بسم الله الرحمن الرحيم

جامعة الملك سعود
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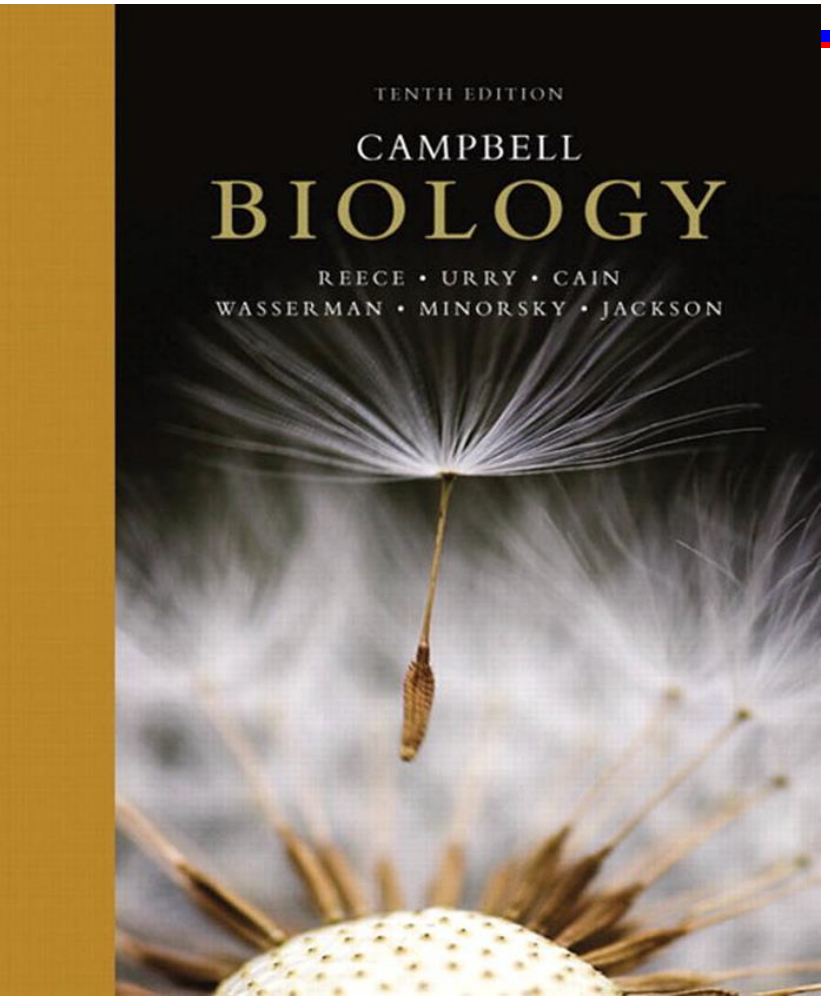


ZOO-352

General Principles of Genetics

Zoology Department

Lecture 10: The Molecular Basis of Inheritance (Molecular Biology)

