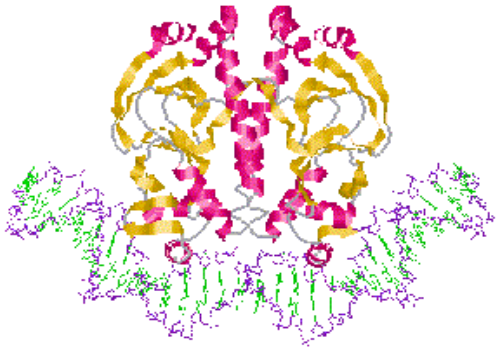
DNA structure, replication and recombination, DNA organization in chromosome

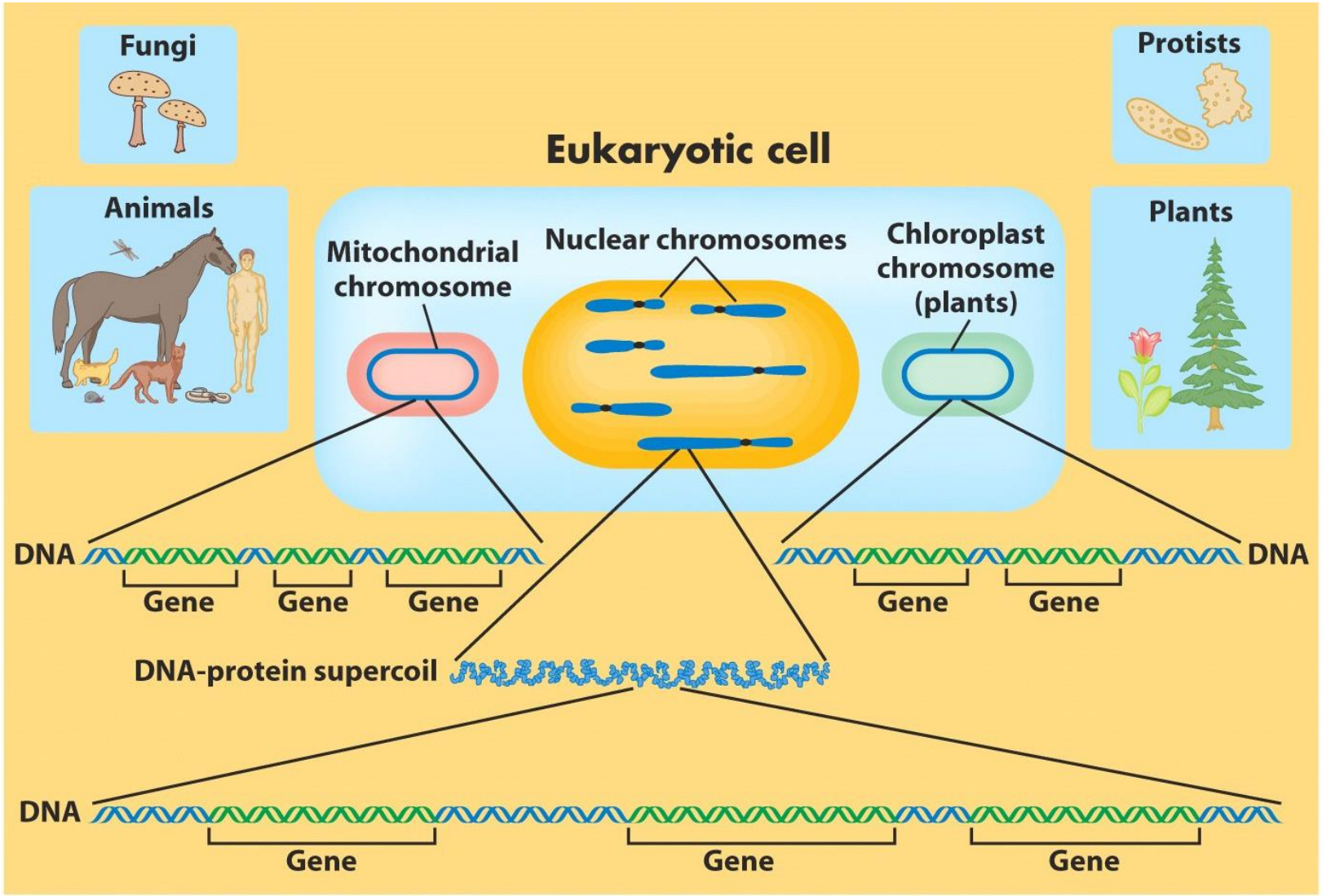


Prof. Dr. İsmail AKYOL
Prof. Dr. M. Ali YILDIZ
Prof. Dr. M. Muhip ÖZKAN
Ankara Üniversitesi

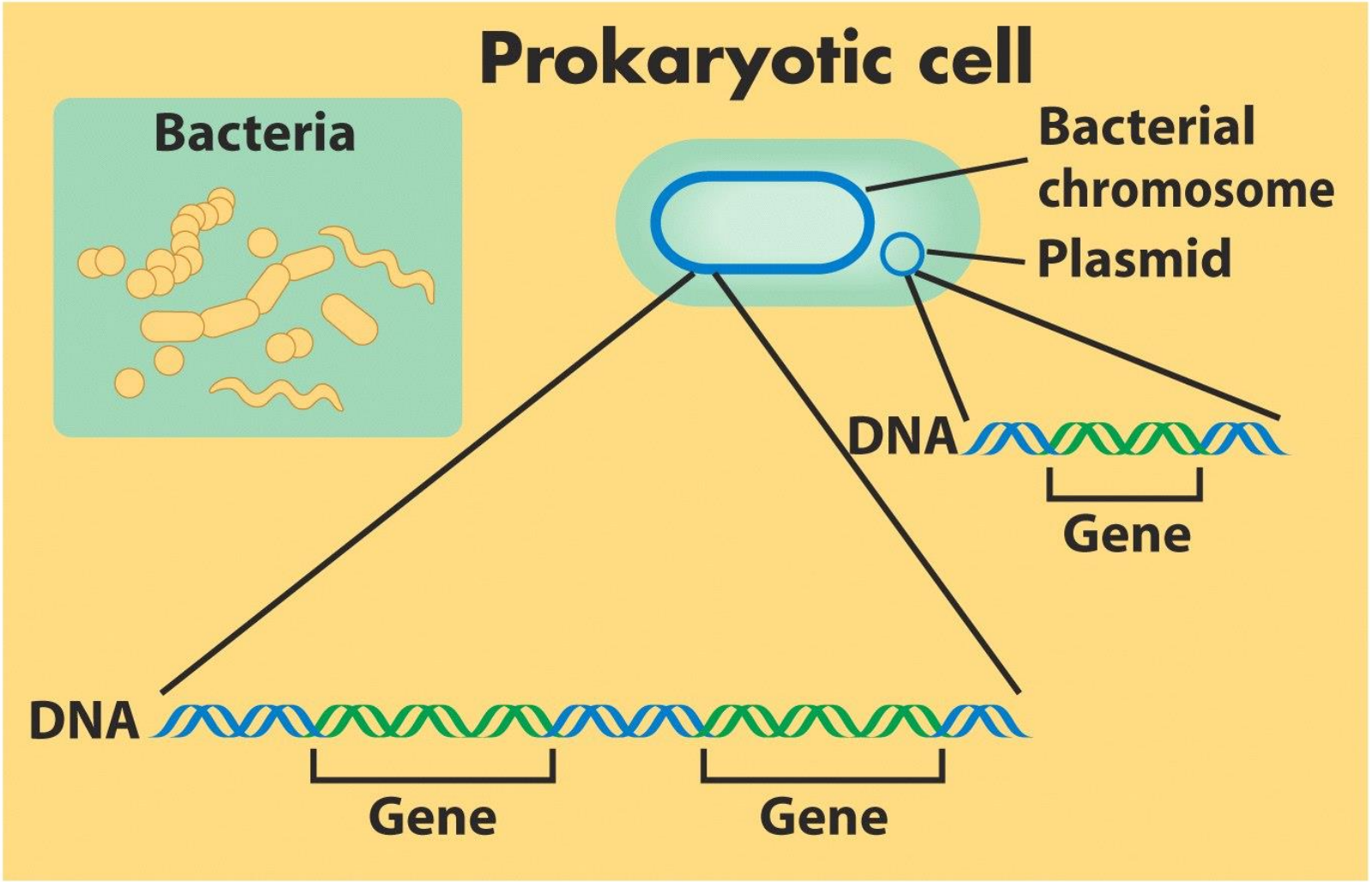
Outline of course

- Except in some viruses, DNA serves as the genetic material in all living organisms on Earth.
- According to the Watson–Crick model, DNA exists in the form of a right-handed double helix.
- The strands of the double helix are antiparallel and are held together by hydrogen bonding between complementary nitrogenous bases.
- The structure of DNA provides the means of storing and expressing genetic information.
- RNA has many similarities to DNA but exists mostly as a single-stranded molecule.
- In some viruses, RNA serves as the genetic material.
- Many techniques have been developed that facilitate the analysis of nucleic acids, most based on detection of the complementarity of nitrogenous bases.

