

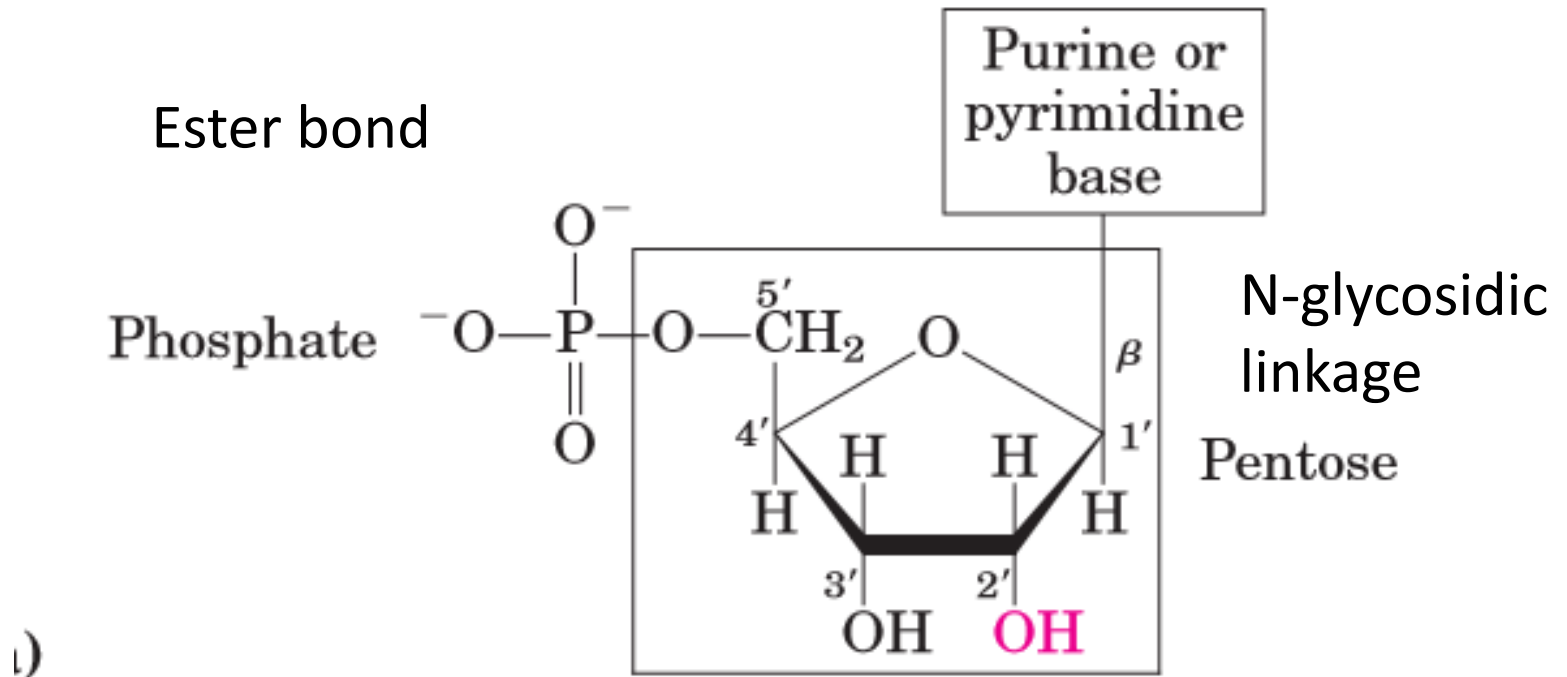
Nucleic acid structure

Gulshan Kumar
School of Fisheries

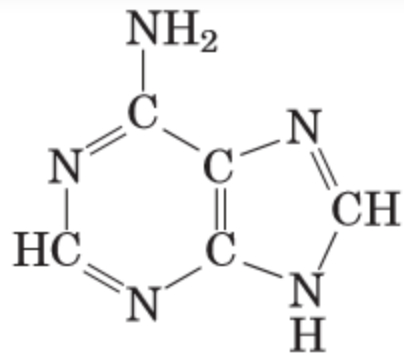
Introduction

- The storage and transmission of biological information are the only known functions of DNA.
- RNA has broader range of function and many classes.
- Central dogma of molecular biology.
- Manipulating nucleic acids.

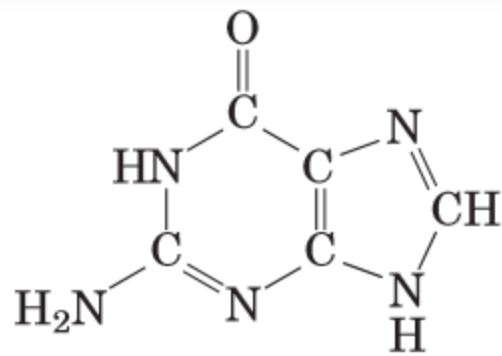
Components of nucleic acids



This is a ribonucleotide. In deoxyribonucleotides the -OH group on the 2 carbon (in red) is replaced with -H .

