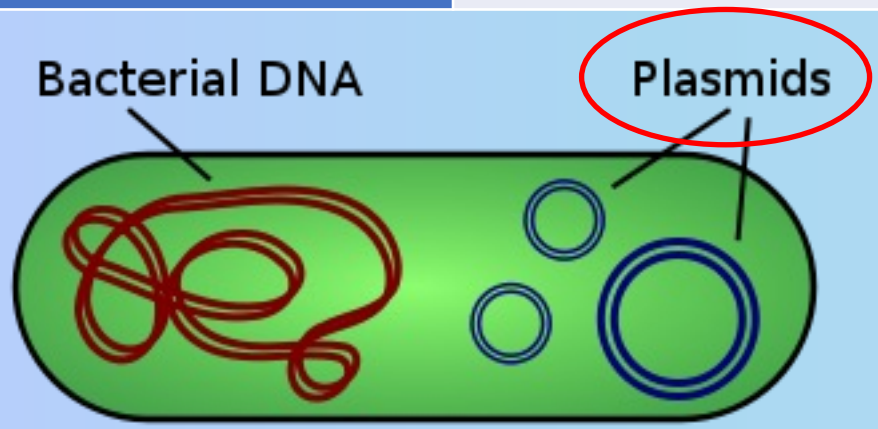
DNA

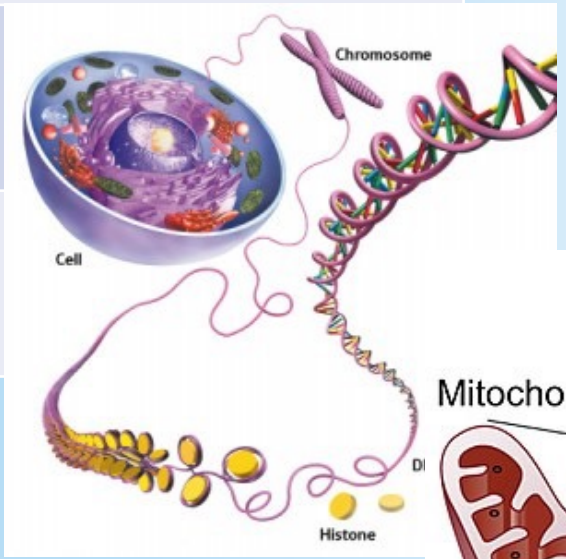
By Ida Nygård

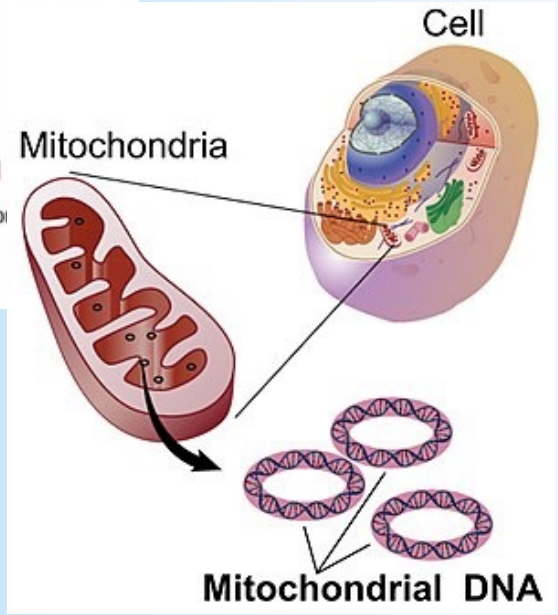
We will cover:

- ❑ Eukaryotes vs prokaryotes
- ❑ DNA structure
- ❑ Types of DNA
- ❑ DNA replication
- ❑ DNA repair

	Prokaryotes	Eukaryotes
Circular DNA	Yes	Yes (mitochondria)
Linear DNA	No	Yes (nucleus)
Nucleus present	No	Yes
Plasmids	Yes	No

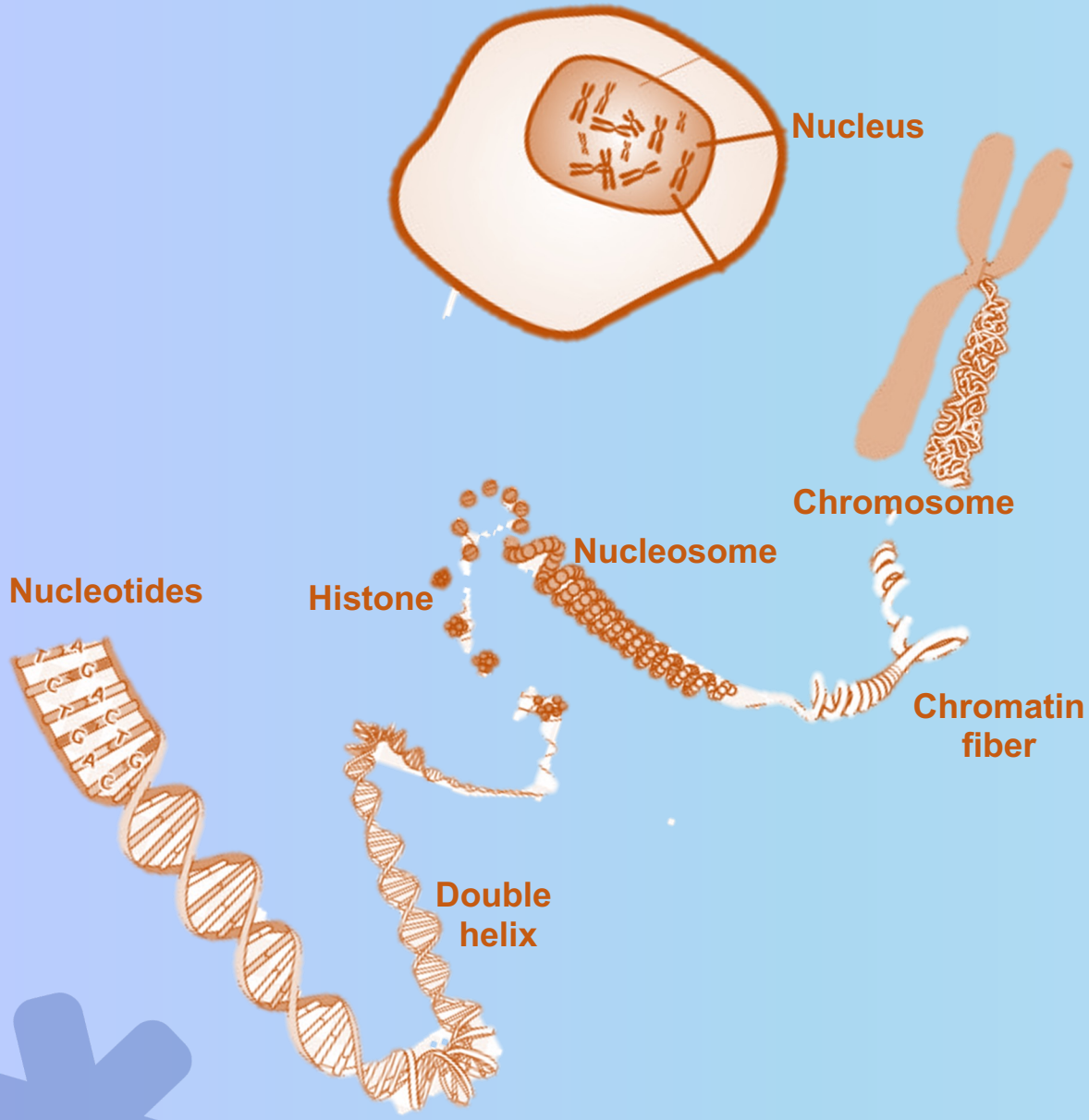






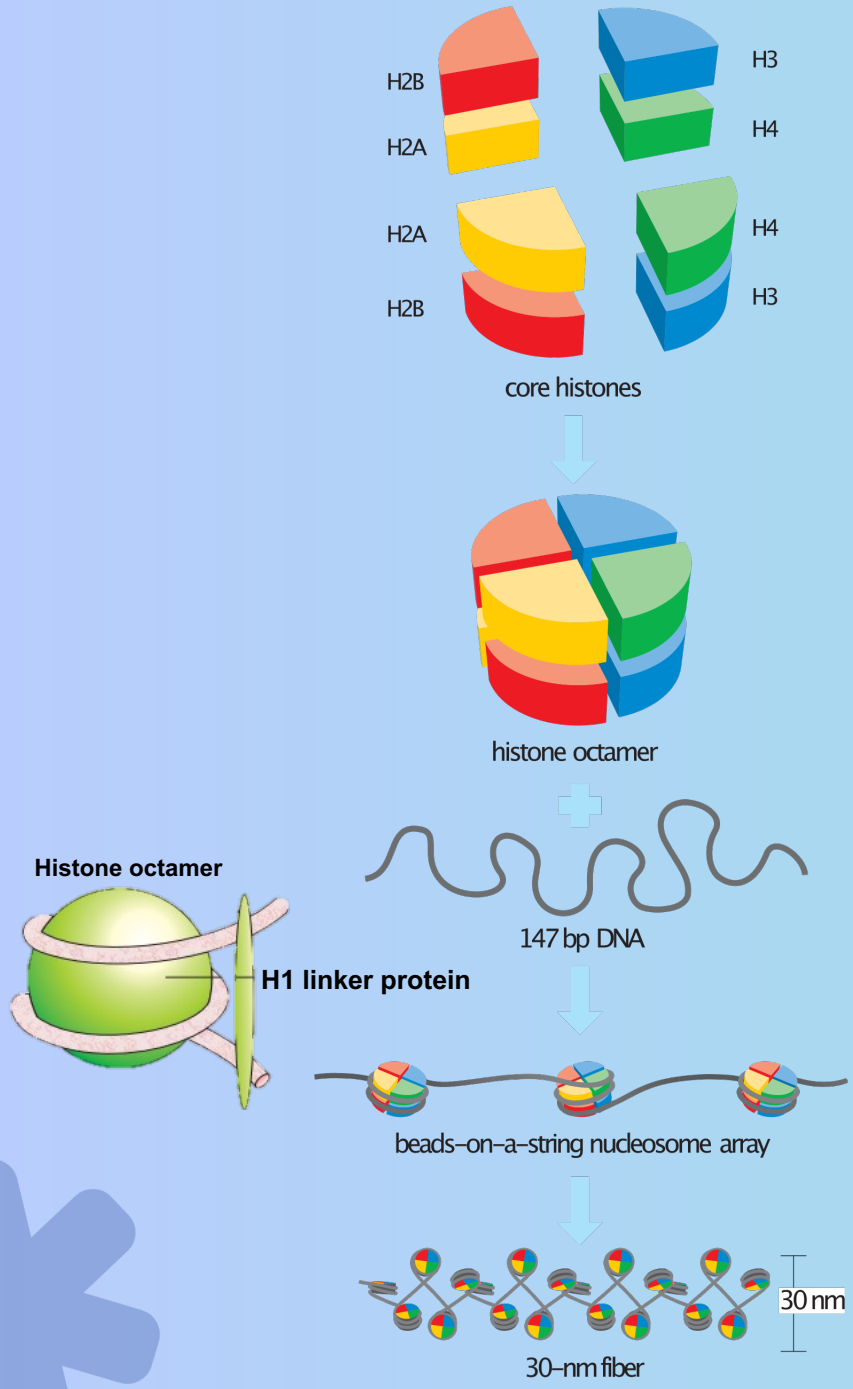
We will cover:

- ✓ Eukaryotes vs prokaryotes
- ❑ DNA structure
- ❑ Types of DNA
- ❑ DNA replication
- ❑ DNA repair



Linear DNA

Histones

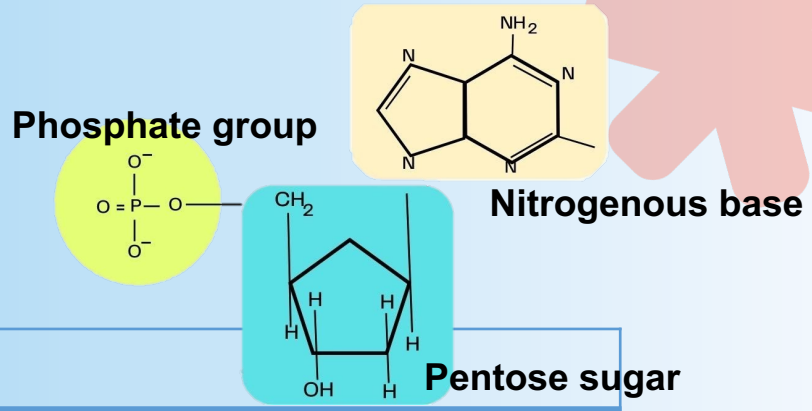


- Histone octamer → lysine and arginine (++)
  - H2A
  - H2B
  - H3
  - H4
- H1 linker protein (++++)
- DNA is negatively charged → binds around histones

