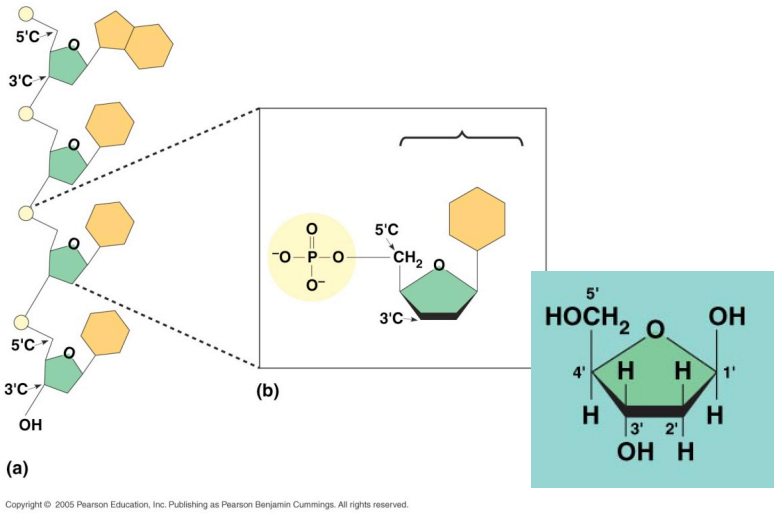
Unit 1: Biochemistry

Section 1-4: Nucleic Acids and DNA Replication
Book Reading: Chapter 5 pages 86-89; Chapter 16 pages 293-307

<u>Structure of Nucleotides and Polynucleotides</u>

- ❖ Nucleic Acids include DNA and RNA

- ❖ Nucleotides are the monomers of polynucleotides and contain three major parts
  - Phosphate group (this is associated with the 5' end of the DNA molecule)
  - Pentose sugar (this is associated with the 3' end of the DNA molecule)
    - RNA- *name the sugar*
    - DNA- *name the sugar*
  - Nitrogenous Base
    - Purines (2 rings)
      - *list*
      -
    - Pyrimidines (1 ring)
      - *list*
      - (DNA only)
      - (RNA only)
- ❖ Formation of Polynucleotides
  - *What kind of reactions link nucleotides together?*
  - *What is the name given to the covalent bond between nucleotides?*
  - *To what end of the chain are new nucleotides added?*
  - This is why we say that DNA is built in a 5' to 3' direction
  -

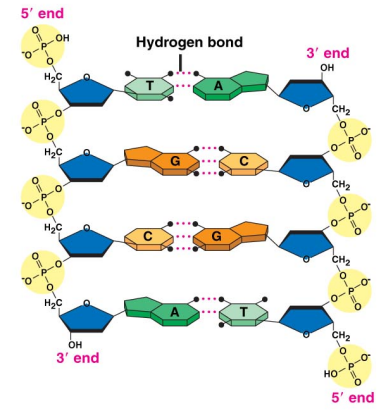


The DNA Double Helix

- The two strands of the double helix are arranged in an antiparallel fashion, one of them going 5'-3' and the other one going in the opposite direction

- The "backbone"
  - *Composed of what?*
  - *How are they linked together?*

- The "rungs" of the ladder
  - *Made up of?*
  - *How are they bonded to each other across the helix?*
  - *How does the hydrophobic/hydrophilic nature of the nitrogenous bases make them uniquely suited for their placement on the inside of the double helix?*
  - Complimentary base pairing- *how are the bases in the DNA paired?*
    - A always to T (with two hydrogen bonds)
    - C always to G (with three hydrogen bonds)



(b) Partial chemical structure

  - Chargraff's Rule- *define*

DNA vs. RNA

- DNA and RNA are both considered nucleic acid

- DNA and RNA have several differences in structural components

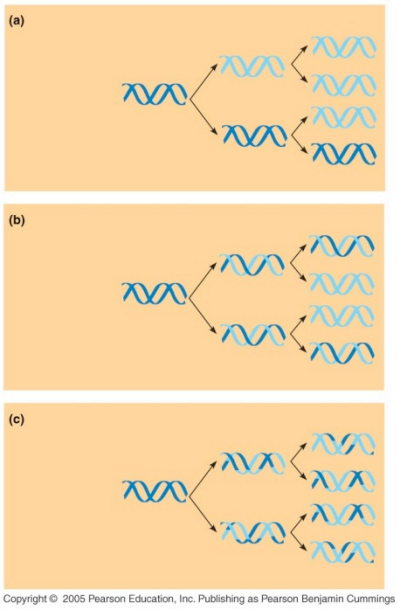
	DNA	RNA
Number of Strands		
Pentose Sugar		
Nitrogenous Bases		

