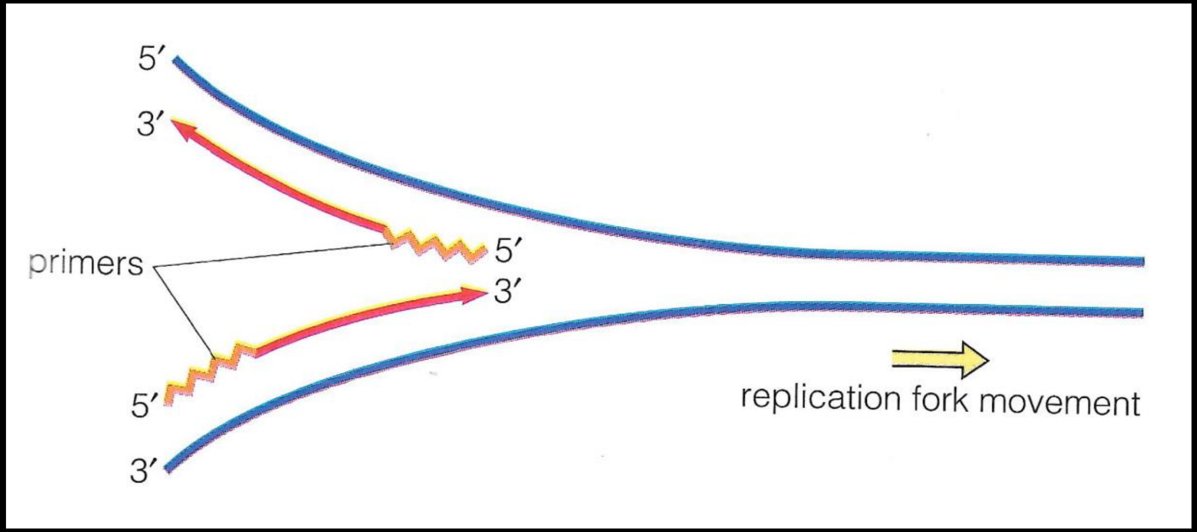


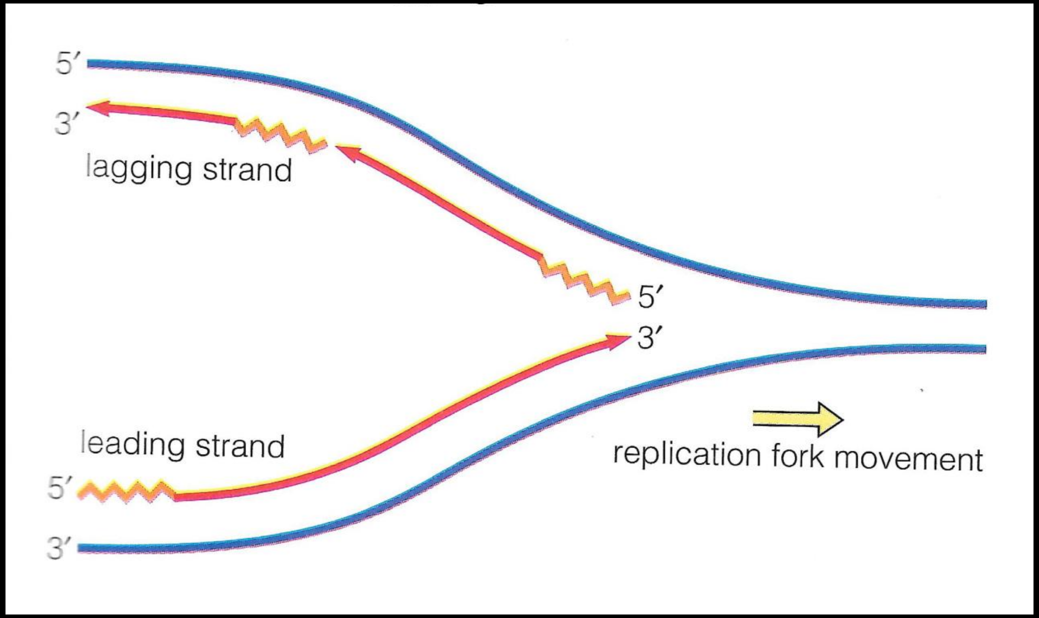
b As the string unwinds, supercoils form ahead of the unwinding if the helix is not allowed to rotate.



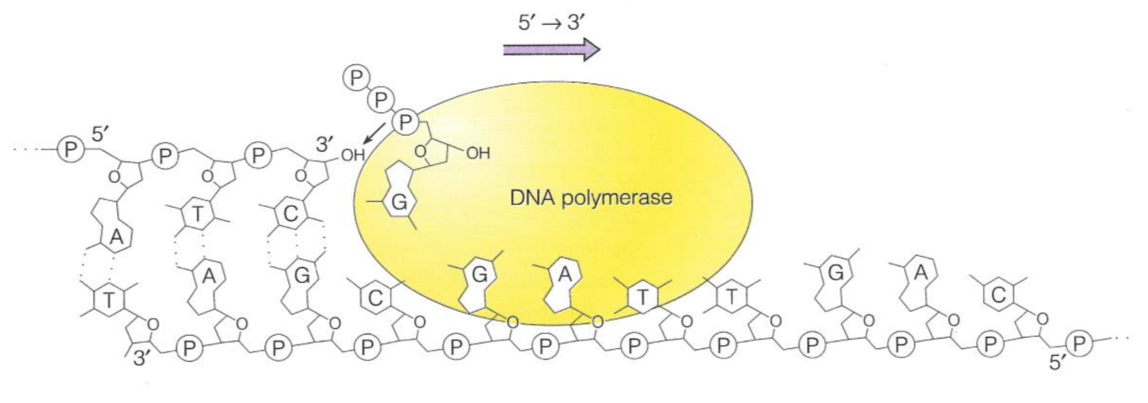
c Rotation relieves the tension from supercoiling.

Semi discontinuous DNA replication

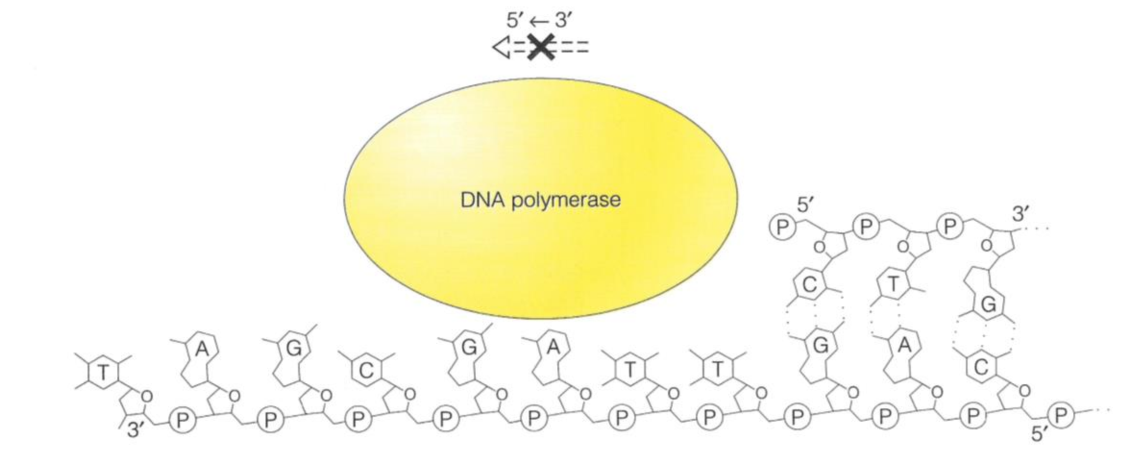




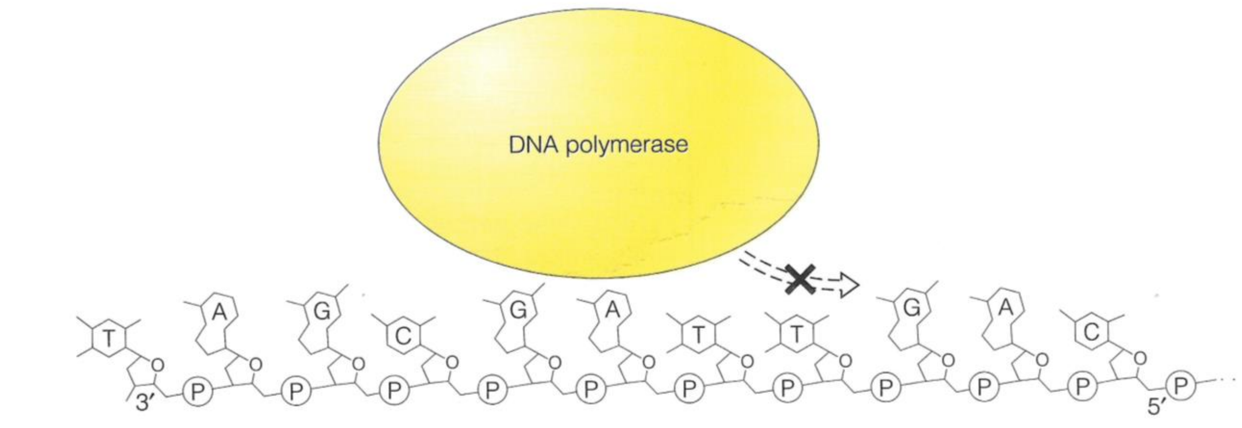
Restrictions on DNA polymerases



a DNA polymerase can extend the nucleotide chain in the 5′ → 3′ direction.



b DNA polymerase cannot extend the nucleotide chain in the 3′ → 5′ direction.



c DNA polymerase cannot initiate synthesis on a template strand without paired nucleotides.