Acetylation = reduces positive charge, decreases bonding
Deacetylation = Increase bonding between histones and DNA

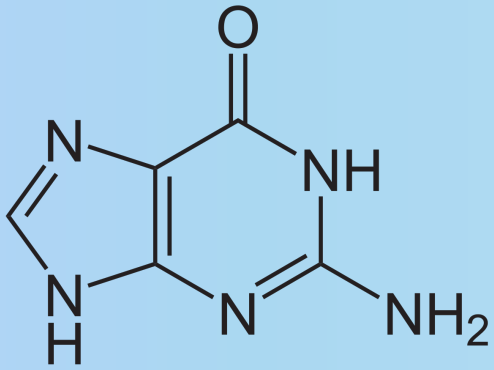
studyaid

Nucleotides



Nitrogenous bases	
PURINES	PYRIMIDINES

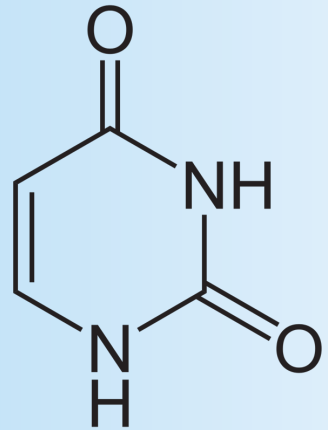
ADENINE



GUANINE

THYMINE

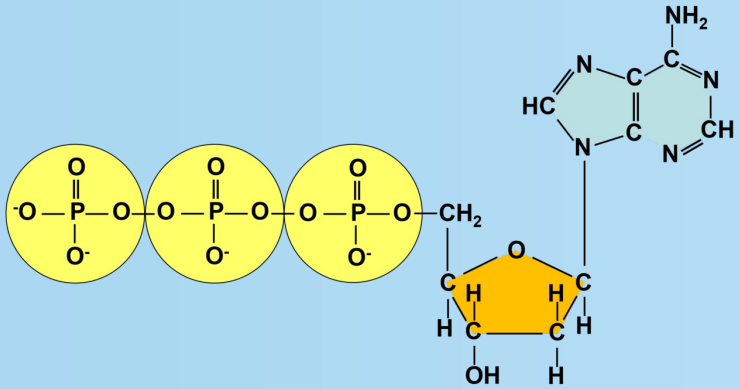
CYTOSINE

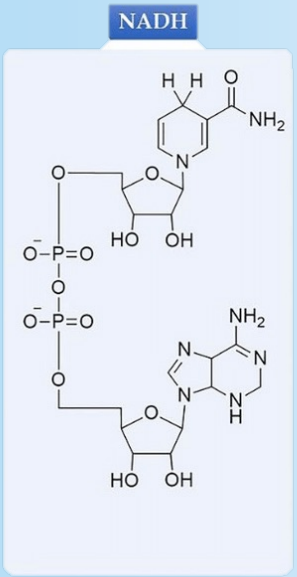


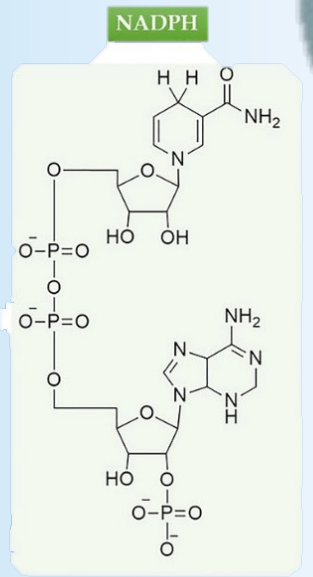
URACIL

Functions

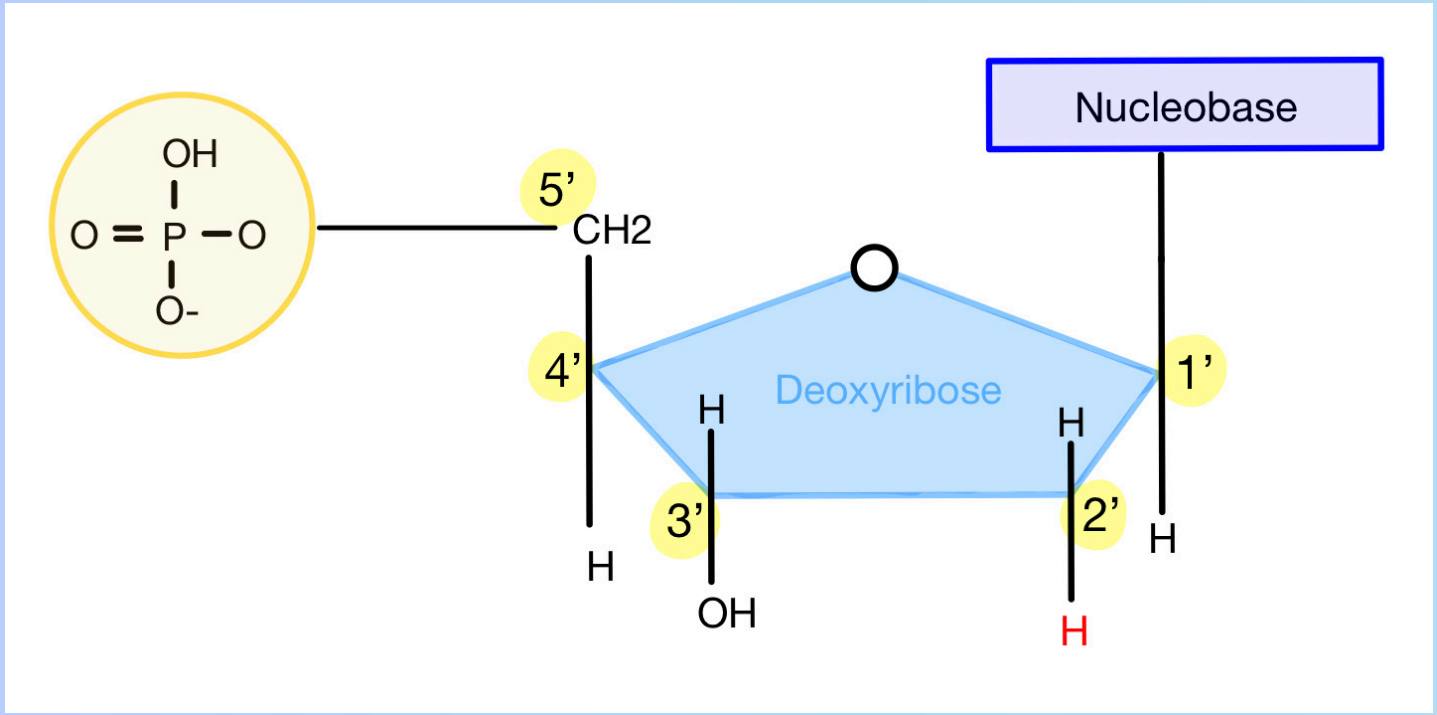
- Precursors of DNA and RNA
- Essential coenzymes
  - Coenzyme A
  - FAD(H2)
  - NAD(H) / NADP(H)
  - cAMP / cGMP
- Energy carriers
  - ATP
  - GTP