- Functions of DNA
  - *list*
  -
  -

- ❖ Functions of RNA
  - Ribosomal RNA
    - rRNA
    - *what is its function?*
  - Transfer RNA
    - tRNA
    - *what is its function?*
  - Messenger RNA
    - mRNA
    - *what is its function?*

<u>DNA Replication</u>

- ❖ Models of DNA Replication
  - Conservative model- *define*
  - Semiconservative Model- *define*
  - Dispersive Model- *define*



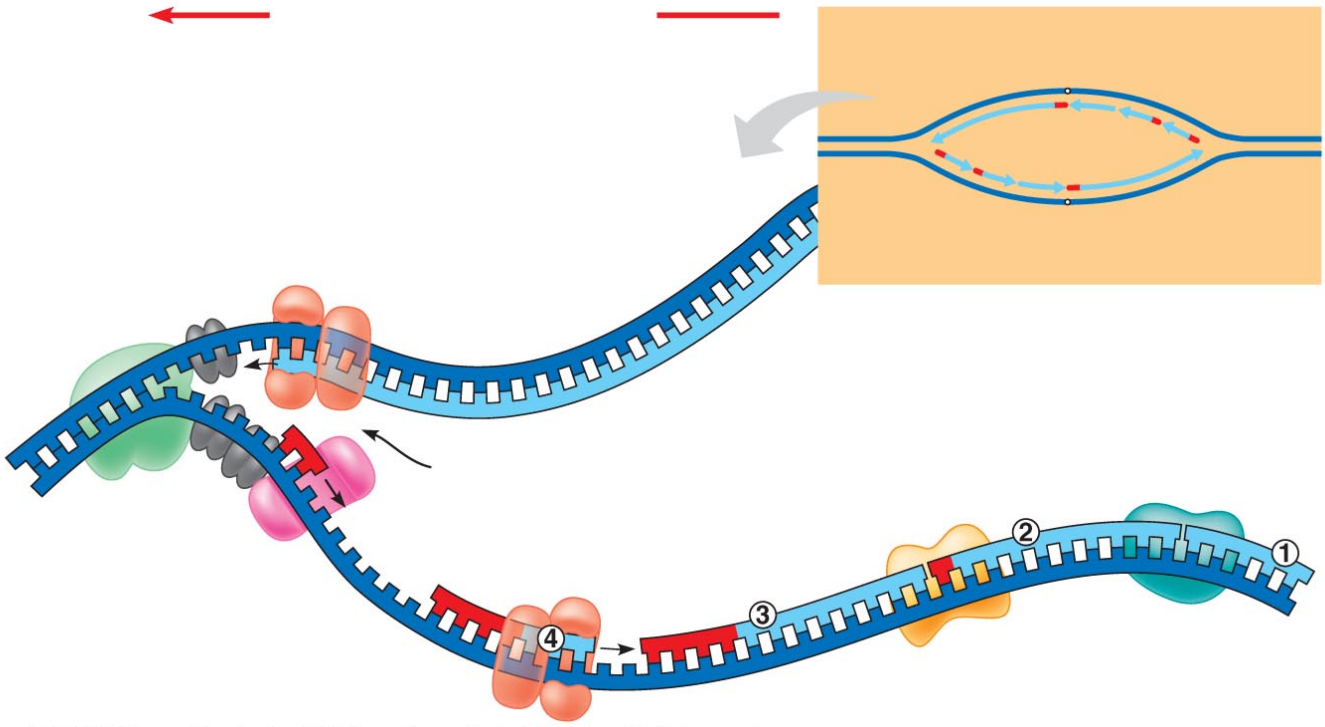
- ❖ The Origin of Replication
  - *define*
  - Prokaryotes have circular DNA and only one origin of replication
  - Eukaryotes may have many origins of replication that result in several replication bubbles that eventually fuse
  - Enzymes Involved in early portions of DNA replication include:
    - Helicase- *function*
    - Topoisomerase- *function*
    - Single-strand Binding Protein- *function*