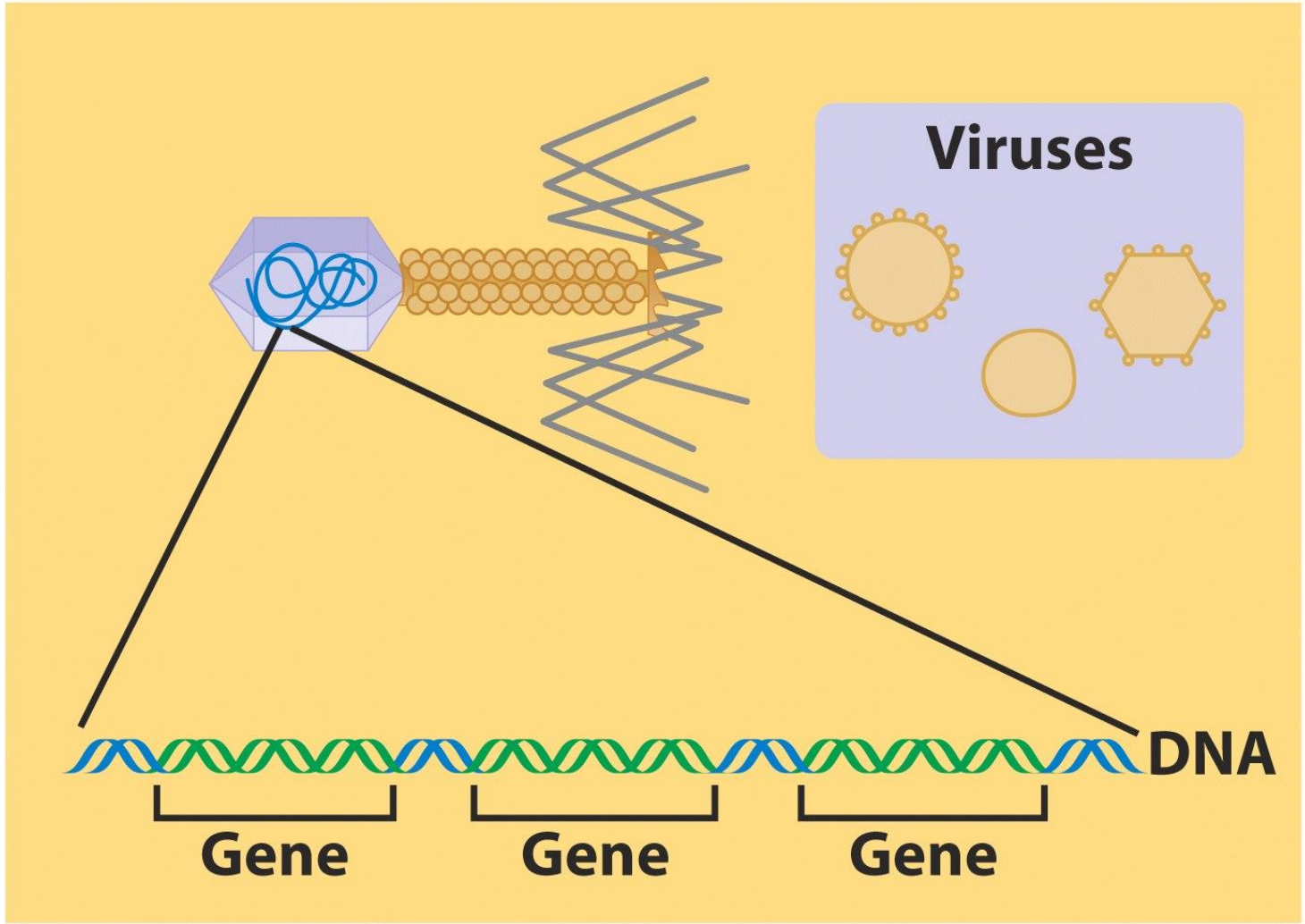
Eukaryotic cell



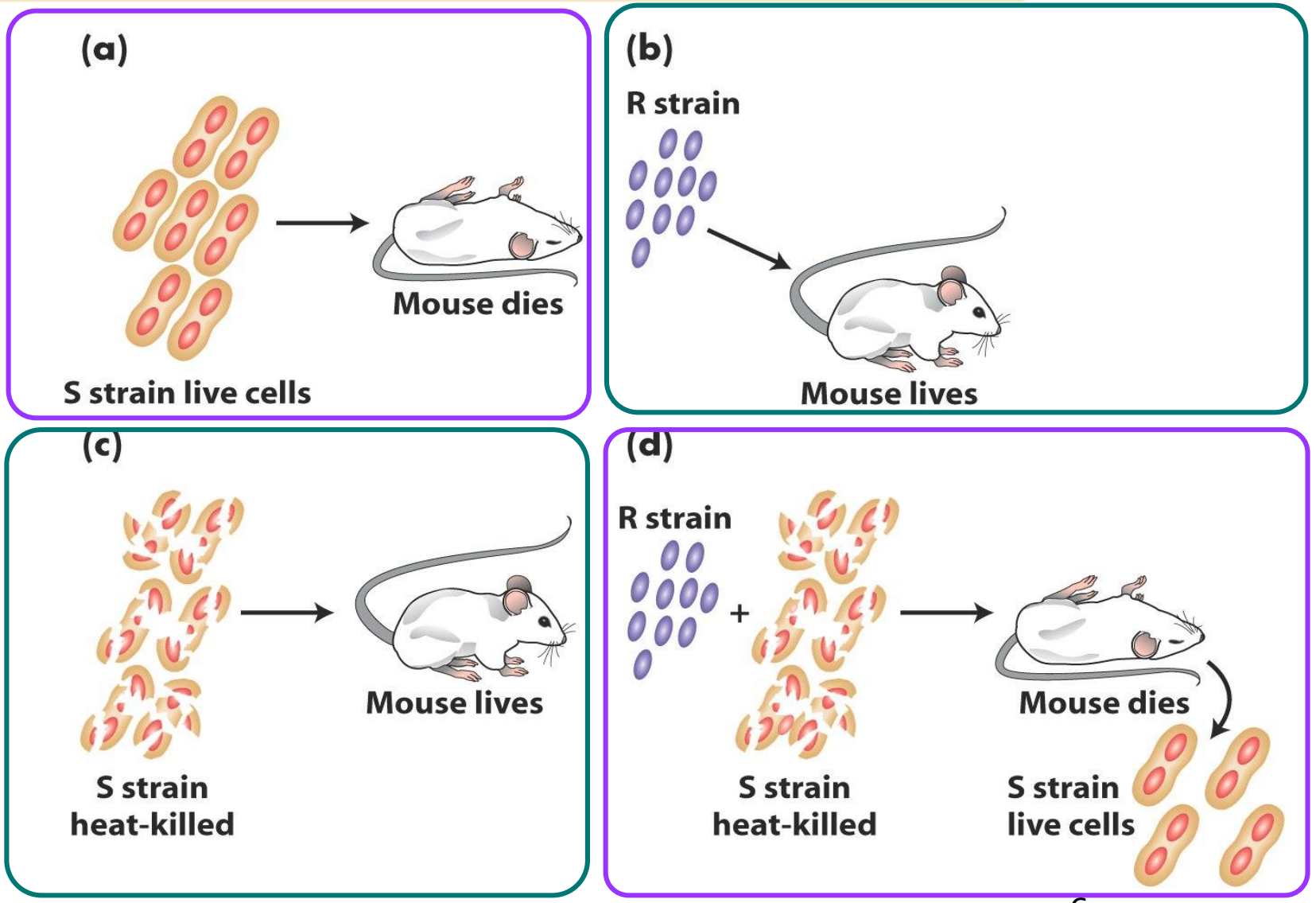
Prokaryotic cell



Viruses



Griffith's transformation experiment



Transformation: The Avery, MacLeod, and McCarty Experiment

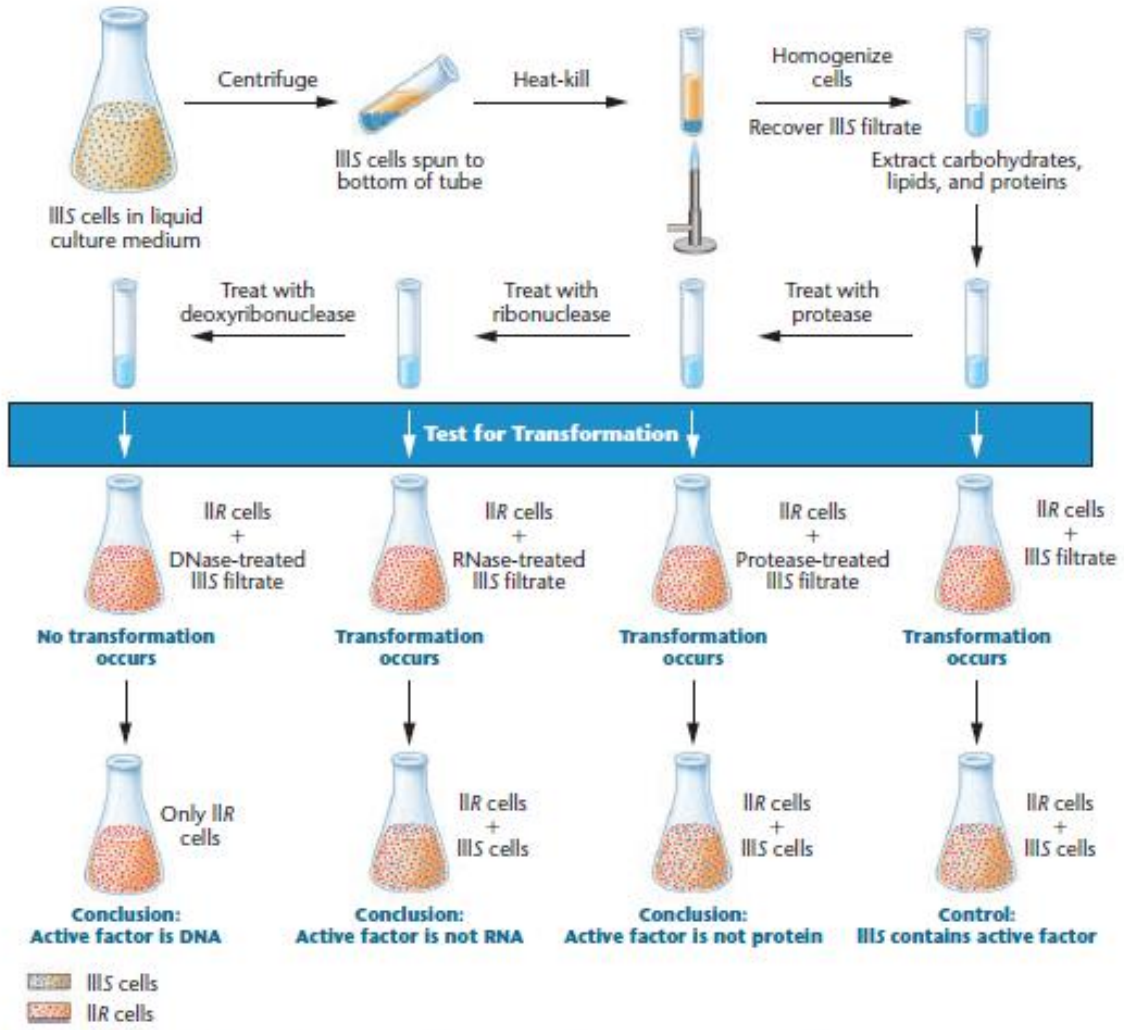
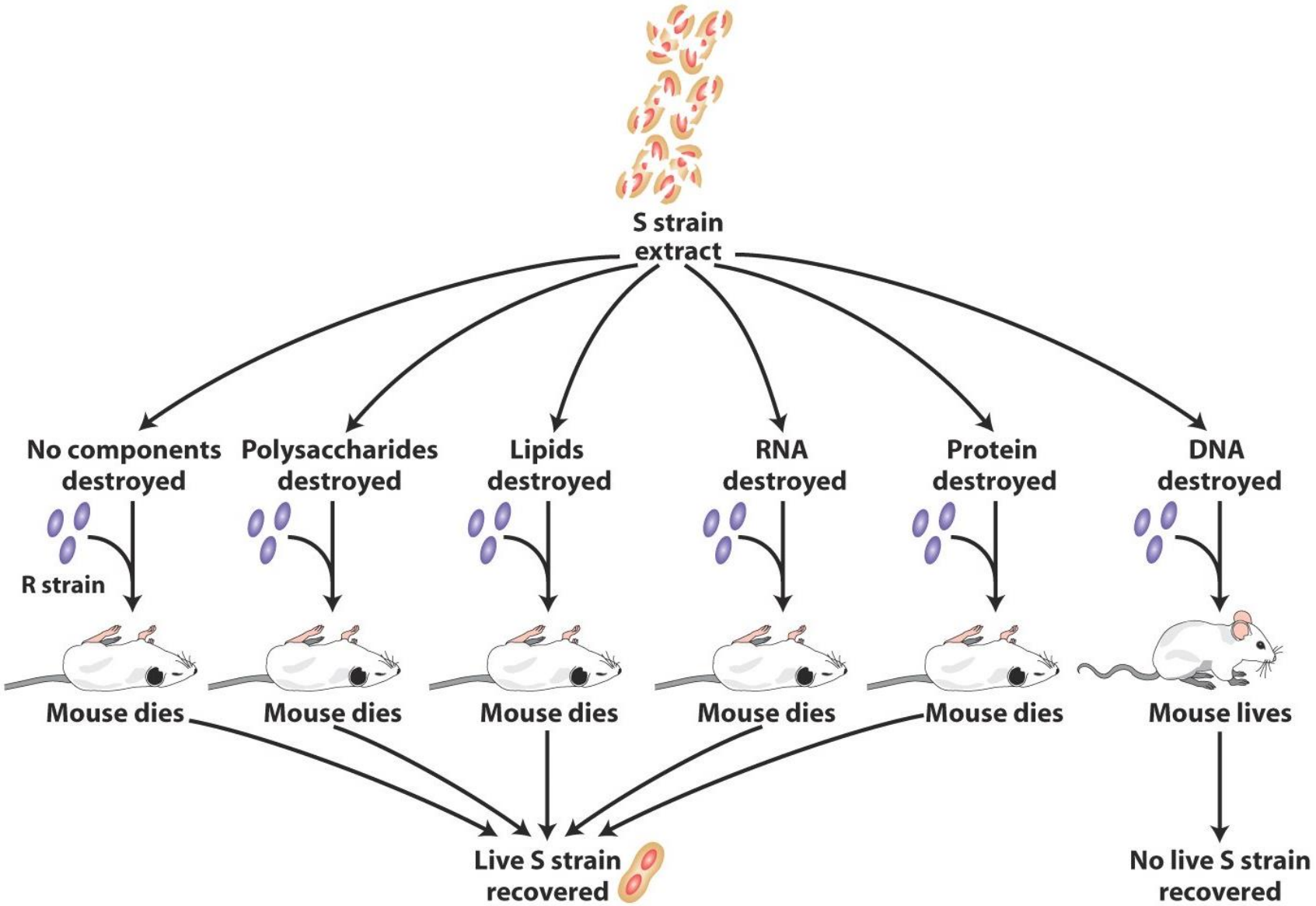
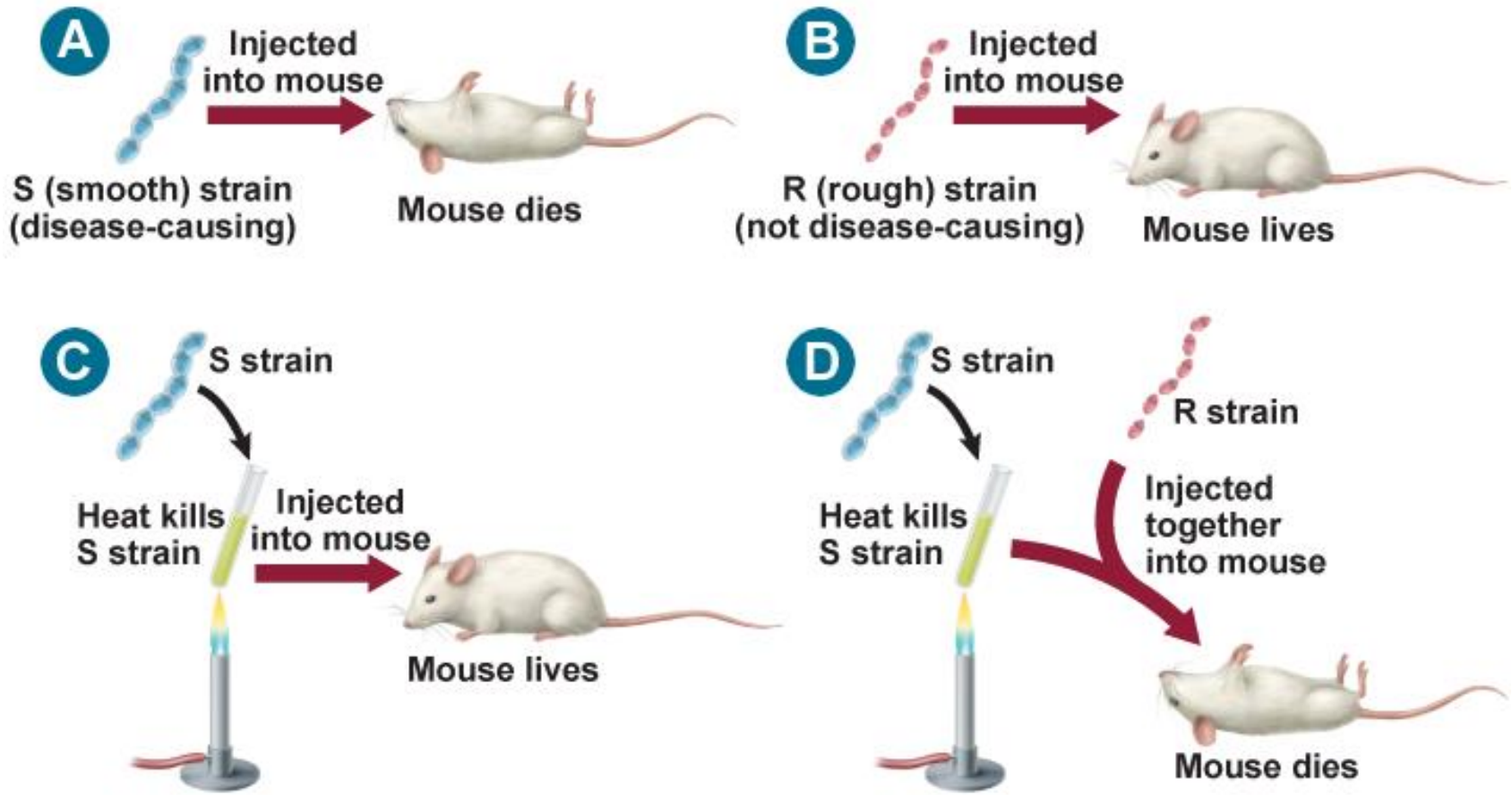
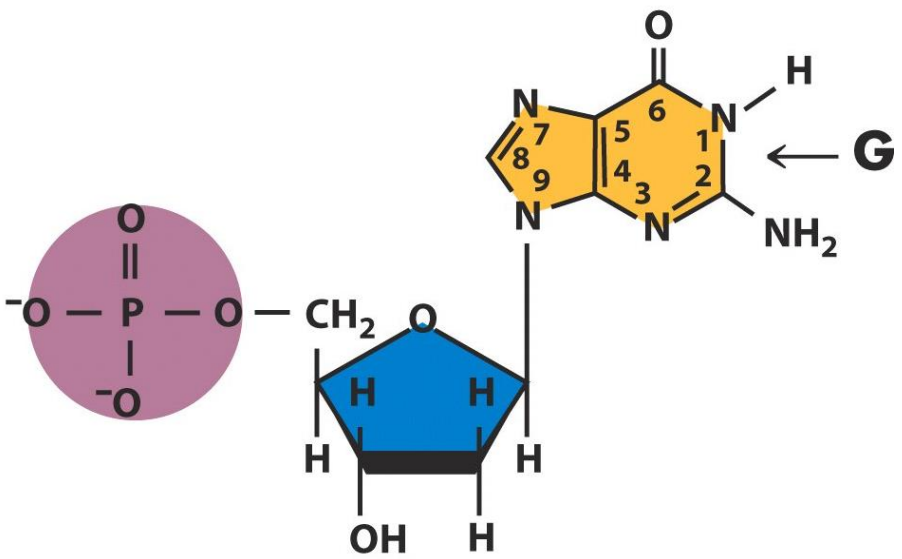


