DNA Replication

DNA

- **Discovery of the DNA double helix**

  A. **1950's**

  B. **Rosalind Franklin** - X-ray photo of DNA.

  C. **Watson and Crick** - described the DNA molecule from Franklin's X-ray.

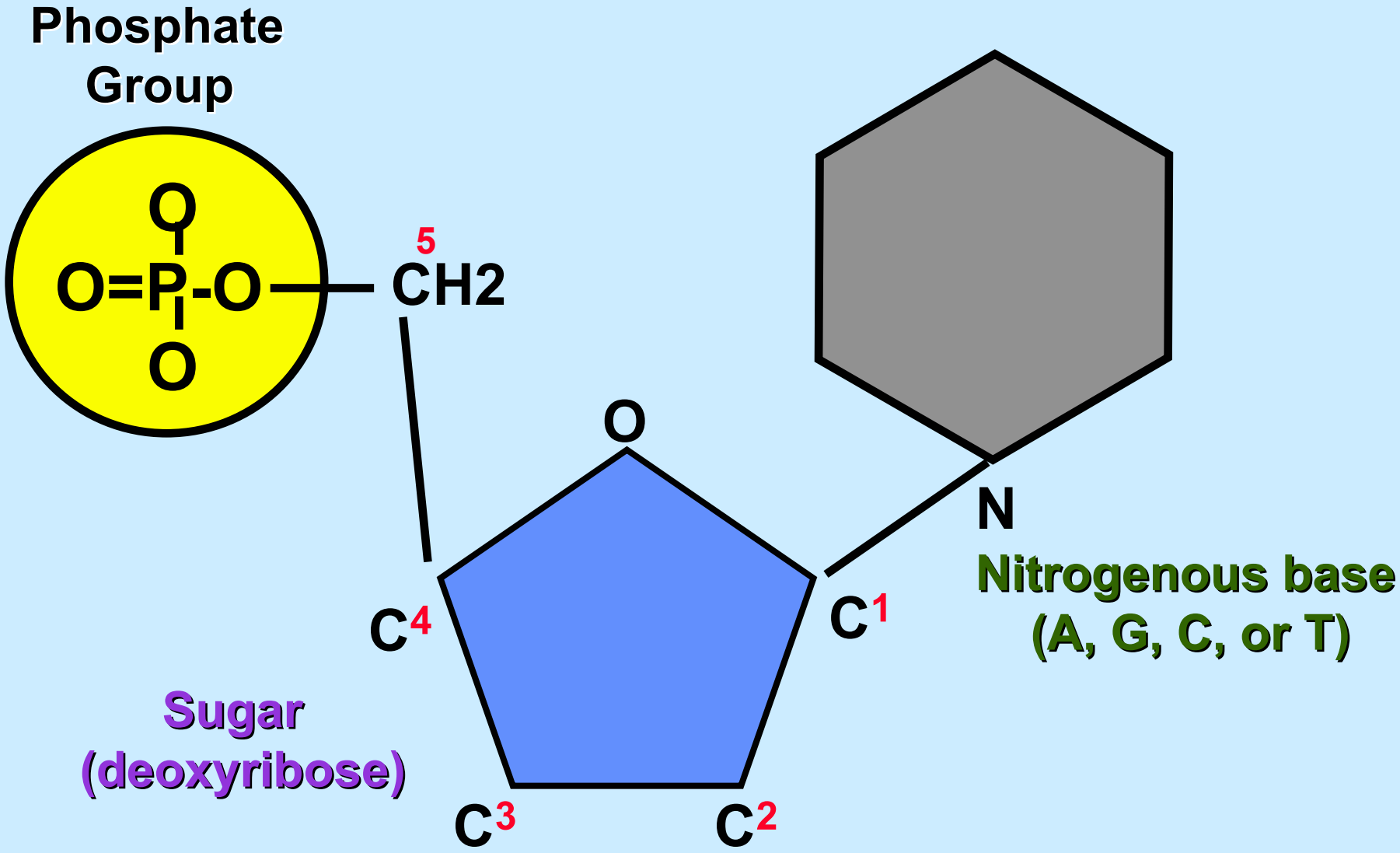
Question:

- What is DNA?

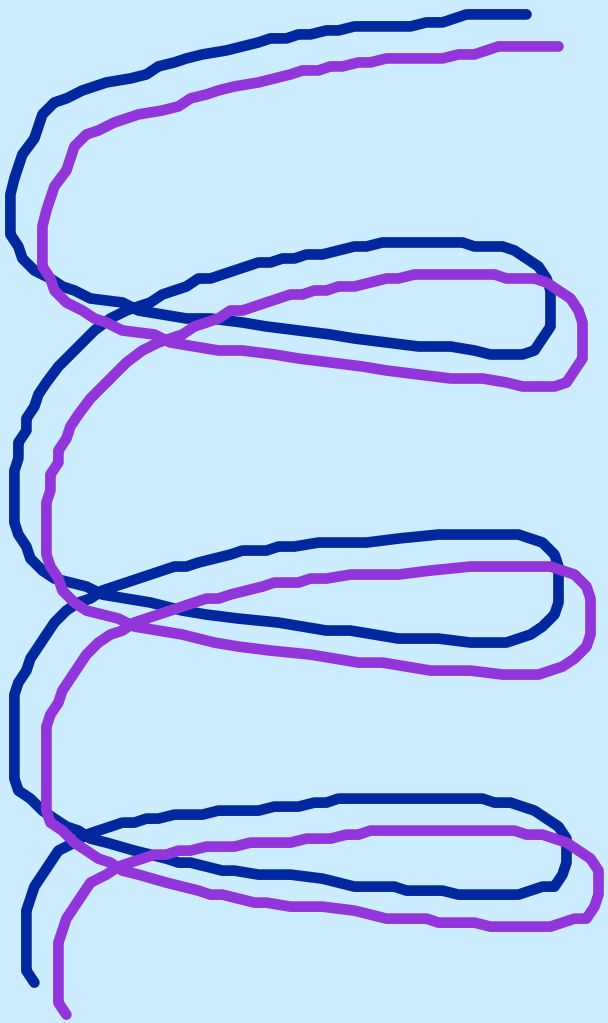
Deoxyribonucleic Acid (DNA)