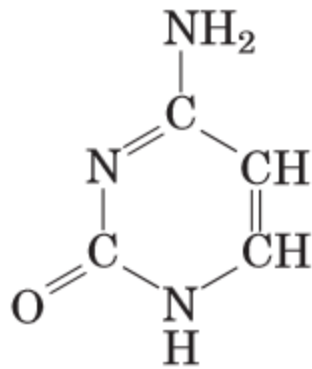


Adenine

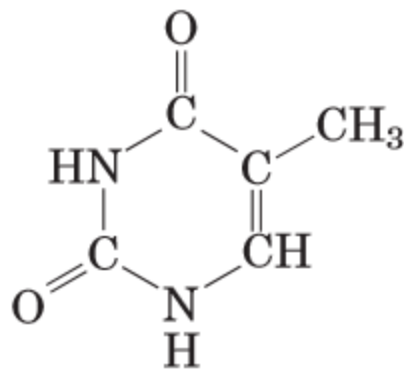


Guanine

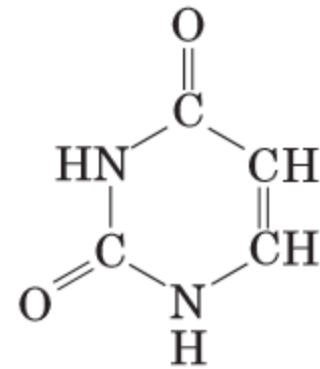
Purines



Cytosine



Thymine
(DNA)



Uracil
(RNA)

Pyrimidines

TABLE 8–1**Nucleotide and Nucleic Acid Nomenclature**

Base	Nucleoside	Nucleotide	Nucleic acid
Purines			
Adenine	Adenosine	Adenylate	RNA
	Deoxyadenosine	Deoxyadenylate	DNA
Guanine	Guanosine	Guanylate	RNA
	Deoxyguanosine	Deoxyguanylate	DNA
Pyrimidines			
Cytosine	Cytidine	Cytidylate	RNA
	Deoxycytidine	Deoxycytidylate	DNA
Thymine	Thymidine or deoxythymidine	Thymidylate or deoxythymidylate	DNA
Uracil	Uridine	Uridylate	RNA

