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SUBJECT – ZOOLOGY

B.Sc. Part-III Semister - V

Zoology Paper - X

DSE- F29 (Molecular cell biology & Animal Biotechnology)

Unit- I - Molecular biology

Chapter – I DNA Replication (Semiconservative model)

DNA Replication

- **Types of DNA replication**
  - Semi-conservative model of DNA replication
  - Prokaryotic DNA replication
  - Eukaryotic DNA replication
  - Inhibitors of DNA replication
    (Analogues, Intercalation, Polymerase Inhibitors)

- **DNA damage**
  - Types and agents of mutations
  - Spontaneous, Radiation, Chemicals.

- **Repair mechanisms**
  - Base Excision, Nucleotide Excision, Mismatch Repair.
- **DNA-recombination**
  - In meiosis
  - Transposition

DNA Replication

- A process in which daughter DNAs are synthesized using the parental DNAs as template.
- Transferring the genetic information to the descendant generation.

DNA Replication

DNA replication includes:

- **Initiation** – replication begins at an **origin of replication**
- **Elongation** – new strands of DNA are synthesized by **DNA polymerase**
- **Termination** – replication is terminated differently in prokaryotes and eukaryotes

DNA Replication in Bacteria

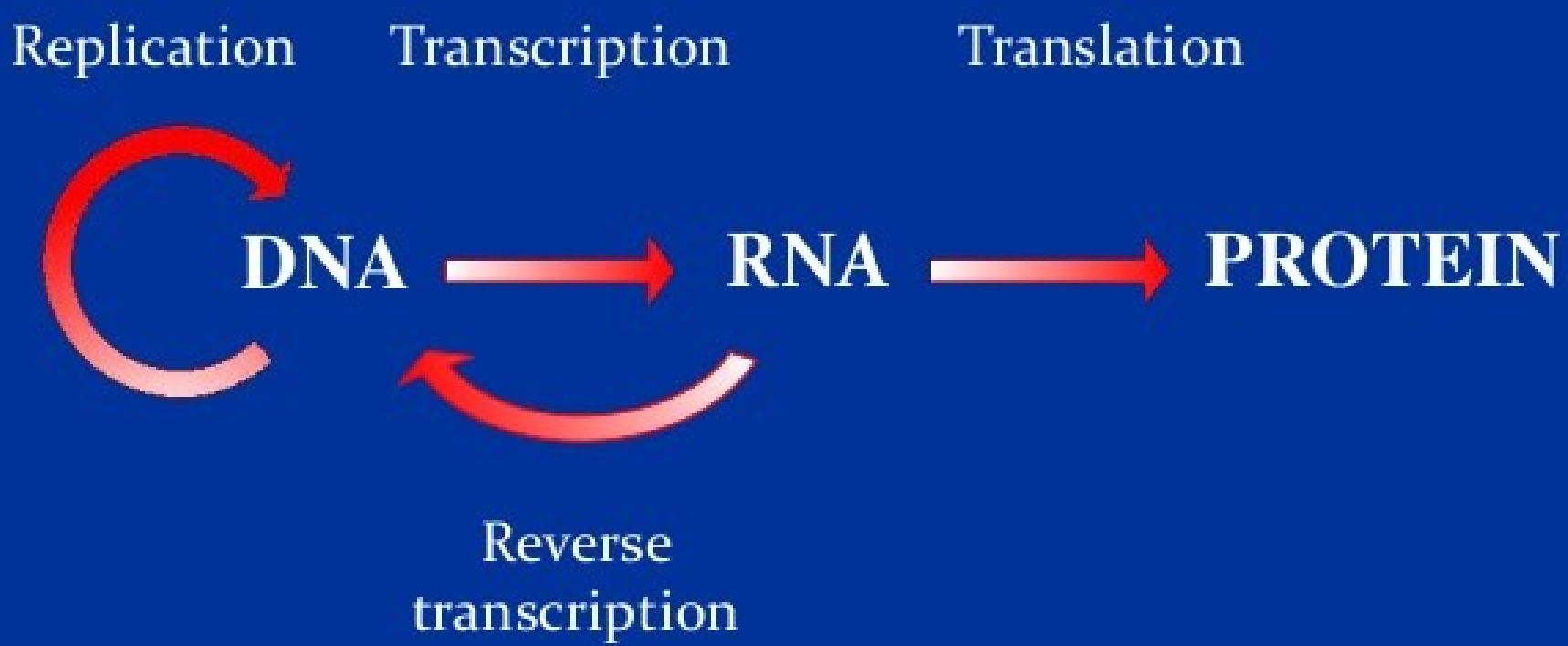
•To begin DNA replication, unwinding enzymes called **DNA helicases** cause the two parent DNA strands to unwind and separate from one another at the origin of replication to form two "Y"-shaped **replication forks**.

•These replication forks are the actual site of DNA copying.

DNA Replication in Bacteria

- **Helix destabilizing proteins** bind to the single-stranded regions so the two strands do not rejoin.
- Enzymes called **topoisimerases** produce breaks in the DNA and then rejoin them in order to relieve the stress in the helical molecule during replication.