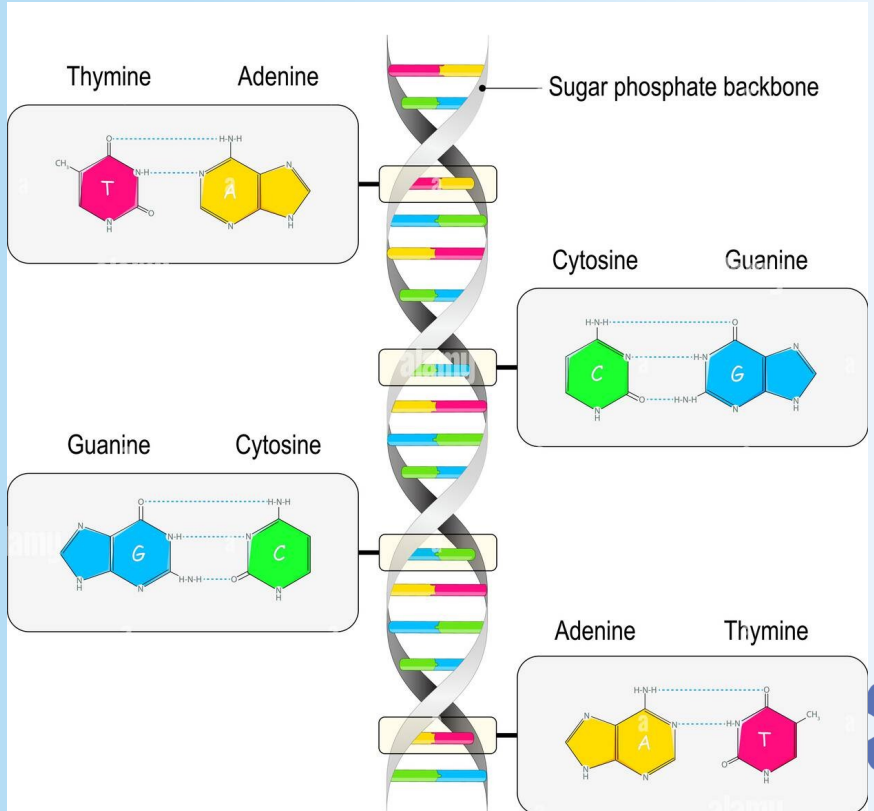


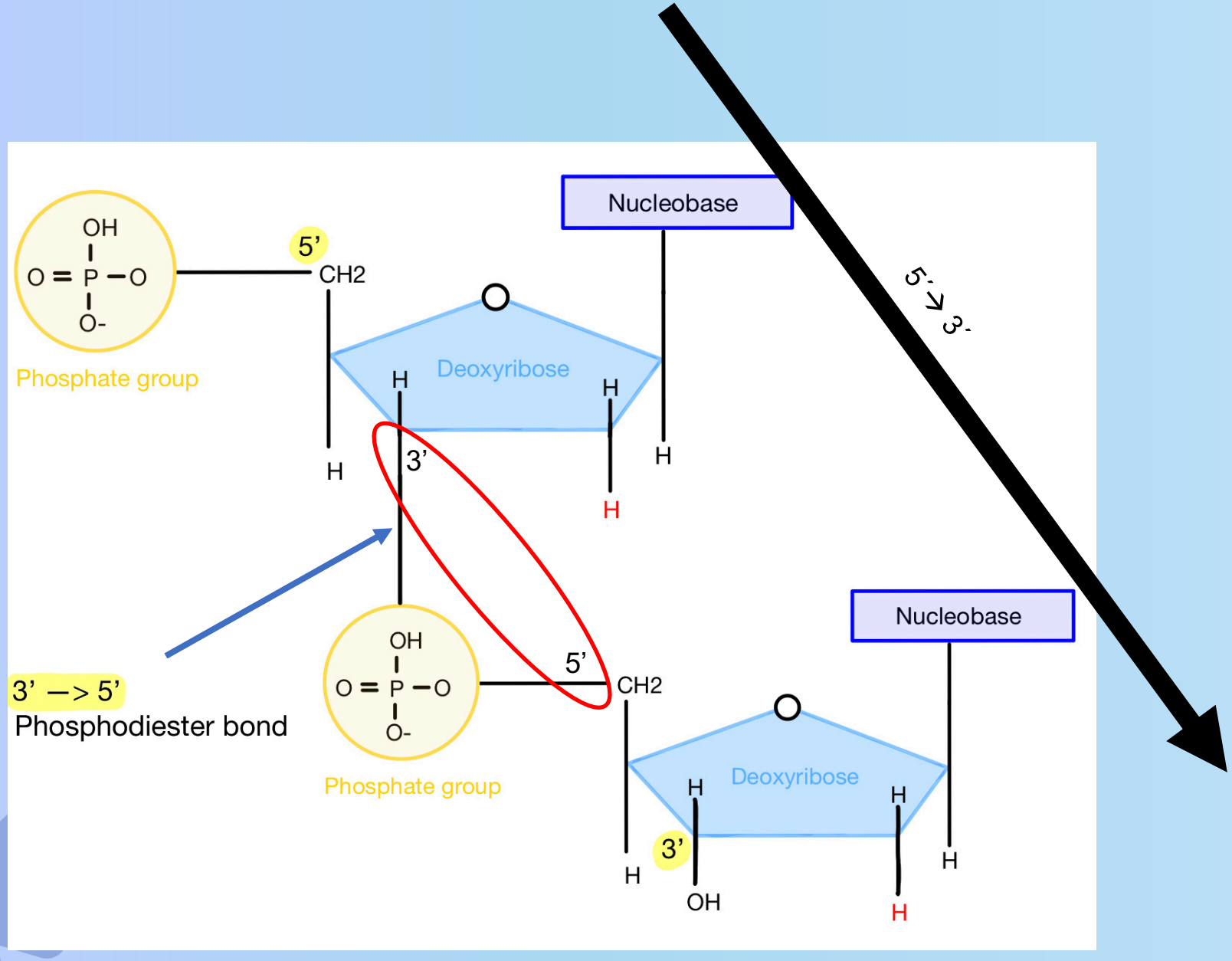


DNA structure



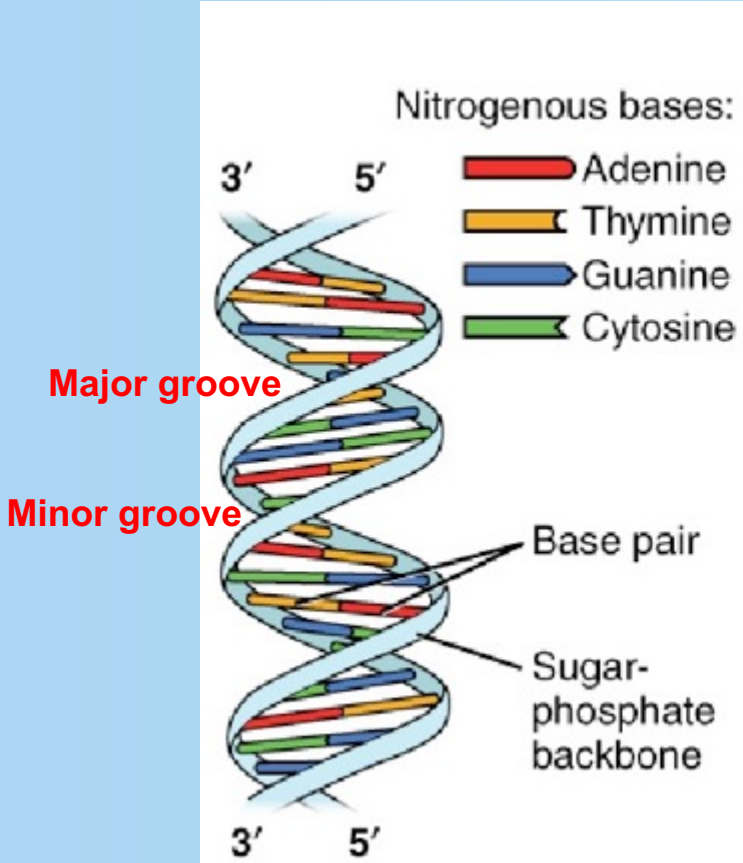
- Nucleotides
  - Nitrogenous base
  - Pentose sugar
  - Phosphate group (-)



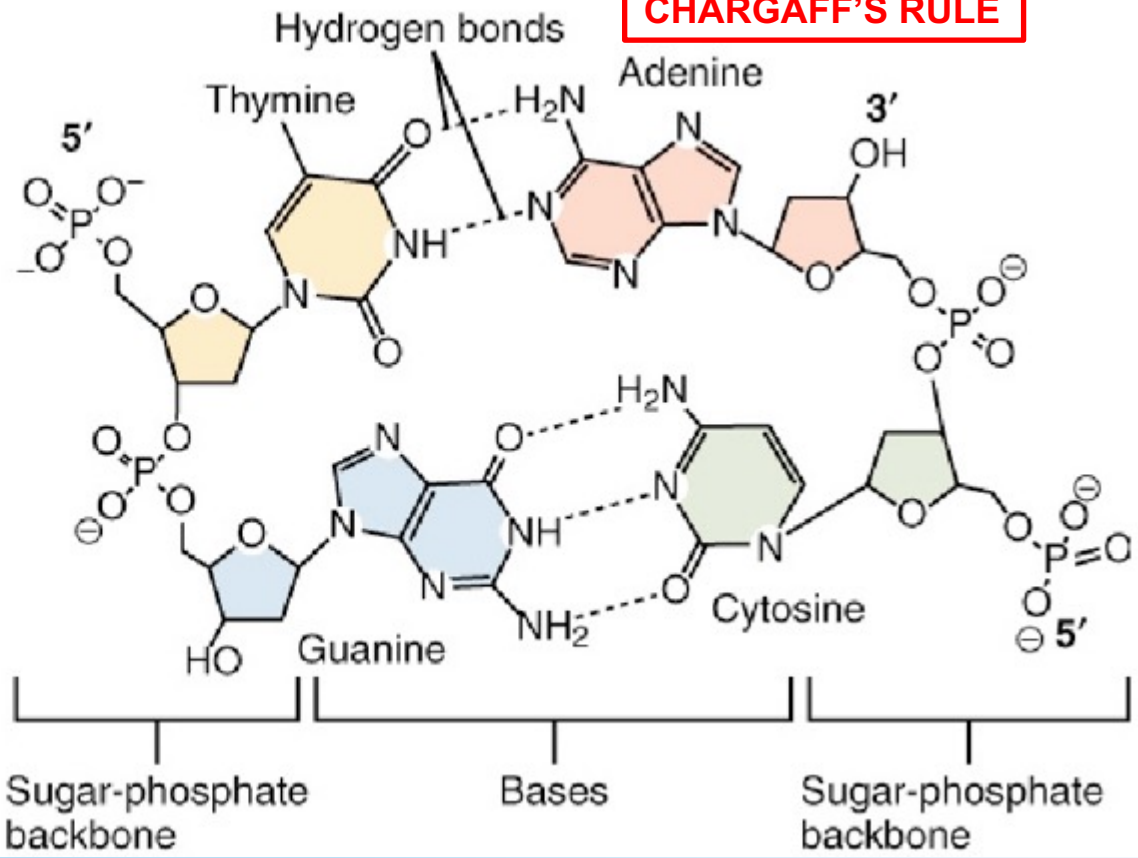

Nucleobase
5' → 3'
OH
O = P – O
O-
Phosphate group
5'
CH2
Deoxyribose
H
H
H
H
3'
3' —> 5'
Phosphodiester bond
OH
O = P – O
O-
Phosphate group
5'
CH2
Nucleobase
Deoxyribose
H
H
H
3'
H
OH
H

Double helix bond

- Antiparallell
  - R = 5'→3'
  - L = 3'→5'
- Double helix is stabilized by different bonds
  - Van der Waal interaction
  - Hydrophobic effect
  - Hydrogen bonds
- Major and minor grooves
  - Provides access for binding of regulatory proteins



CHARGAFF'S RULE



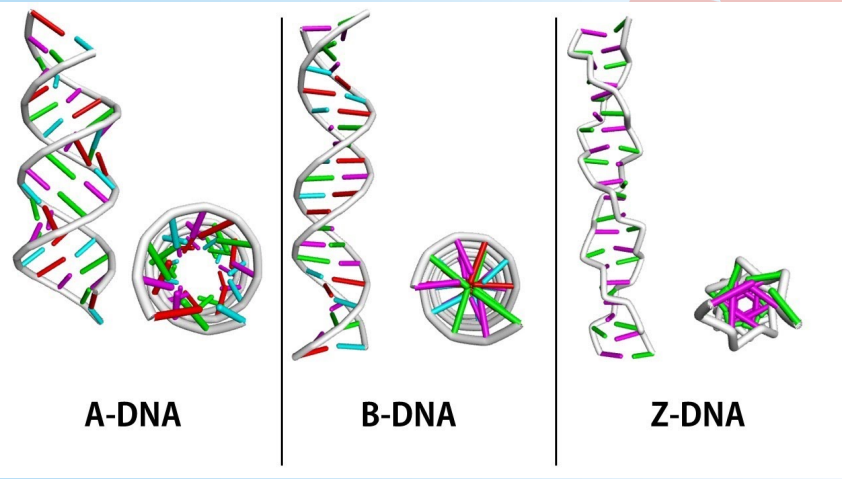
Dactinomycin acts on minor groove
→ Inhibits DNA replication

studyaid

We will cover:

- ✓ Eukaryotes vs prokaryotes
- ✓ DNA structure
- ❑ Types of DNA
- ❑ DNA replication
- ❑ DNA repair

Types of DNA



	DNA B-type *High humidity DNA*	**DNA A-type** *Dehydrated B-DNA*	**DNA Z-type**
Helical rotation	Right-handed	Right-handed	Left-handed
Distance between BP	3.4Å	2.3Å	3.8Å
Base pairs per 360°	10bp	11bp	12bp
Helical diameter	20Å = 2.0 nm	26Å = 2.6 nm	18Å = 1.8 nm
Characteristics	Chromosomal DNA	DNA-RNA hybrids or double stranded RNA	Influences gene expression and regulation

Denaturation of DNA = loss of helical structure (heat or alkali)

We will cover:

- ✓ Eukaryotes vs prokaryotes
- ✓ DNA structure
- ✓ Types of DNA
- ❑ DNA replication
- ❑ DNA repair

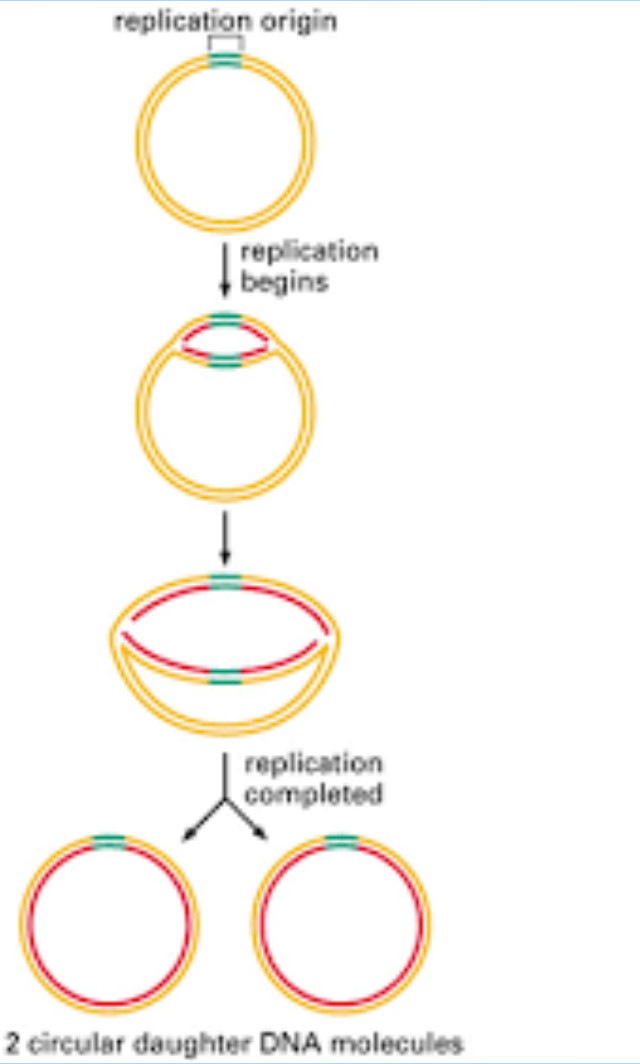
1. Go to wooclap.com
2. Enter the event code in the top banner