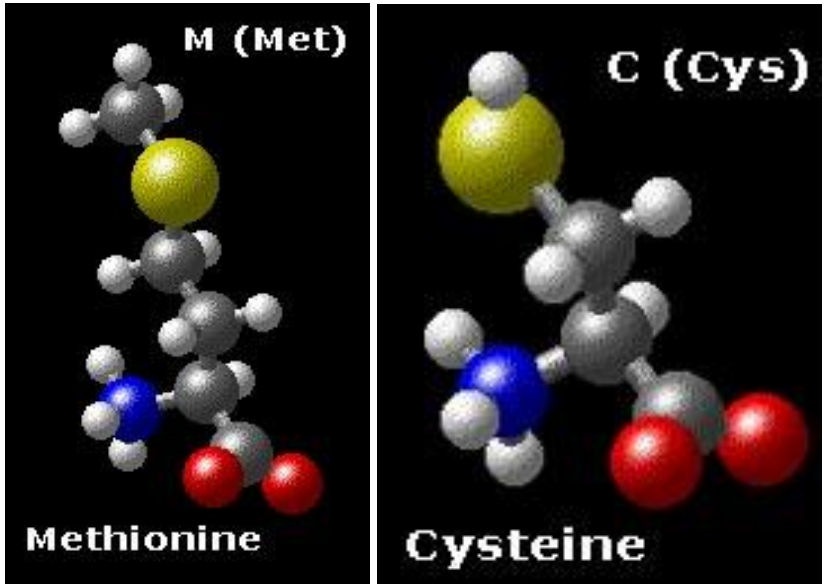
FIGURE 10.3 Summary of Avery, MacLeod, and McCarty's experiment demonstrating that DNA is the transforming principle.


S strain extract
No components destroyed
Polysaccharides destroyed
Lipids destroyed
RNA destroyed
Protein destroyed
DNA destroyed
R strain
Mouse dies
Mouse dies
Mouse dies
Mouse dies
Mouse dies
Mouse lives
Live S strain recovered
No live S strain recovered

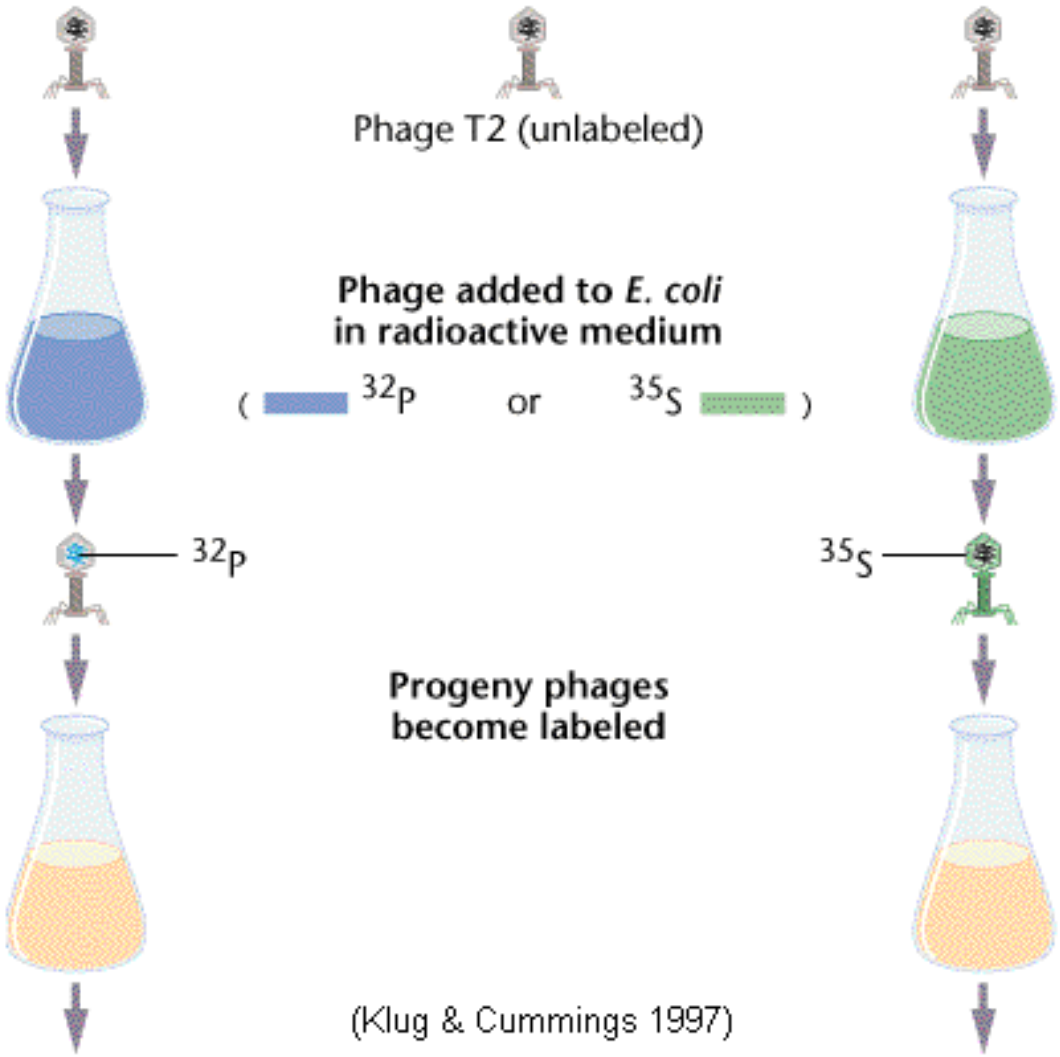

A
Injected into mouse
S (smooth) strain (disease-causing)
Mouse dies
B
Injected into mouse
R (rough) strain (not disease-causing)
Mouse lives
C
S strain
Heat kills S strain
Injected into mouse
Mouse lives
D
S strain
R strain
Heat kills S strain
Injected together into mouse
Mouse dies