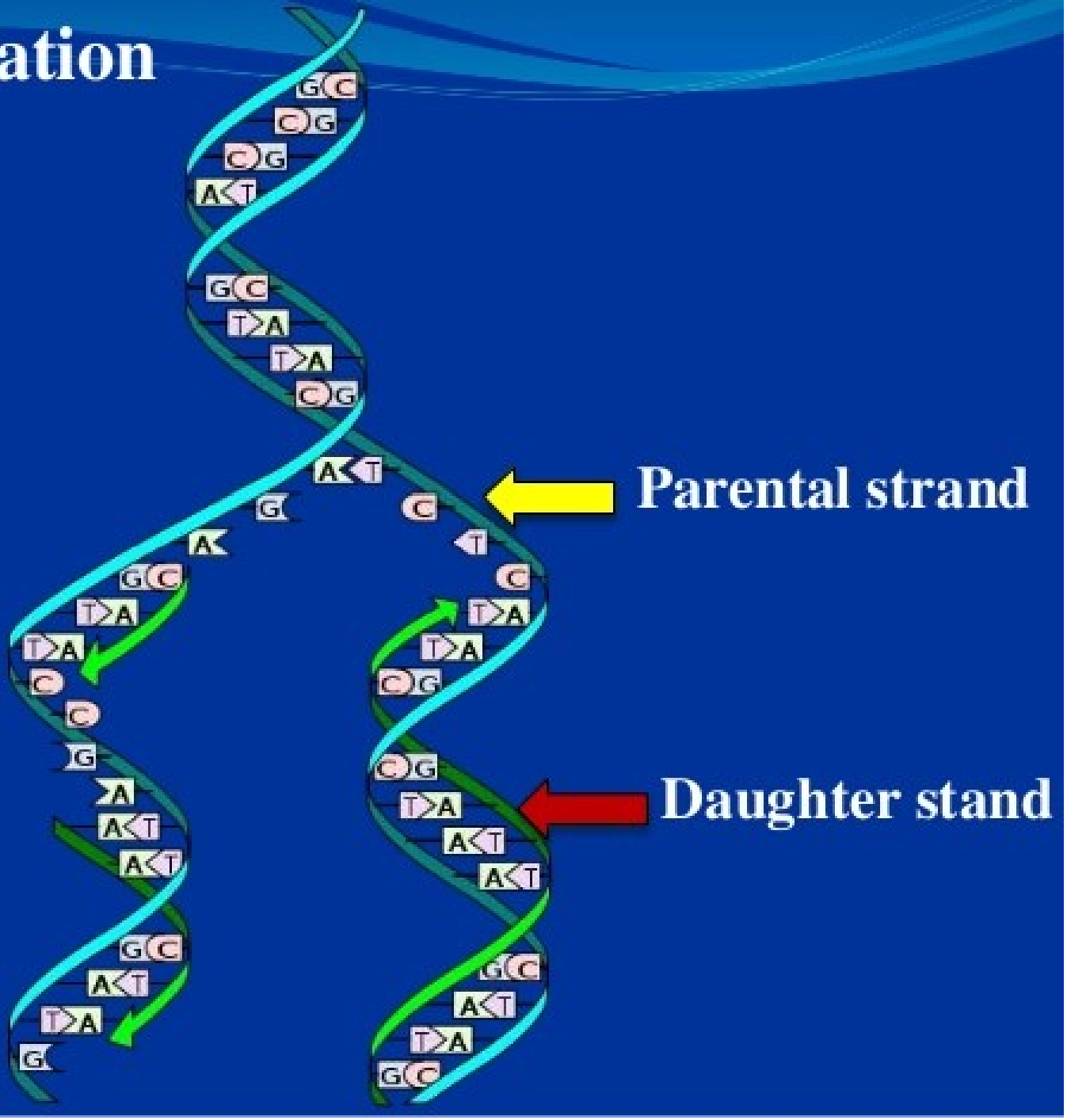
Central dogma



- DNA replication is a biological process that occurs in all living organisms and copies their exact DNA. It is the basis for biological inheritance.
- Replication is the process of synthesis of daughter DNA from parental DNA by the enzyme DNA Polymerase.
- $(\text{dNMP})_n + \text{dNTP} \longrightarrow (\text{dNMP})_{n+1} + \text{PPi}$

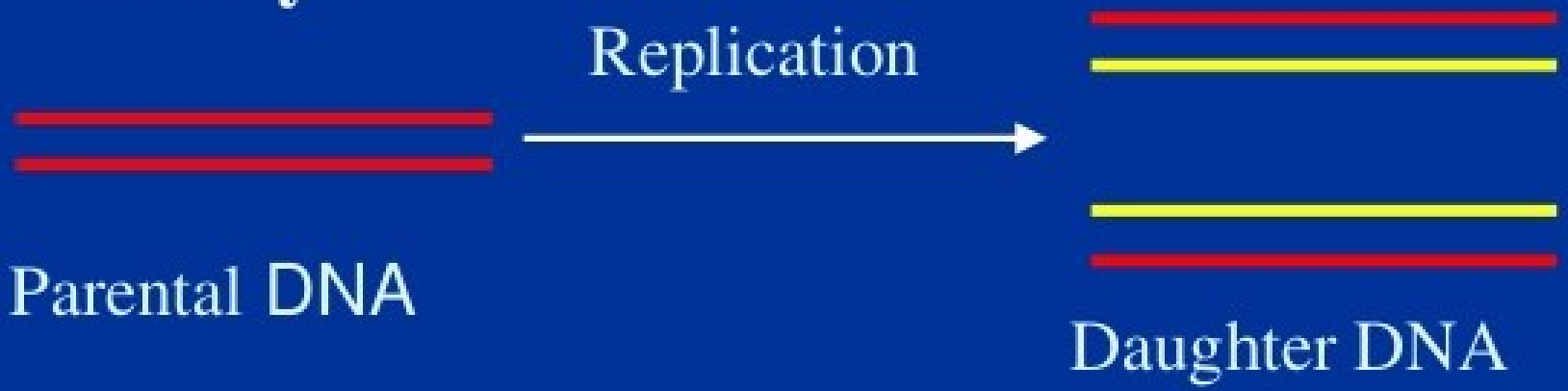
  DNA → Lengthened DNA

DNA Replication



DNA Replication

- **A reaction in which daughter DNAs are synthesized using the parental DNAs as the template.**
- **Transferring the genetic information to the descendant generation with a high fidelity.**