Event code
SHLIAY

studyaid

DNA replication

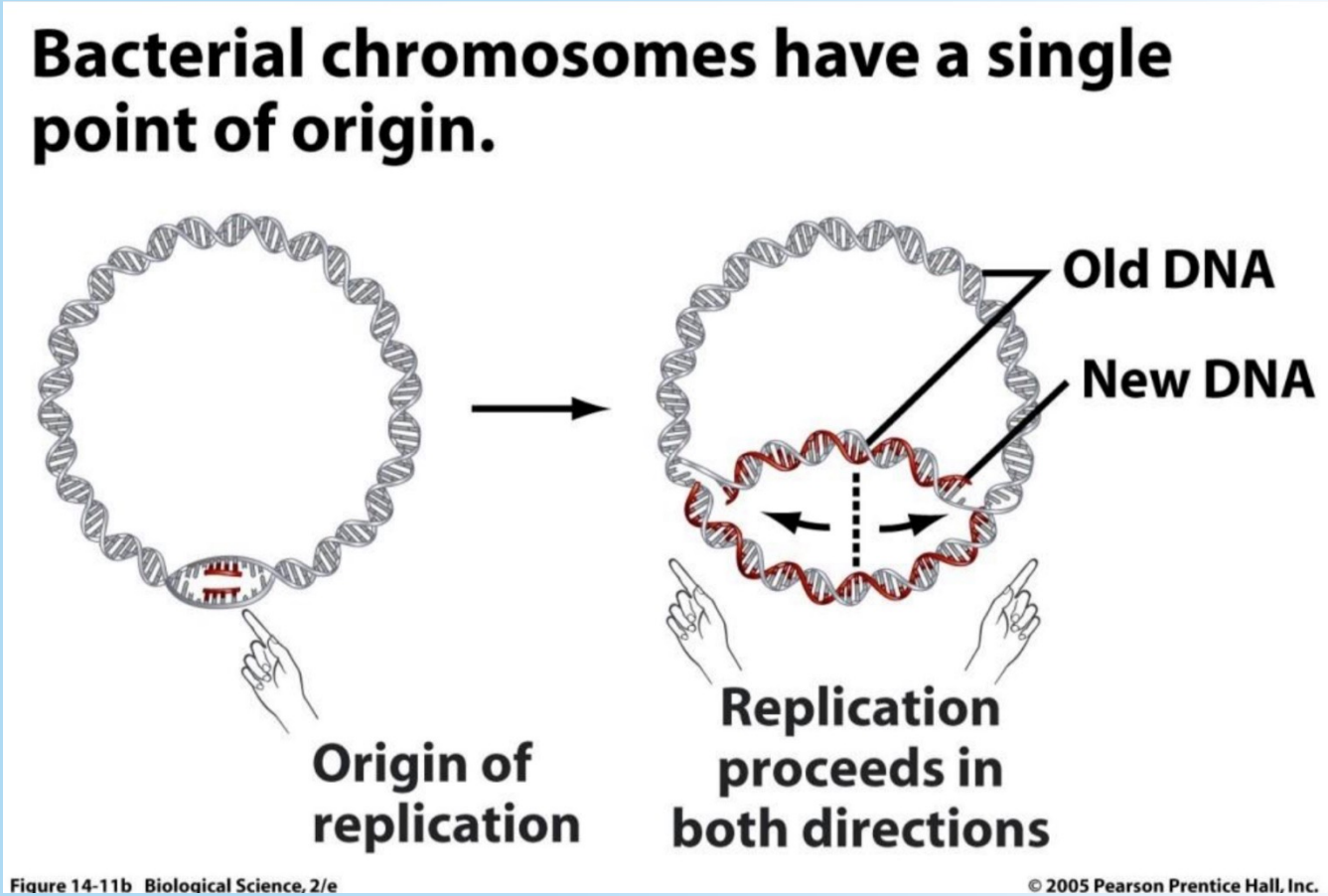
Prokaryotic DNA replication



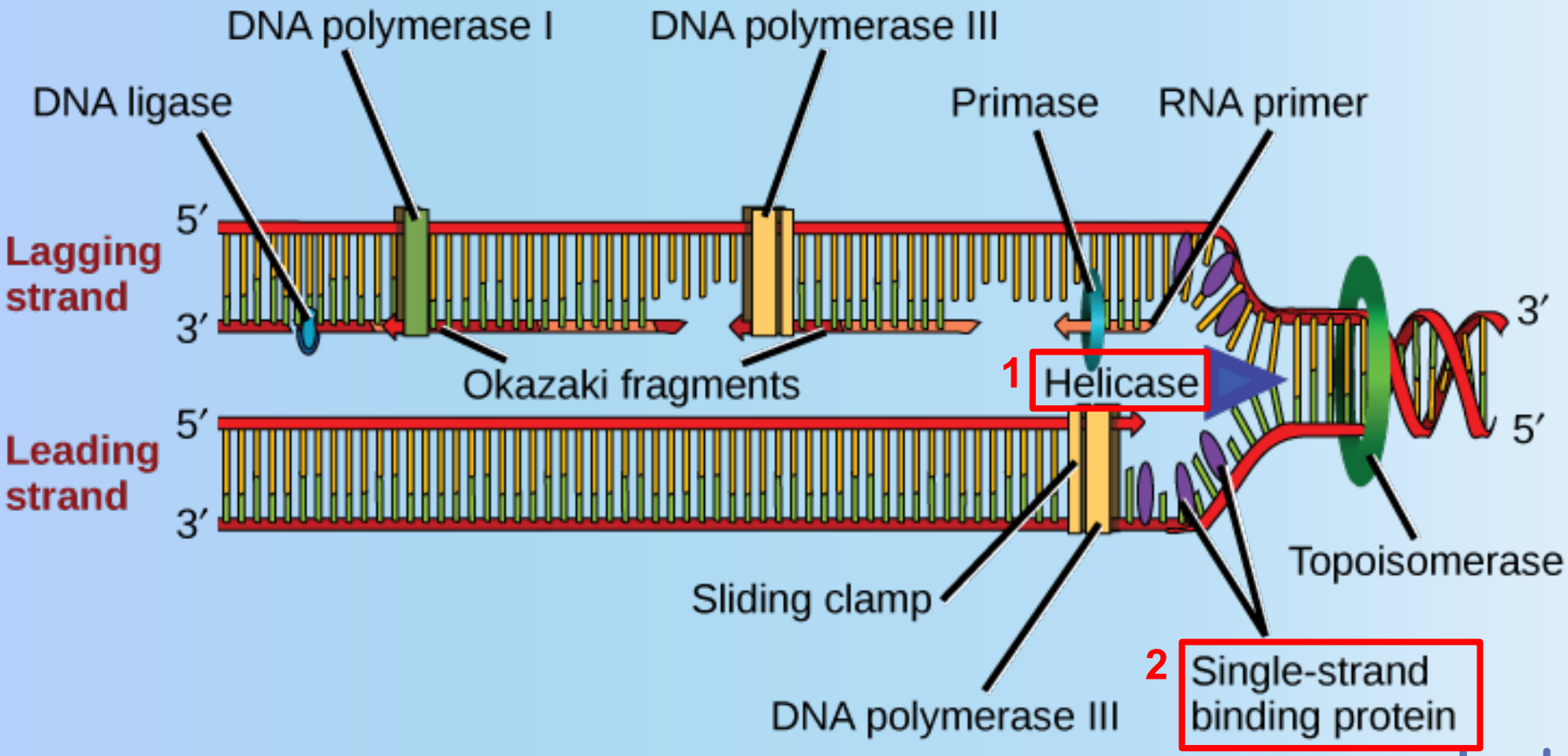
1. Initiation
2. Elongation
3. Termination

1. Initiation

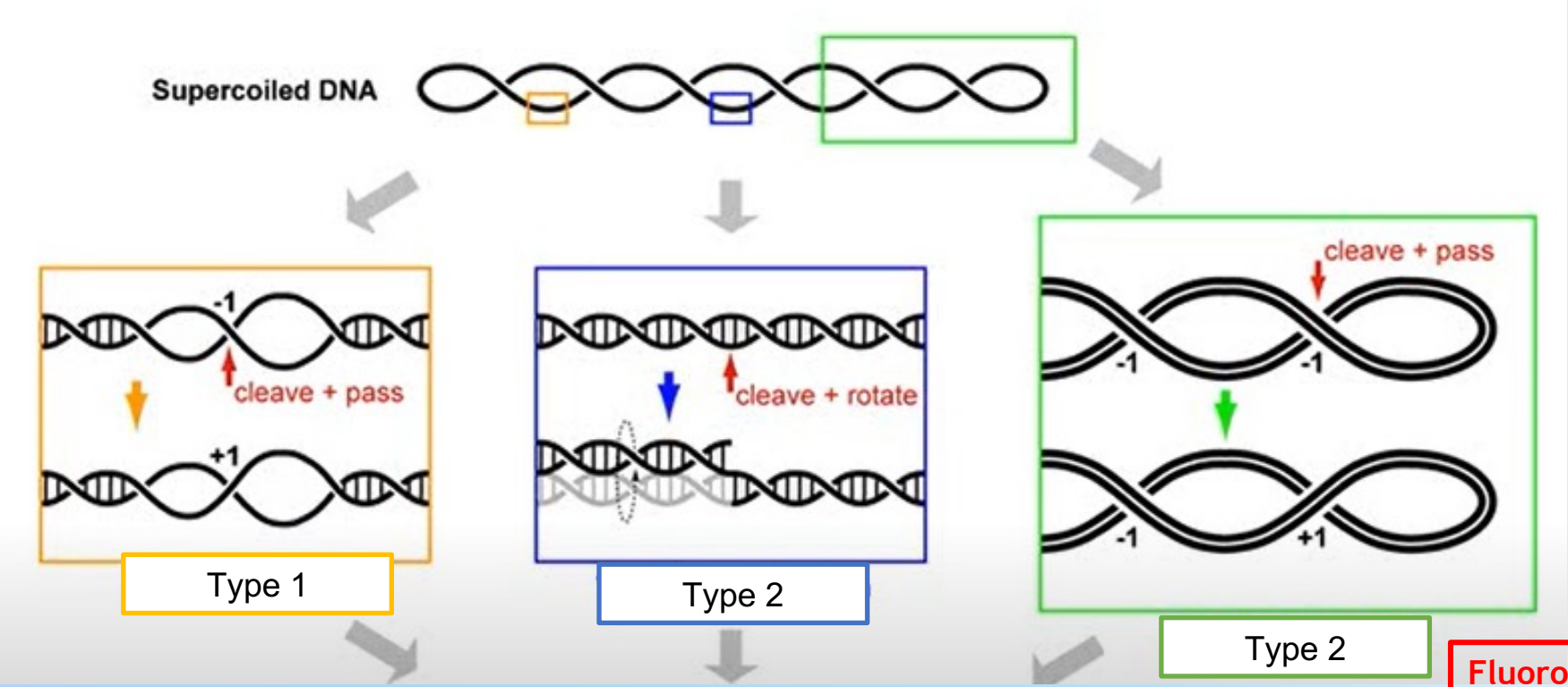
- Origin of replication = Ori
  - DnaA proteins bind to an AT-rich segment of ~30 molecules
- In e.coli = OriC