Figure 2.18 Restrictions on DNA polymerases.

An RNA primer for initiation of DNA synthesis

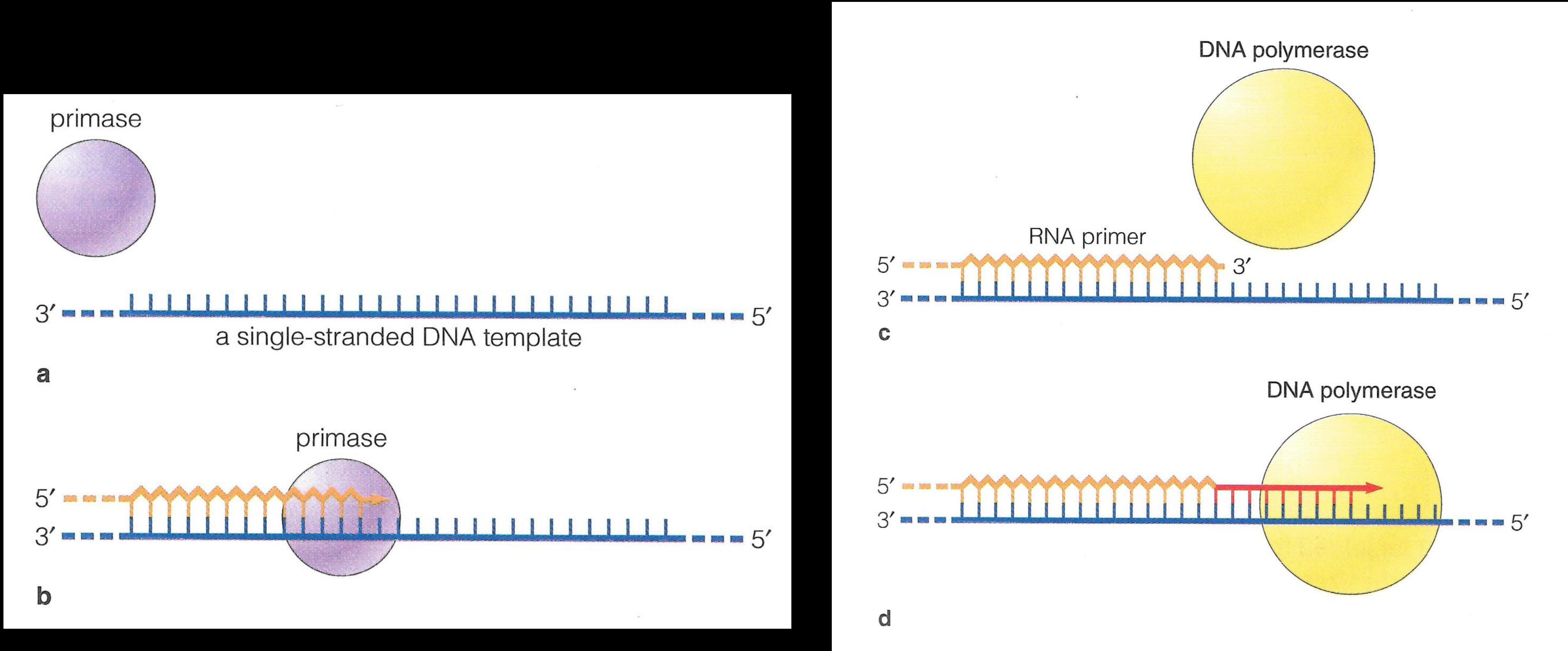
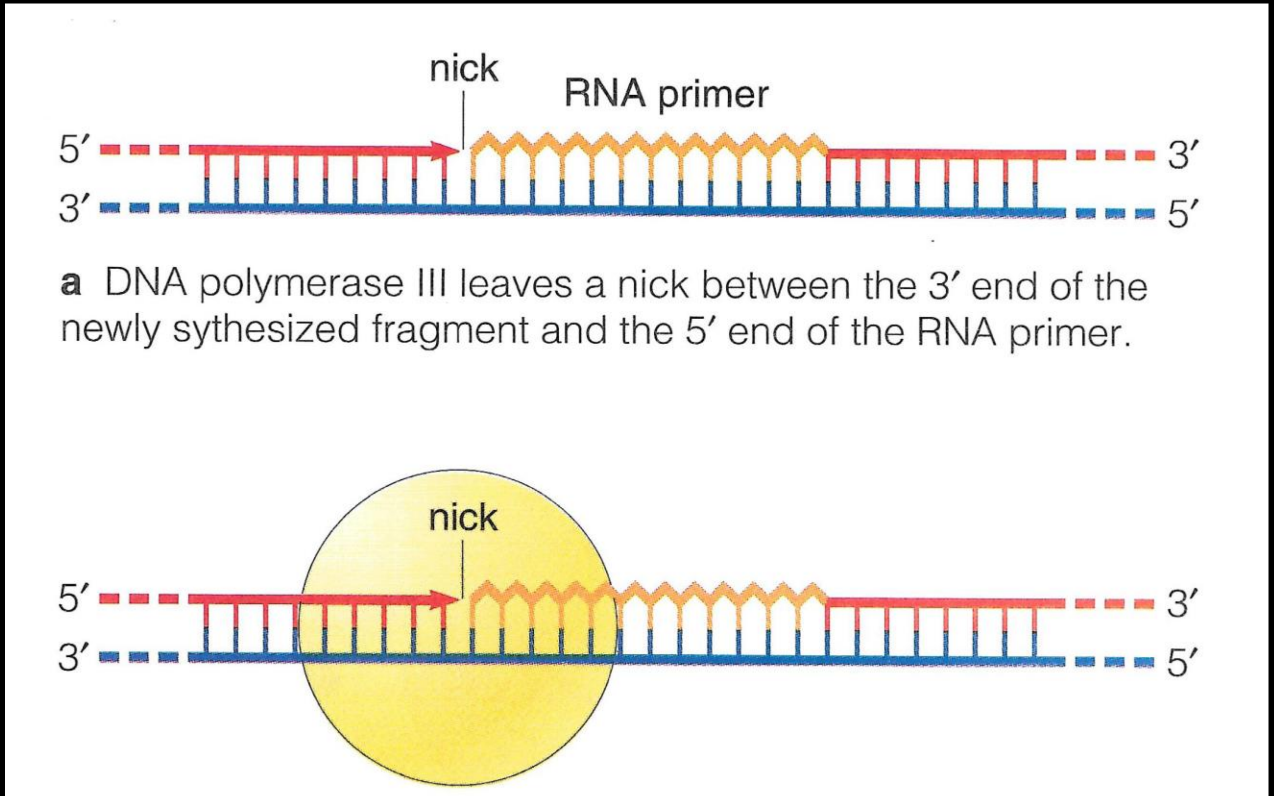