❖ The Energy Requirements of DNA Synthesis

- Each new nucleotide enters as a nucleoside triphosphate
- The triphosphate portion of the nucleoside carries a lot of potential energy due to the negative charges grouped together
- As the nucleotide binds to the DNA strand, it loses two of its phosphate groups
- The two phosphate groups are then separated, releasing energy that drives the process of polymerization of the new DNA

❖ Synthesis of the Leading Strand (*read this section in the book, but I will give you detailed notes during lecture of the important features)*

-
- Primase-
- DNA Polymerase III
- DNA Polymerase I
- DNA Ligase



❖ Synthesis of the Lagging Strand *(read this section in the book, but I will give you detailed notes during lecture of the important features)*

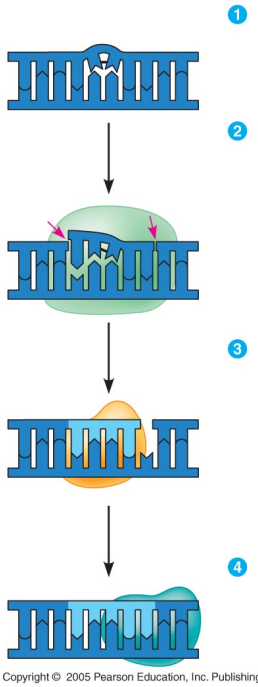
-
-
- Primase
- DNA Polymerase III
- DNA Polymerase I
- DNA ligase

❖ DNA Replication Machine

- *First way in which the traditional model of representing DNA as a railroad track along which the enzymes move is inaccurate*
- *Second reason*
- In eukaryotic cells, multiple copies of the DNA machine are likely anchored in the nuclear matrix to copy multiple chromosomes at a time

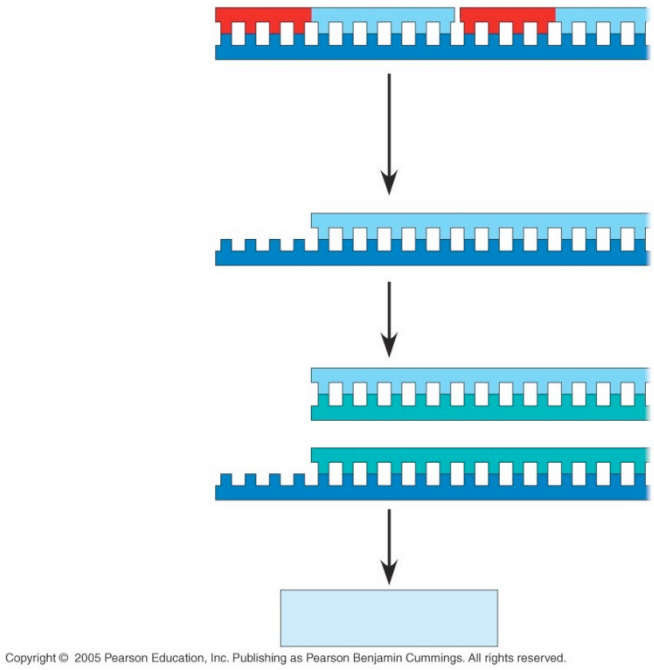
❖ Proofreading and Repair

- Proofreading
  - occurs simultaneously with replication
  - *how does it work?*
- Repair Mechanisms- Nucleotide Excision Repair
  - Several DNA repair enzymes have evolved to recognize problems in DNA
  - Nuclease- *what does it do?*
  - DNA polymerase *what does it do?*
  - DNA ligase- *what does it do?*



Erosion of Gene Coding DNA and Aging

- The problem with the lagging strand in eukaryotic DNA
  - DNA polymerase can only add nucleotides to the 3' end of a strand
  - After the primer at the end of the lagging strand is removed, DNA polymerase cannot add new nucleotides
  - *why is this a problem?*



- Telomers
  - Telomers *what are they?*
  - *What is their function?*
  - Telomers do not prevent DNA shortening, but do postpone the erosion of genes

- Telomerase
  - *What is it?*
  - *In what cells is it active?*