Structure of nucleic acids

Polynucleotide chain

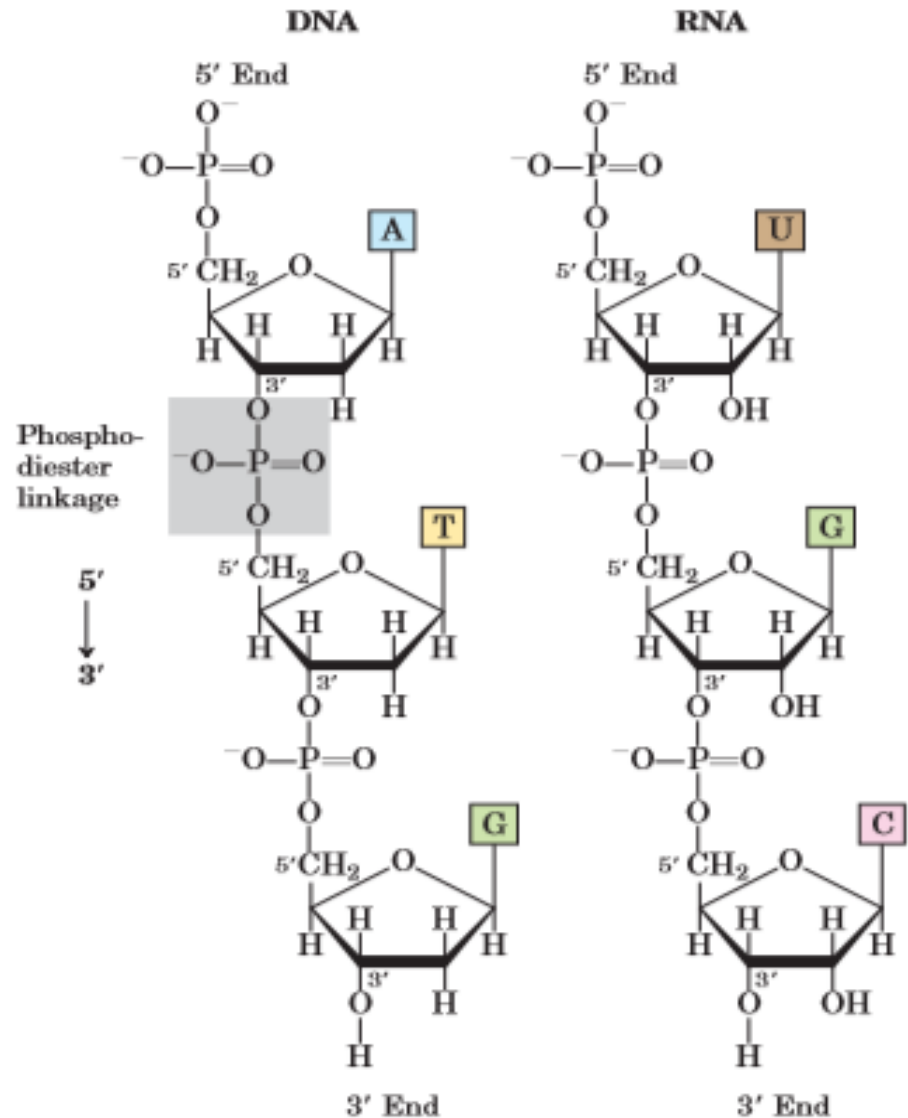
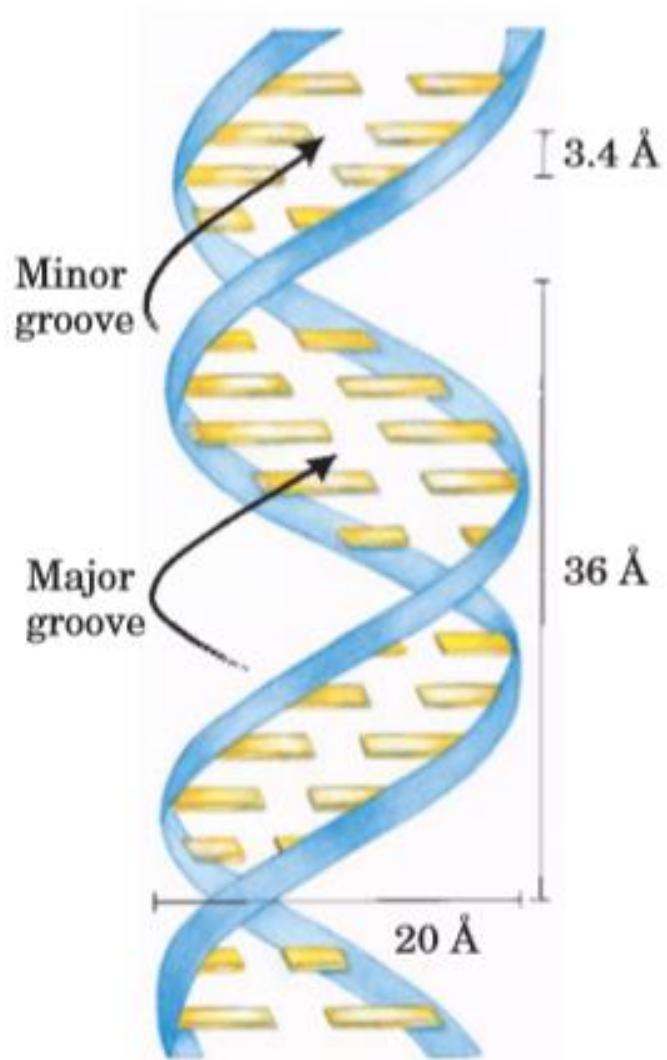


FIGURE 2-7 The structure of DNA and RNA polynucleotide chains. The DNA chain is composed of deoxyribose sugars and nitrogenous bases (A, T, and G). The RNA chain is composed of ribose sugars and nitrogenous bases (U, G, and C). The chains are linked by phosphodiester bonds.

- DNA was first isolated and characterized by Friedrich Miescher in 1868. He called the phosphorus-containing substance “nuclein.”
- Later by the experiments during 1940s, of Oswald T. Avery, Colin MacLeod, and Maclyn McCarty and in 1952, experiments by Alfred D. Hershey and Martha Chase by using bacteriophages with its labeled DNA and protein, they proved DNA as genetic material.
- Another important clue to the structure of DNA came from the work of Erwin Chargaff and his colleagues in the late 1940s. They found that the four nucleotide bases of DNA occur in different ratios in the DNAs of different organisms and that the amounts of certain bases are closely related.

These data, collected from DNAs of a great many different species, led Chargaff to the following conclusions:

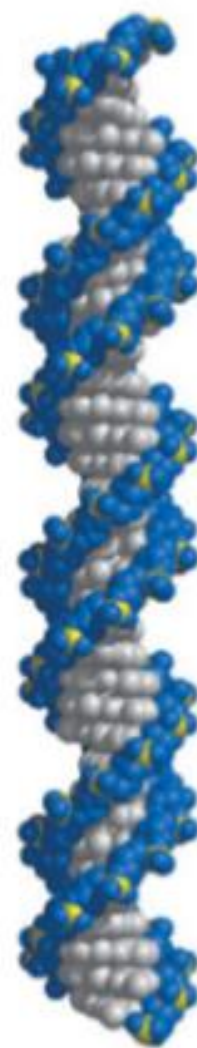
1. The base composition of DNA generally varies from one species to another.
2. DNA specimens isolated from different tissues of the same species have the same base composition.
3. The base composition of DNA in a given species does not change with an organism's age, nutritional state, or changing environment.
4. In all cellular DNAs, regardless of the species, the number of adenosine residues is equal to the number of thymidine residues (that is, $A = T$), and the number of guanosine residues is equal to the number of cytidine residues ($G = C$). From these relationships it follows that the sum of the purine residues equals the sum of the pyrimidine residues; that is, $A + G = T + C$.