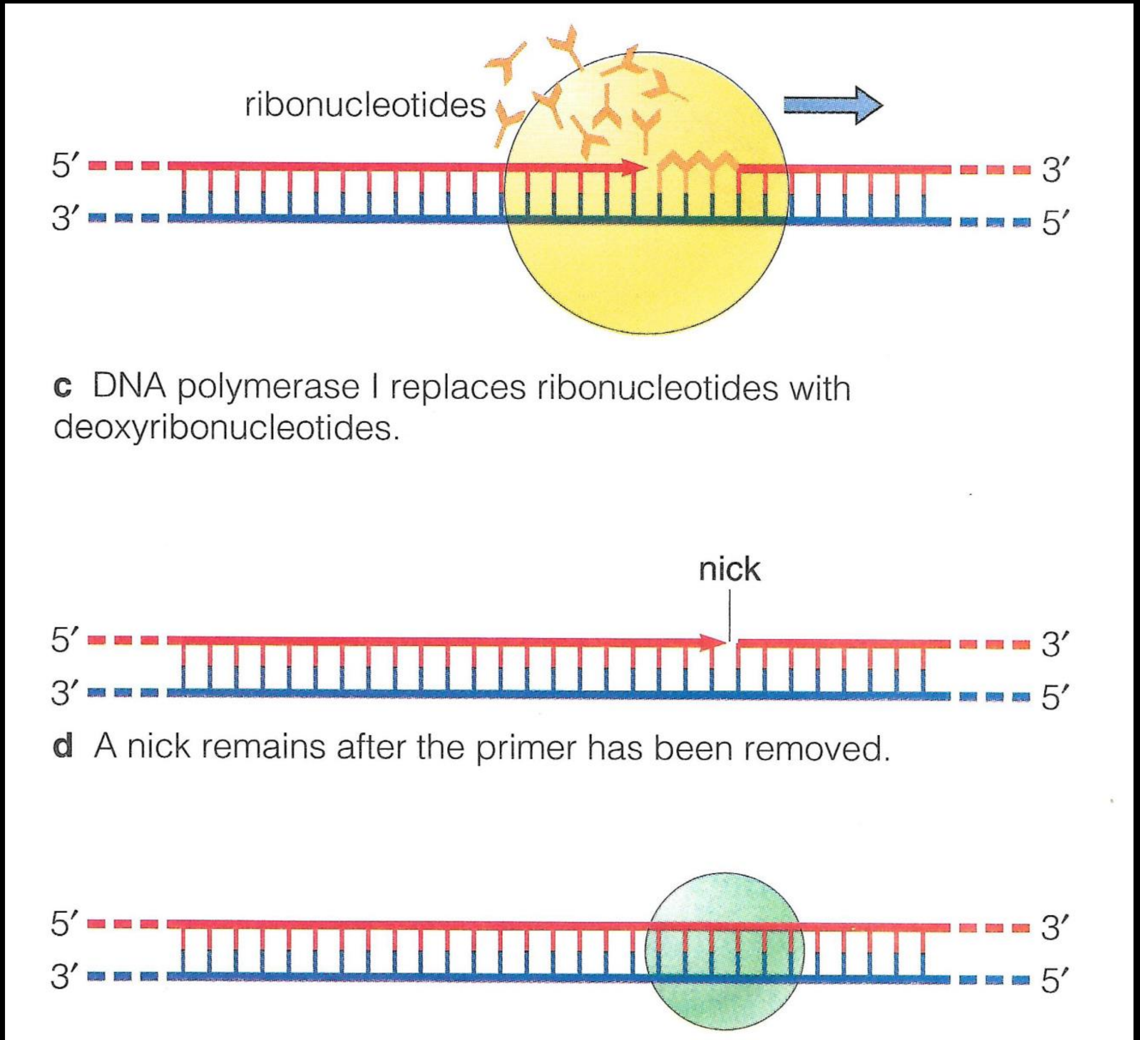
Figure 2.19 An RNA primer for initiation of DNA synthesis. The straight line represents a DNA strand, and the zigzag line represents an RNA strand.

Primer removal by DNA polymerase I



a DNA polymerase III leaves a nick between the 3′ end of the newly sythesized fragment and the 5′ end of the RNA primer.

b DNA polymerase I binds at the nicked site.



c DNA polymerase I replaces ribonucleotides with deoxyribonucleotides.

d A nick remains after the primer has been removed.

e DNA ligase seals the nick.

Figure 2.20 Primer removal by DNA polymerase I.

Molecular structure of DNA Polymerase III holoenzyme in *E.coli*

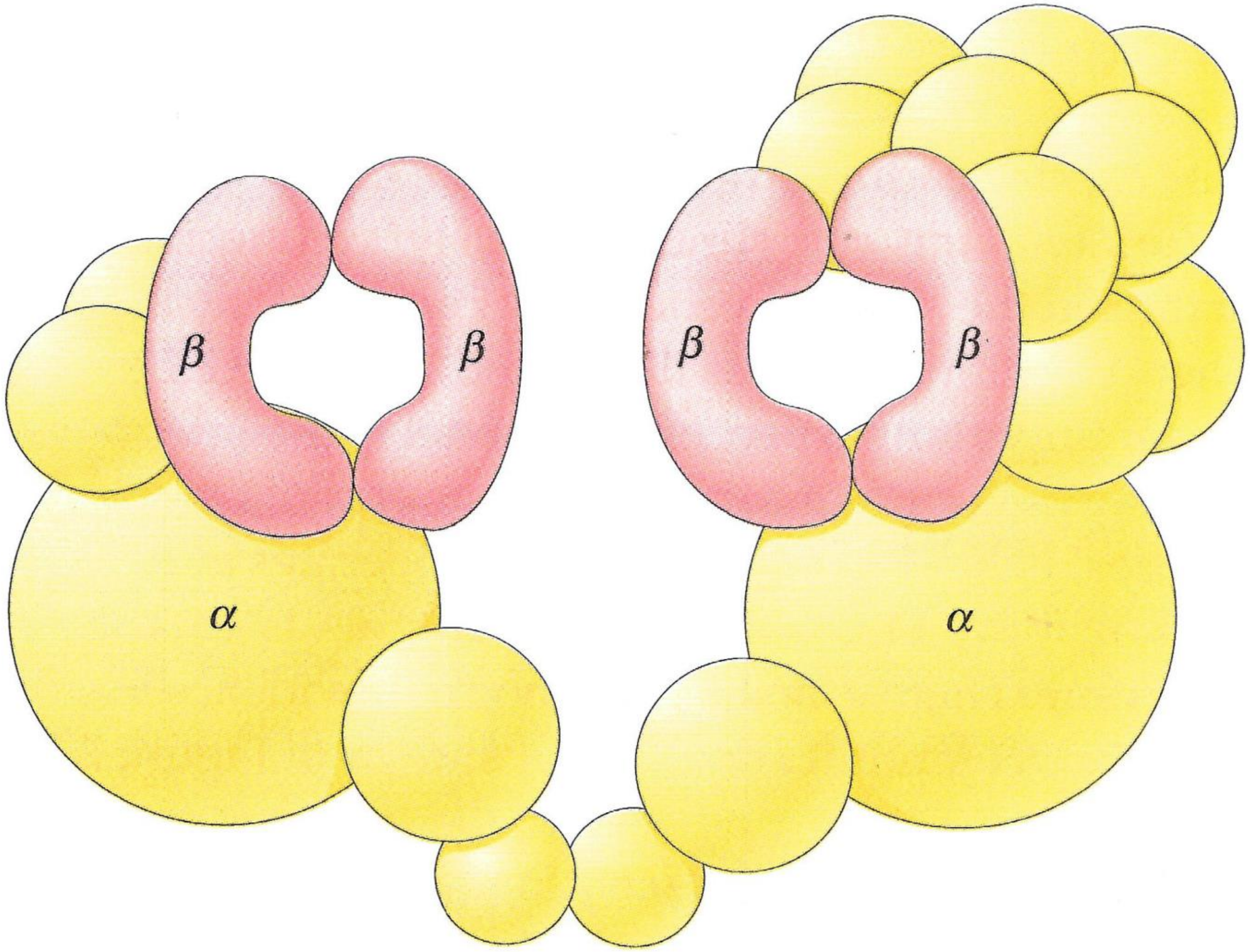


Figure 2.21 The molecular structure of the DNA polymerase III holoenzyme in *E. coli.*

Model of DNA replication in Prokaryotes with simultaneous synthesis of leading and lagging strands