Replication fork formation



Supercoiling

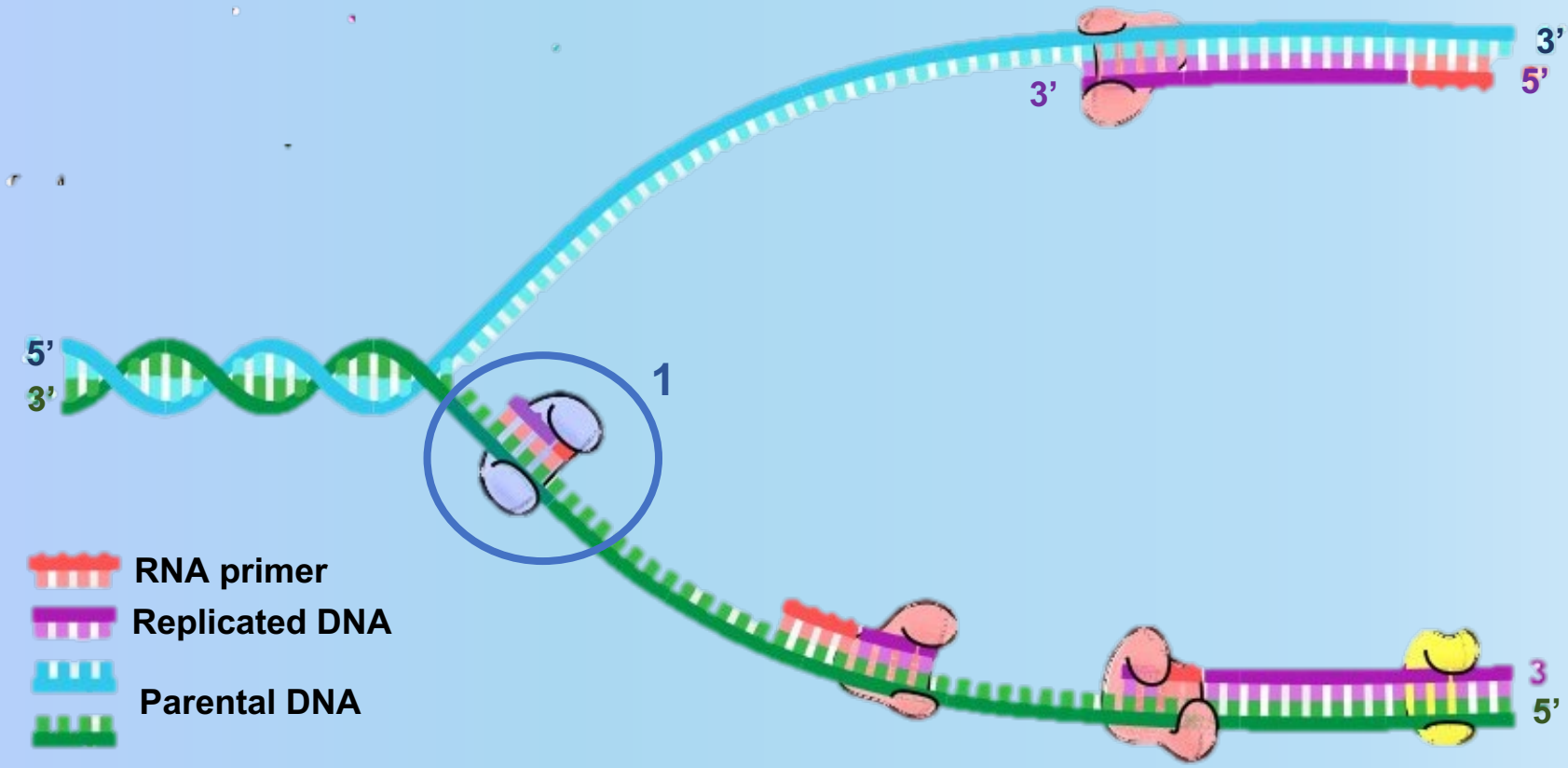


Topoisomerase type 1	Topoisomerase type 2
- ssDNA uncoiling - ATP INdepedent	- dsDNA uncoiling - ATP dependent - DNA gyrase

Fluoroquinolones:
Inhibits DNA gyrase
Increases nuclease domain
Inhibits ligase
→ Destroys DNA

studyaid

Replication

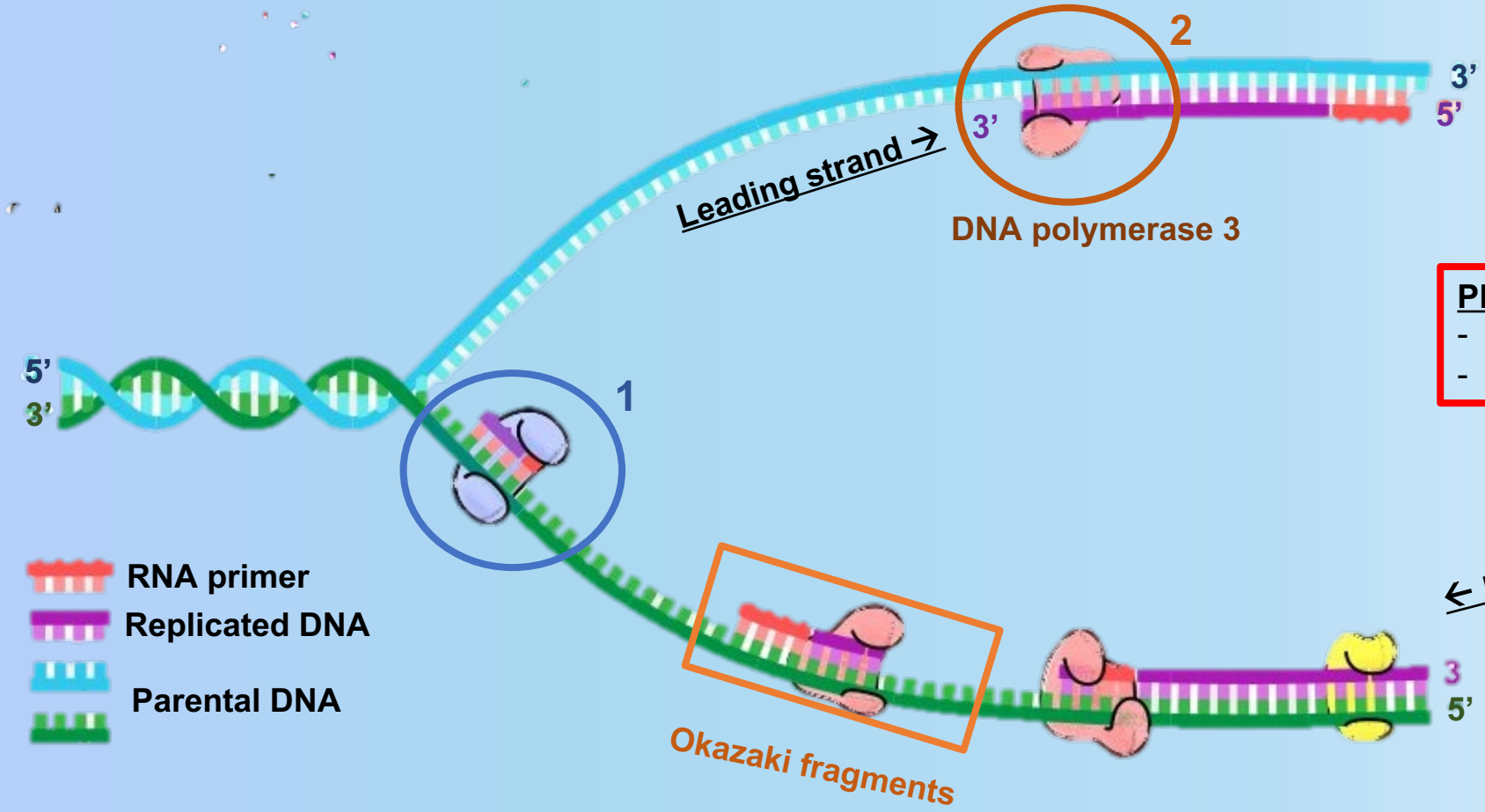


Primase:
Synthesizing short RNA primer from DNA template

Ligase:
Joins two DNA fragments

DNA polymerase

Replication



PROOFREADING
- Reads 3'→5'
- 3'→5' exonuclease activity

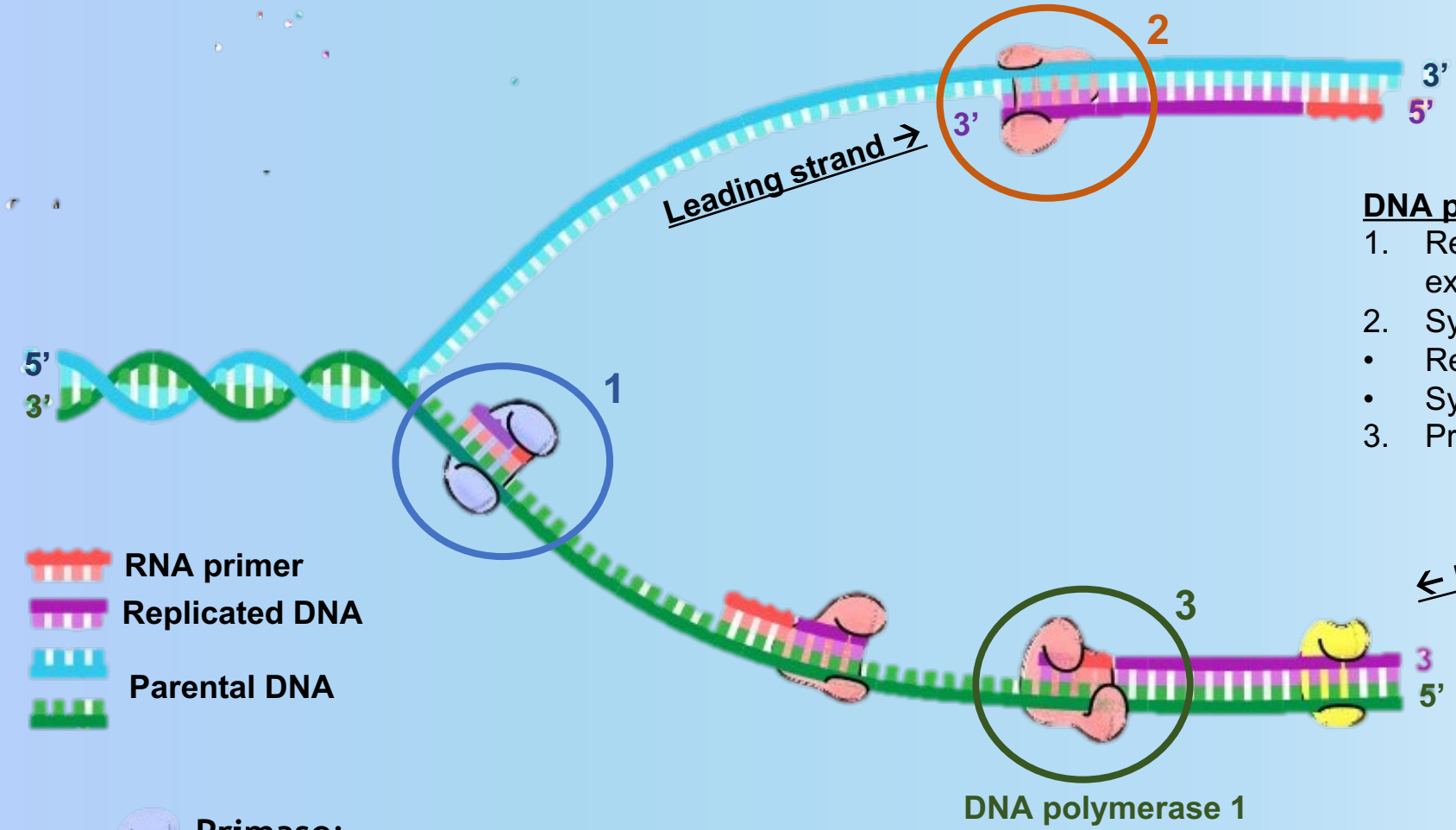
Primase:
Synthesizing short RNA primer from DNA template