(a)



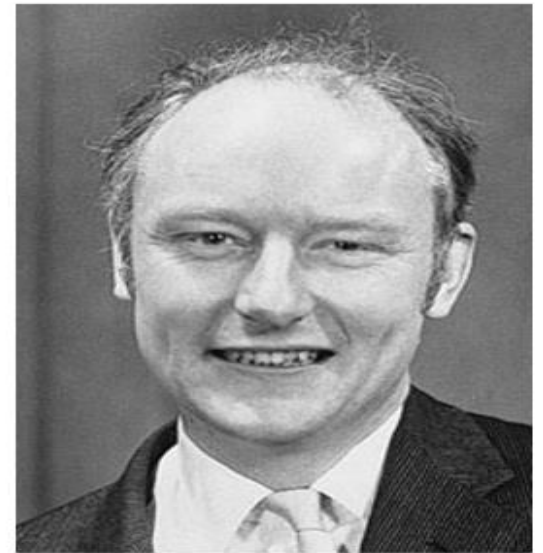
(b)



(c)



James D. Watson



Francis Crick,
1916–2004

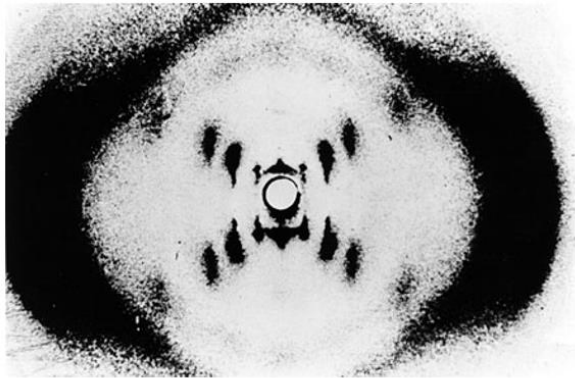


FIGURE 8-12 X-ray diffraction pattern of DNA. The spots forming a cross in the center denote a helical structure. The heavy bands at the left and right arise from the recurring bases.