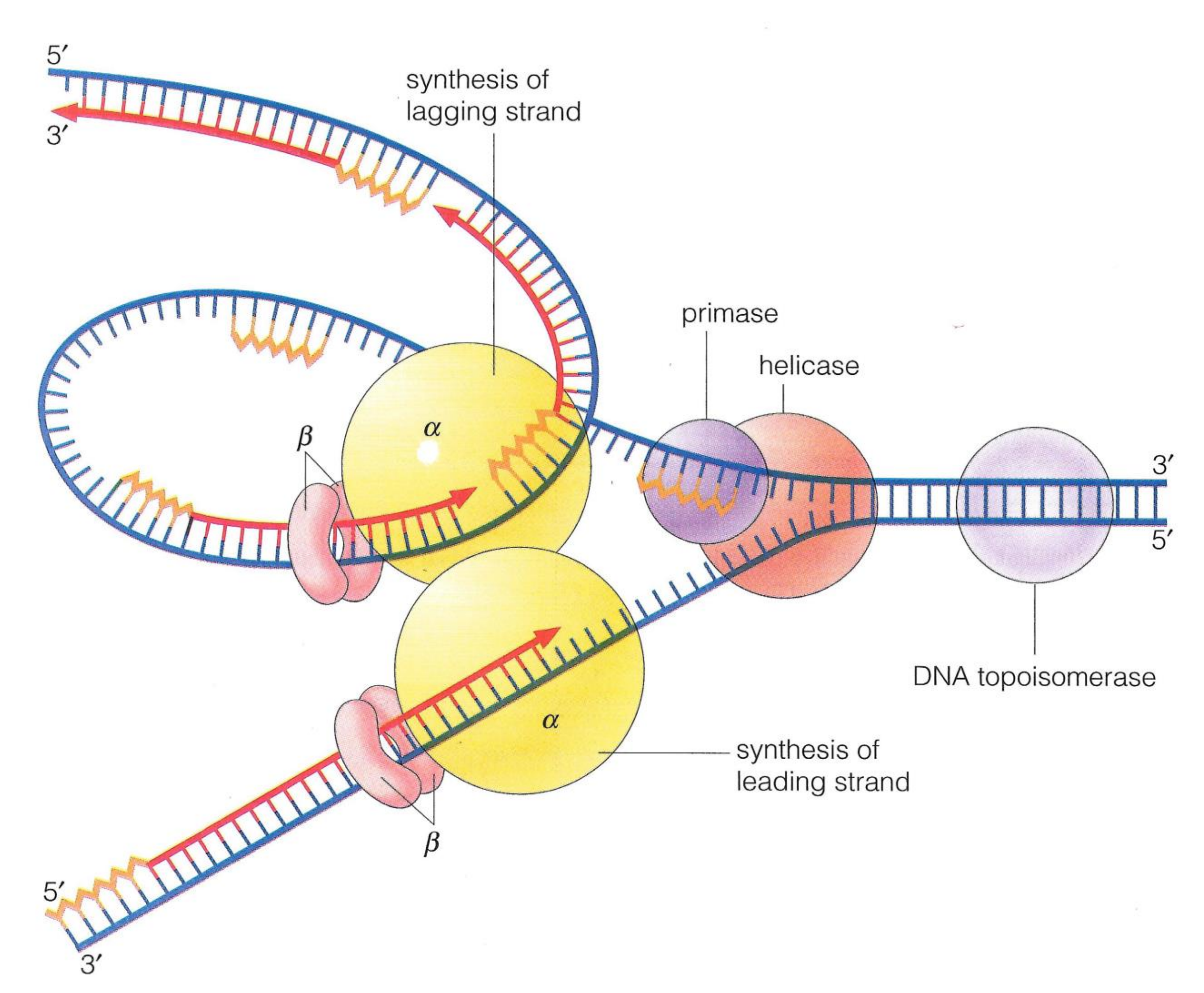


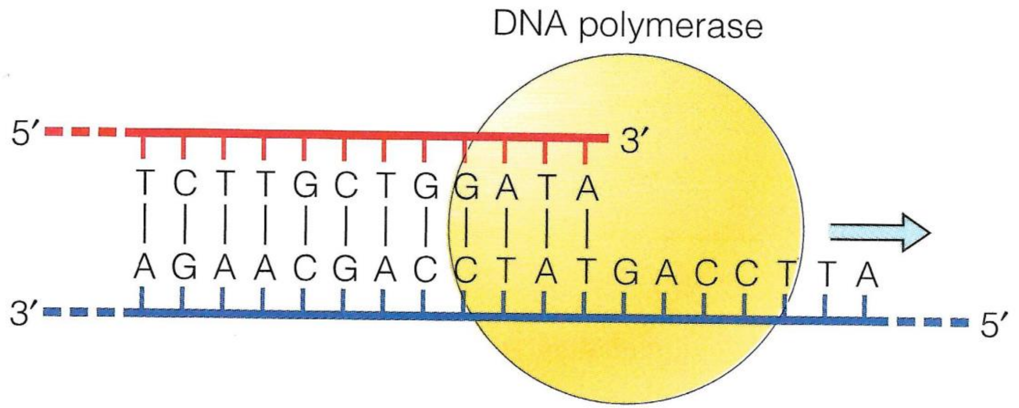
Figure 2.22 Model of DNA replication in prokaryotes with simultaneous synthesis of leading and lagging strands.

Prokaryotic DNA Polymerases

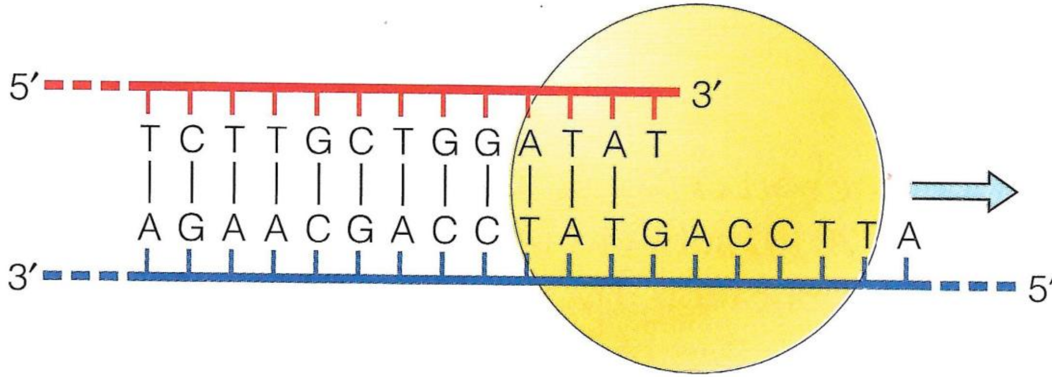
Table 2.1 Prokaryotic DNA Polymerases

Polymerase	Functions
DNA polymerase I	Removal of nucleotides during DNA repair (5′→3′ exonuclease); synthesis of DNA during repair; synthesis of short gaps in DNA; primer removal (5′→3′ exonuclease); proofreading (3′→5′ exonuclease)
DNA polymerase II	Synthesis of DNA during repair; proofreading (3′→5′ exonuclease)
DNA polymerase III	DNA synthesis; proofreading (5′→3′ exonuclease)

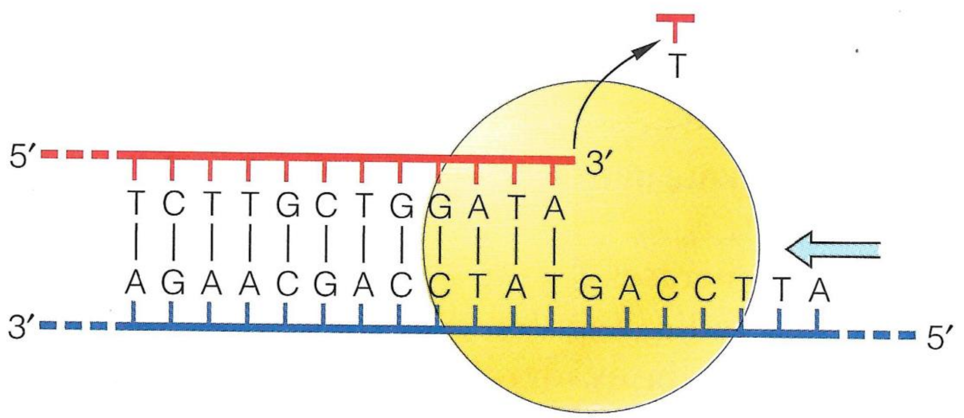
Proofreading newly synthesized DNA



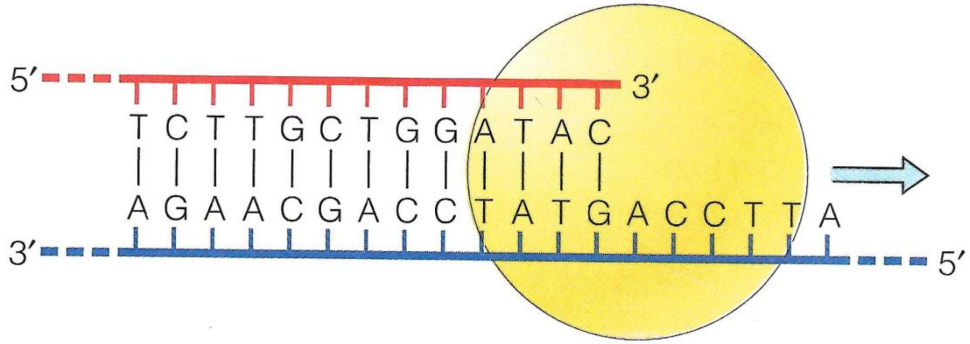
a DNA polymerase adds correctly paired nucleotides in the 5′ → 3′ direction.



b DNA polymerase adds a mispaired nucleotide.



c DNA polymerase reverses direction and acts as a 3′ → 5′ exonuclease to remove the mispaired nucleotide.



d DNA polymerase resumes DNA synthesis in the 5′ → 3′ direction.