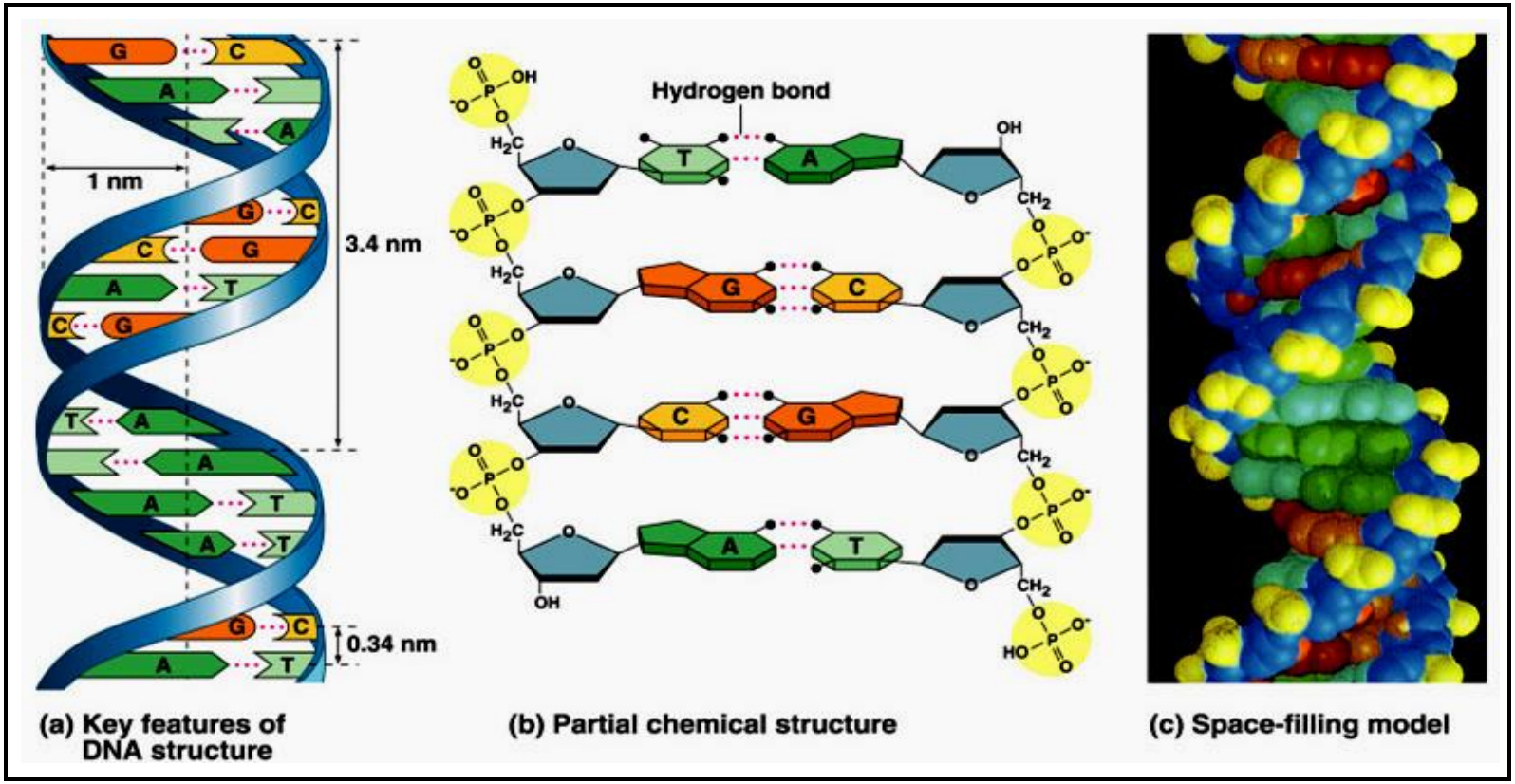
1440-1441H

Objectives

- **The Molecular Basis of Inheritance.**
  - Building a Structural Model of DNA.
  - The Components of Nucleic Acids.
    - Nucleotide Polymers.
    - The Structures of DNA and RNA Molecules.
  - Inheritance is based on replication of the DNA double helix

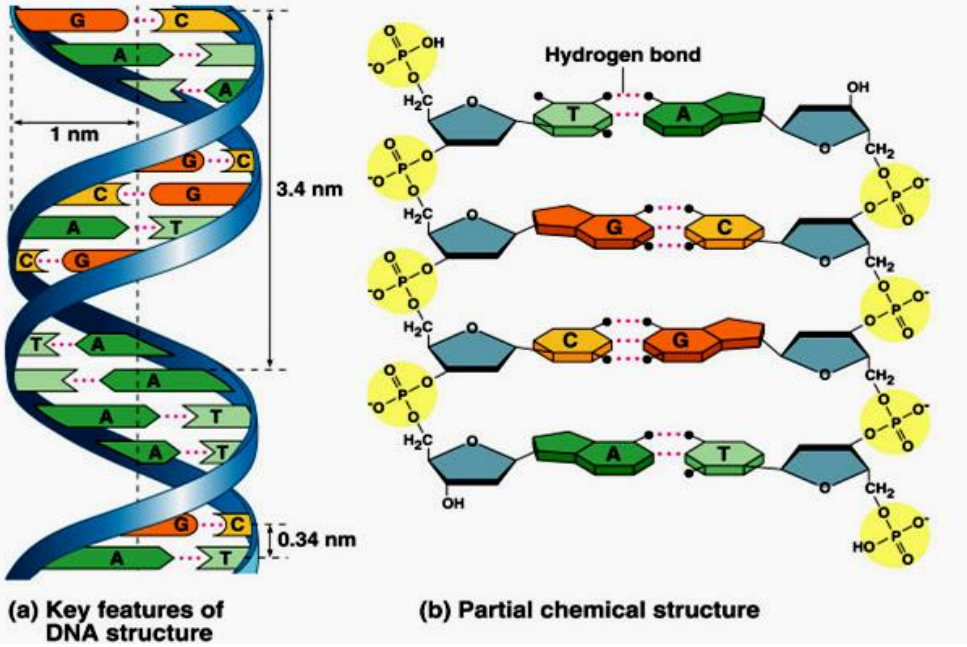
THE MOLECULE BASIS OF INHERITANCE

Section A: DNA as the Genetic Material



http://highered.mcgraw-hill.com/olcweb/cgi/pluginpop.cgi?it=swf::500::500::/sites/dl/free/0073040541/577014/dna_structure.swf::DNA Structure

Watson and Crick discovered the double helix by building models to conform to X-ray data