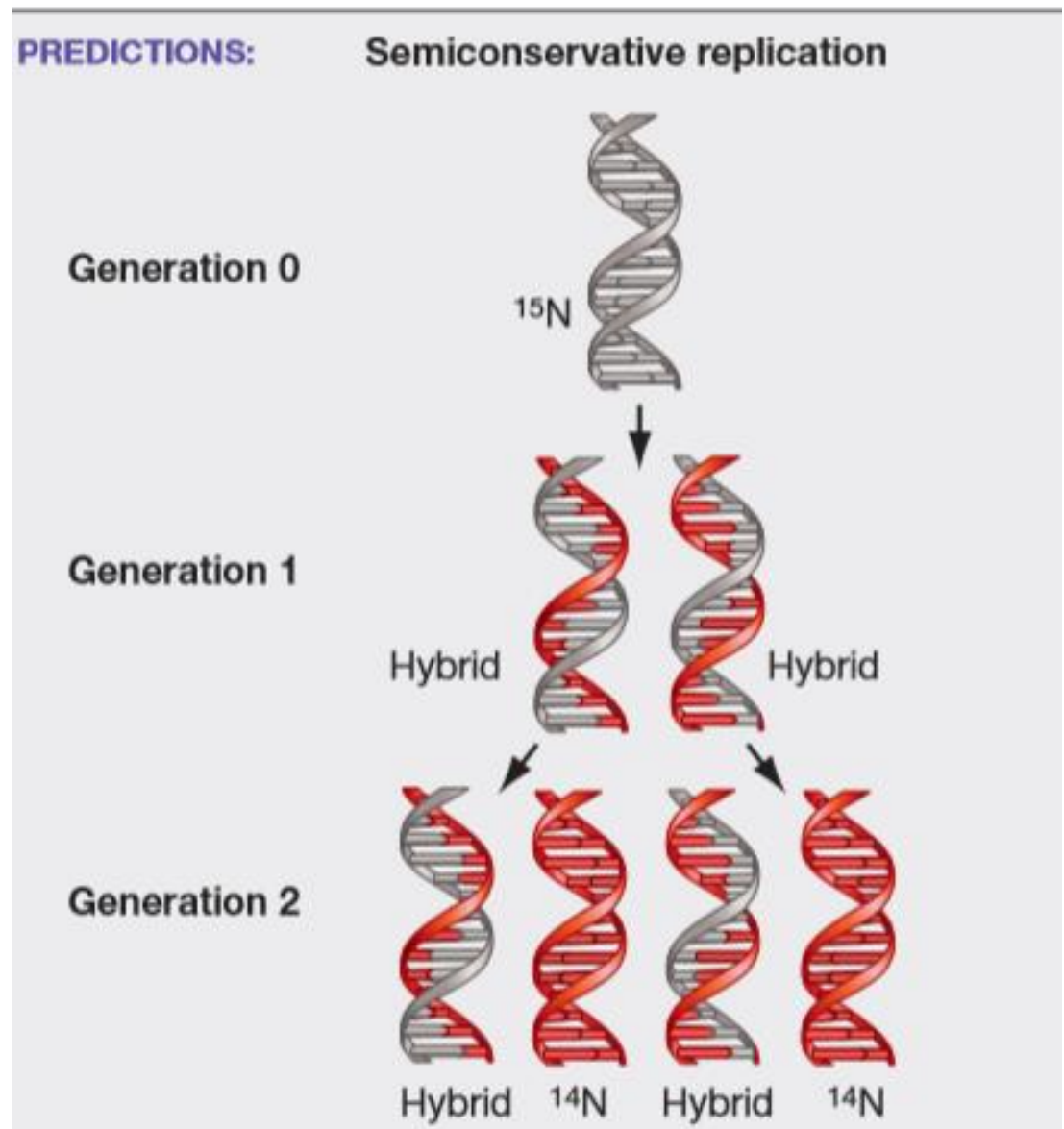
Rosalind Franklin,
1920–1958



Maurice Wilkins,
1916–2004

DNA replication

The Meselson–Stahl
Experiment (1958)



Stages of DNA replication

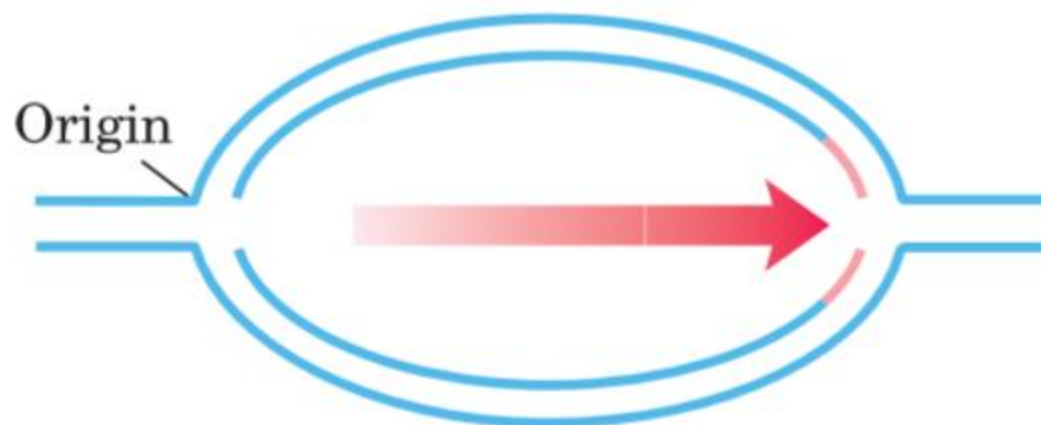
- **1. Initiation**
- Recognition of origin
- Unwinding of DNA and denaturation to make it single stranded.
- Synthesis of RNA primers
- Loading of DNA polymerase
- **2. Elongation**
- Synthesis of leading and lagging strand
- Primer removal and nick sealing
- Ligation of okazaki fragments
- Proof reading
- **3. Termination** at termination sequences in bacteria and at telomere in eukaryotes.

Replication begins at an origin and usually proceeds bidirectionally.

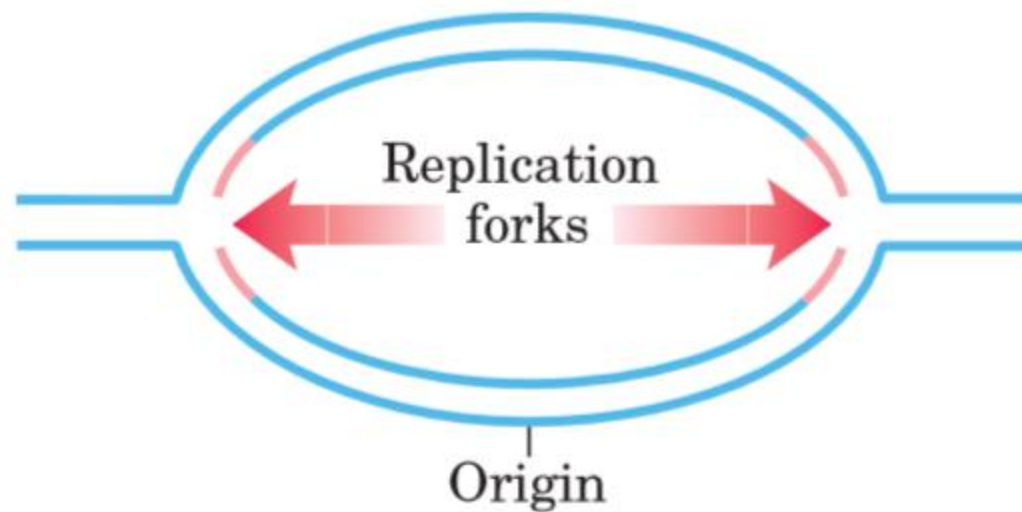
The replication fork is the Y-shaped region where the parent-DNA double helix is split into two single strands and copied.