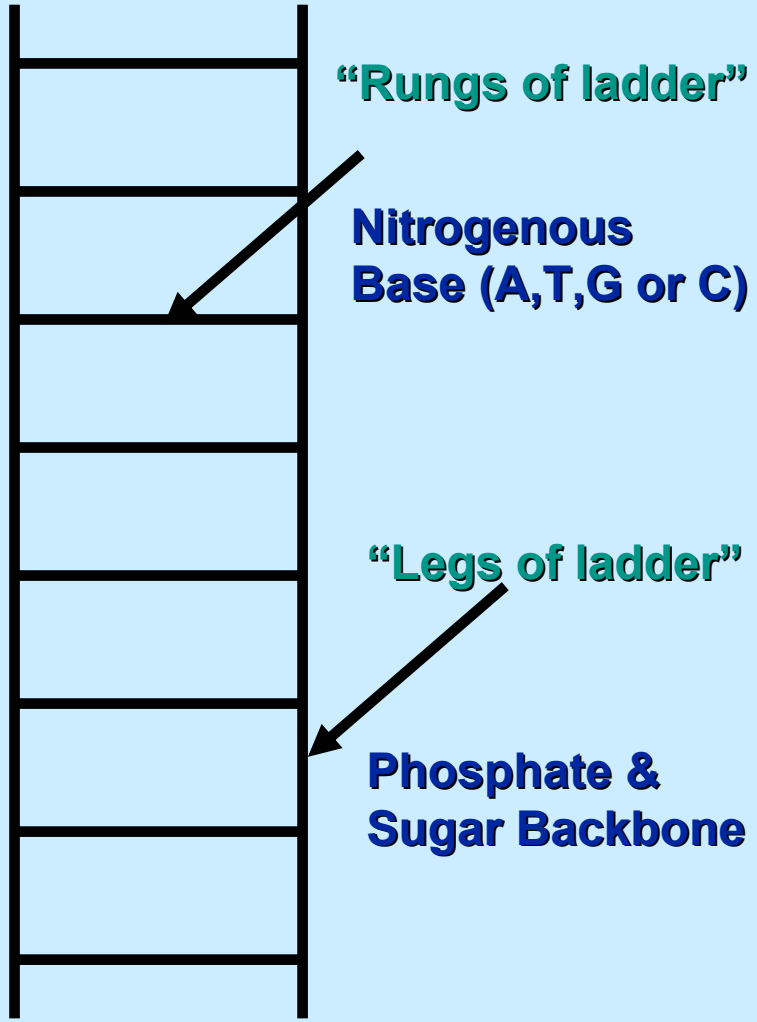
- Made up of **nucleotides** (DNA molecule) in a **DNA double helix.**
- **Nucleotide**:
    1. **Phosphate group**
    2. **5-carbon sugar**
    3. **Nitrogenous base**
- **~2 nm wide**