Ligase:
Joins two DNA fragments

DNA polymerase

studyaid

Replication



DNA polymerase 1

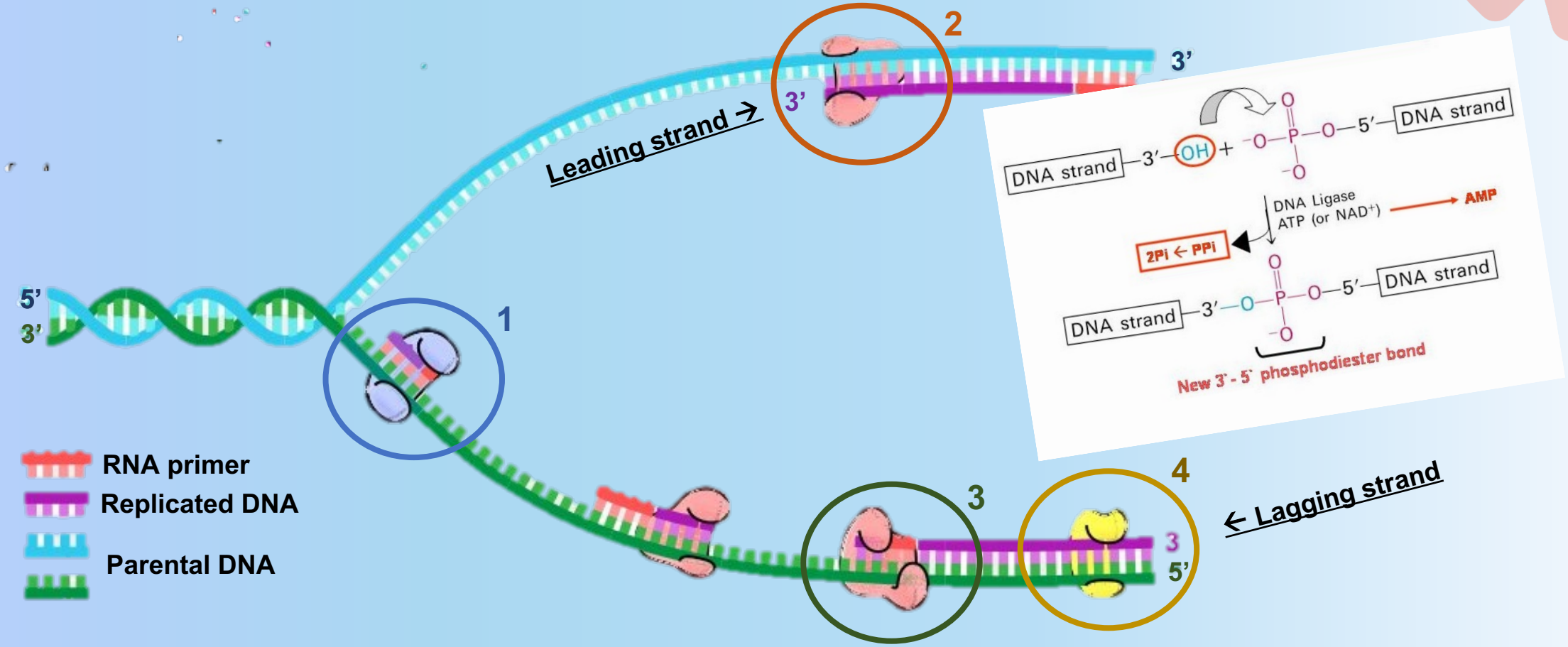
1. Removes RNA primer with 5'→3' exonuclease activity
2. Synthesize DNA in the gaps
   - Reads DNA 3'→5'
   - Synthesizes 5'→3'
3. Proofreading with 3'→5' exonuclease

Primase:
Synthesizing short RNA primer from DNA template

Ligase:
Joins two DNA fragments

DNA polymerase

Replication



Primase:
Synthesizing short RNA primer from DNA template

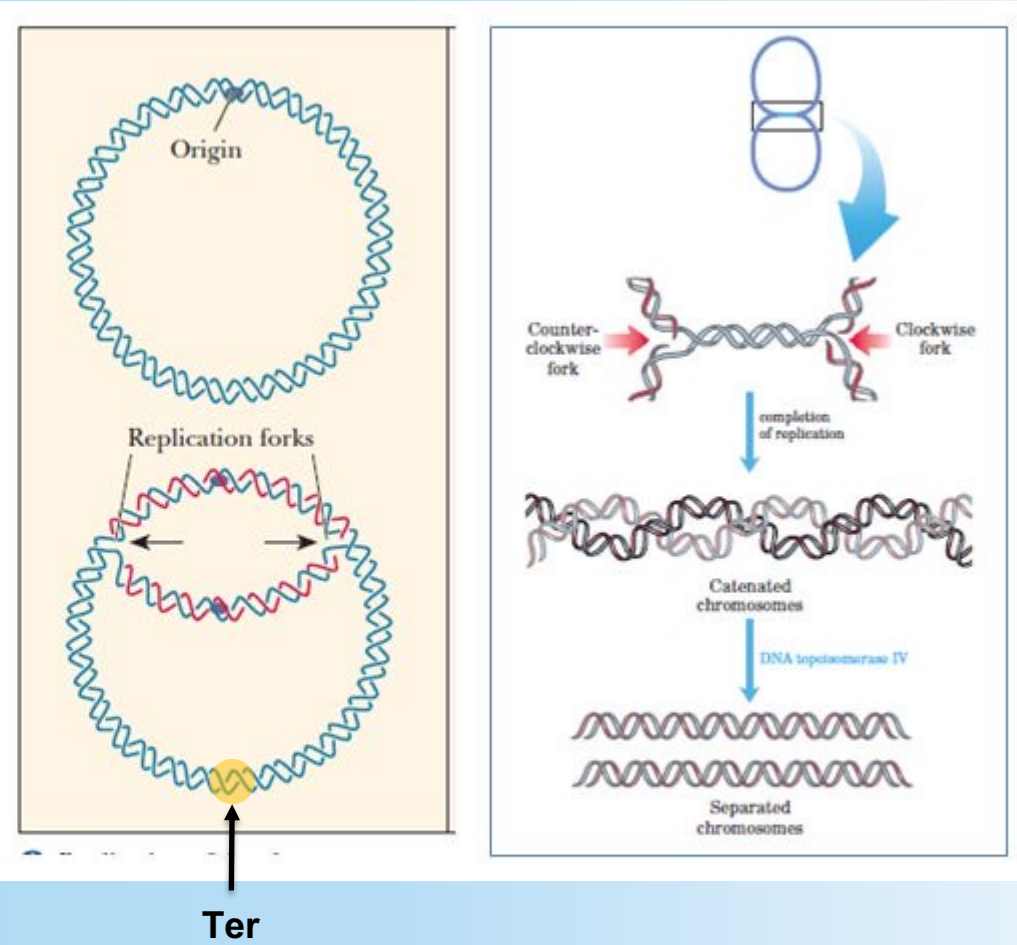
Ligase:
Joins two DNA fragments

DNA polymerase

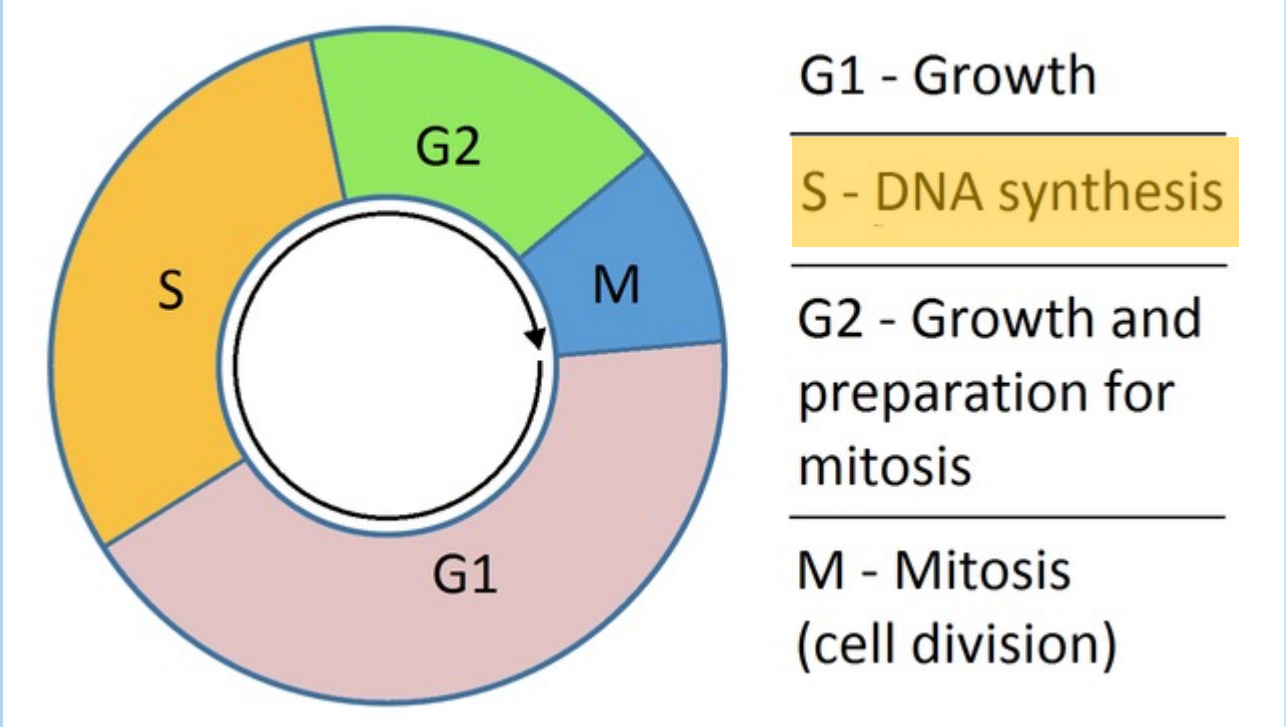
studyaid

Termination

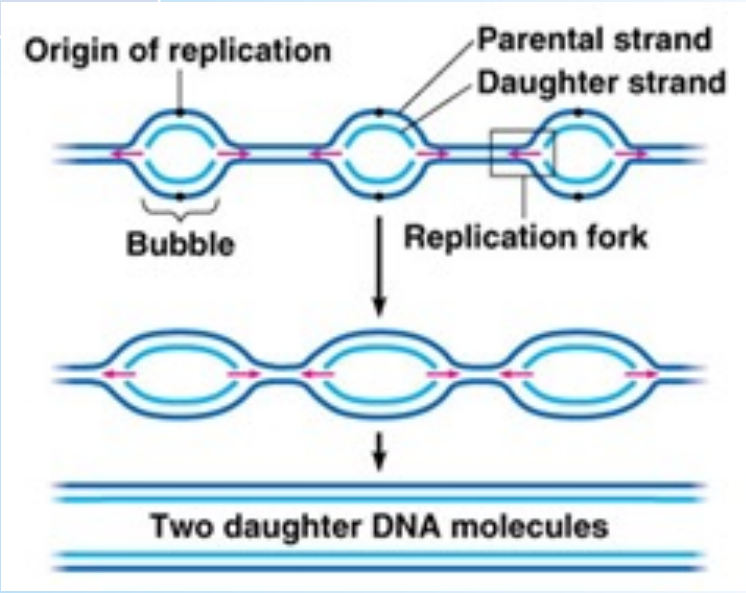
- Replication forks meet at the terminus region (Ter)
- Terminal utilization Protein (Tus) will inhibit the helicase
  → termination of replication
- DNA topoisomerase IV will seperate the chromosome



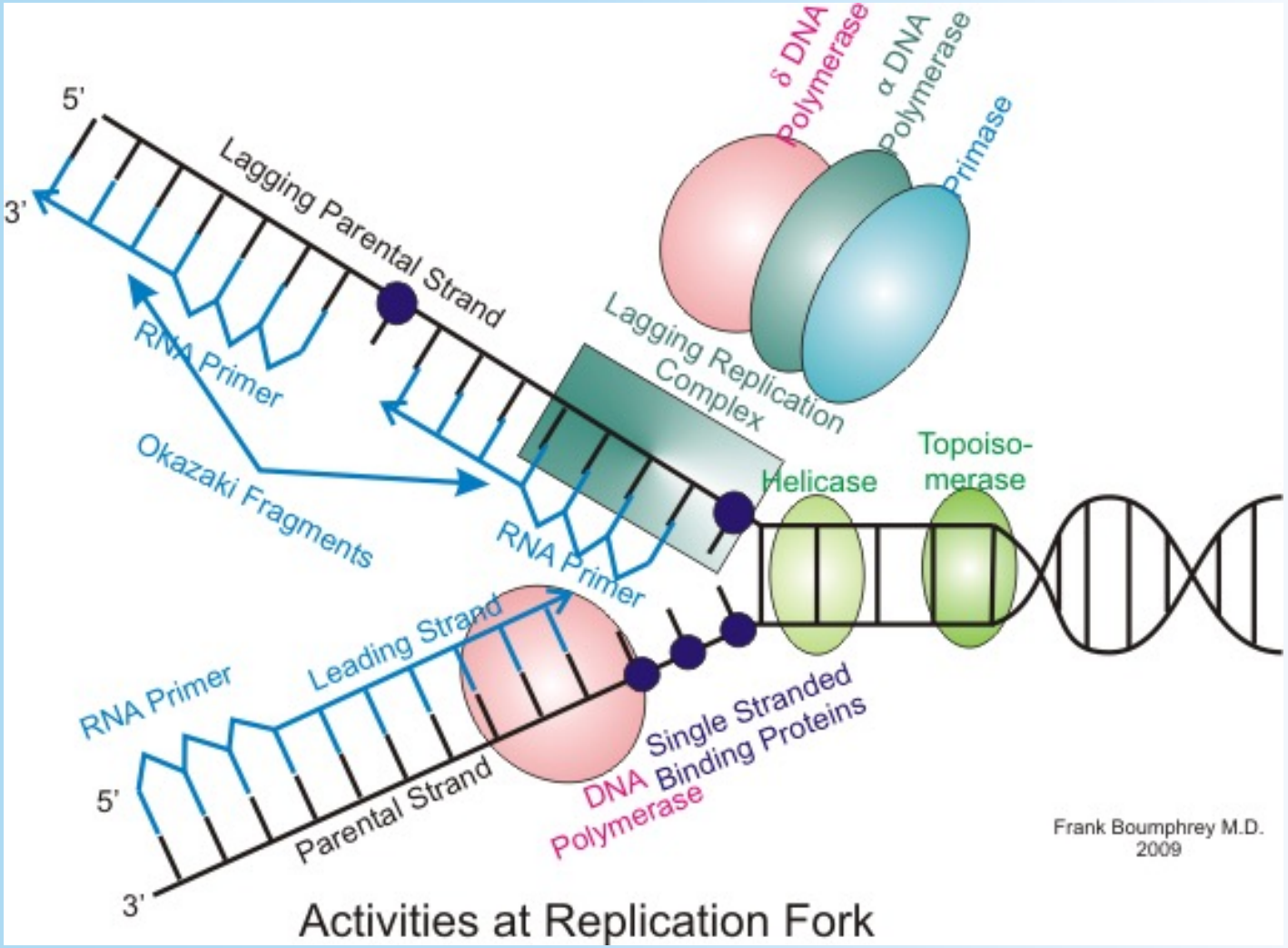
Eukaryotic DNA replication



	Prokaryotes	Eukaryotes
Origin	Single	Multiple
DNA polymerase	Numbers I, III	Greek letters α ε δ
Primer excision	DNA pol I	Rnase H FEN1