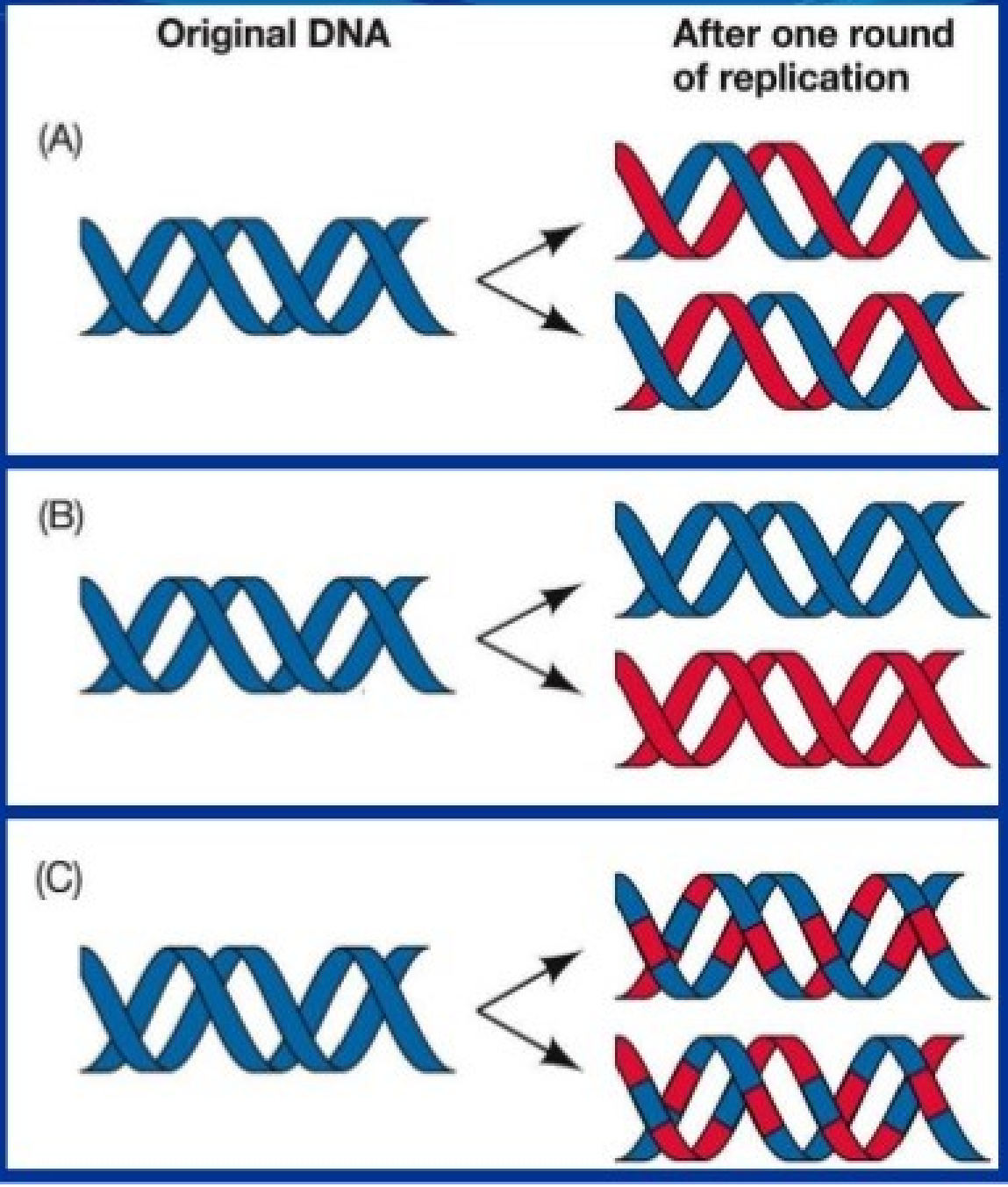
Three possible replication patterns:

1. ***Semiconservative replication***
2. ***Conservative replication***
3. ***Dispersive replication***

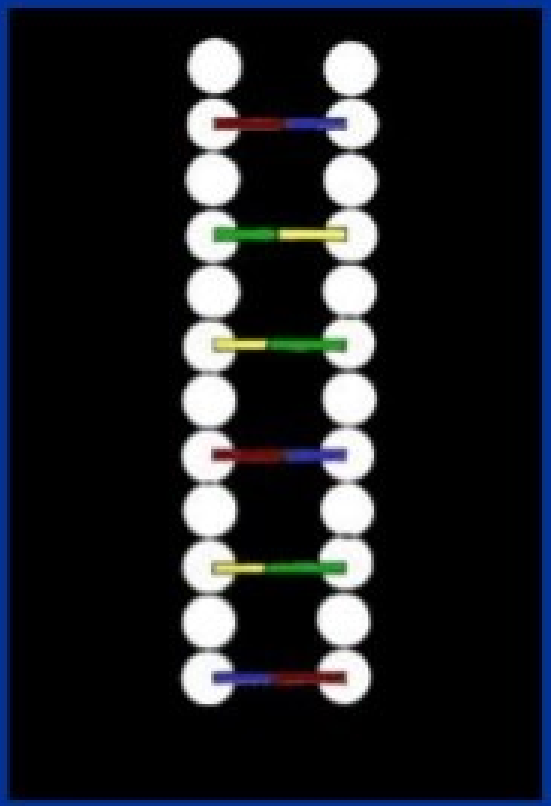
Semiconservative replication

Conservative replication

Dispersive replication



Each parent strand serves as a template for a new strand and the two new DNA strands each have one old and one new strand