DNA Nucleotide

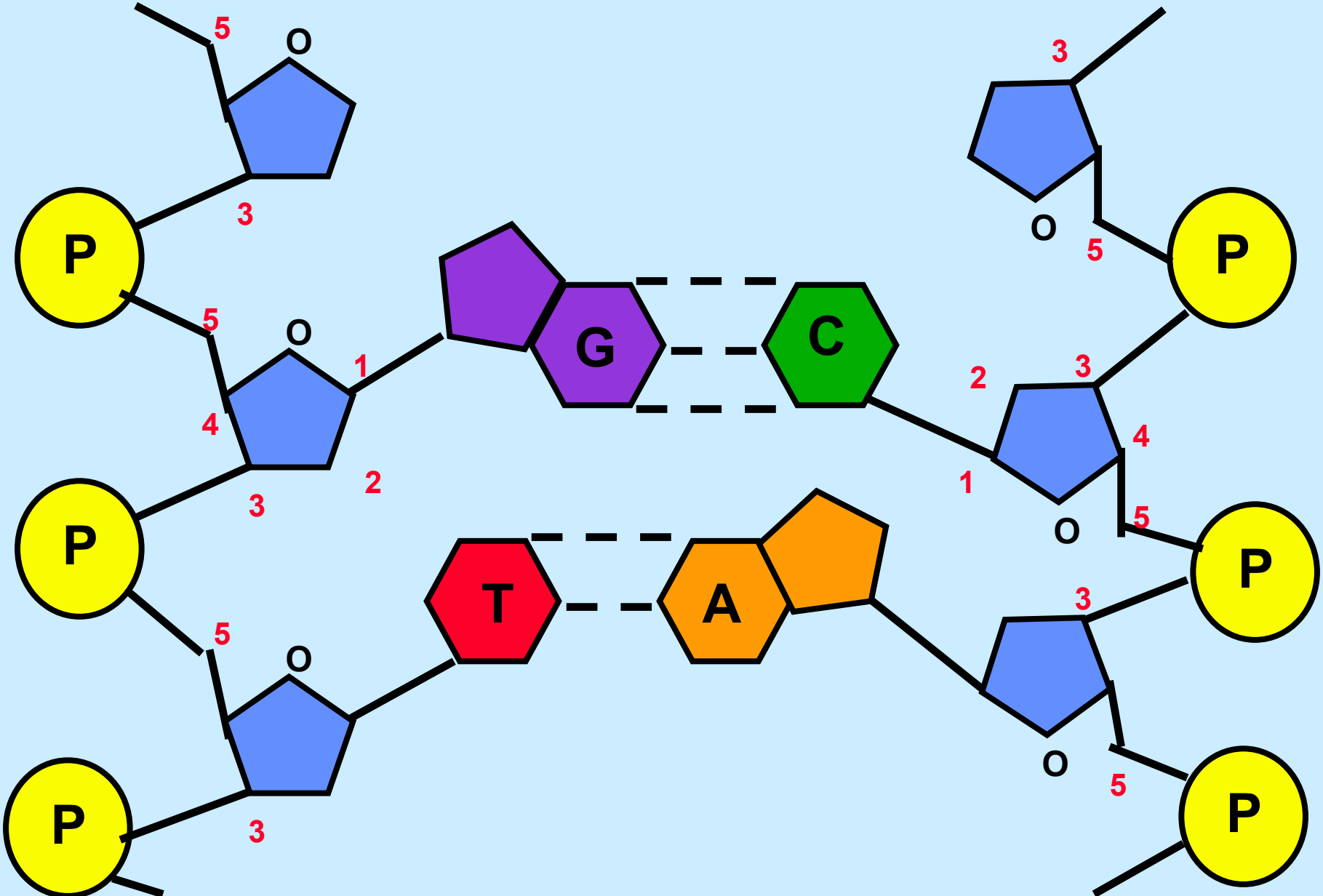


DNA Double Helix



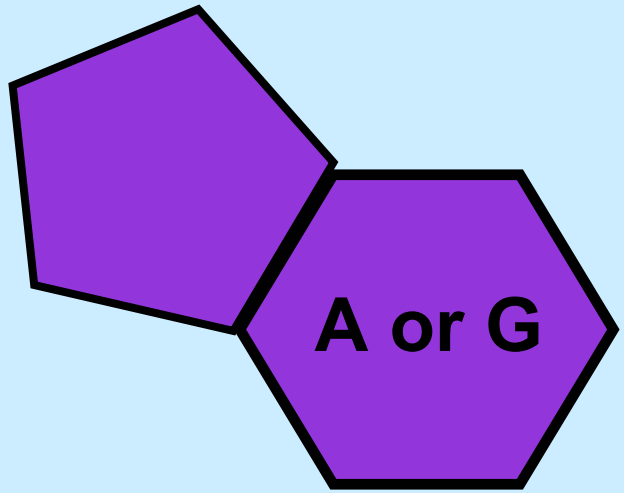


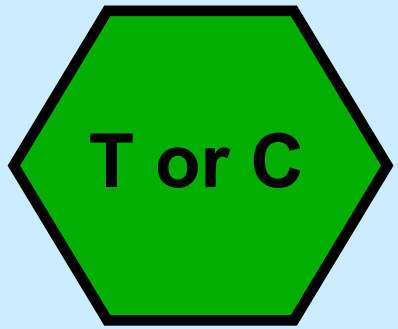
DNA Double Helix



Nitrogenous Bases

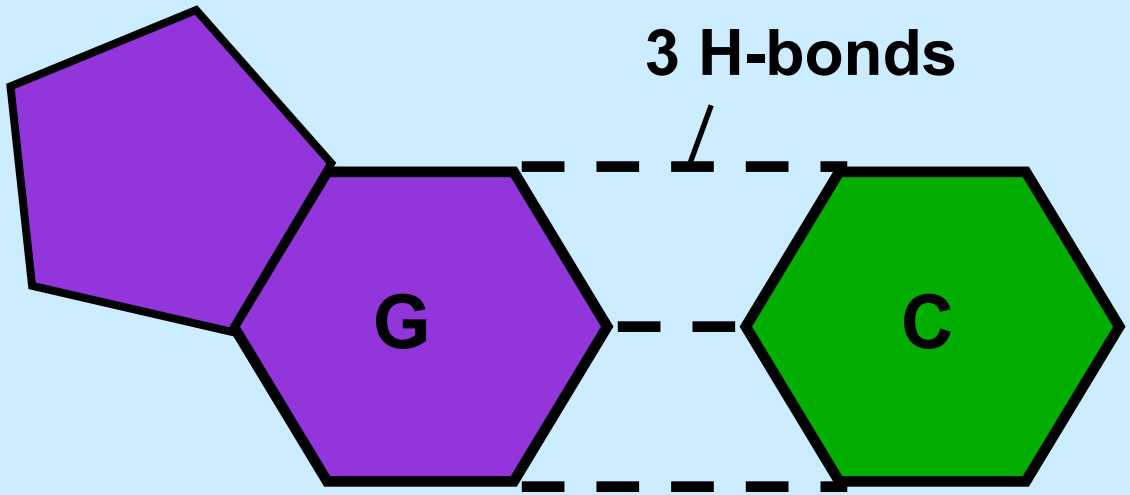
- **PURINES**
  1. Adenine (A)
  2. Guanine (G)
- **PYRIMIDINES**
  3. Thymine (T)
  4. Cytosine (C)



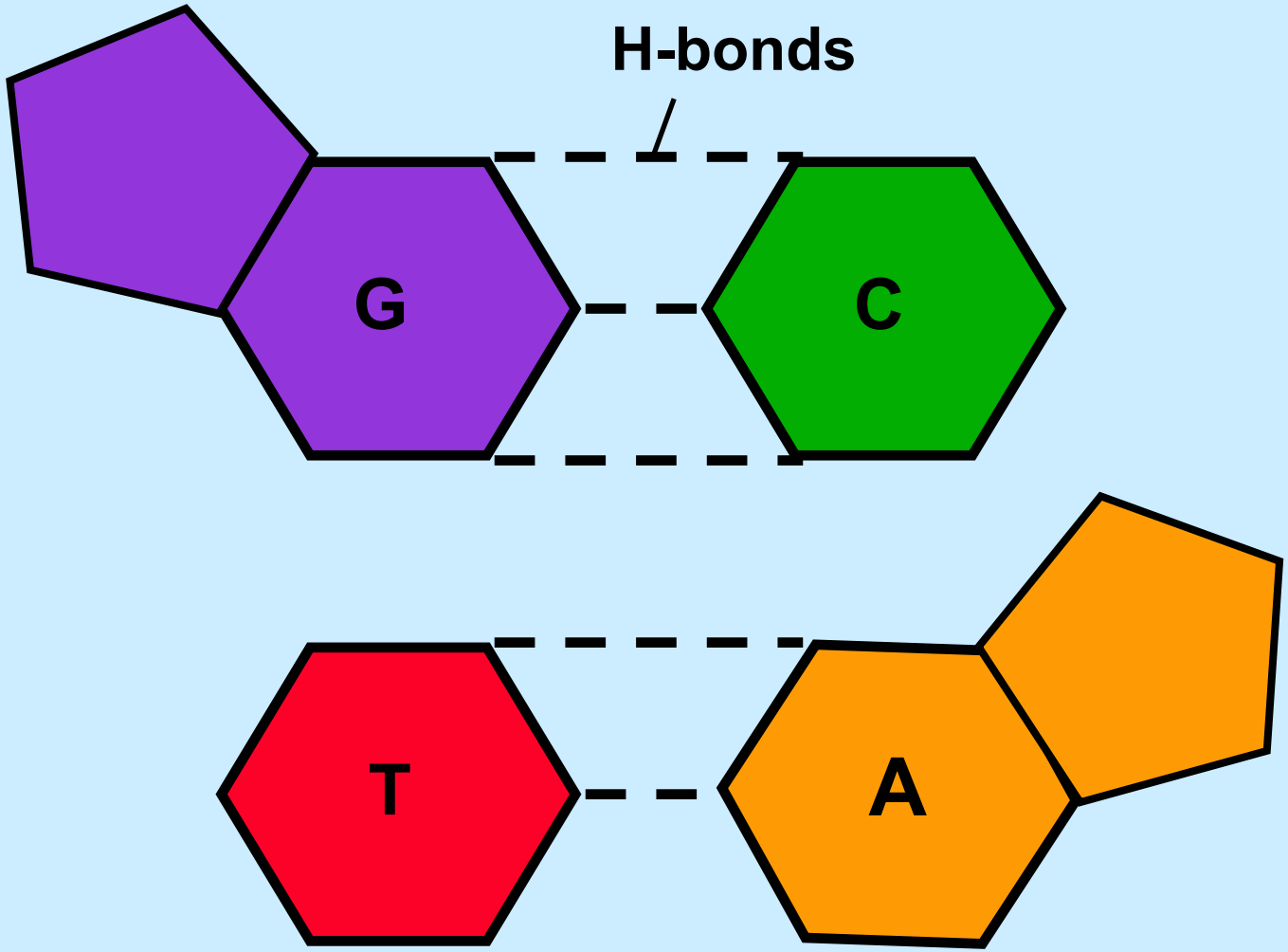


BASE-PAIRINGS

Purines	Pyrimidines	Base Pairs	# of H-Bonds
Adenine (A)	Thymine (T)	A = T	2
Guanine (G)	Cytosine (C)	C ≡ G	3