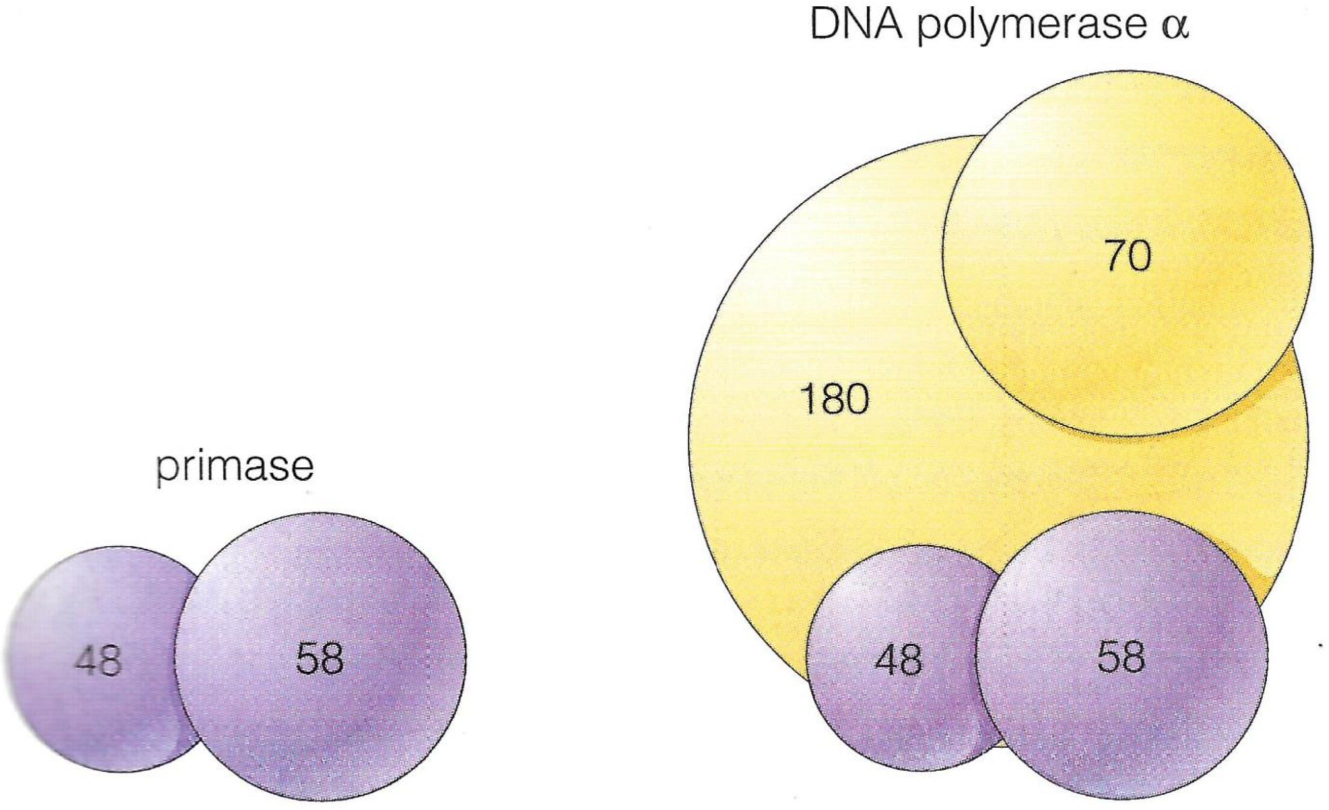
Figure 2.23 DNA proofreading in prokaryotes.

Eukaryotic DNA Polymerases

Table 2.2 Eukaryotic DNA Polymerases

Mammalian Polymerase	Corresponding Polymerase in Yeast	Functions
α	pol I	Synthesis of lagging strand; primer synthesis
β	none	Synthesis of DNA during repair
δ	pol III	Synthesis of leading strand; proofreading ($3' \rightarrow 5'$ exonuclease)
ε	pol II	Synthesis of DNA during repair; proofreading ($3' \rightarrow 5'$ exonuclease)
γ	mitochondrial DNA polymerase	Mitochondrial DNA synthesis; proofreading ($3' \rightarrow 5'$ exonuclease)

Eukaryotic DNA Polymerases



a The 48 and 58 kD subunits of DNA polymerase α may function on their own as a primase.

b They may also function as a primase when part of the entire enzyme.

Figure 2.24 DNA polymerase α in mammals.

Model of DNA replication in Eukaryotes with simultaneous synthesis of leading and lagging strands

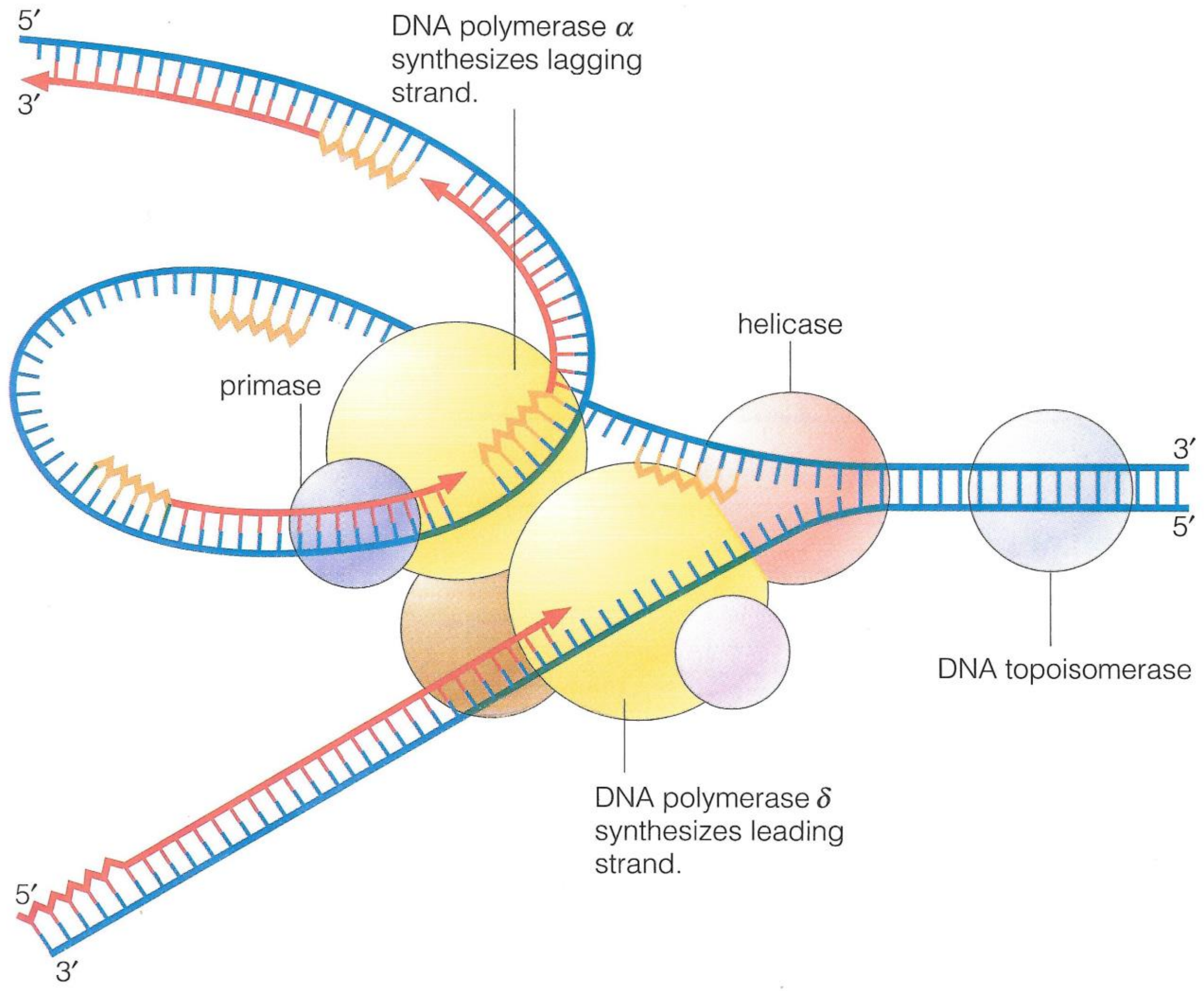
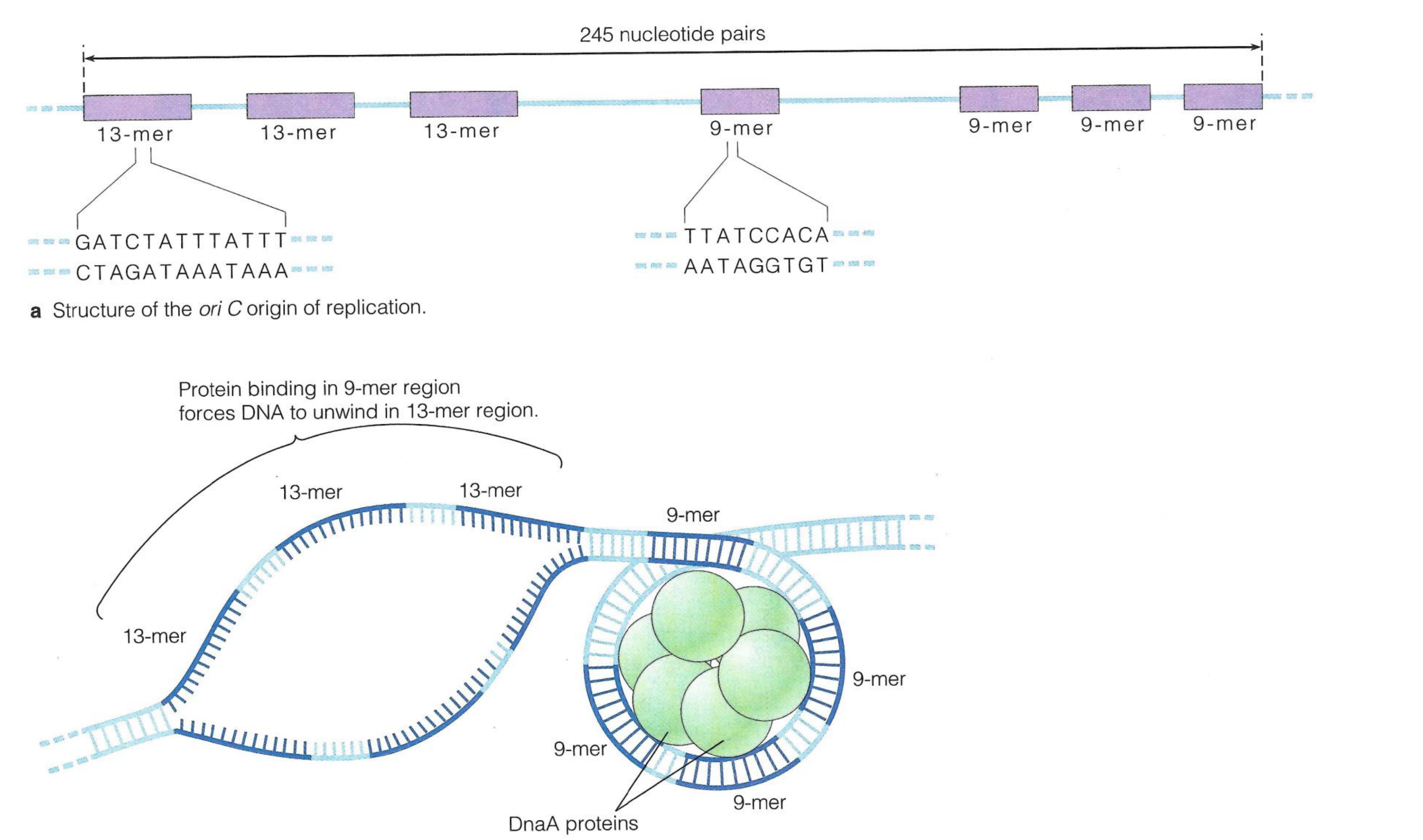


Figure 2.25 Model of DNA replication in eukaryotes with simultaneous synthesis of leading and lagging strands.