(b)

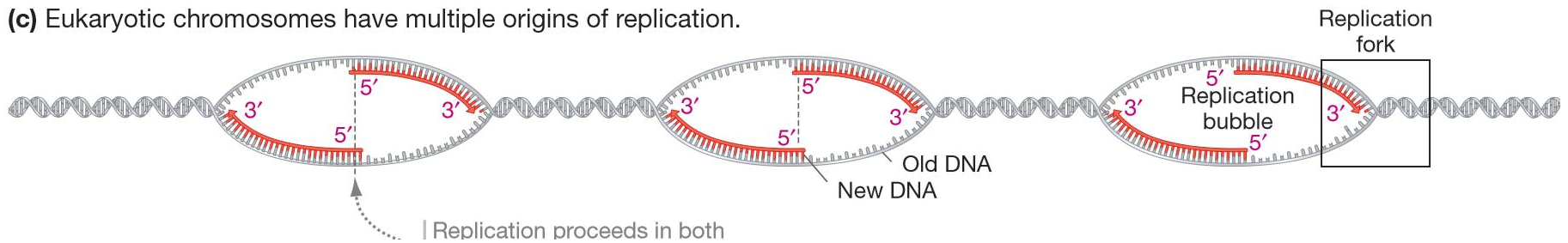
Unidirectional



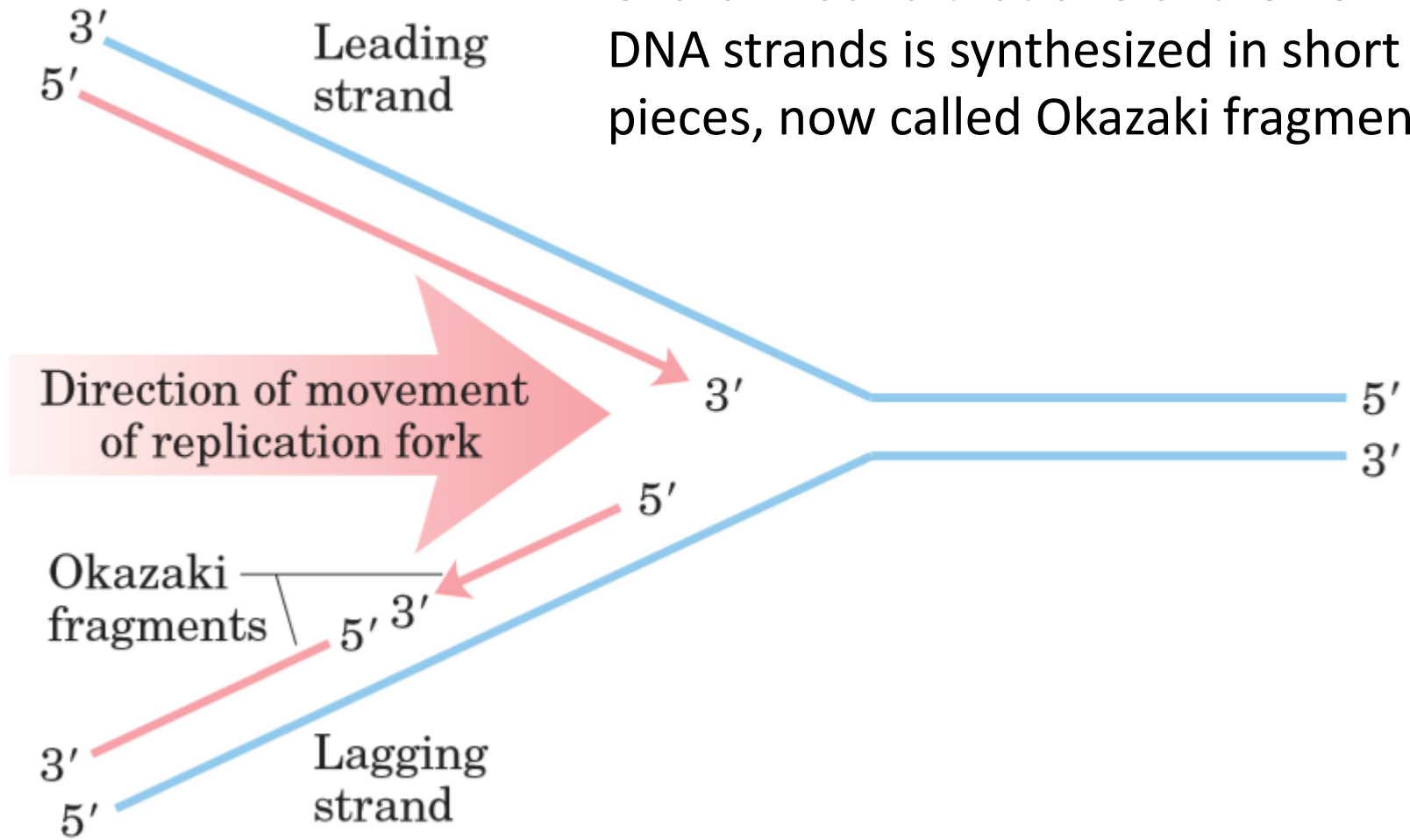
Bidirectional