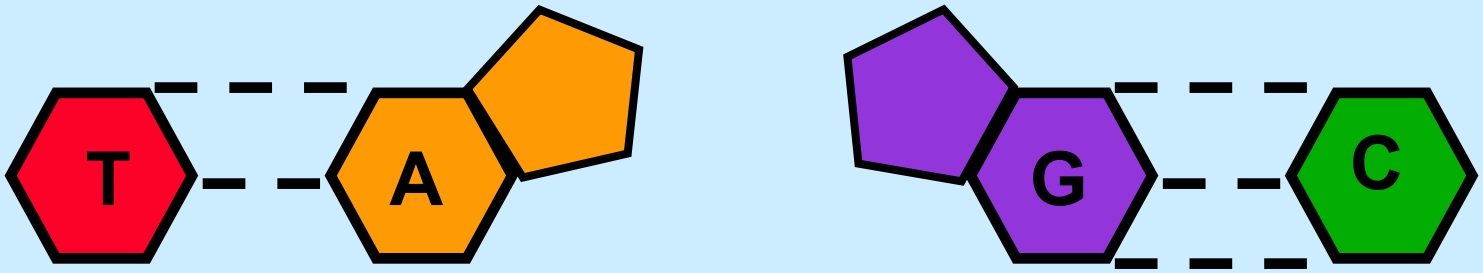


BASE-PAIRINGS



Chargaff's Rule

- **Adenine** must pair with **Thymine**
- **Guanine** must pair with **Cytosine**
- Their amounts in a given DNA molecule will be **about the same**.



Question:

- If there is 30% Adenine, how much Cytosine is present?

Answer:

- There would be 20% Cytosine.

Adenine (30%) = Thymine (30%)

Guanine (20%) = Cytosine (20%)

(50%) = (50%)

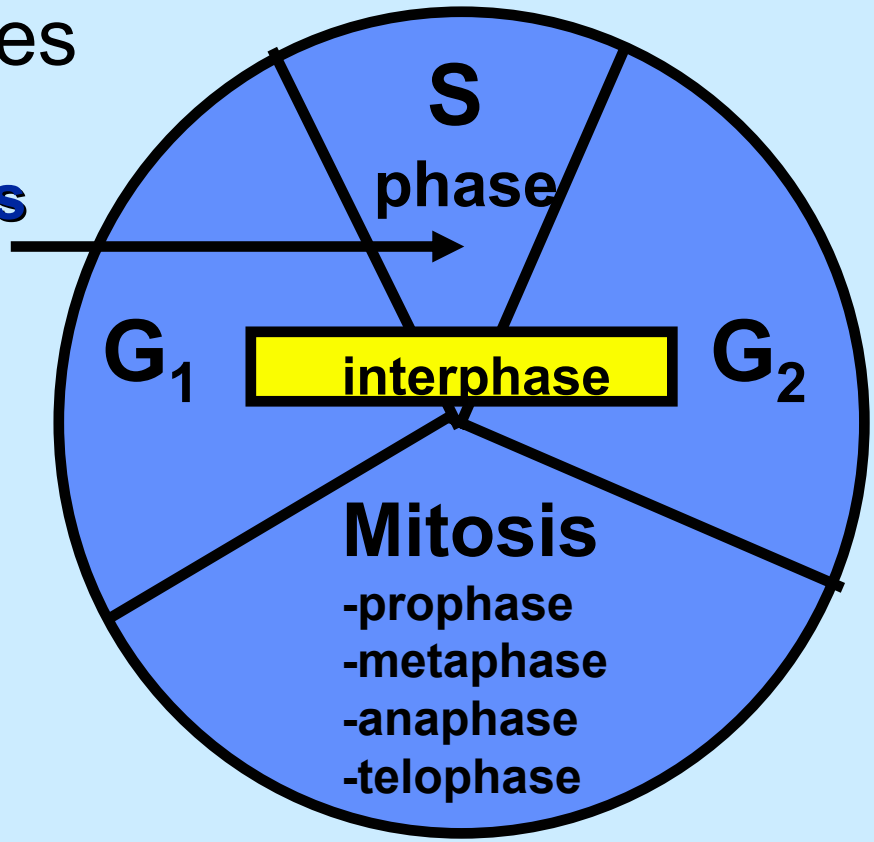
Question:

- When and where does DNA Replication take place?

Synthesis Phase (S phase)

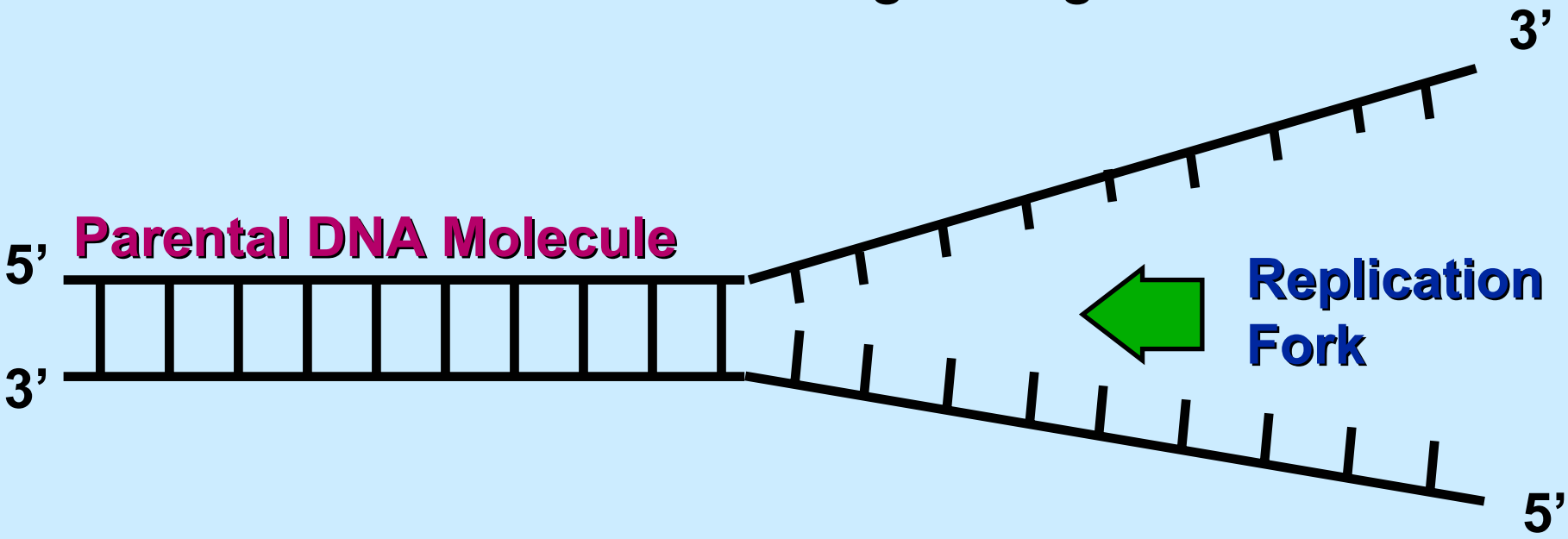
- **S phase** in **interphase** of the **cell cycle**.
- **Nucleus** of eukaryotes

DNA replication takes place in the S phase.