Origin of replication

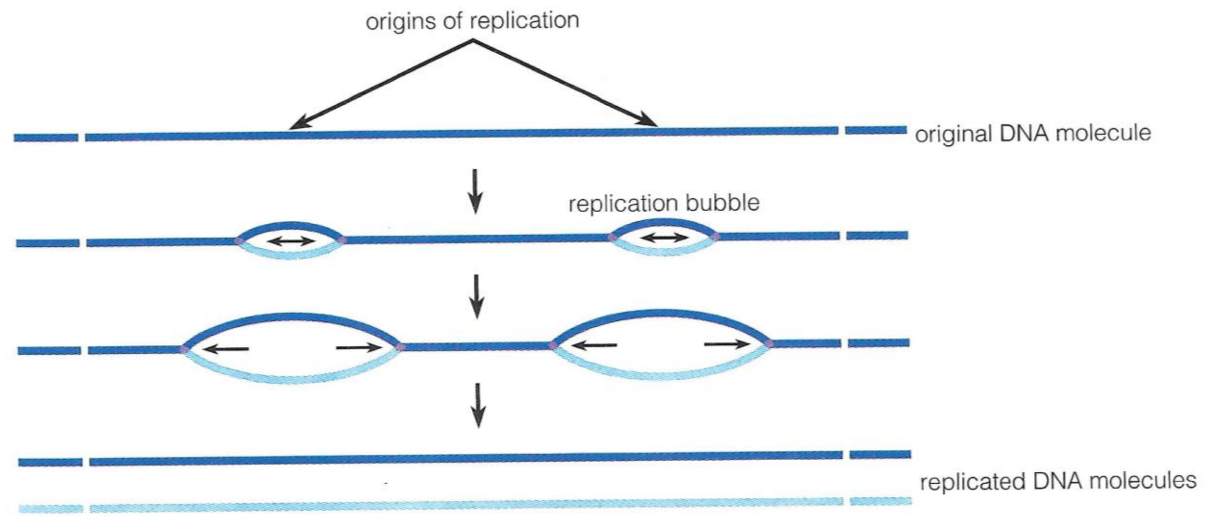


a Structure of the *ori C* origin of replication.

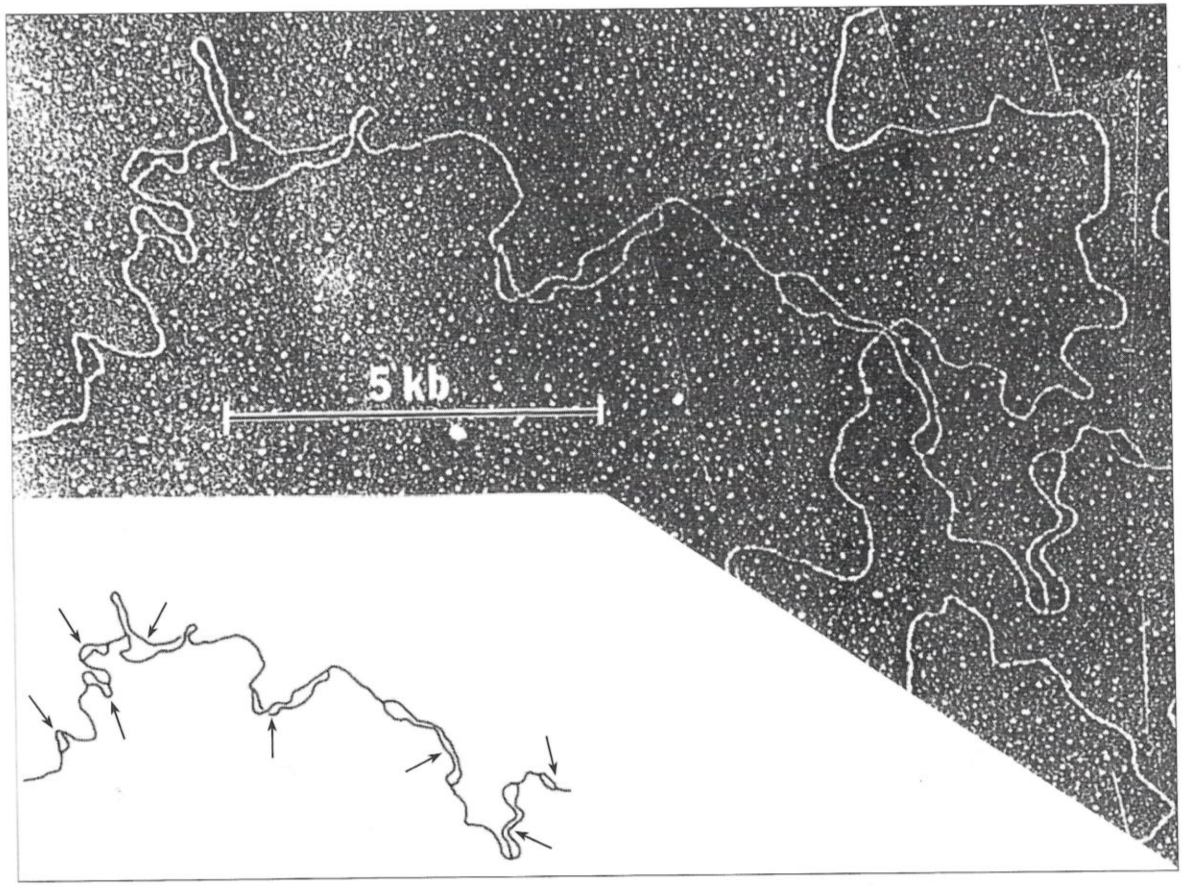
b Function of the DnaA proteins that cause the DNA to unwind.

Figure 2.26 The *oriC* origin of replication in *E. coli.*

Bidirectional replication



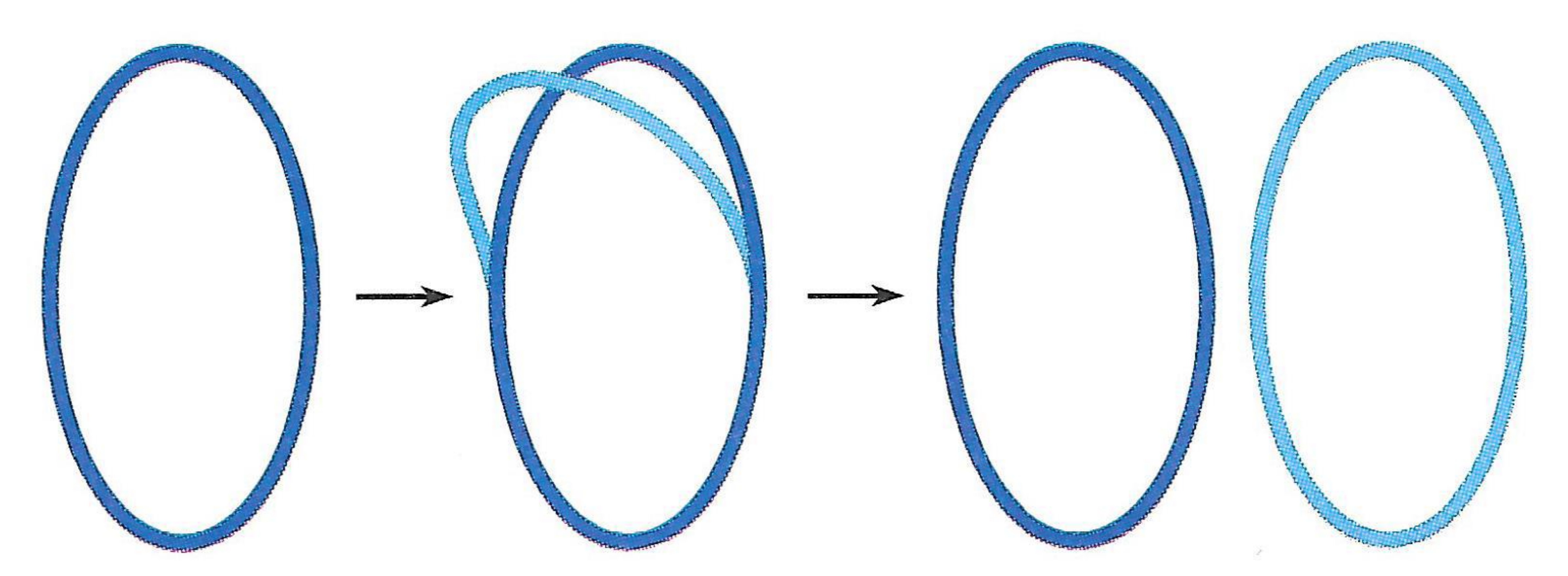
a Replication “bubbles” forming from two origins of replication.



b Replication bubbles (indicated by arrows) in *Drosophila melanogaster* DNA.