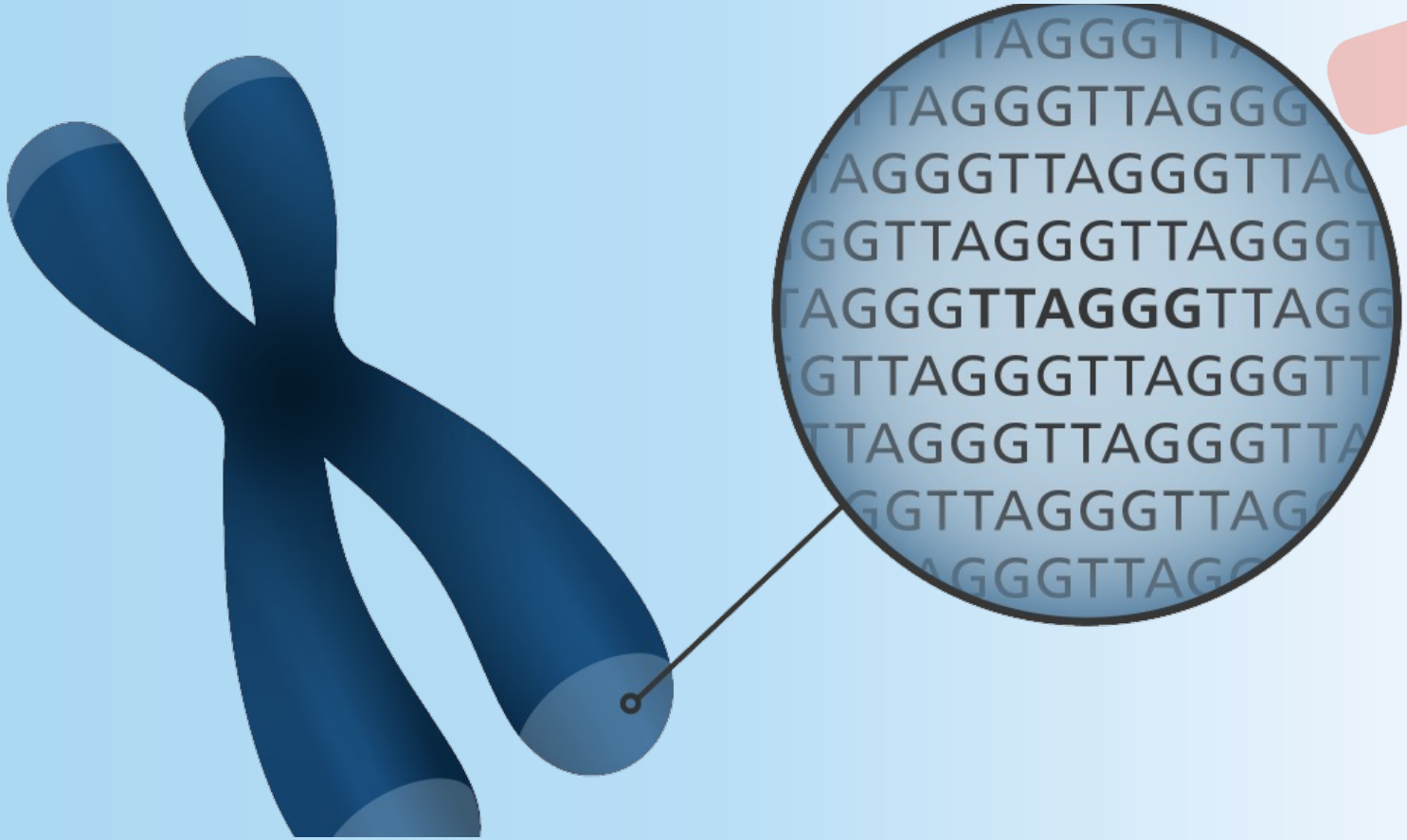
DNA polymerase	
Pol α	Initiation of DNA synthesis In complex with primer
Pol ε	DNA replication of <u>leading</u> strand
Pol δ	DNA replication of <u>lagging</u> strand
Pol γ	DNA replication in mitochondria



Telomeres

= complex of non-coding DNA located at the end of linear chromosome

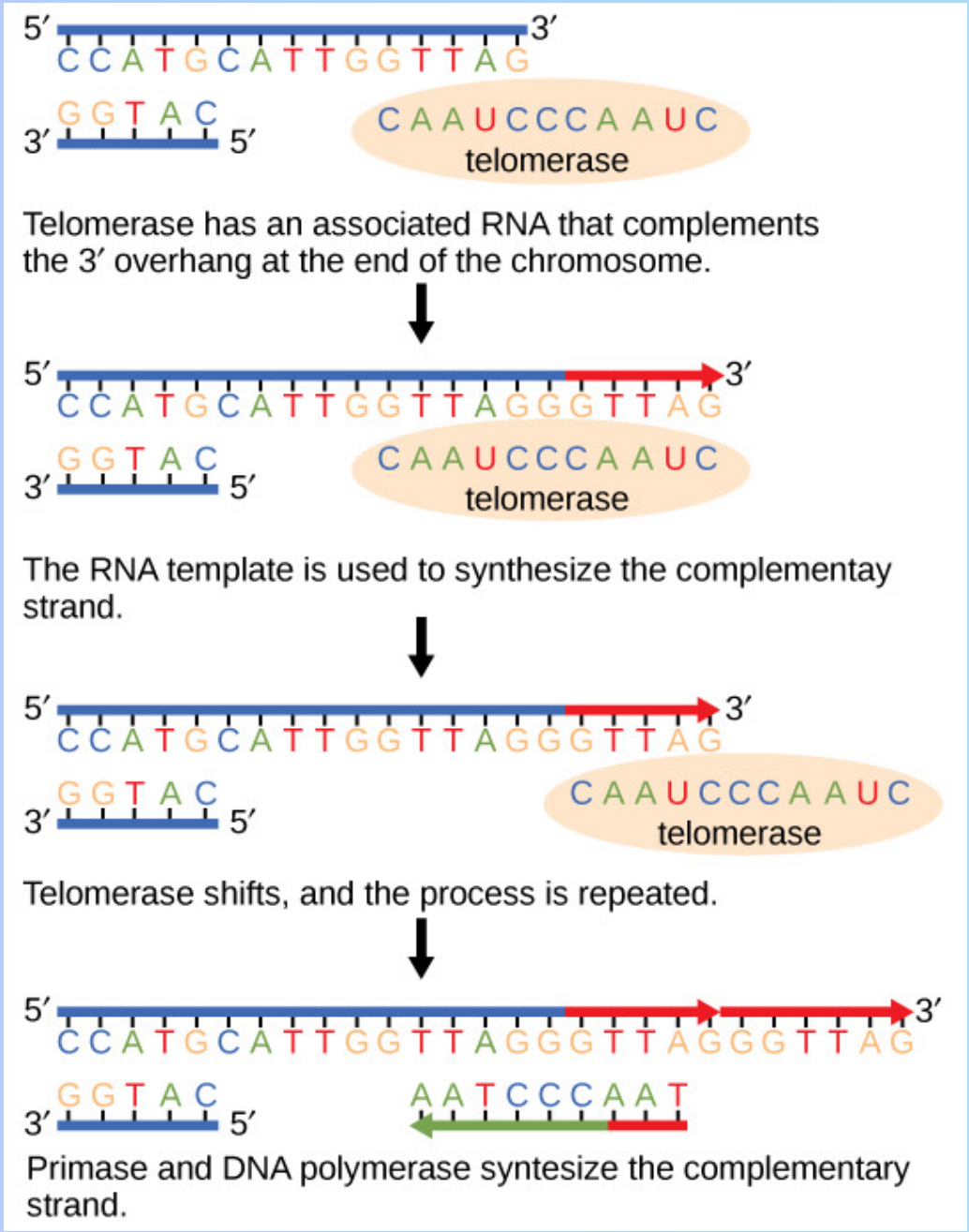
- Prevent attack from nucleases
- Consist of repeating sequence of bases → TTAGGG
- Will shorten after each replication
  - Too short telomere can affect the gene transcription
  - **Telomerase** in cells that often replicates



studyaid

Telomerase

- Found in germ cells, stem cells and cancer cells
- Maintain telomere length in cell



We will cover:

- ✓ Eukaryotes vs prokaryotes
- ✓ DNA structure
- ✓ Types of DNA
- ✓ DNA replication
- ❑ DNA repair