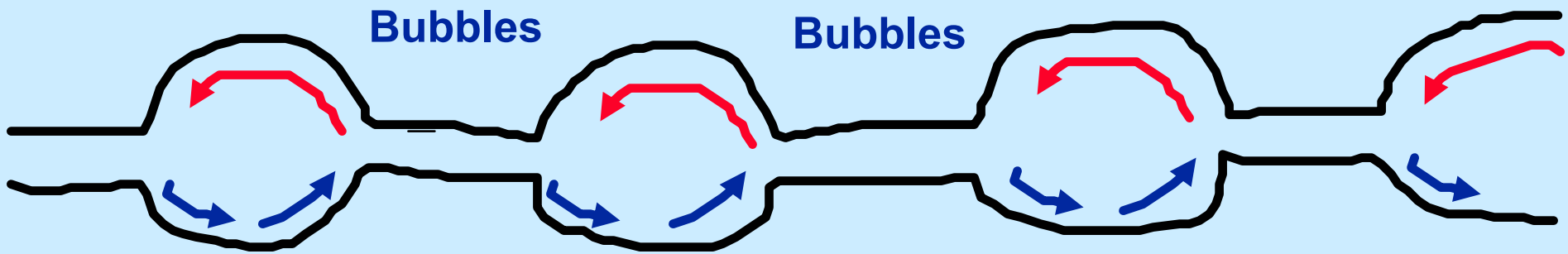
DNA Replication

- **Origins of replication**
  1. **Replication Forks**: **hundreds** of **Y-shaped** regions of **replicating DNA molecules** where new strands are growing.



DNA Replication

- **Origins of replication**
  2. **Replication Bubbles**:
     a. **Hundreds** of replicating bubbles **(Eukaryotes)**.
     b. **Single** replication fork **(bacteria)**.



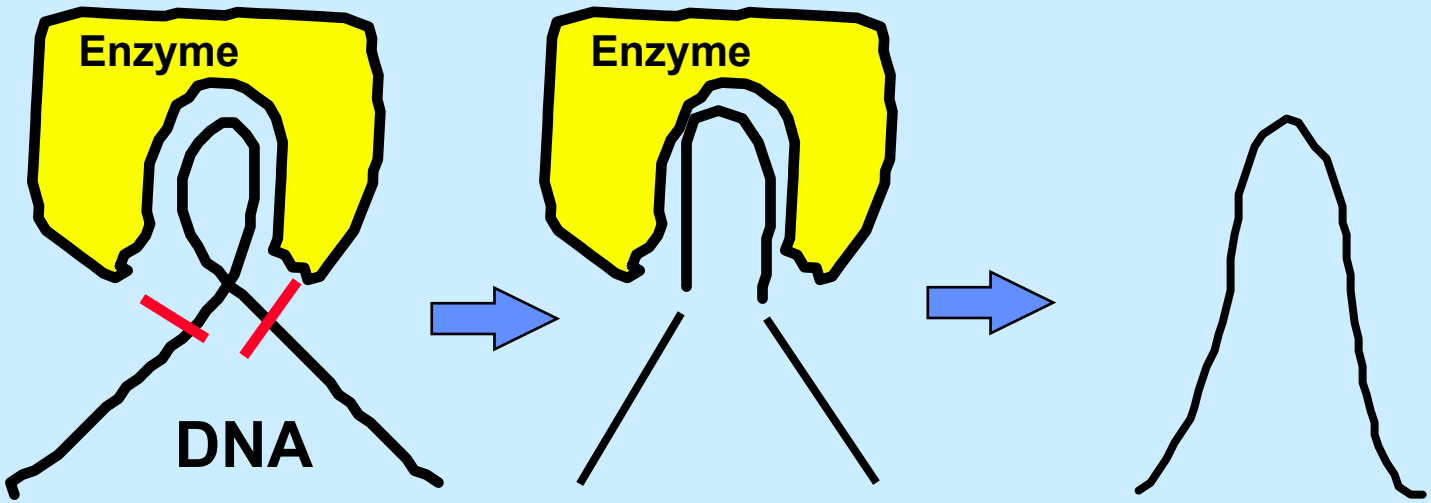
DNA Replication

- **Strand Separation**:
  1. **Helicase**: enzyme which catalyze the **unwinding** and **separation** (breaking H-Bonds) of the parental double helix.

  2. **Single-Strand Binding Proteins**: proteins which attach and help keep the separated strands apart.

DNA Replication

- **Strand Separation**:
  3. **Topoisomerase**: **enzyme which relieves stress** on the **DNA molecule** by allowing free rotation around a single strand.



DNA Replication

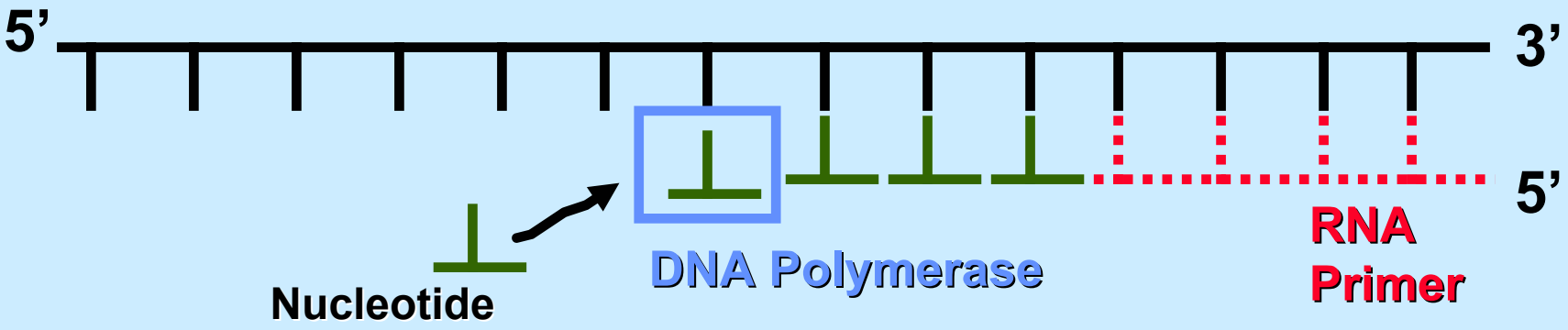
- **Priming:**
  1. **RNA primers**: before new DNA strands can form, there must be small pre-existing **primers (RNA)** present to start the addition of new nucleotides **(DNA Polymerase)**.