The Hershey–Chase Experiment

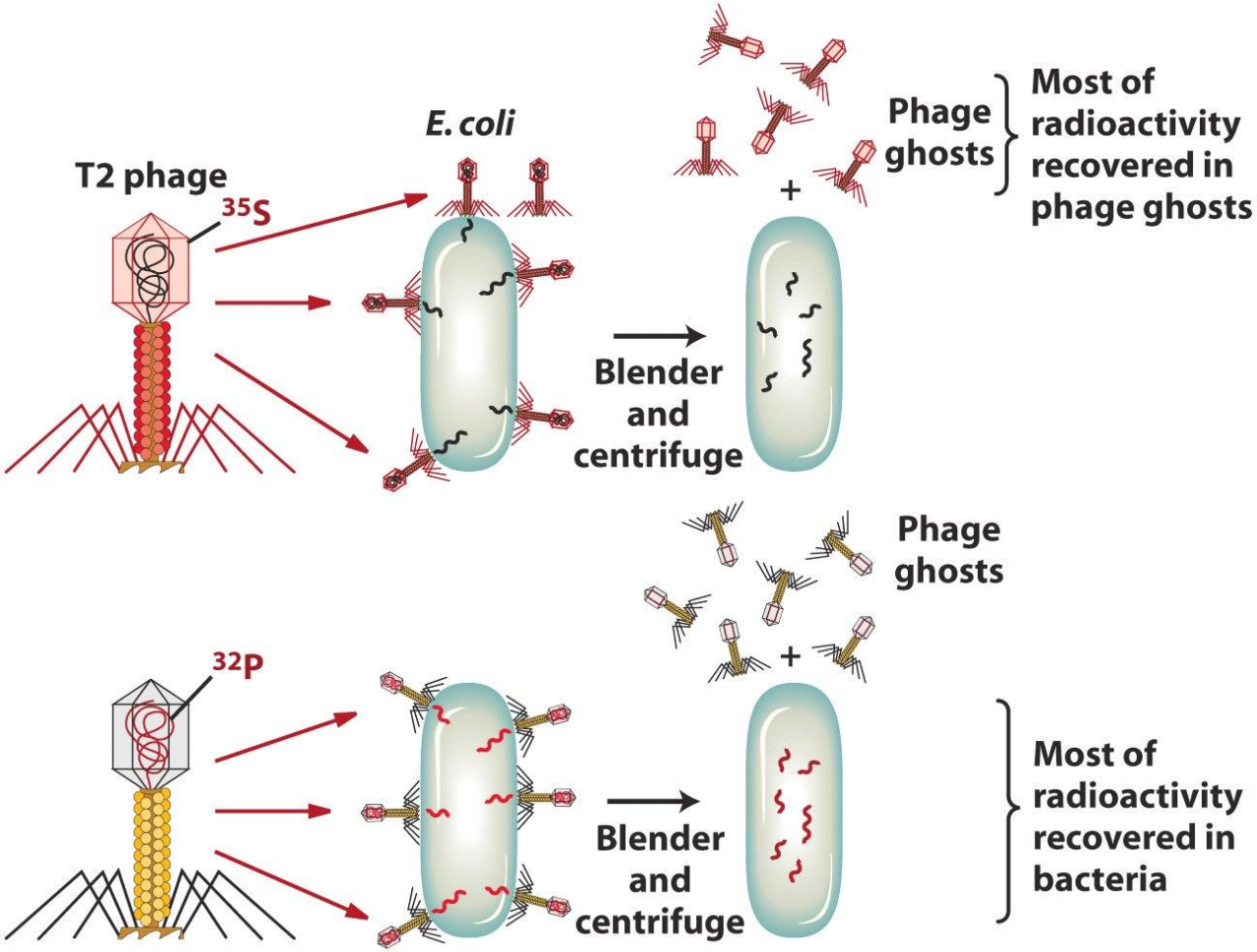




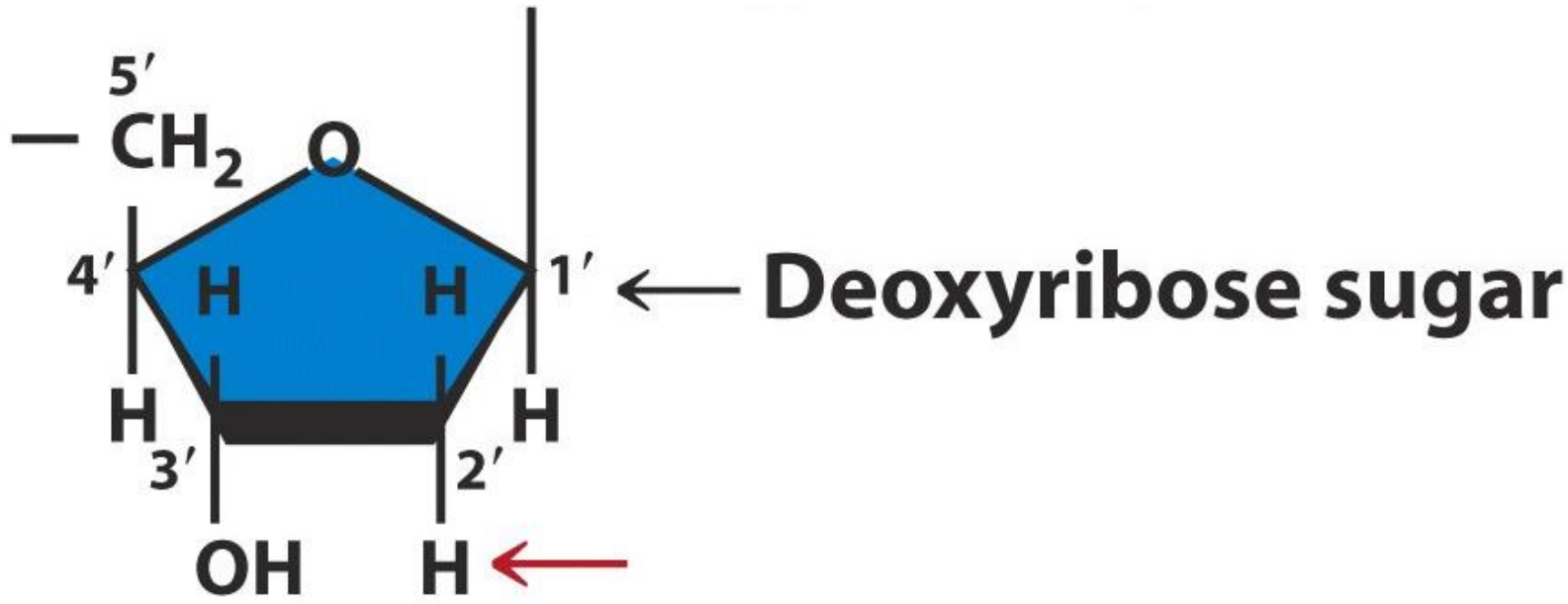
The Hershey–Chase Experiment



The Hershey–Chase Experiment

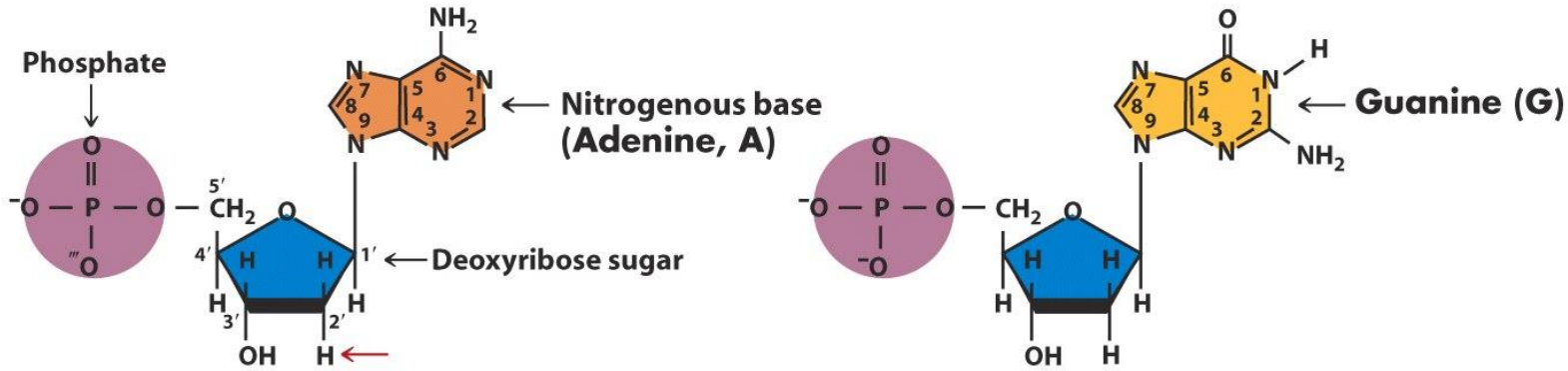


Deoxyribose sugar



Deoxyribose nucleotides

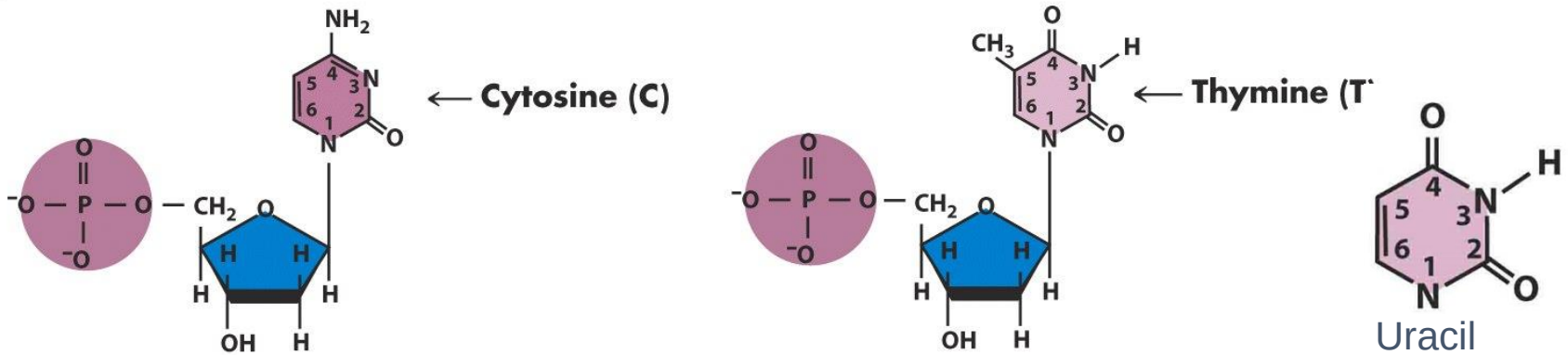
Purine nucleotides



Deoxyadenosine 5′-monophosphate (dAMP)

Deoxyguanosine 5′-monophosphate (dGMP)

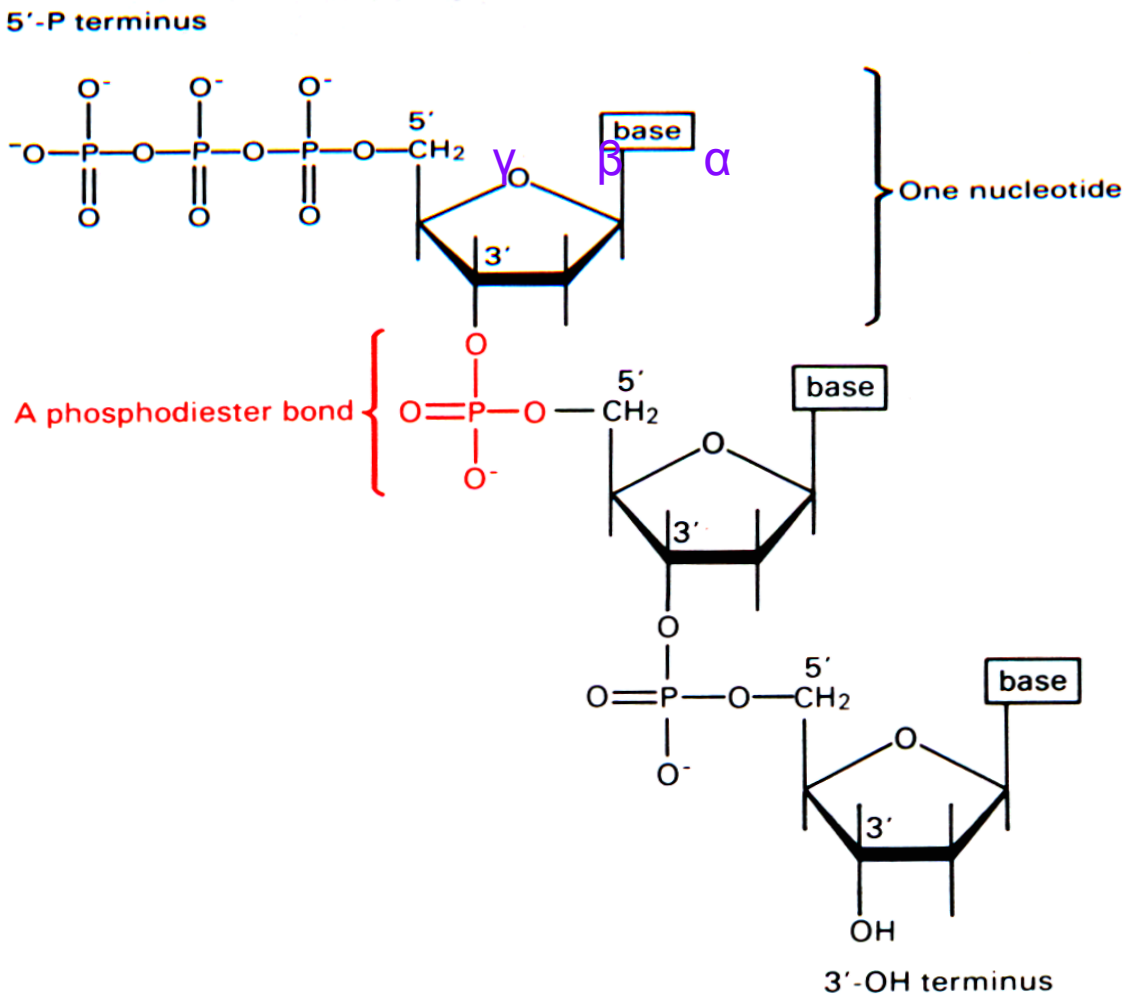
Pyrimidine nucleotides



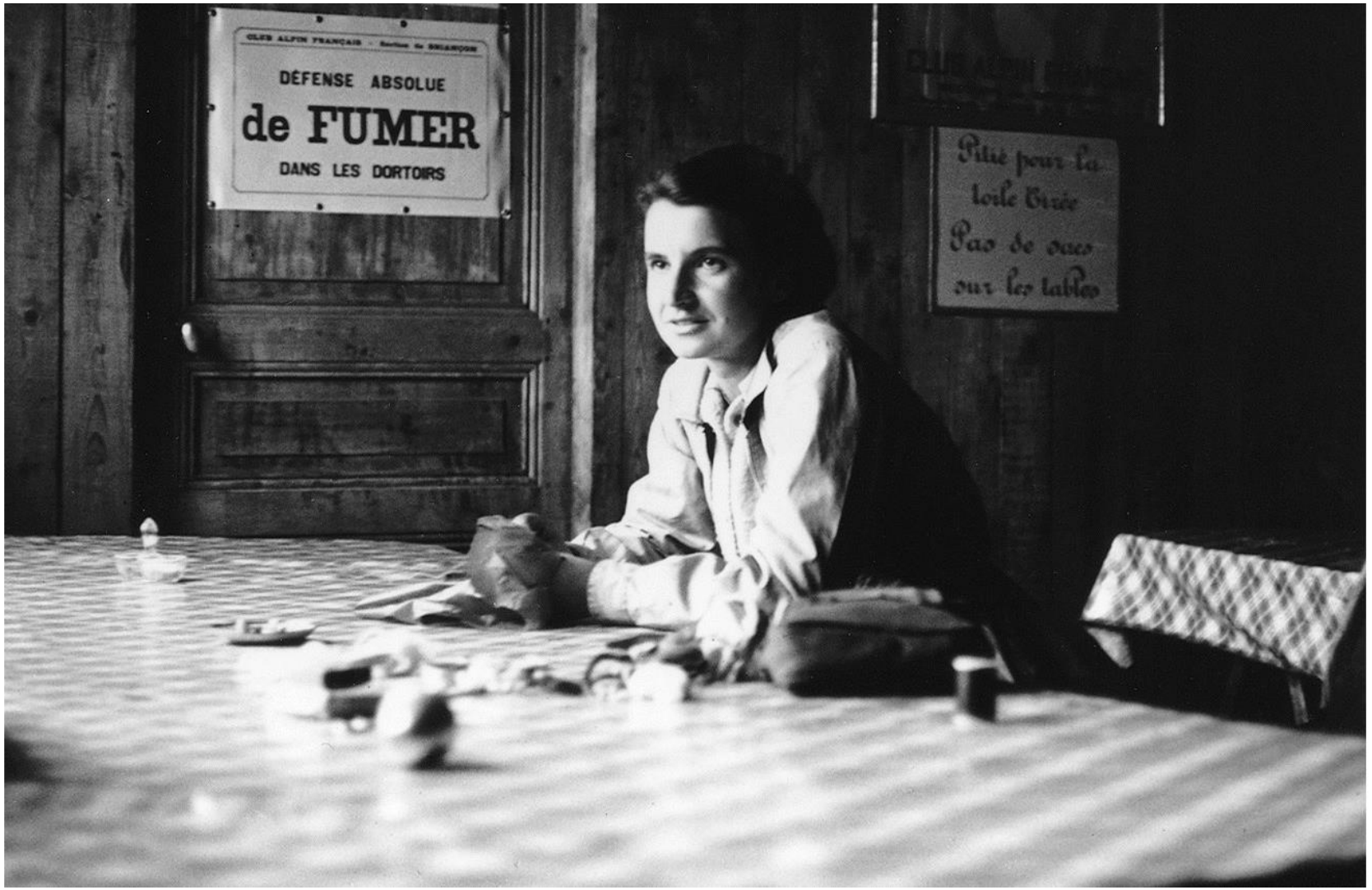
Deoxycytidine 5′-monophosphate (dCMP)

Deoxythymidine 5′-monophosphate (dTMP)