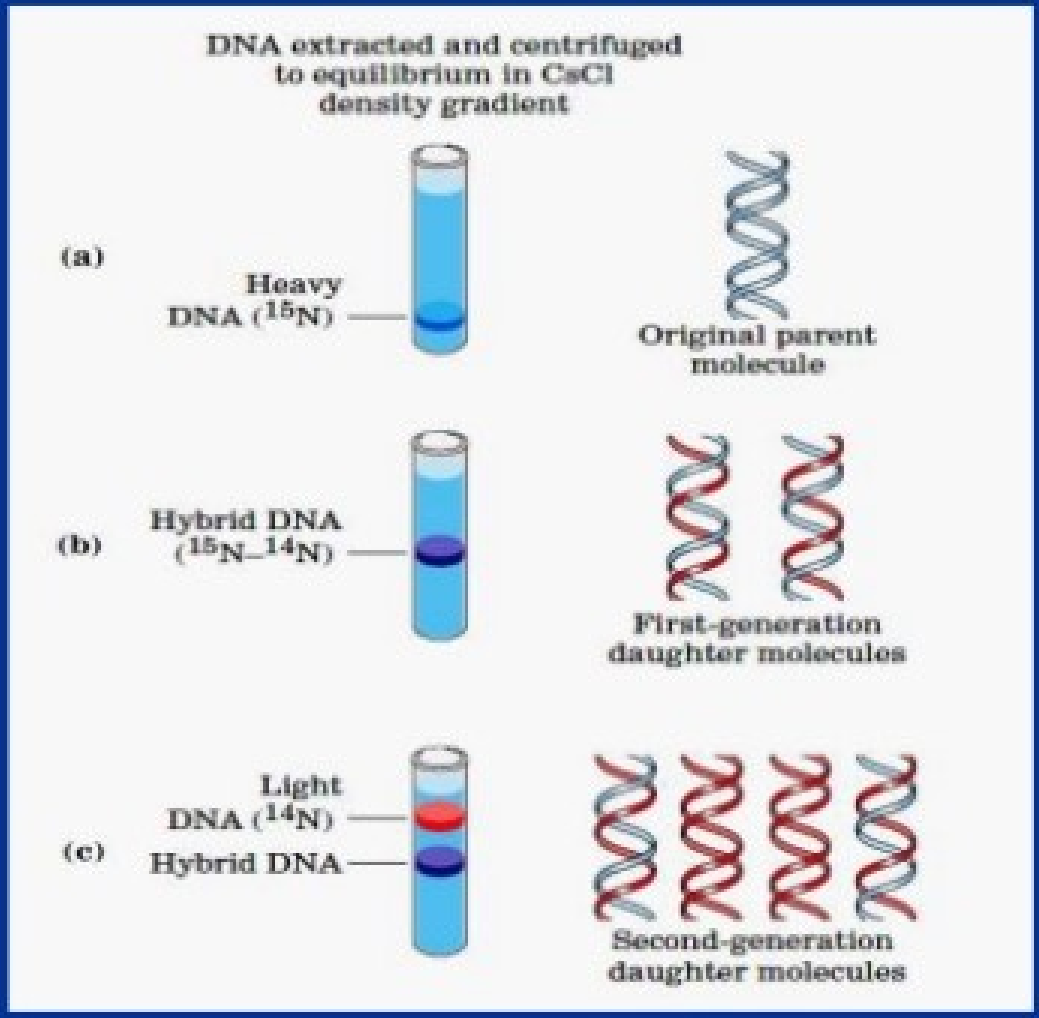


Characteristics of Replication

- Semi-conservative replication
- Bidirectional replication
- Semi-continuous replication
- High fidelity

Meselson and Stahl experiment [1958]

demonstrated Semiconservative replication



1 ***E. coli*** **grown in the presence of ^{15}N (a heavy isotope of Nitrogen) for many generations**

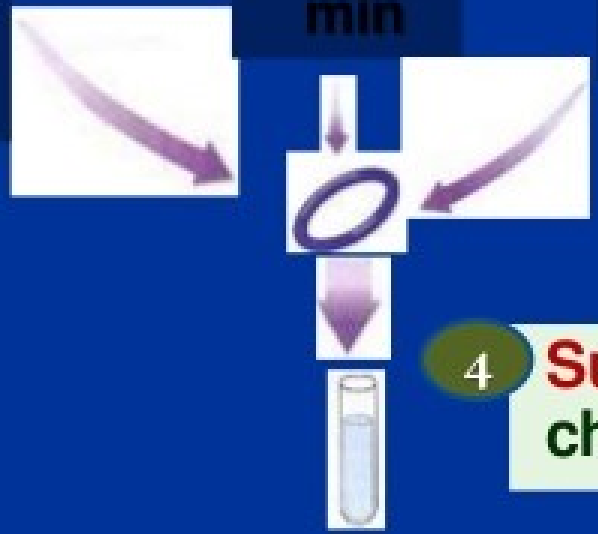
- **Cells get heavy-labeled DNA**

2 ***E. coli*** **placed in medium containing only ^{14}N (a light isotope of Nitrogen**