  2. **Primase**: enzyme that polymerizes (synthesizes) the **RNA Primer**.

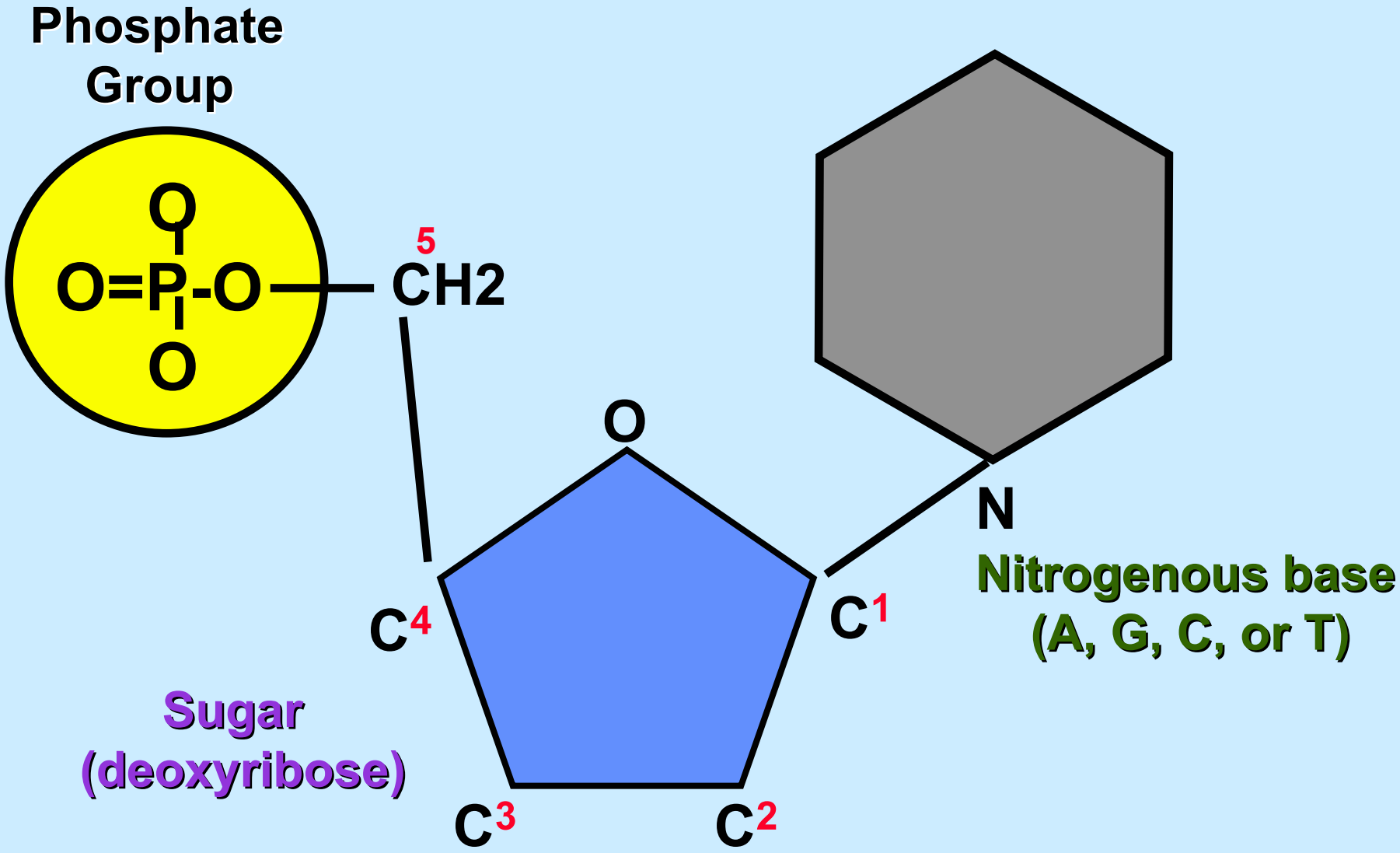
DNA Replication

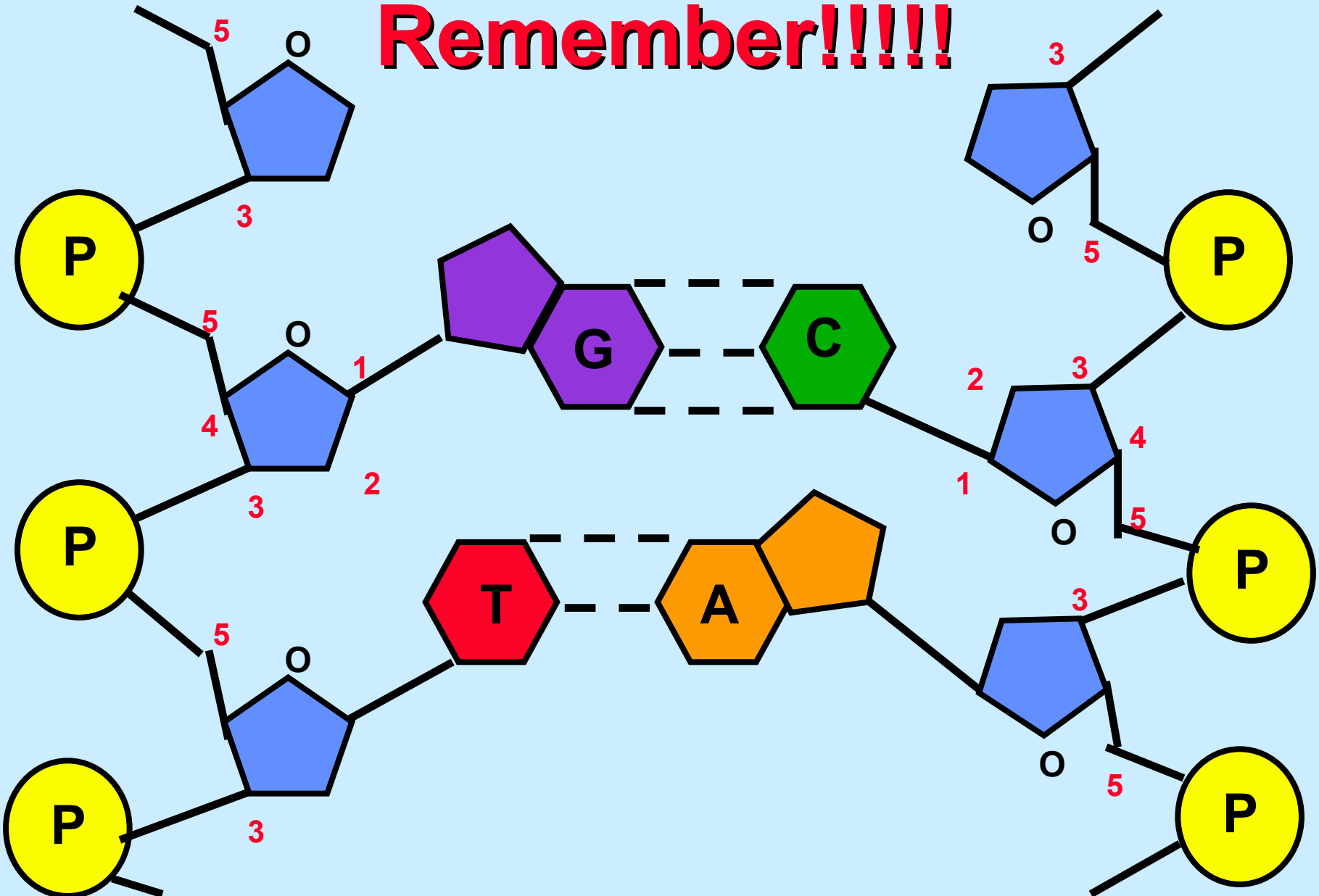
- **Synthesis of the new DNA Strands:**

  1. **DNA Polymerase**: with a **RNA primer** in place, DNA Polymerase (enzyme) catalyze the **synthesis of a new DNA strand in the 5' to 3' direction**.



Remember!!!!