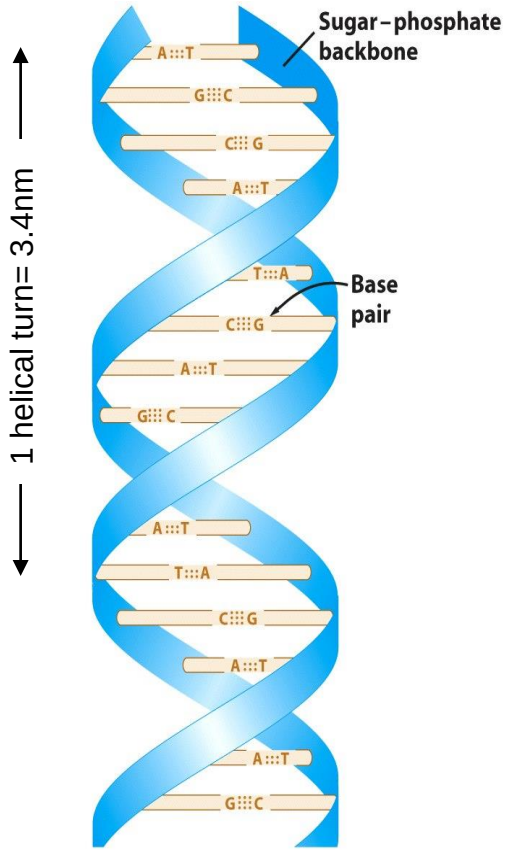
DNA chain

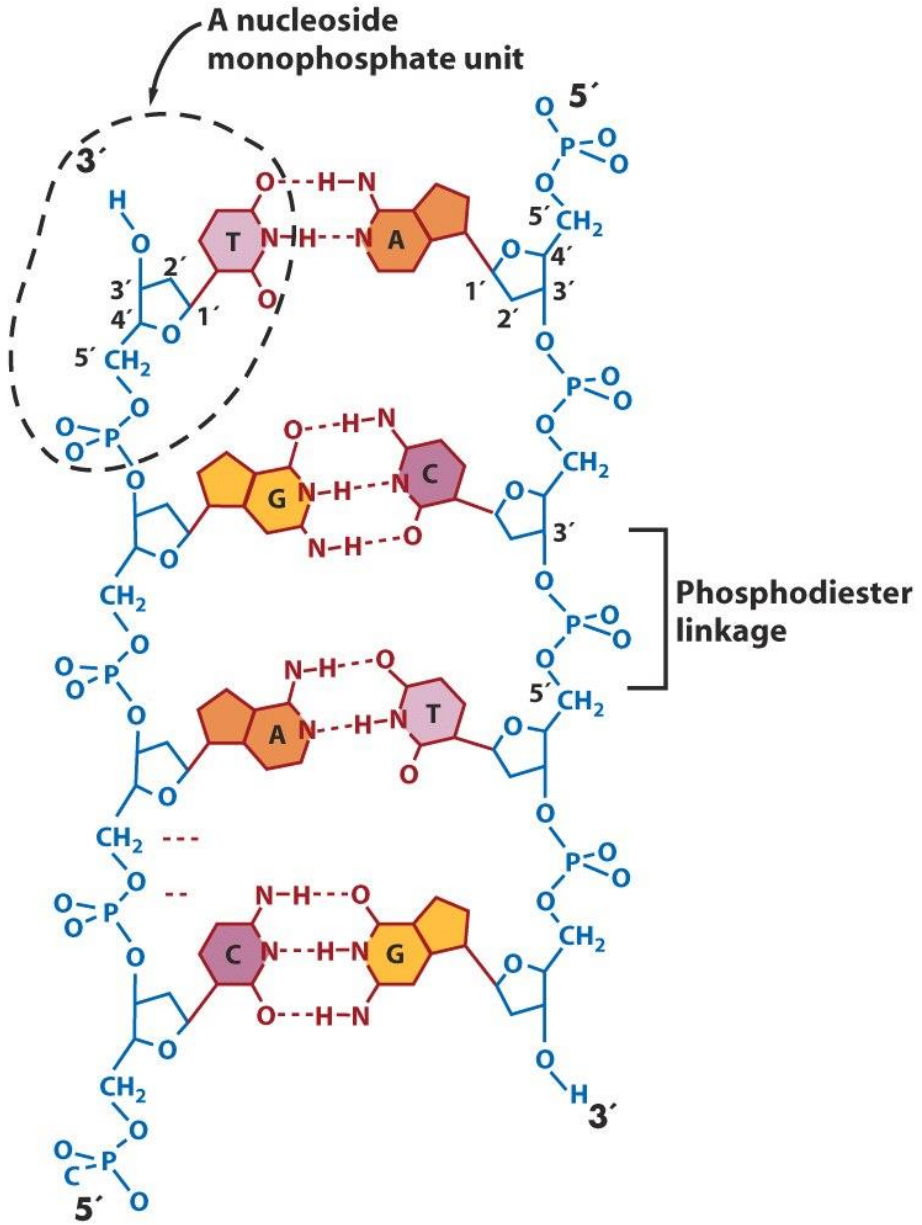

5′-P terminus
γ
β
α
base
One nucleotide
A phosphodiester bond
5′
3′
OH
3′-OH terminus