Figure 2.27 Bidirectional replication. (Photo courtesy of D. S. Hogness.)

Strategy for replicating circular DNA (Theta mode replication in *E. coli*)



Electron micrograph of theta mode replication in *E. coli*

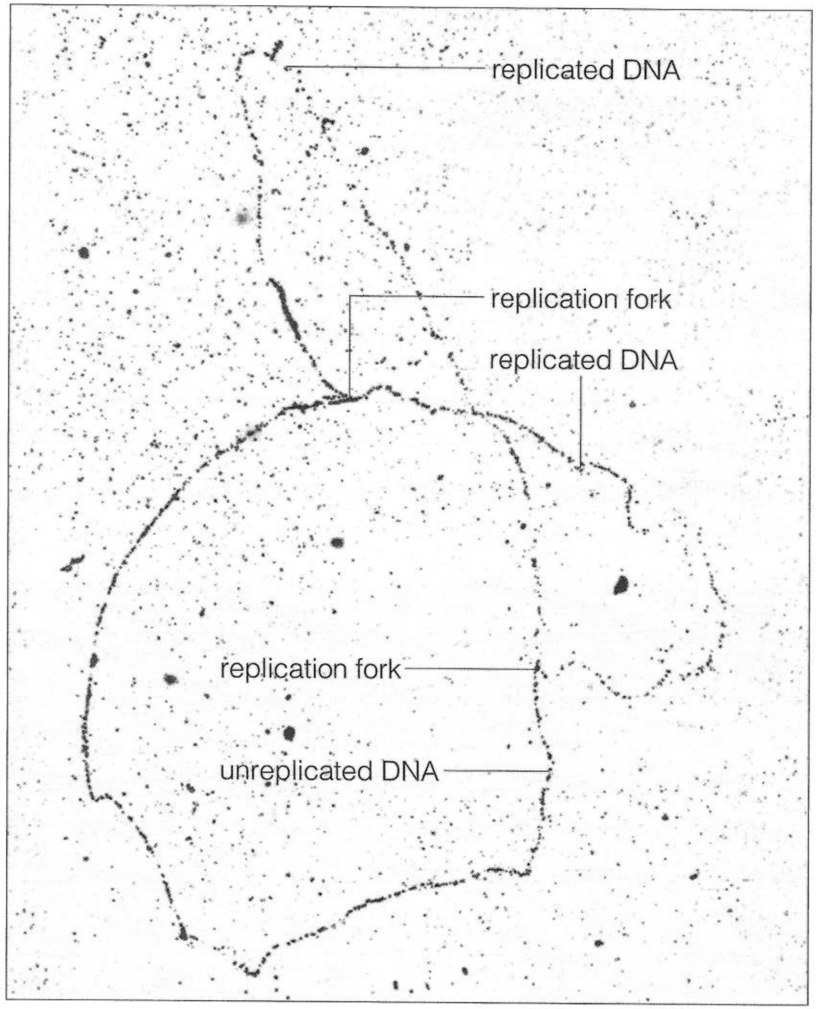
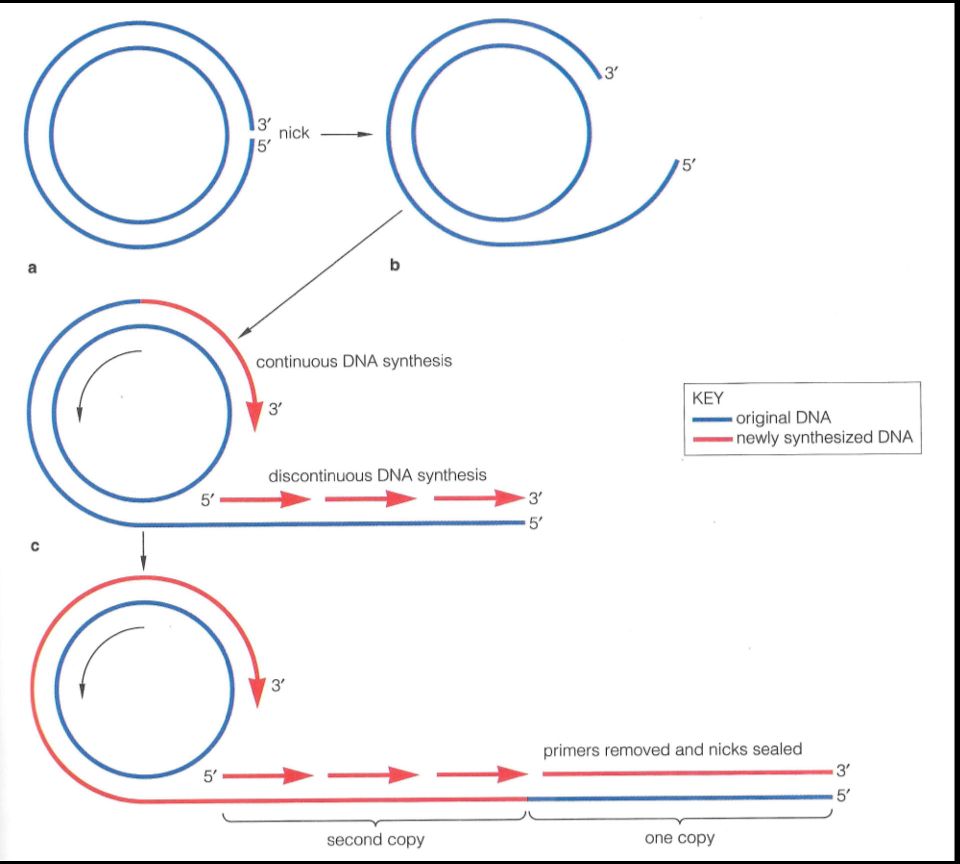


Figure 2.29 Electron micrograph of θ-mode replication in *E. coli.* (Photo from Cairns, J. 1963. The chromosome of *Echerichia coli. Cold Spring Harbor Symposia on Quantitative Biology* 28:43–46. Reprinted by permission of the publisher.)