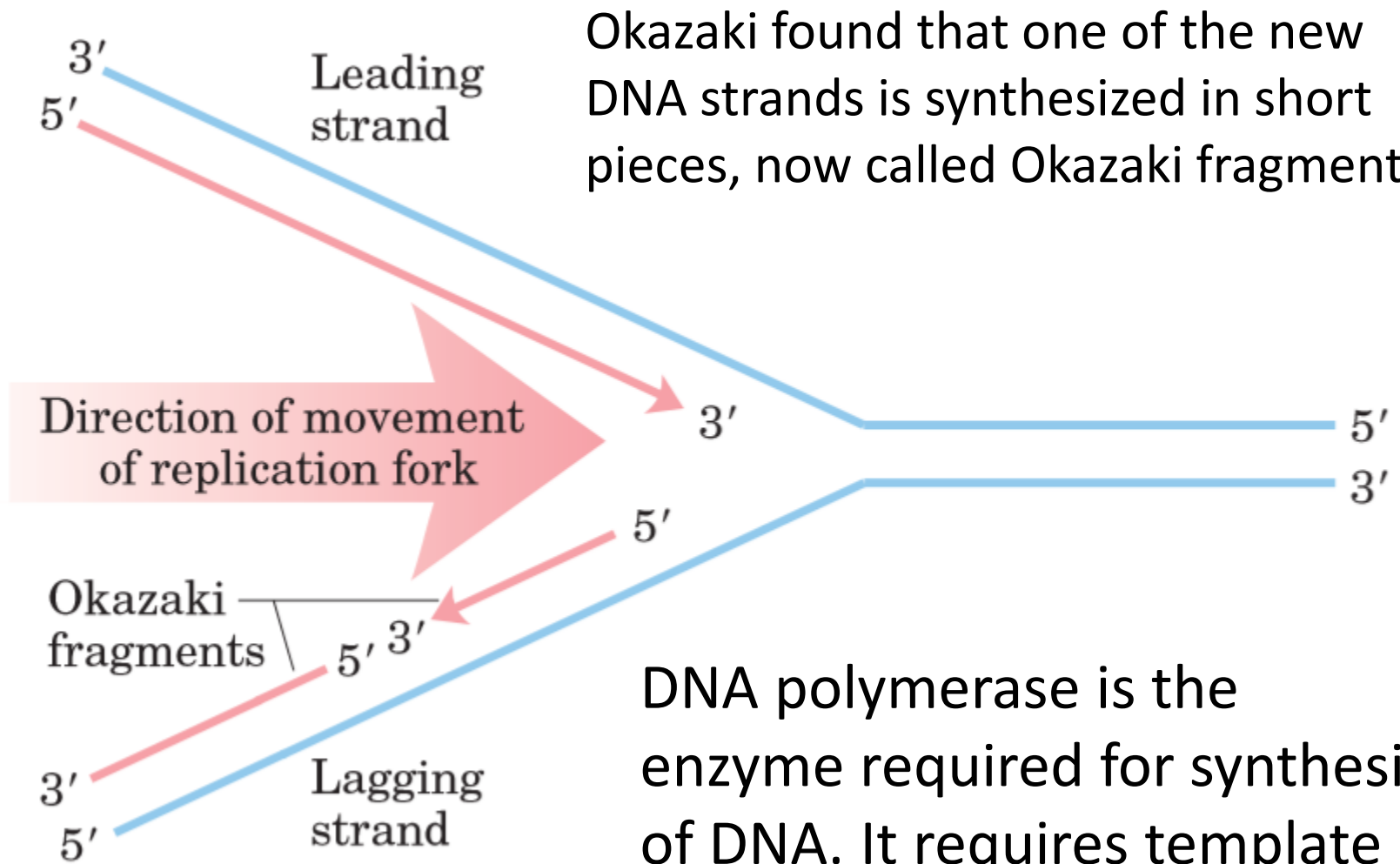


(c) Eukaryotic chromosomes have multiple origins of replication.