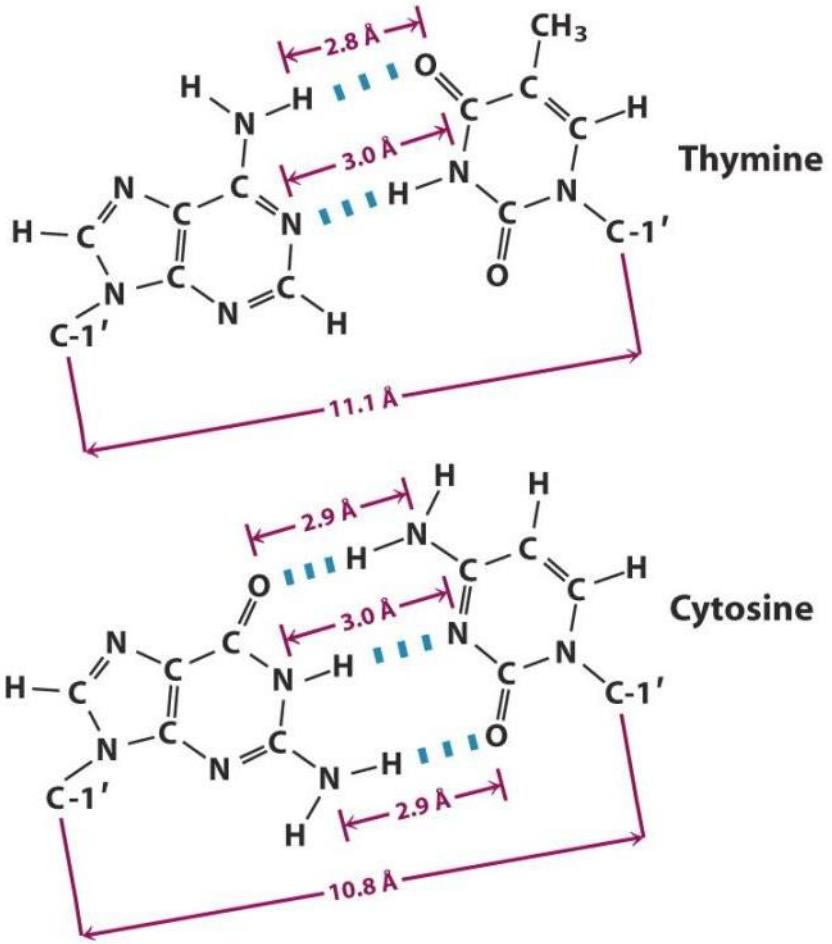
Rosalind Franklin



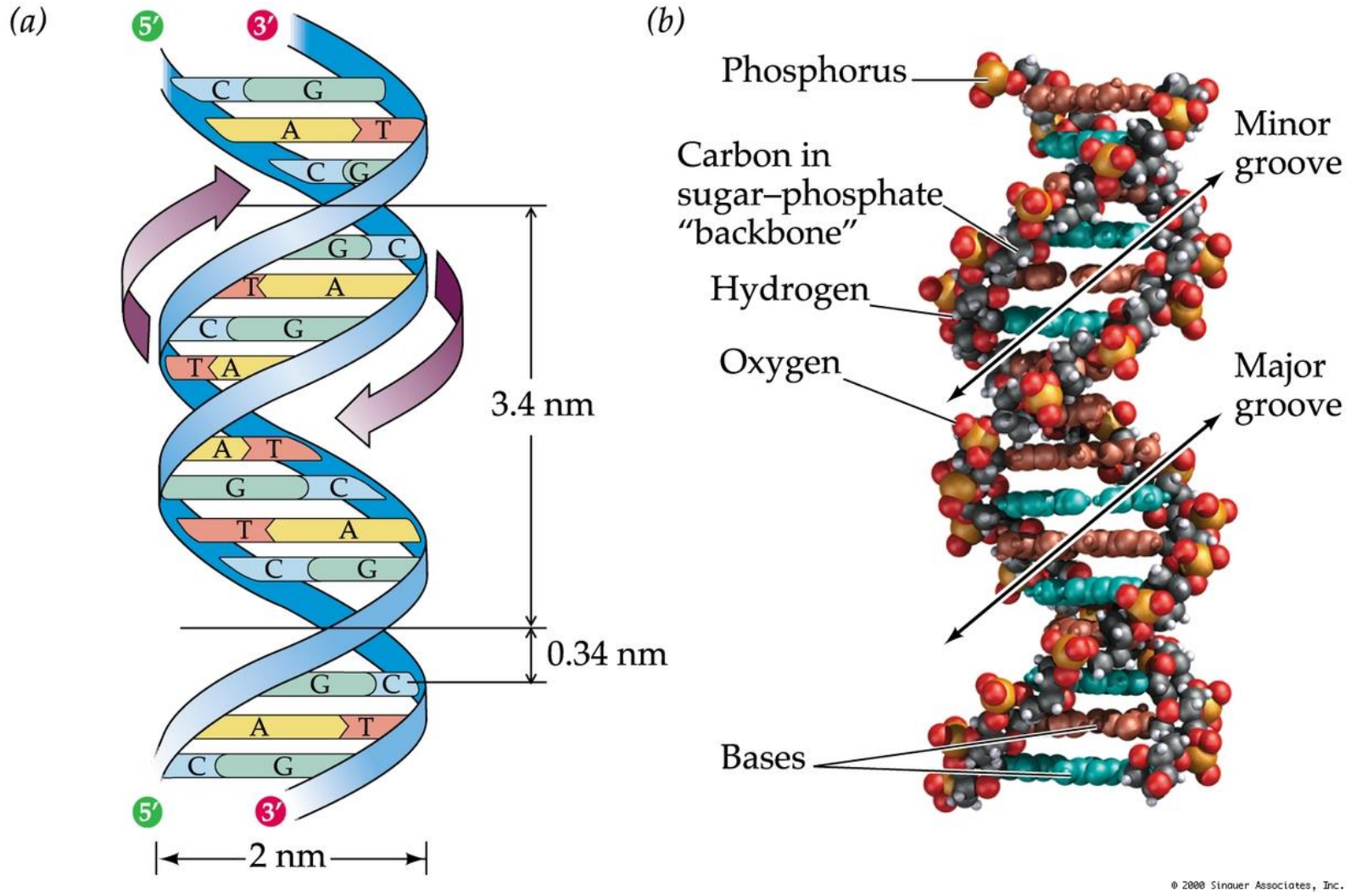
Francis Crick ve James Watson DNA Model



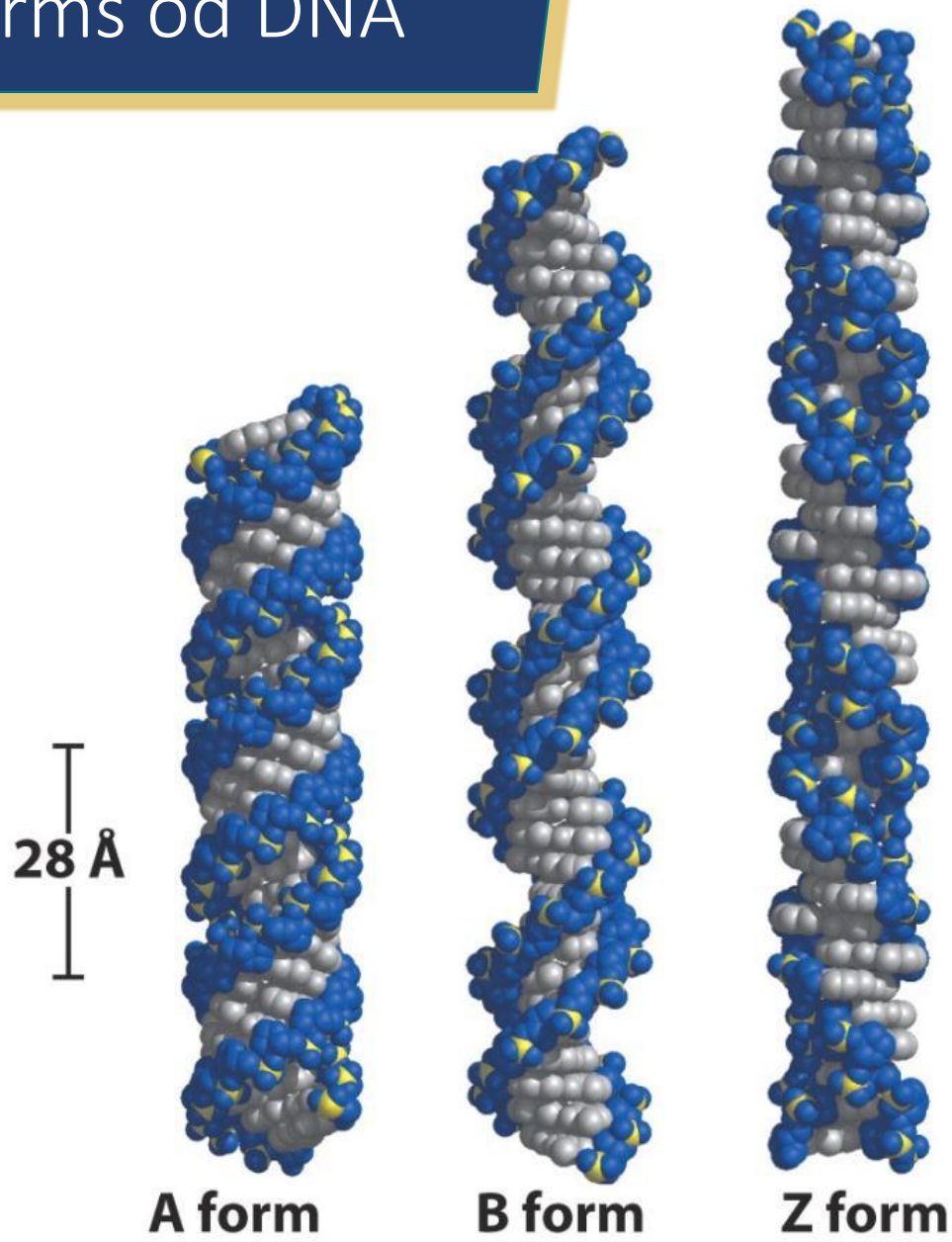

A nucleoside monophosphate unit
Phosphodiester linkage
5′
3′
T
A
G
C


Thymine
2.8 Å
3.0 Å
11.1 Å
Cytosine
2.9 Å
3.0 Å
2.9 Å
10.8 Å

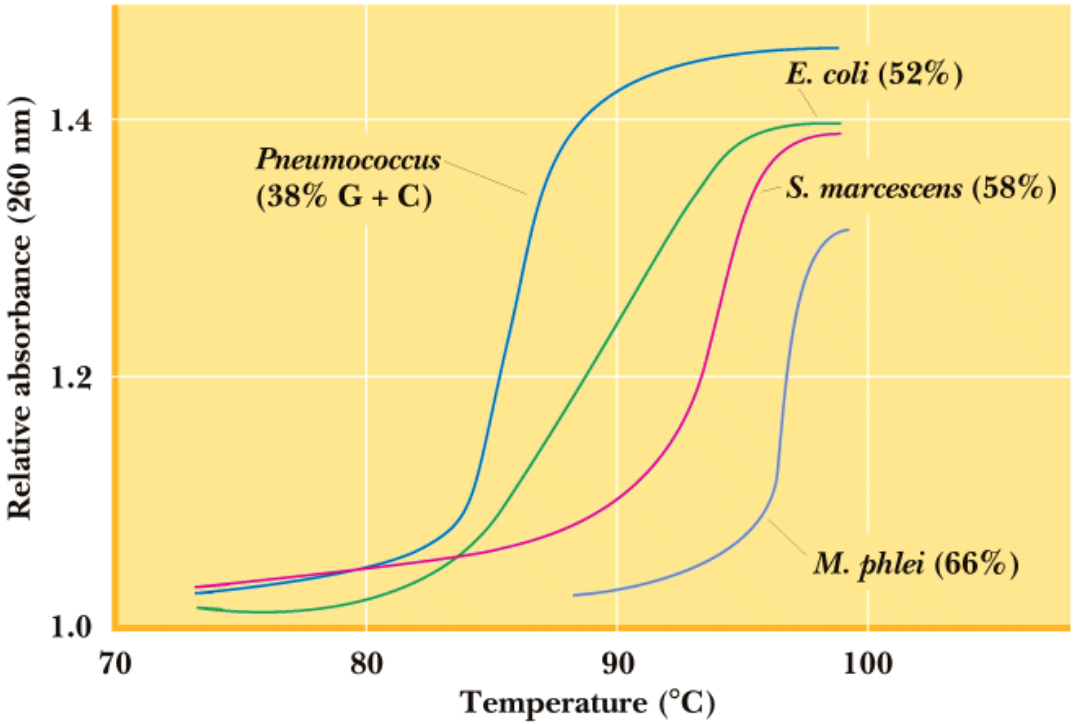
Antiparelel Structure

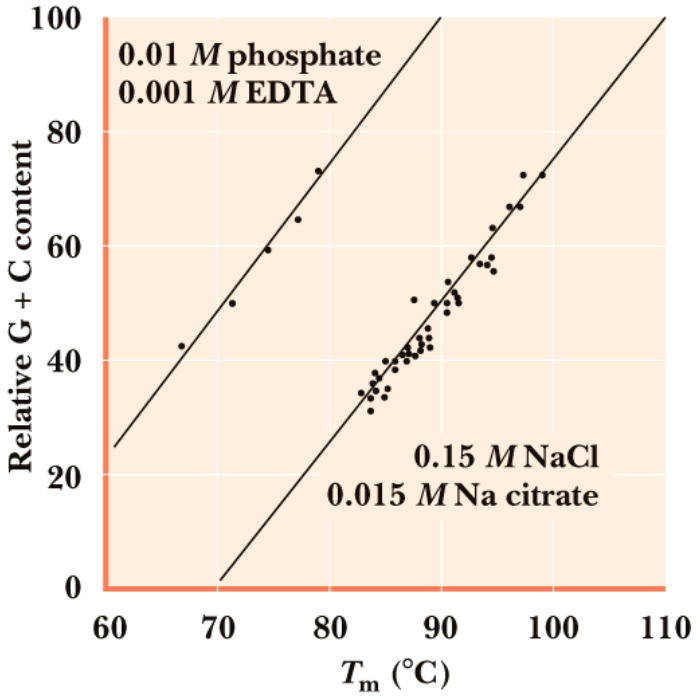


A, B and Z forms od DNA

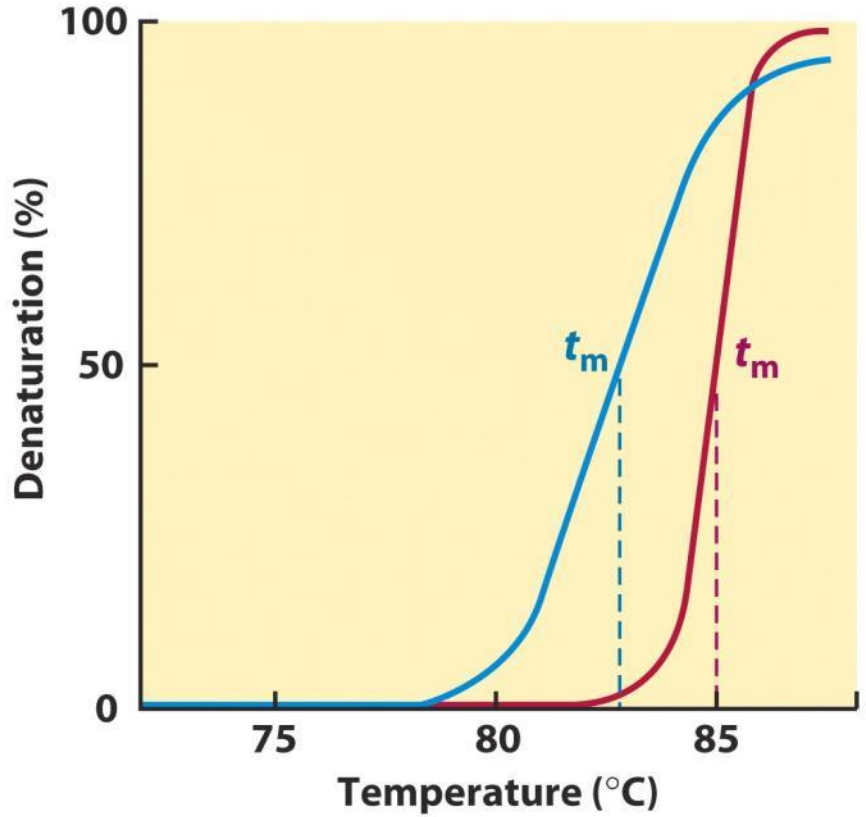


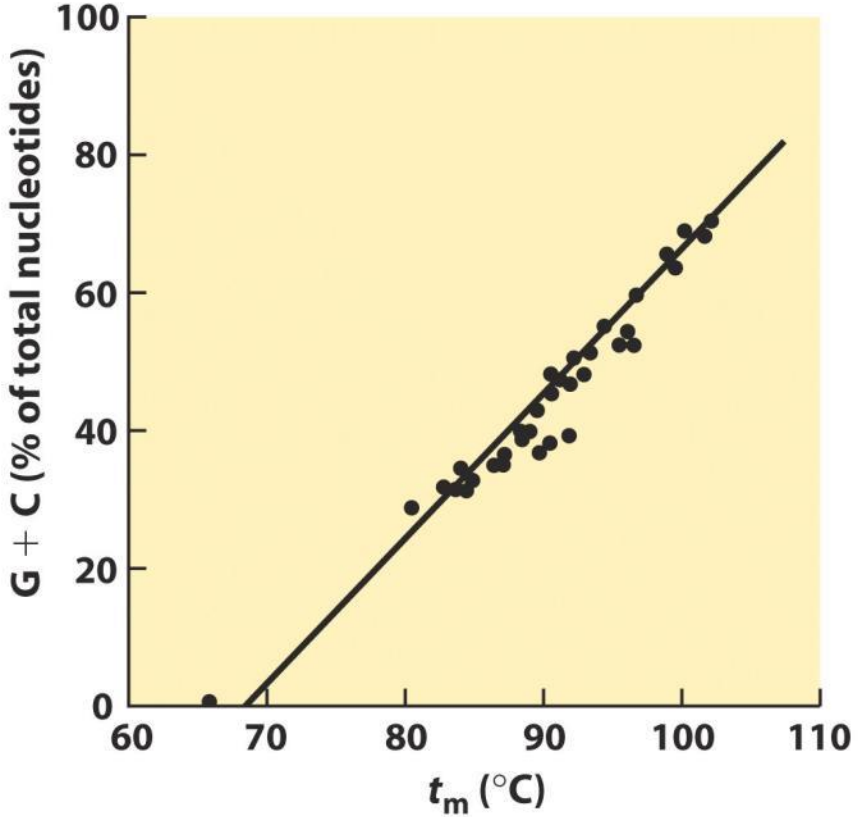
DNA Denaturation