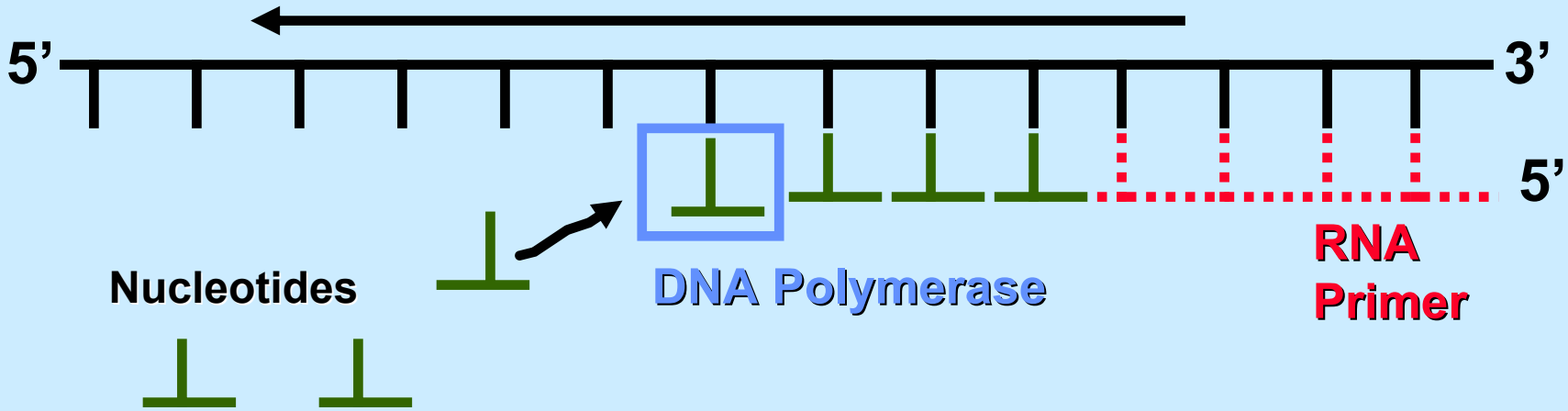

Phosphate Group
O
O=P-O
O
5
CH2
O
N
Nitrogenous base (A, G, C, or T)
C4
C1
Sugar (deoxyribose)
C3
C2


Remember!!!!!
5
O
3
P
5
O
1
4
2
3
G
C
3
O
5
P
2
3
4
1
5
O
P
T
A
5
O
3
3
O
5
P
P

DNA Replication

- **Synthesis of the new DNA Strands:**

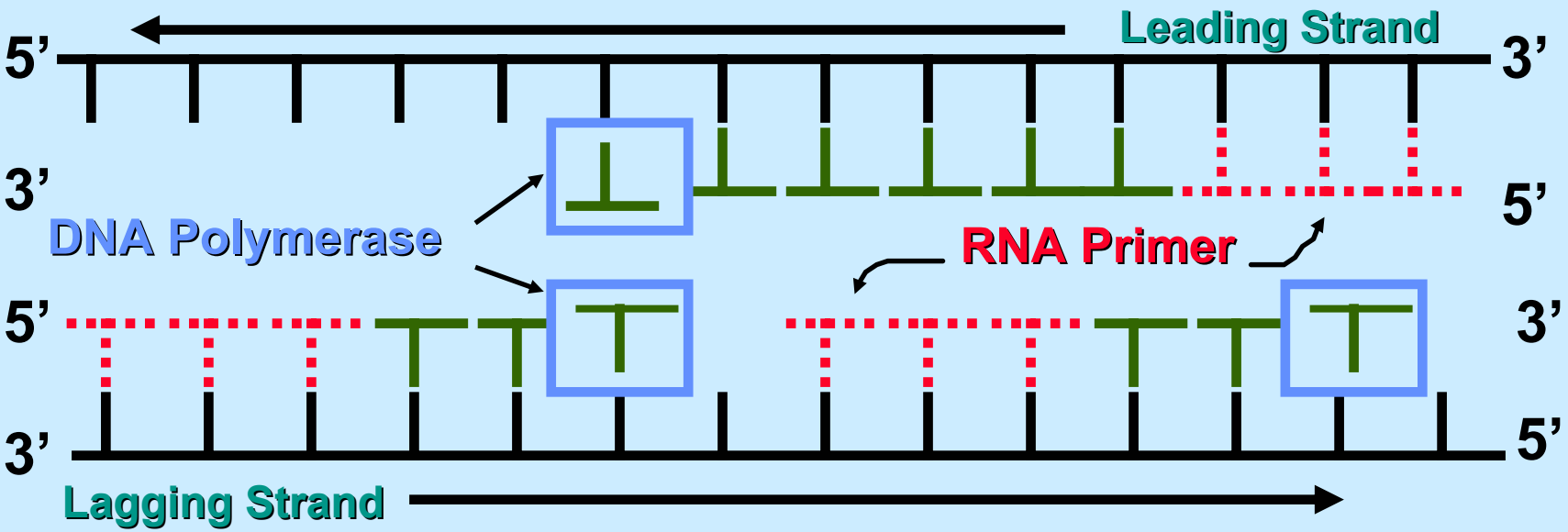
  2. **Leading Strand**: synthesized as a **single polymer** in the **5' to 3' direction**.