Sampled at: 0 min

20 min

40 min

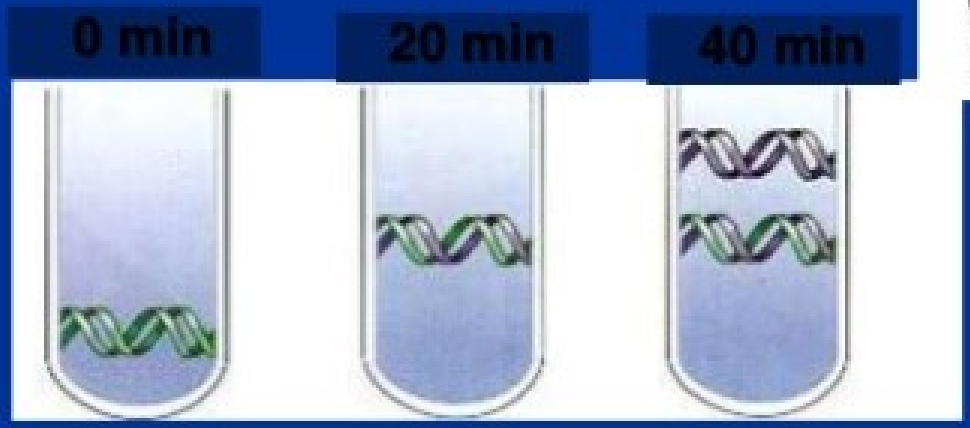


3 **Cells broken open to extract DNA**

4 **Suspended DNA in Cesium chloride (CsCl) solution.**

5

CsCl density gradient centrifugation

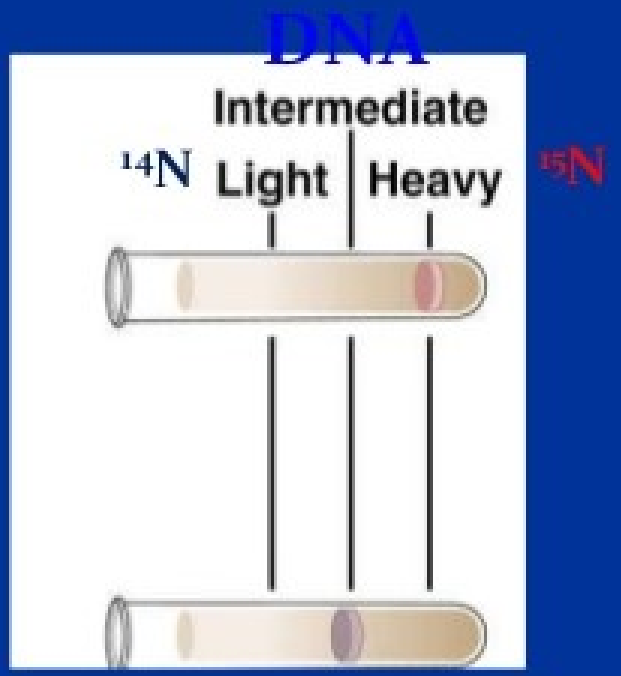


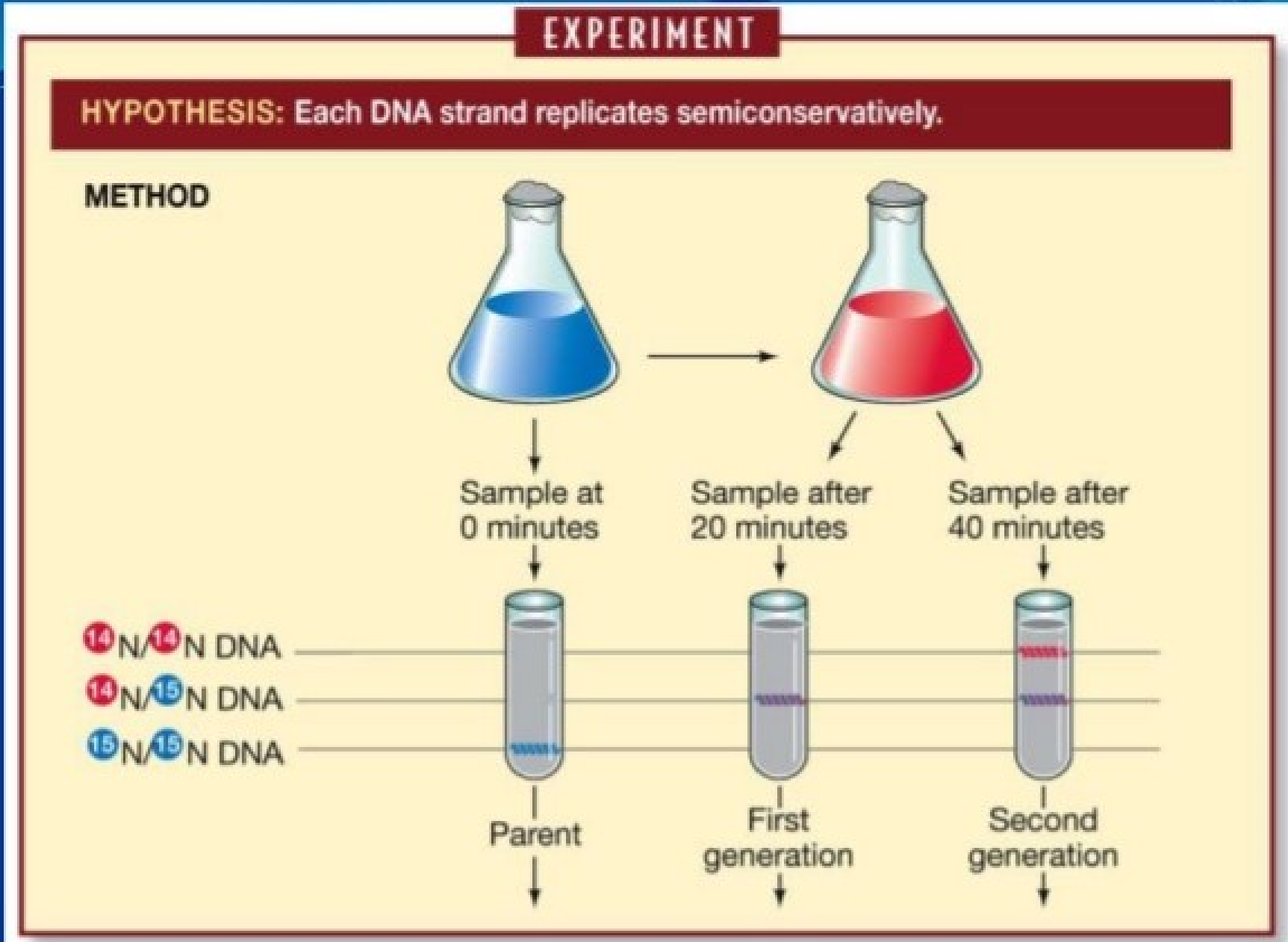
Both strands heavy

F1 generation DNA (one heavy/one light strand)

F2 generation DNA:

- Two light strands
- One heavy/One light strand




EXPERIMENT
HYPOTHESIS: Each DNA strand replicates semiconservatively.
METHOD
Sample at 0 minutes
Sample after 20 minutes
Sample after 40 minutes
14N/14N DNA
14N/15N DNA
15N/15N DNA
Parent
First generation
Second generation

Three rounds of replication:

Original DNA

0 min

1st Round:

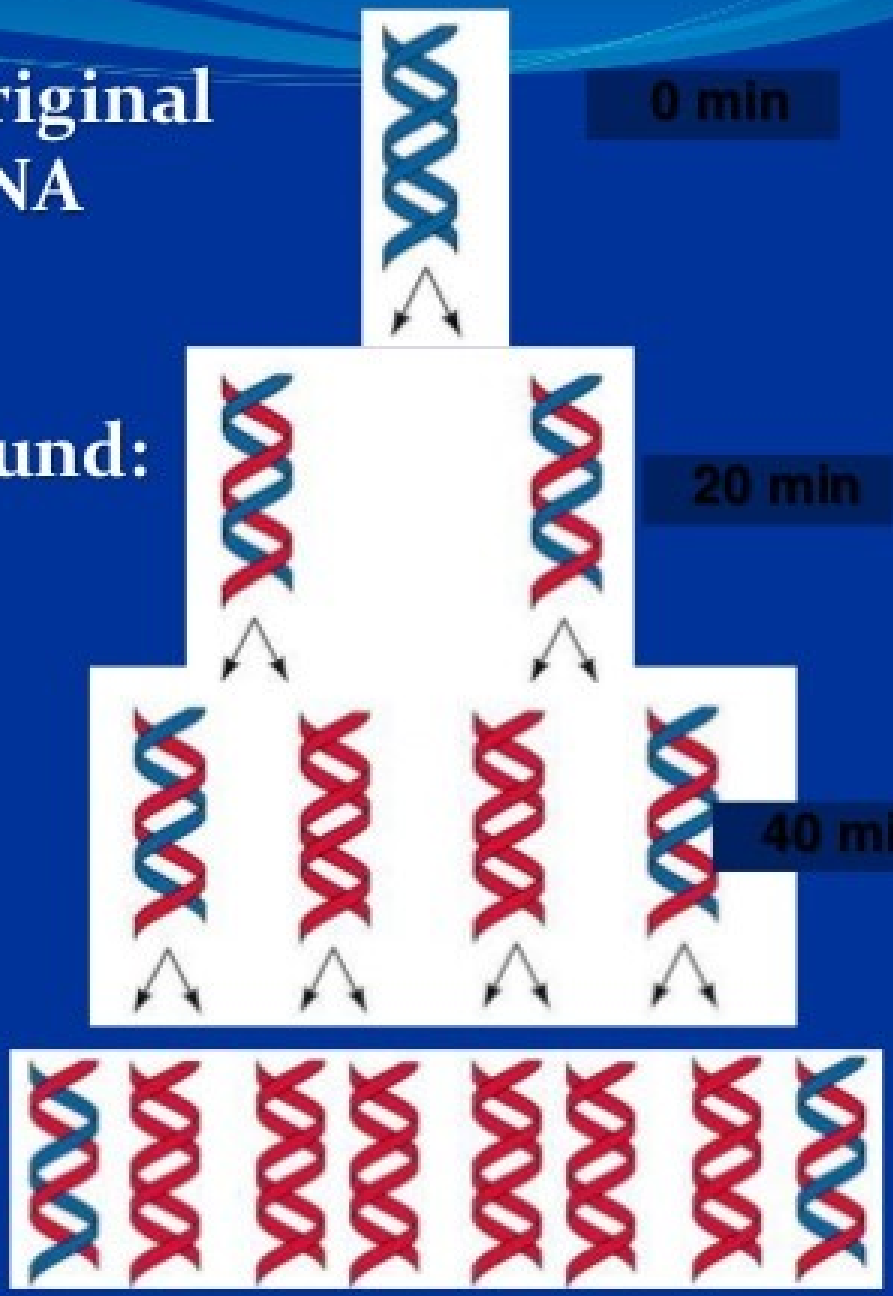
20 min

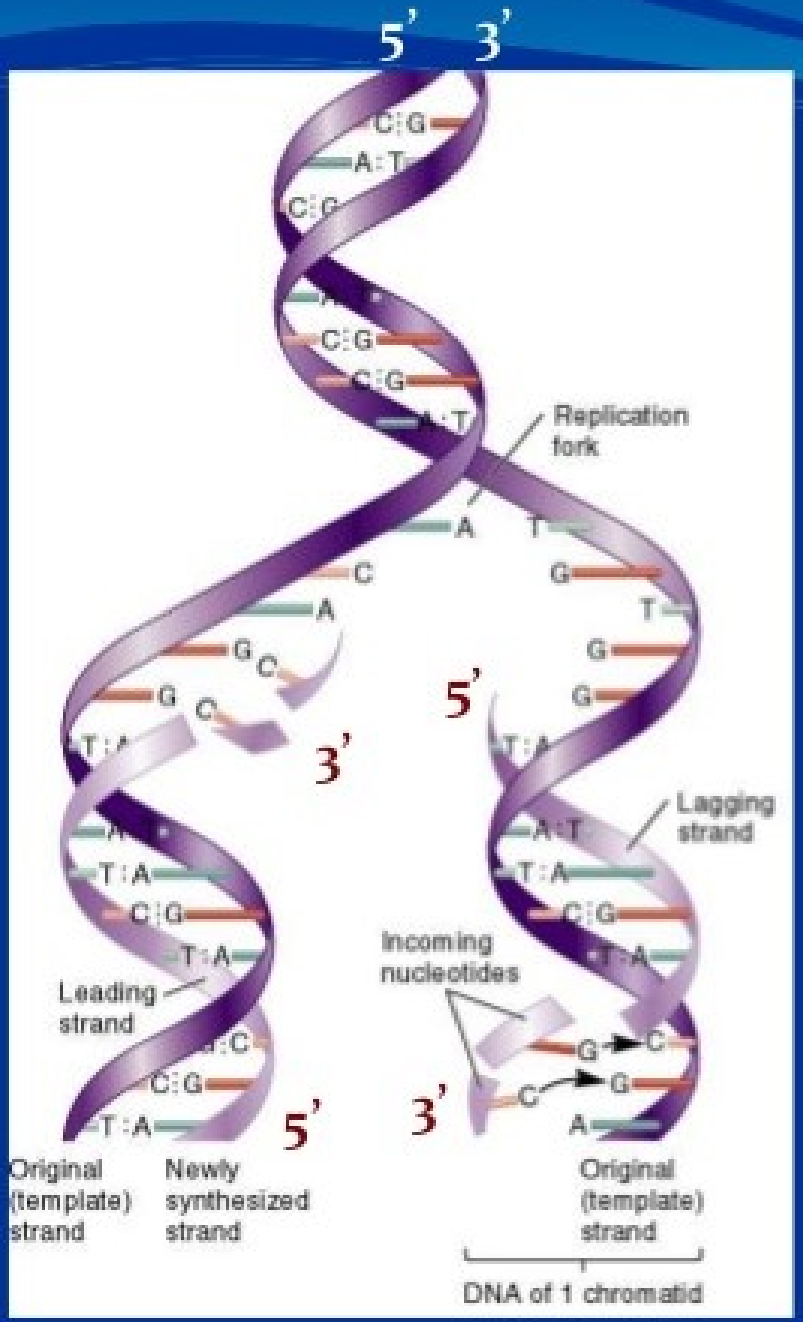
2nd Round:

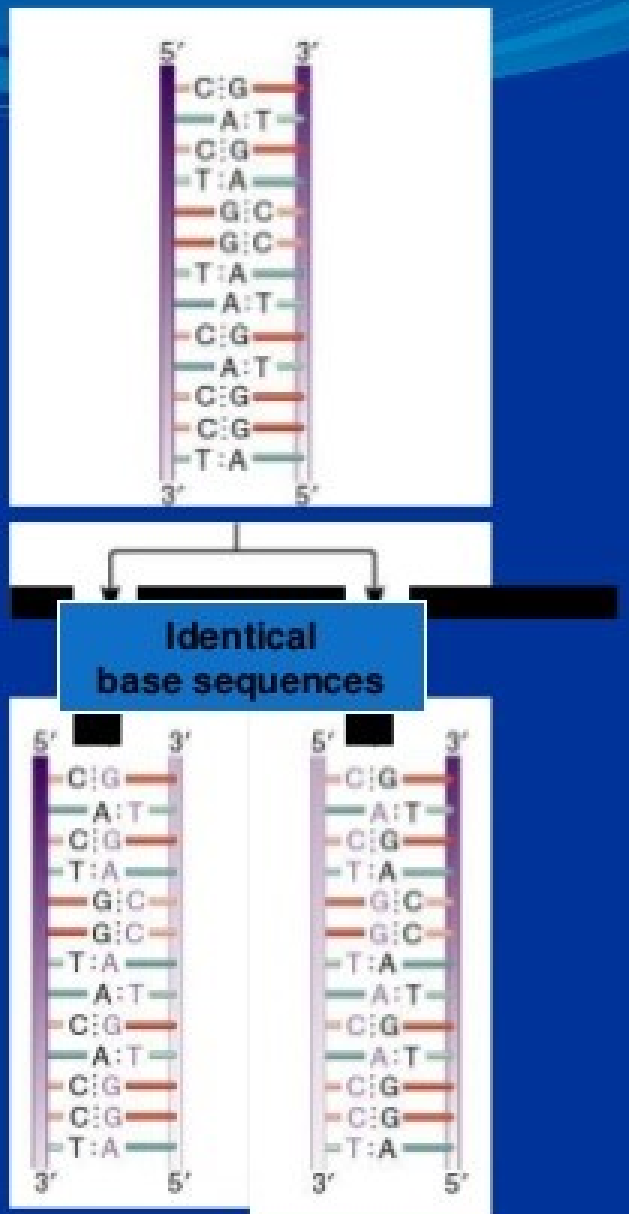
40 min

3rd Round:

60 min?



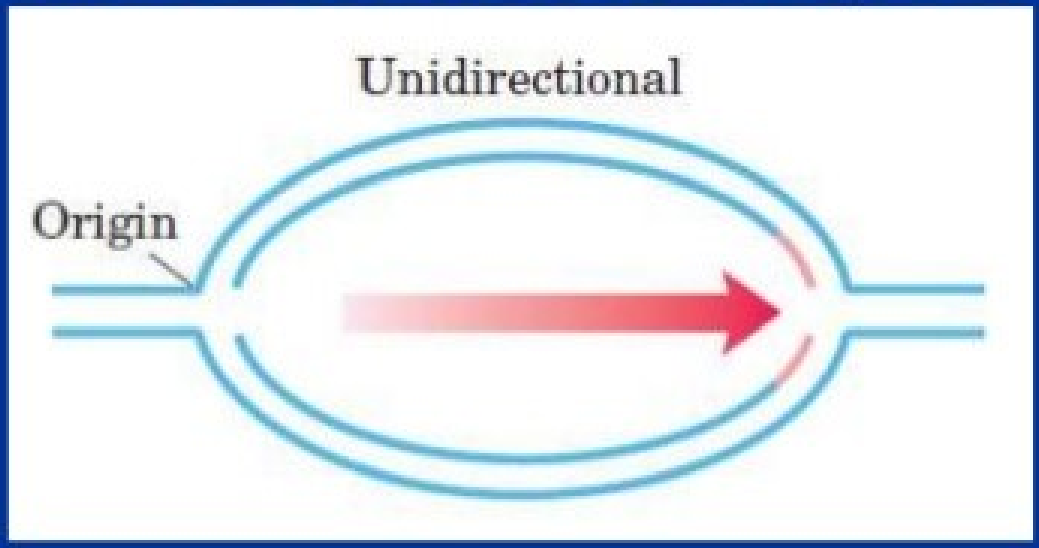

5'
3'
Replication fork
Leading strand
Lagging strand
Incoming nucleotides
Original (template) strand
Newly synthesized strand
Original (template) strand
DNA of 1 chromatid

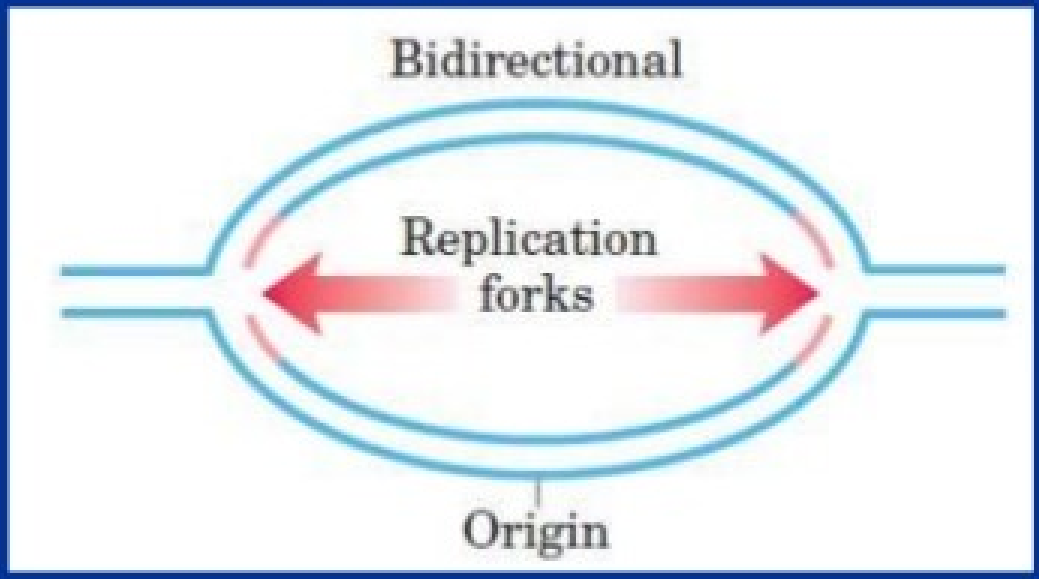

Identical base sequences

Semiconservative Replication

Half of the parental DNA molecule is conserved in each new double helix, paired with a newly synthesized complementary strand. This is called semiconservative replication.

Direction of the DNA Replication





Thank You