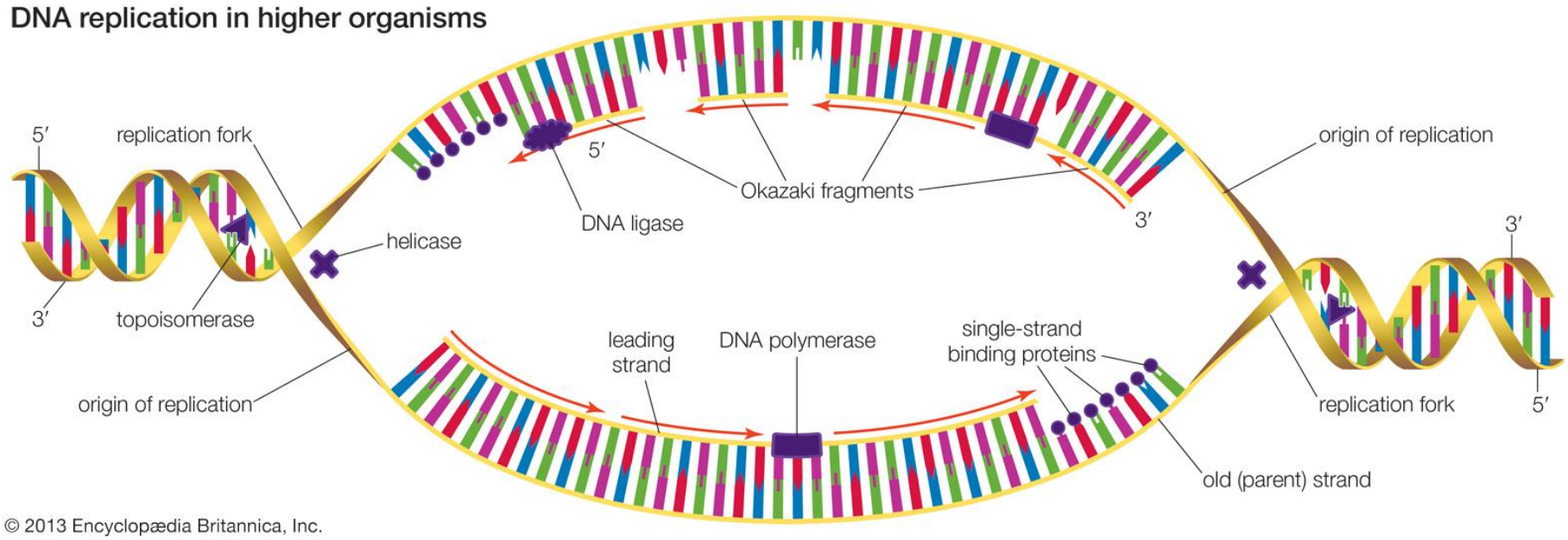




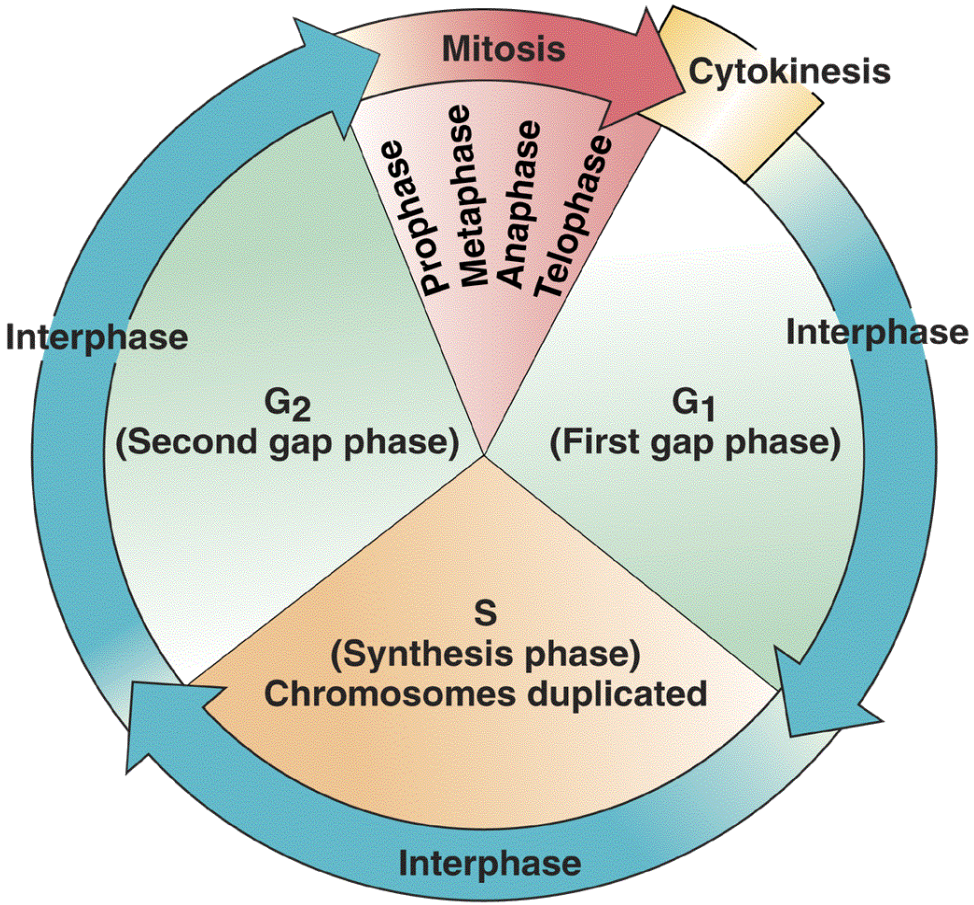
DNA Denaturation

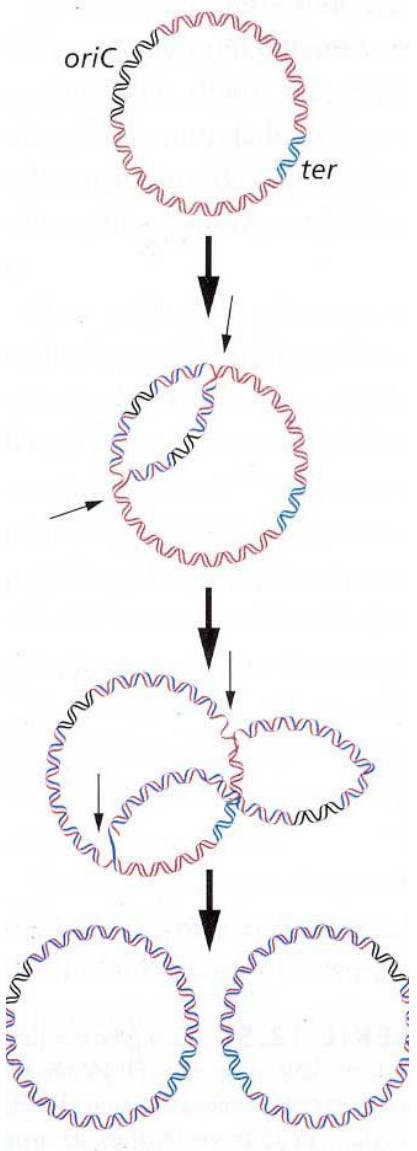




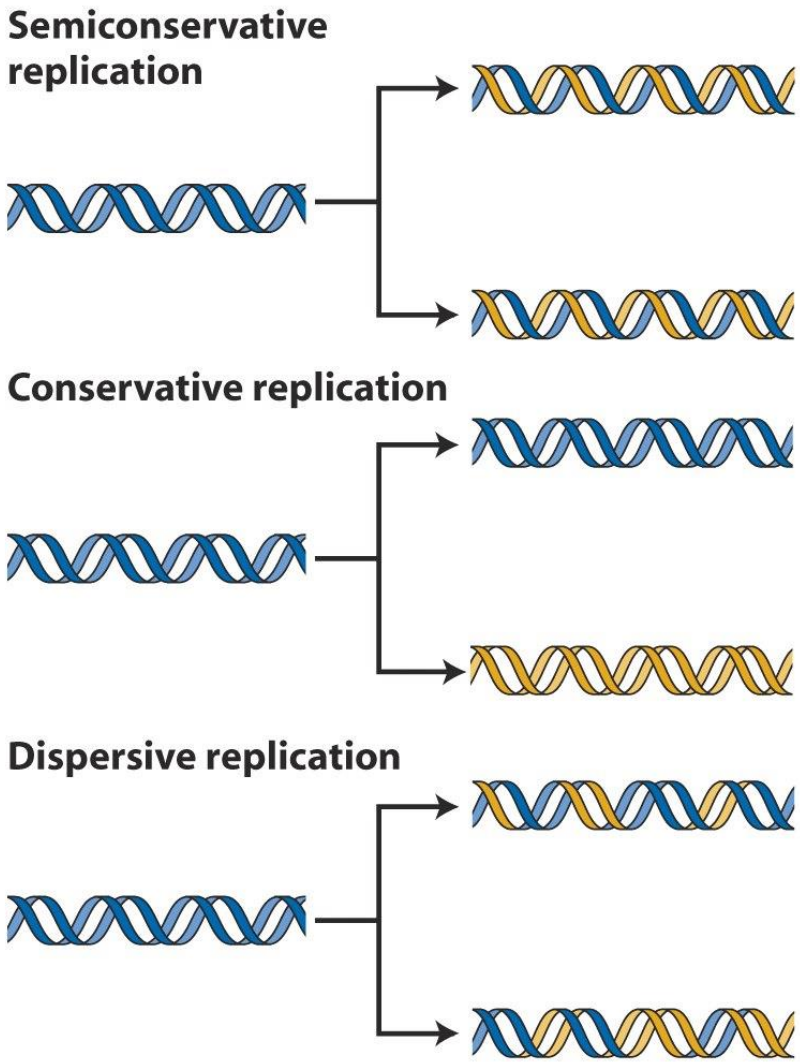


DNA Replication


Mitosis
Cytokinesis
Prophase
Metaphase
Anaphase
Telophase
Interphase
Interphase
G2
(Second gap phase)
G1
(First gap phase)
S
(Synthesis phase)
Chromosomes duplicated
Interphase


oriC
ter

DNA Replication Model



The Meselson–Stahl Experiment

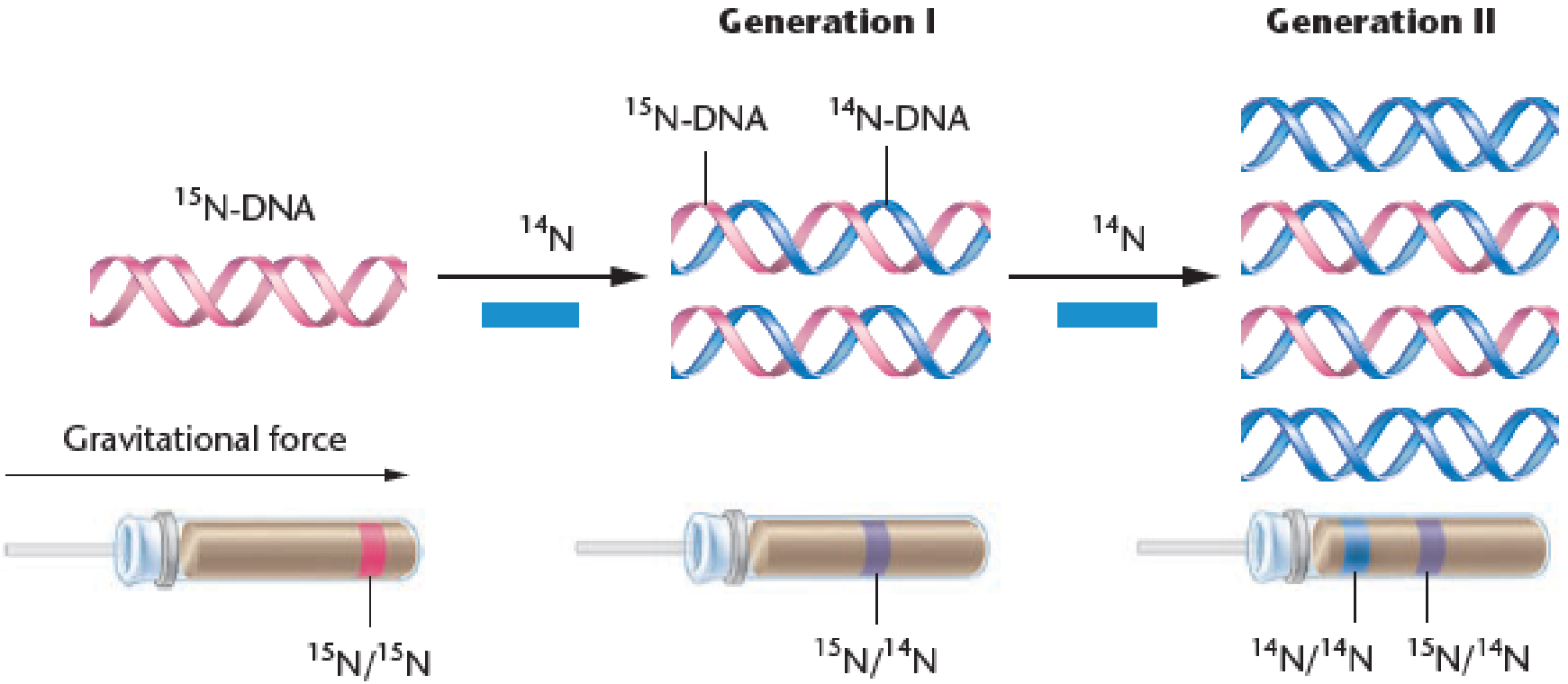
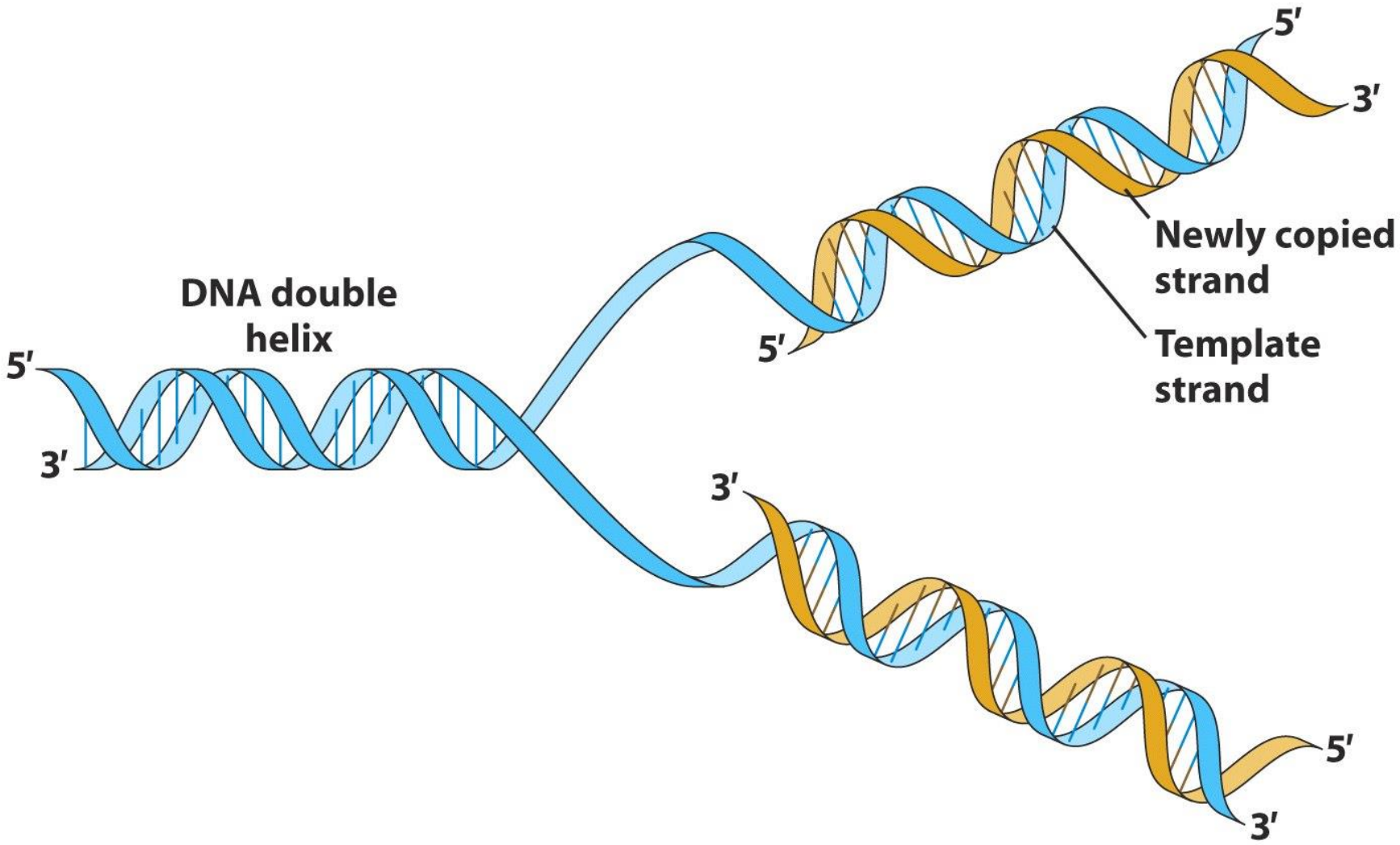
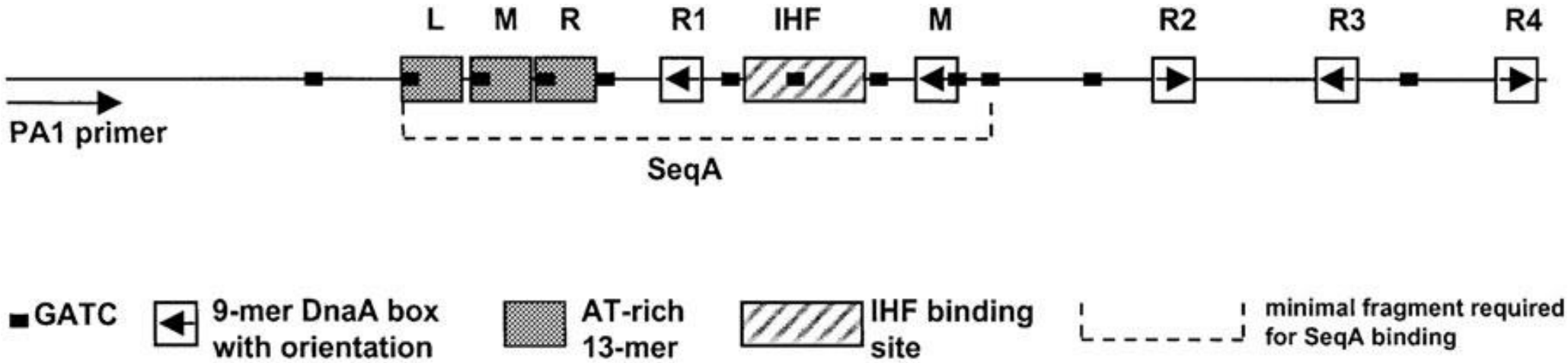