DNA Replication

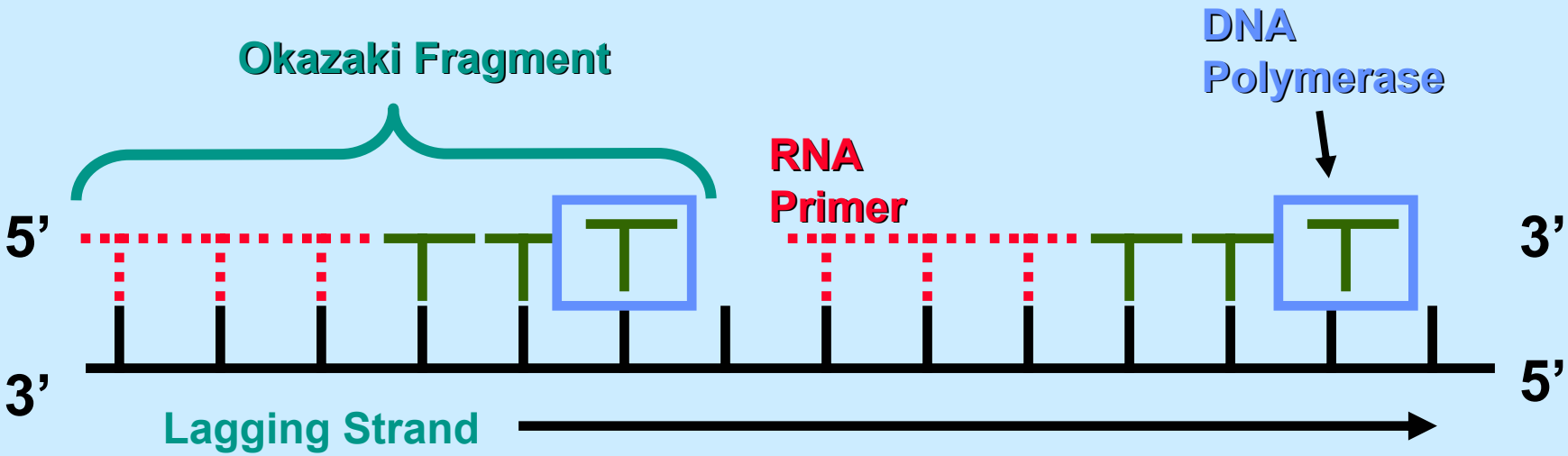
- **Synthesis of the new DNA Strands:**

  3. **Lagging Strand**: also synthesized in the **5' to 3' direction**, but **discontinuously** against overall direction of replication.



DNA Replication

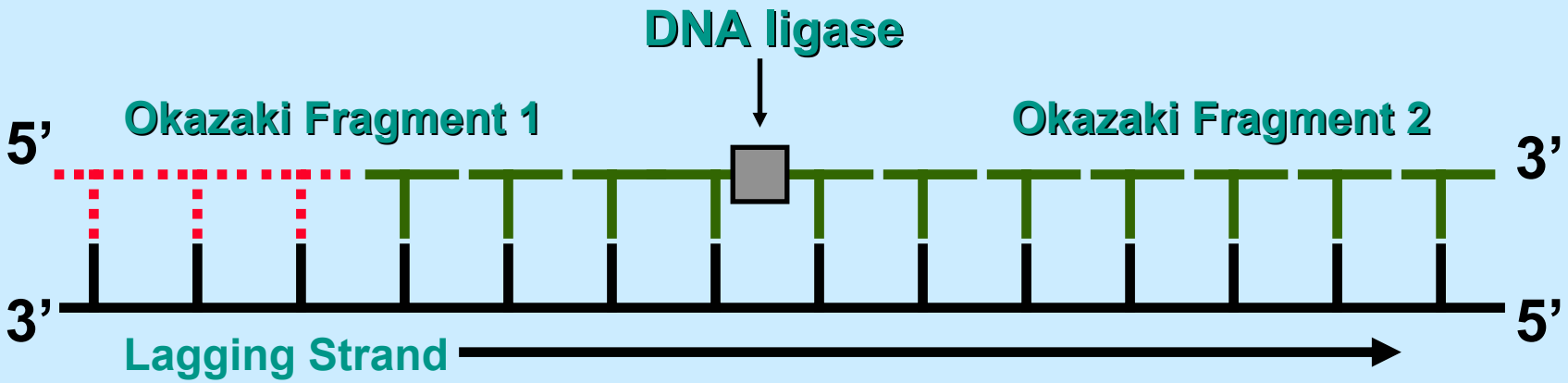
- **Synthesis of the new DNA Strands:**
  4. **Okazaki Fragments**: series of short segments on the **lagging strand.**



DNA Replication

- **Synthesis of the new DNA Strands:**
  5. **DNA ligase**: **a linking enzyme that catalyzes the formation of a covalent bond from the 3' to 5' end of joining stands.**

Example: joining two Okazaki fragments together.



DNA Replication

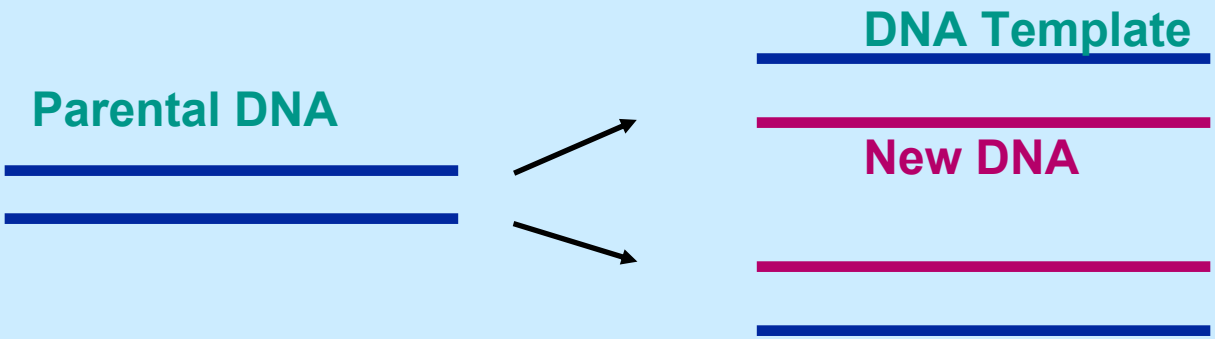
- **Synthesis of the new DNA Strands:**

6. **Proofreading**: initial base-pairing errors are usually corrected by **DNA polymerase**.

DNA Replication

- **Semiconservative Model:**

  1. **Watson and Crick showed:** the two strands of the parental molecule separate, and each functions as a template for synthesis of a new complementary strand.



DNA Repair

- **Excision repair:**
  1. Damaged segment is **excised** by a **repair enzyme** (there are over 50 repair enzymes).

  2. **DNA polymerase** and **DNA ligase** replace and bond the new nucleotides together.

Question:

- **What would be the complementary DNA strand for the following DNA sequence?**

DNA 5’-GCGTATG-3’

Answer:

DNA 5’-GCGTATG-3’

DNA 3’-CGCATAC-5’