Rolling circle mode replication



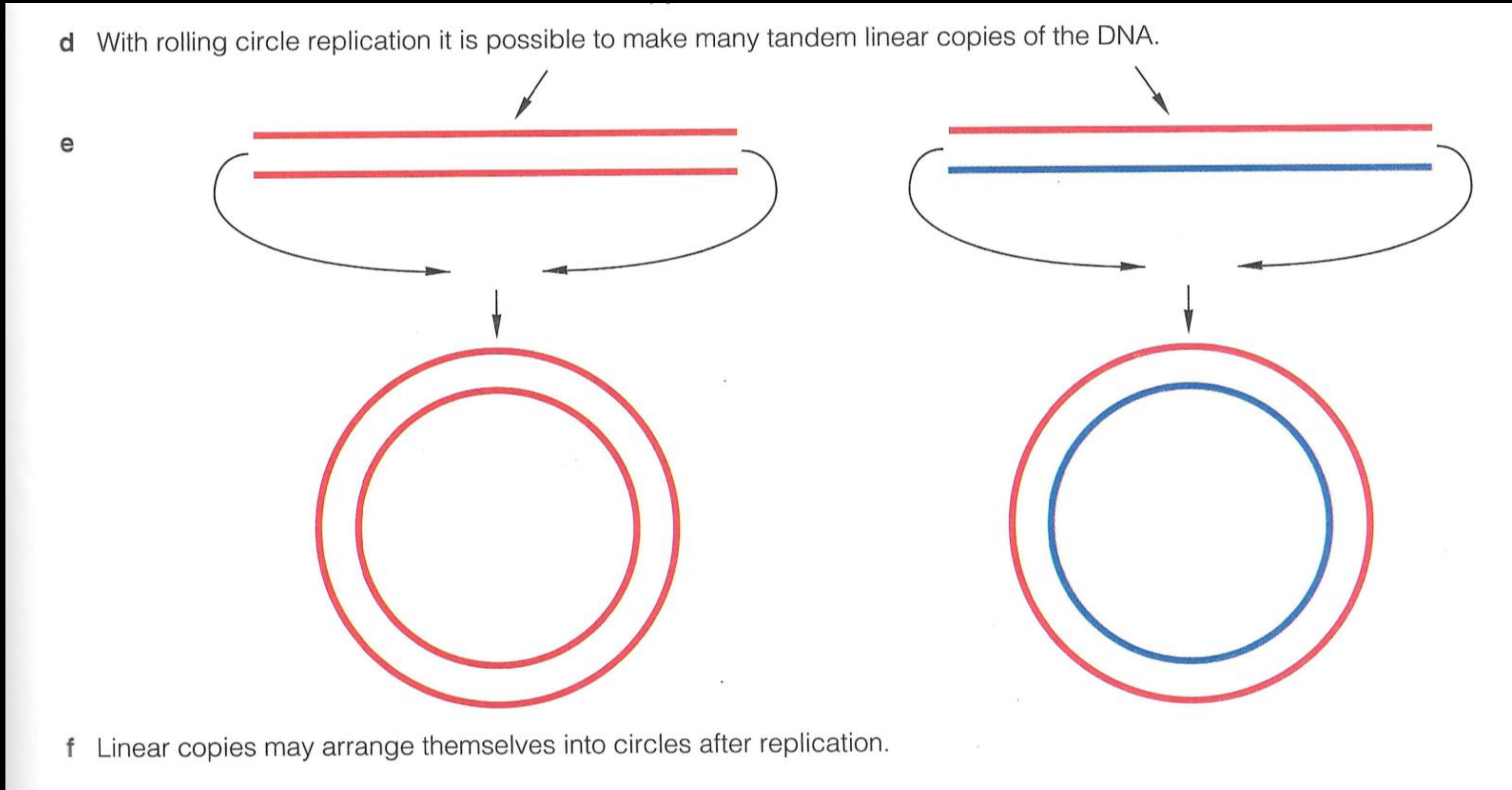


Figure 2.30 σ-mode (rolling circle) replication.

Linear DNA Replication

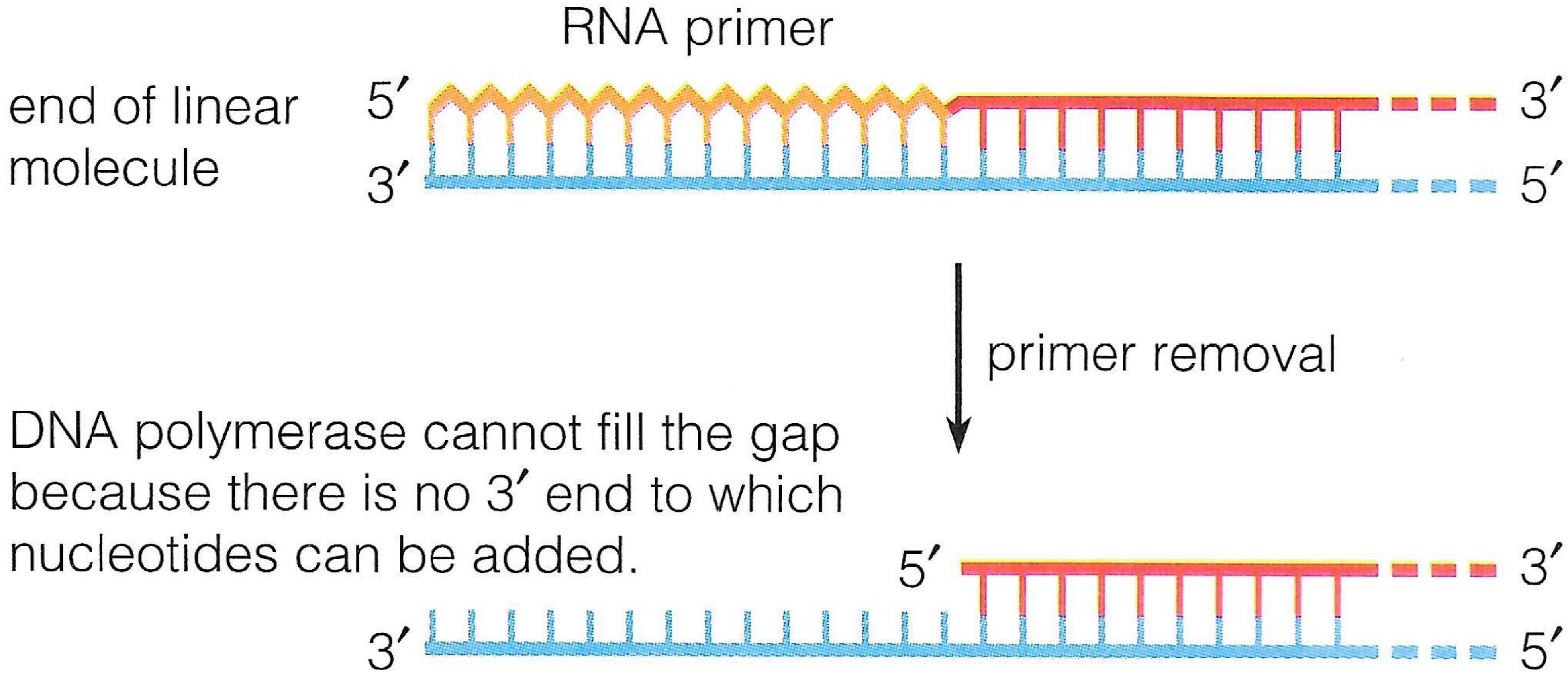


Figure 2.32 The linear DNA replication paradox. How can the gap at the end of the linear molecule be filled?

D loop mode replication

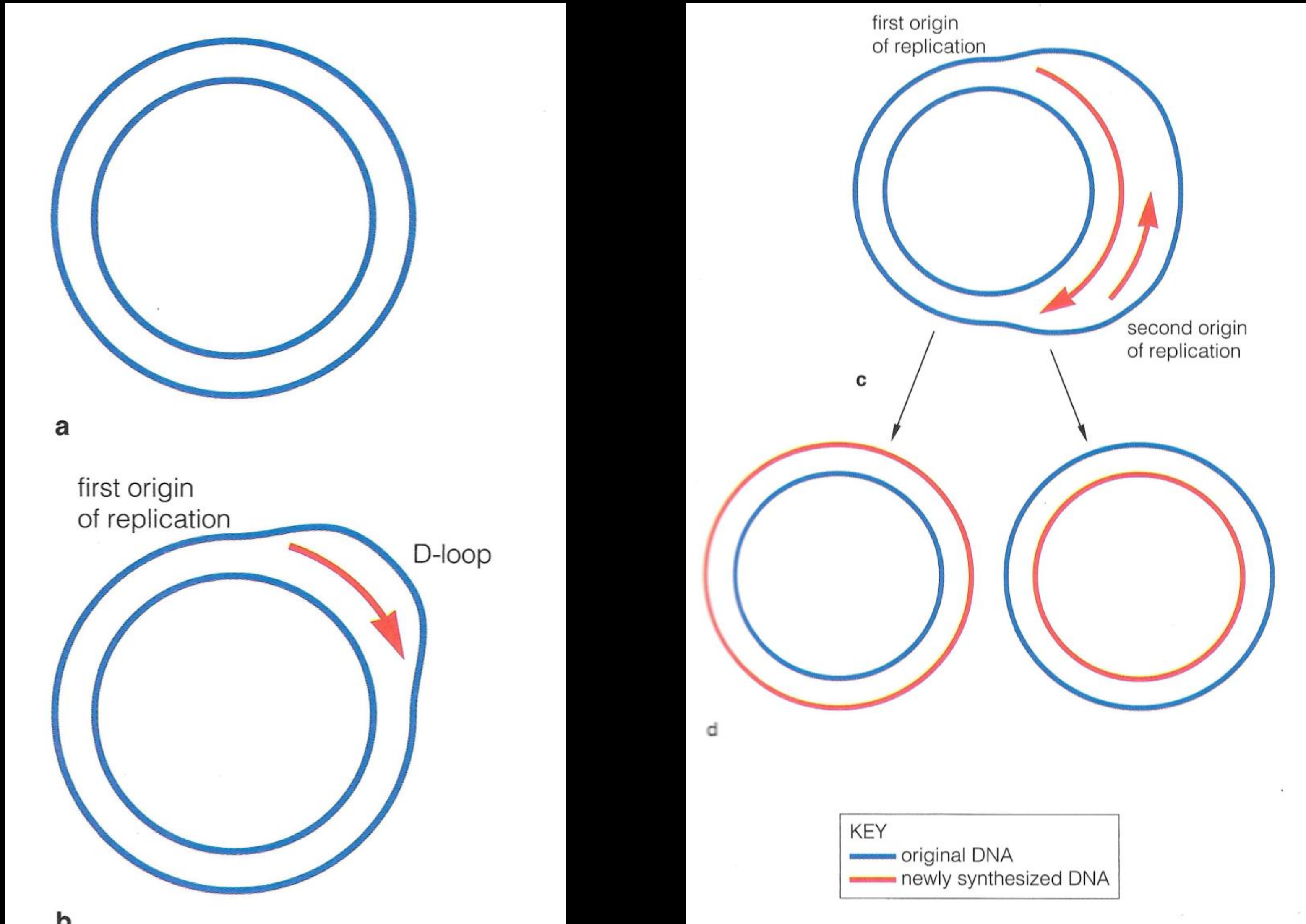


Figure 2.31 D-loop replication.

A model for replicating the ends of linear chromosomes in eukaryotes