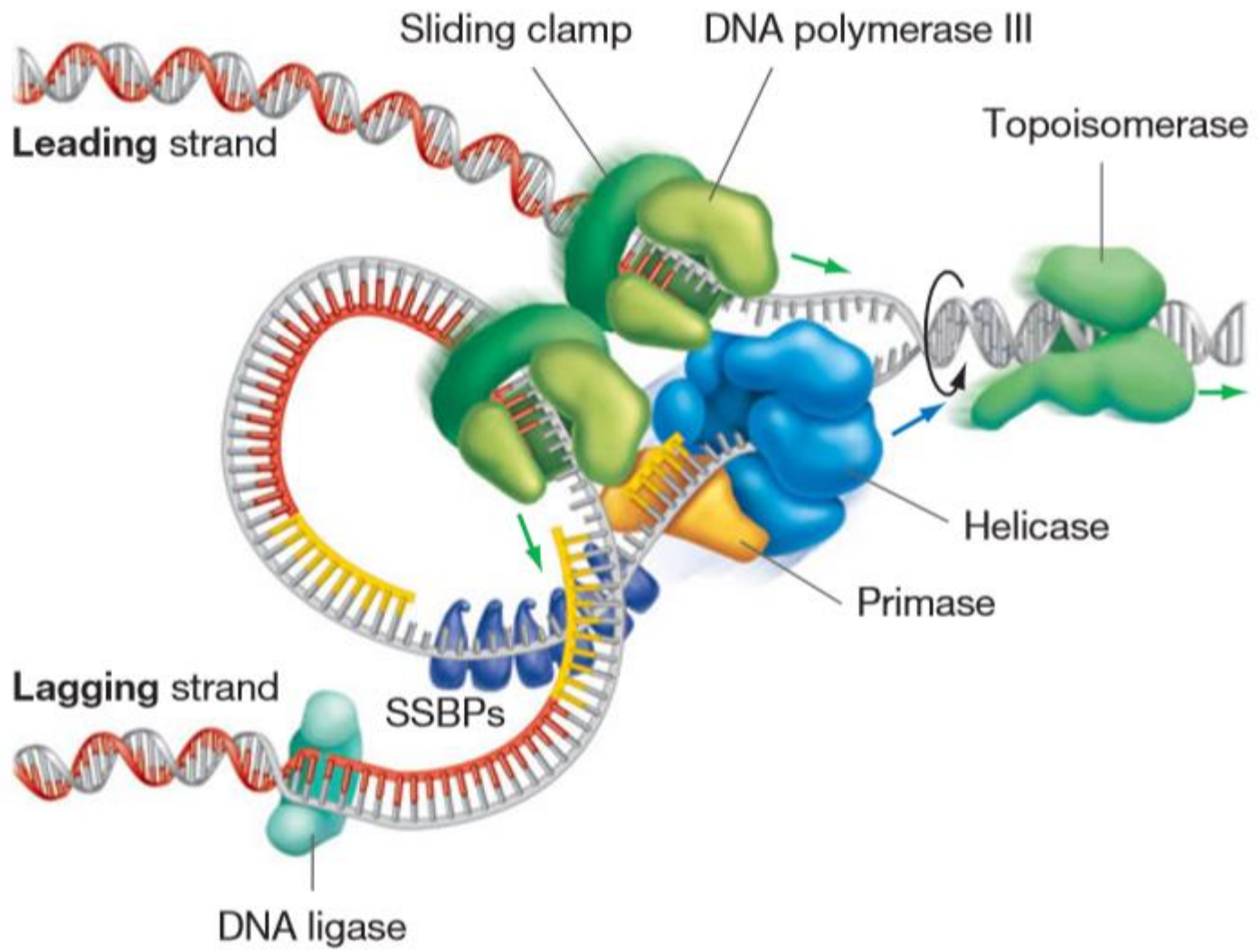
Okazaki found that one of the new DNA strands is synthesized in short pieces, now called Okazaki fragments.



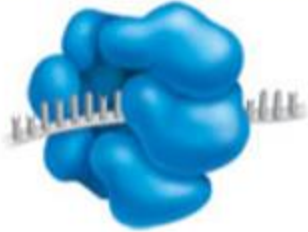




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DNA polymerase is the enzyme required for synthesis of DNA. It requires template and primer.



SUMMARY TABLE 15.1 Proteins Required for DNA Synthesis in Bacteria

Name	Structure	Function
<i>Opening the helix</i>		
Helicase		Catalyzes the breaking of hydrogen bonds between base pairs to open the double helix
Single-strand DNA-binding proteins (SSBPs)		Stabilizes single-stranded DNA
Topoisomerase		Breaks and rejoins the DNA double helix to relieve twisting forces caused by the opening of the helix

Leading strand synthesis

Primase



Catalyzes the synthesis of the RNA primer

DNA polymerase III



Extends the leading strand

Sliding clamp



Holds DNA polymerase in place during strand extension

Lagging strand synthesis

Primase



Catalyzes the synthesis of the RNA primer on an Okazaki fragment

DNA polymerase III



Extends an Okazaki fragment

Sliding clamp



Holds DNA polymerase in place during strand extension

DNA polymerase I



Removes the RNA primer and replaces it with DNA

DNA ligase



Catalyzes the joining of Okazaki fragments into a continuous strand