1 Go to wooclap.com

2 Enter the event code in the top banner

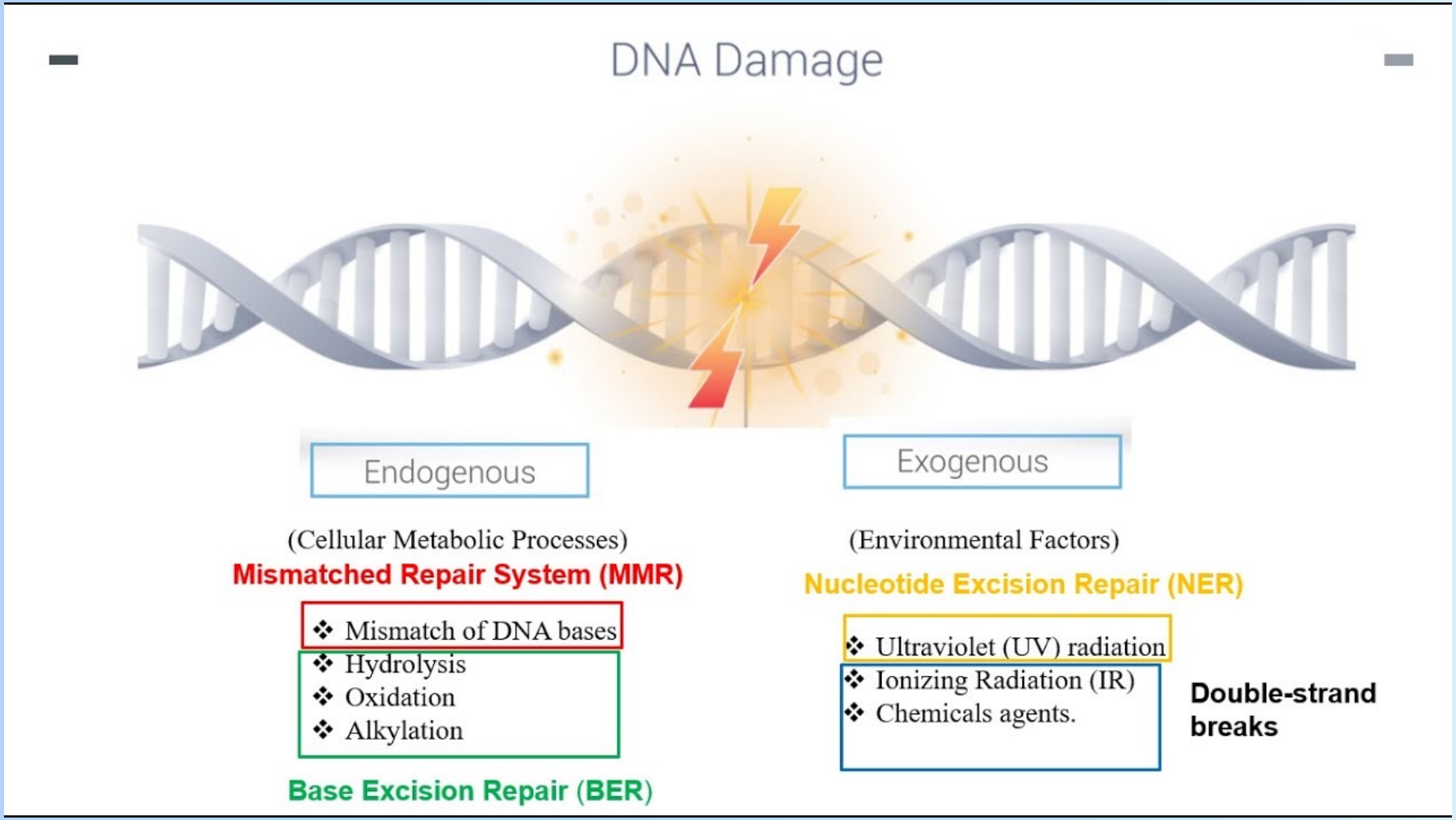
Event code
LBNPKU

Copy participation link

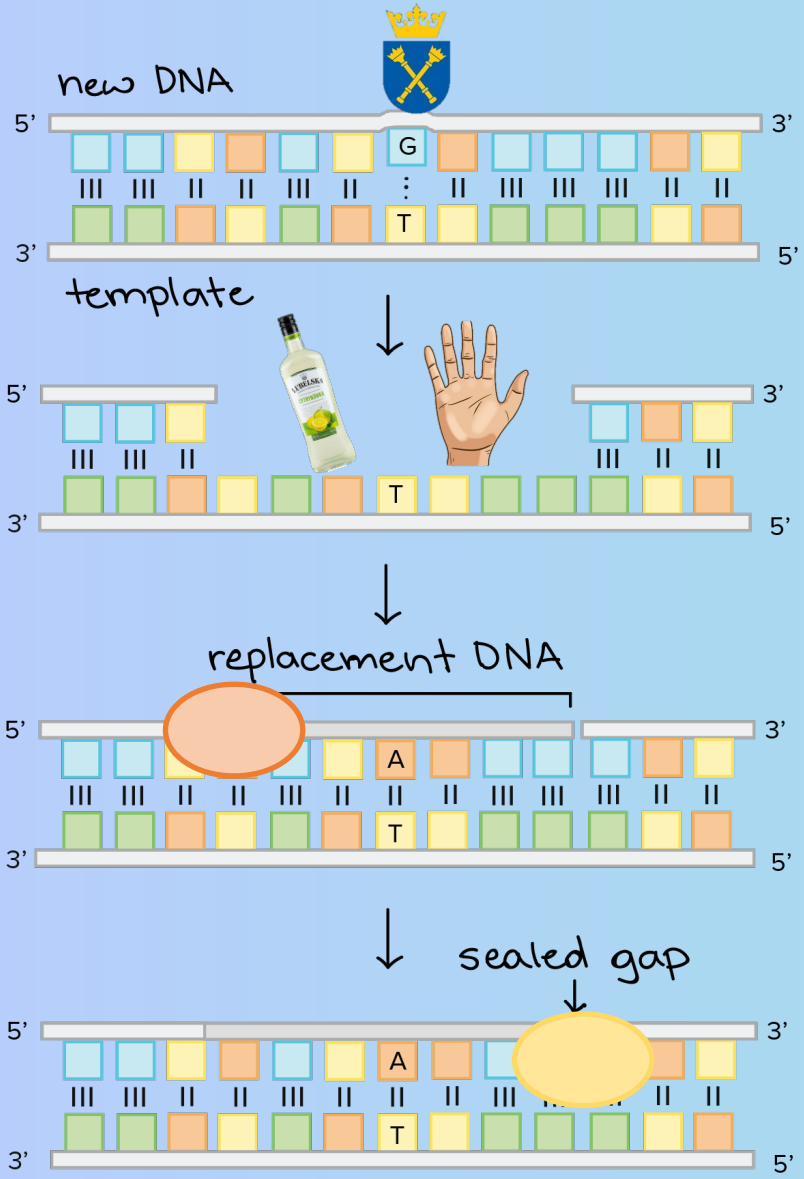
studyaid

DNA REPAIR

DNA damage


DNA Damage
Endogenous
(Cellular Metabolic Processes)
Mismatched Repair System (MMR)
❖ Mismatch of DNA bases
❖ Hydrolysis
❖ Oxidation
❖ Alkylation
Base Excision Repair (BER)
Exogenous
(Environmental Factors)
Nucleotide Excision Repair (NER)
❖ Ultraviolet (UV) radiation
❖ Ionizing Radiation (IR)
❖ Chemicals agents.
Double-strand breaks

Mismatched repair system (MMR)



A mismatch is detected in newly synthesized DNA.

The new DNA strand is cut, and the mispaired nucleotide and its neighbors are removed.

The missing patch is replaced with correct nucleotides by a DNA polymerase.

A DNA ligase seals the gap in the DNA backbone.

MutS – school office

Detects wrong nucleotide

MutL – Lubelska

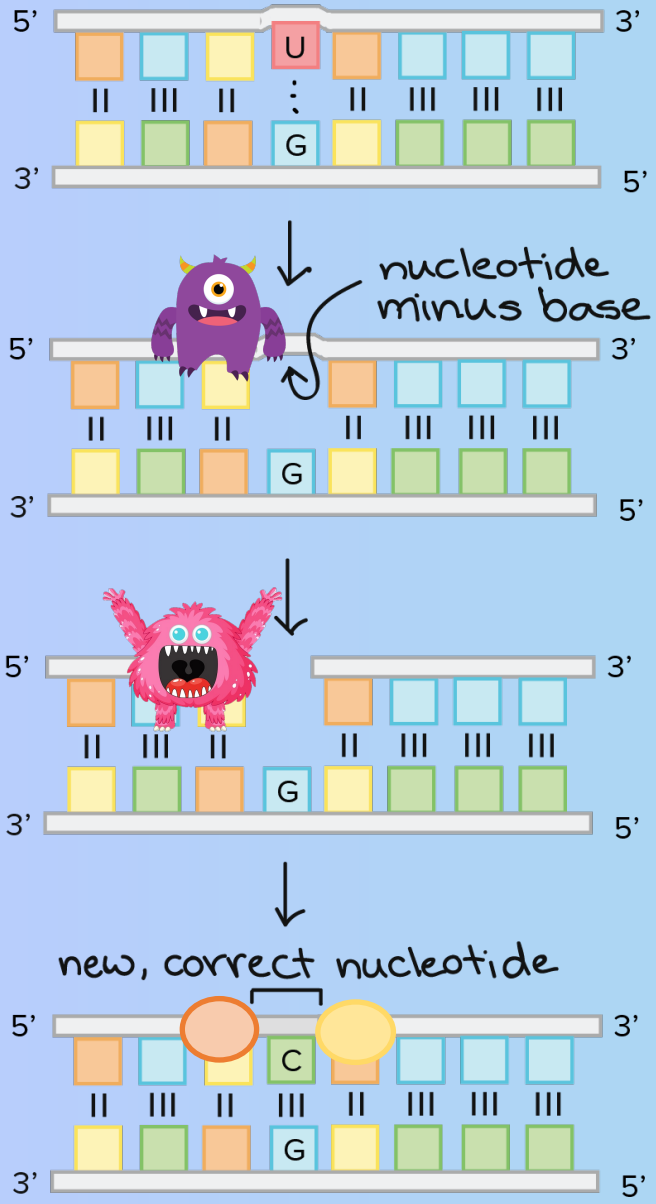
Activates MutH

MutH – Hand

Excise nucleotide

studyaid

Base excision repair (BER)



Deamination converts a cytosine base into a uracil.

The uracil is detected and removed, leaving a base-less nucleotide.

The base-less nucleotide is removed, leaving a small hole in the DNA backbone.

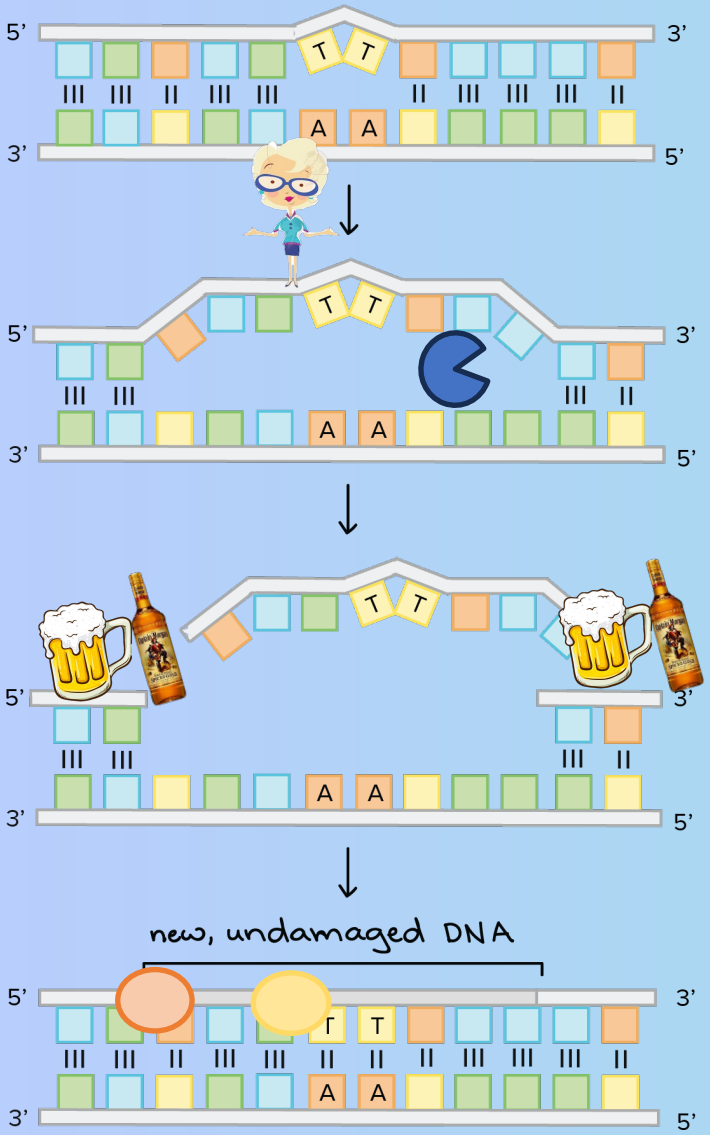
The hole is filled with the right base by a DNA polymerase, and the gap is sealed by a ligase.

DNA GLYCOSYLASE
Removes nitrogenous base → AP site

AP ENDONUCLEASE
Removes nucleotide (phosphoribose backbone)

studyaid

Nucleotide excision repair (NER)



UV radiation produces a thymine dimer.

Once the dimer has been detected, the surrounding DNA is opened to form a bubble.

Enzymes cut the damaged region out of the bubble.

A DNA polymerase replaces the excised (cut-out) DNA, and a ligase seals the backbone.

UvrA – Agatha

Recognizes dimer

UvrB – Beer

Removes dimer in complex with UvrC

UvrC – Captain morgan

Removes dimer in complex with UvrB

Xeroderma pigmentosum

- Pyrimidine dimers form in skin
- Mutation in repair enzymes
- Cannot repair DNA
- Mutations & skin cancer

studyaid

We will cover:

- ✓ Eukaryotes vs prokaryotes
- ✓ DNA structure
- ✓ Types of DNA
- ✓ DNA replication
- ✓ DNA repair

1 Go to wooclap.com

2 Enter the event code in the top banner

Event code

NIANDR

studyaid