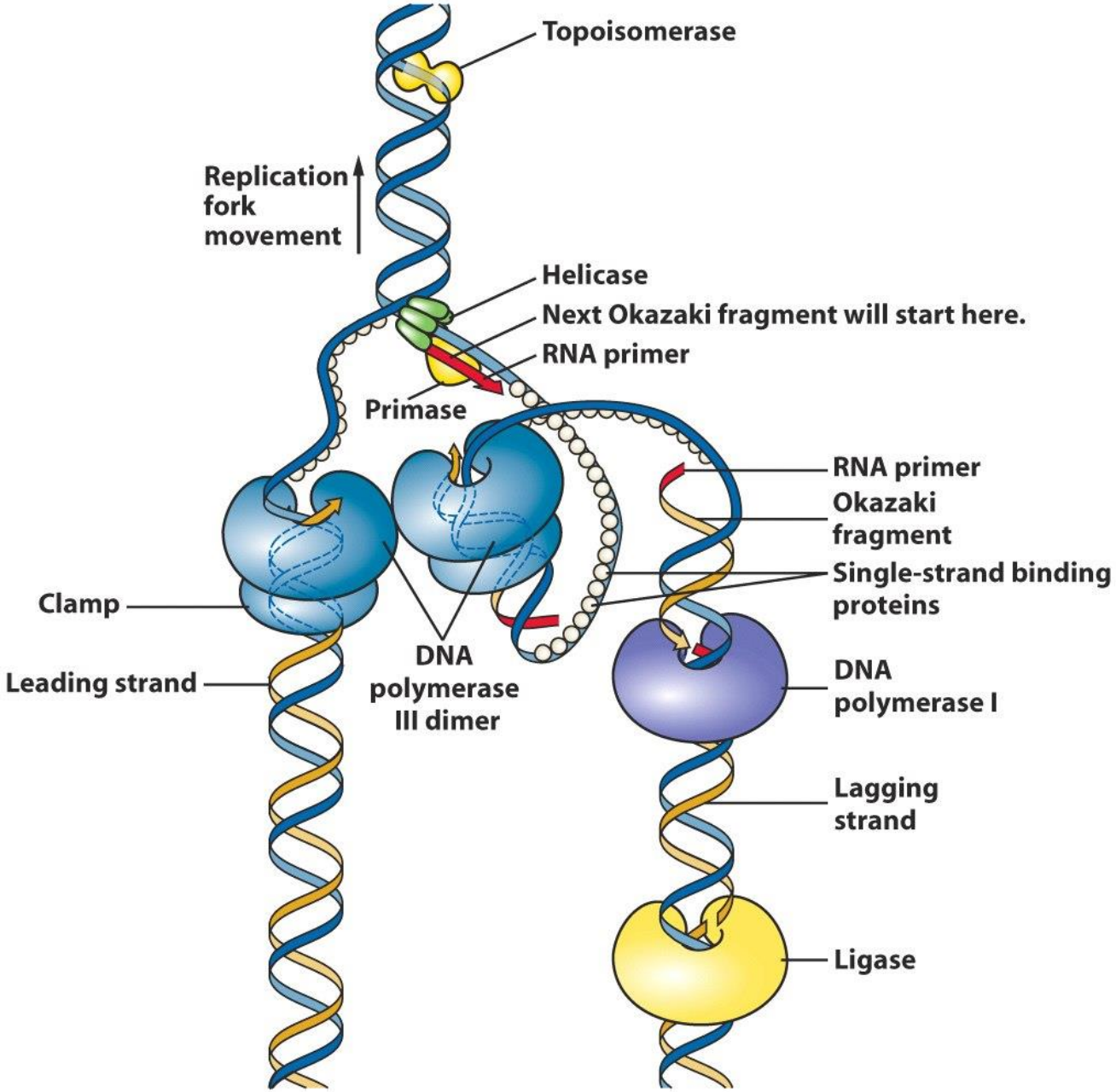
FIGURE 11.4 The expected results of two generations of semiconservative replication in the Meselson–Stahl experiment.

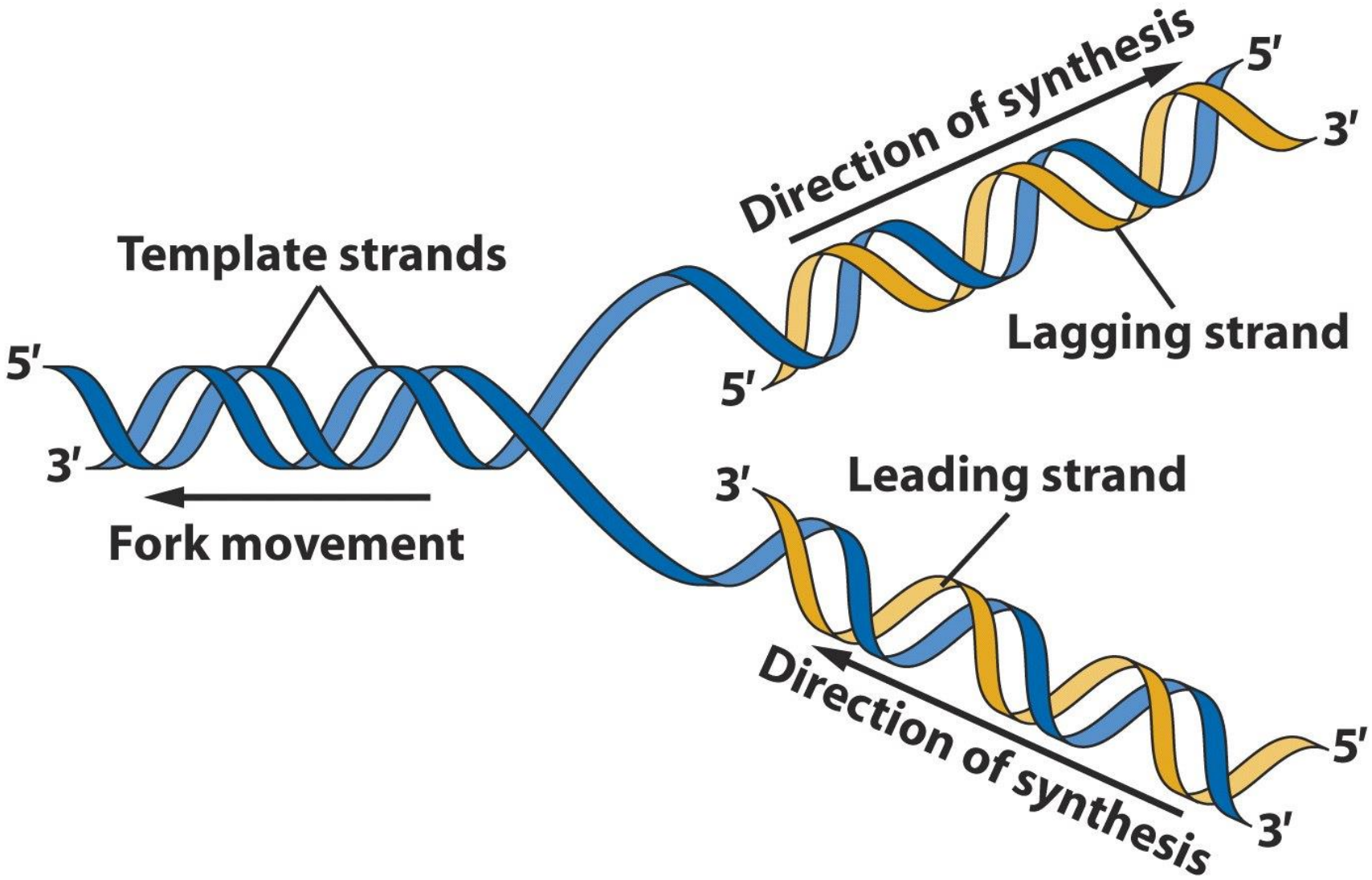

DNA double
helix
5′
3′
5′
3′
Newly copied
strand
Template
strand
3′
5′
3′



DnaA box : 5’ TTATCCACA 3’

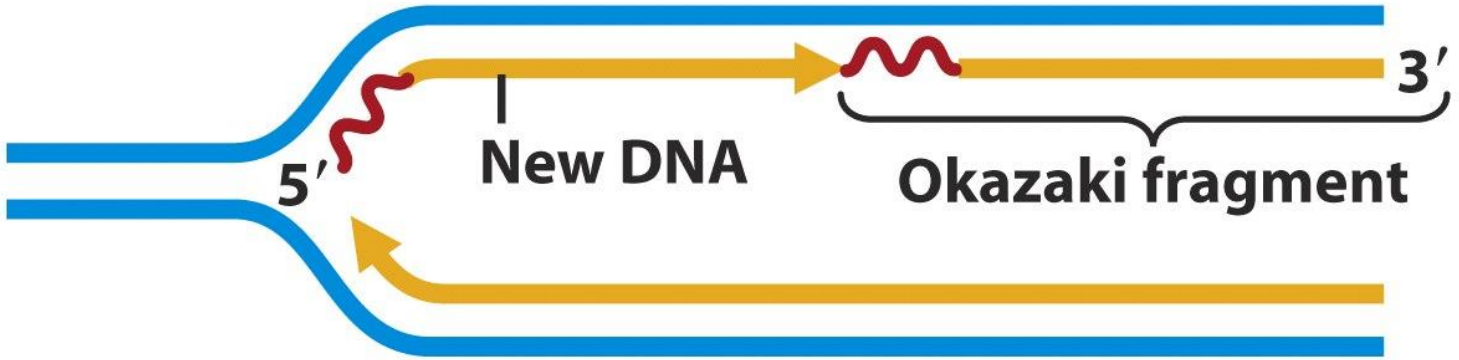
AT-rich 13 mer : 5’ GATCTNTTNTTTT 3’


Topoisomerase
Replication fork movement
Helicase
Next Okazaki fragment will start here.
RNA primer
Primase
RNA primer
Okazaki fragment
Single-strand binding proteins
Clamp
Leading strand
DNA polymerase III dimer
DNA polymerase I
Lagging strand
Ligase

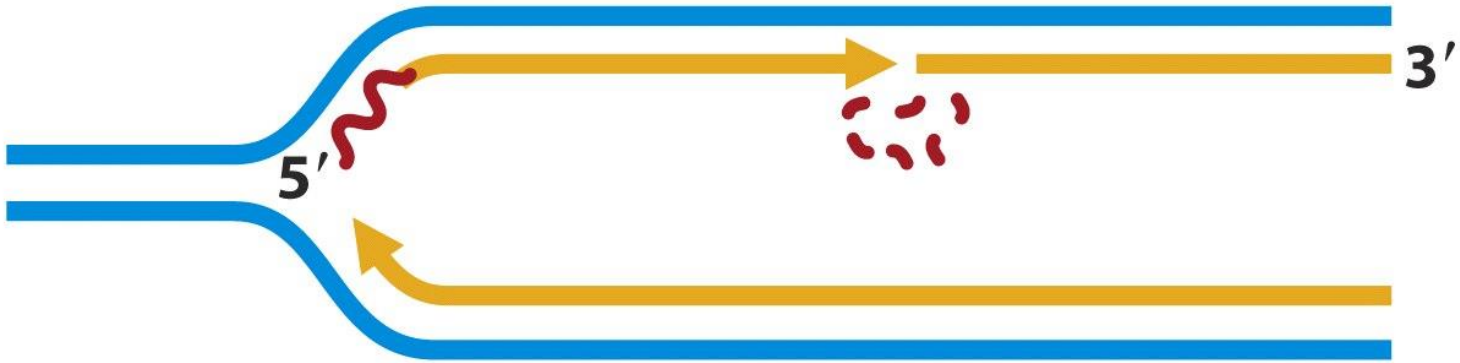

Direction of synthesis
5′
3′
Template strands
5′
3′
Lagging strand
5′
3′
Leading strand
Fork movement
Direction of synthesis
5′
3′

1. Primase synthesizes short RNA oligonucleotides (primer) copied from DNA.

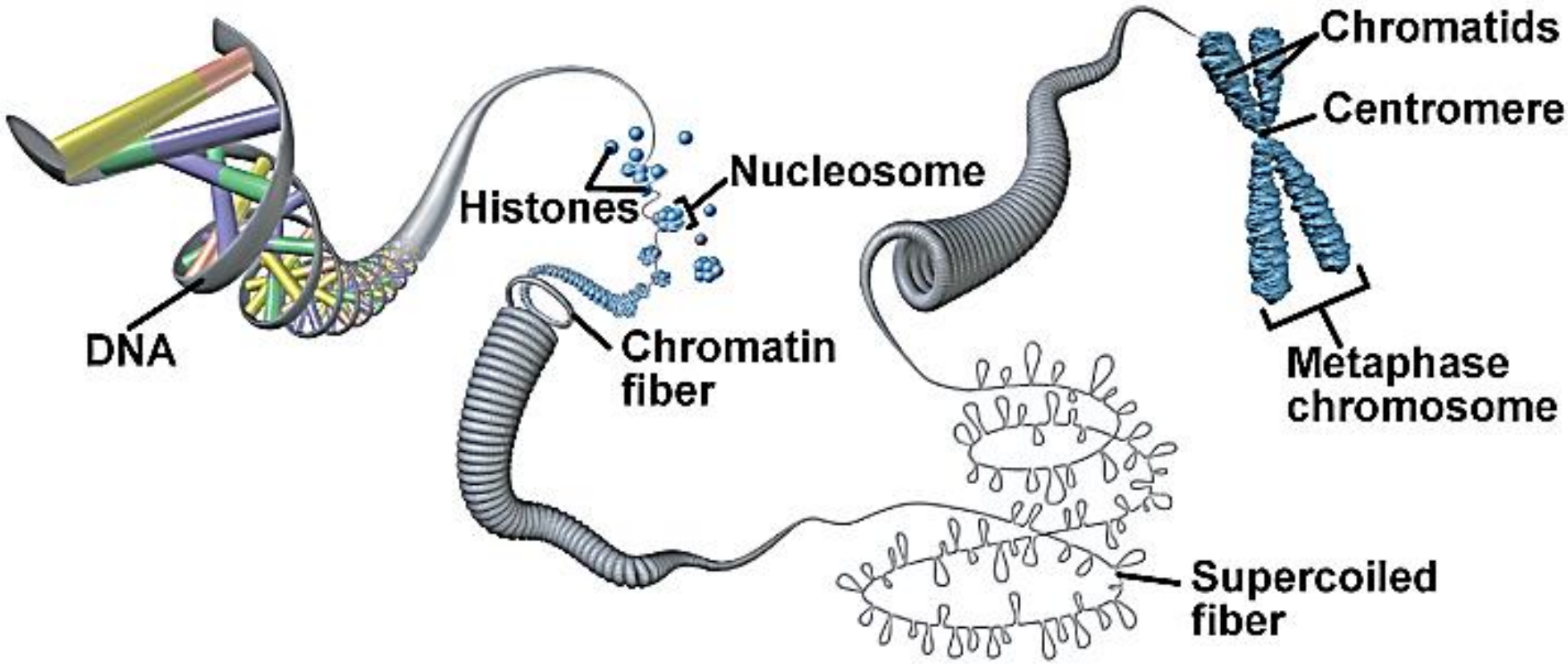
2. DNA polymerase III elongates RNA primers with new DNA.



3. DNA polymerase I removes RNA at 5′ end of neighboring fragment and fills gap.



4. DNA ligase connects adjacent fragments.


Chromatids
Centromere
Nucleosome
Histones
DNA
Chromatin fiber
Metaphase chromosome
Supercoiled fiber