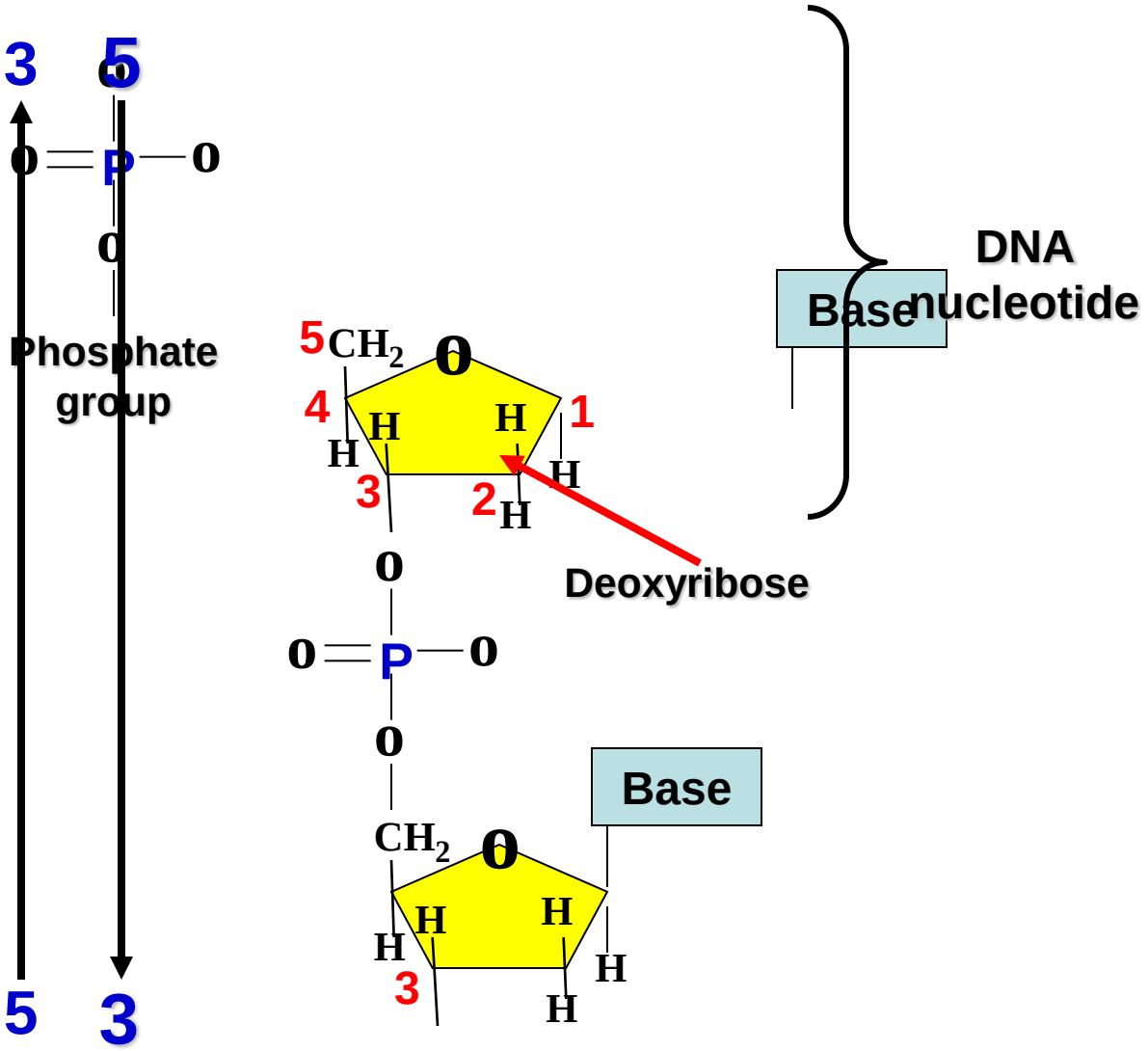
In April 1953, James Watson and Francis Crick shook the scientific world with an elegant double-helical model for the structure of deoxyribonucleic acid or DNA.

Watson and Crick began to work on a model of DNA with two strands, the double helix.

DNA : Introduction

- **The amino acid sequence of a polypeptide is programmed by a gene.**
- **A gene is a small region in the DNA.**
- **Nucleic acids store and transmit hereditary information** المعلومات الوراثية.
- **There are two types of nucleic acids: ribonucleic acid (RNA) and deoxyribonucleic acid (DNA).**
- **DNA also directs mRNA synthesis, thus, controls protein synthesis.**
- **Organisms inherit** تتوارث **DNA from their parents.**
  - **Each DNA molecule is very long and usually consists of hundreds to thousands of genes.**
  - **When a cell divides** تنقسم**, its DNA is copied and passed to the next generation of cells.**
- **The mRNA interacts with ribosomes to direct the synthesis of amino acids in a polypeptide (protein)**

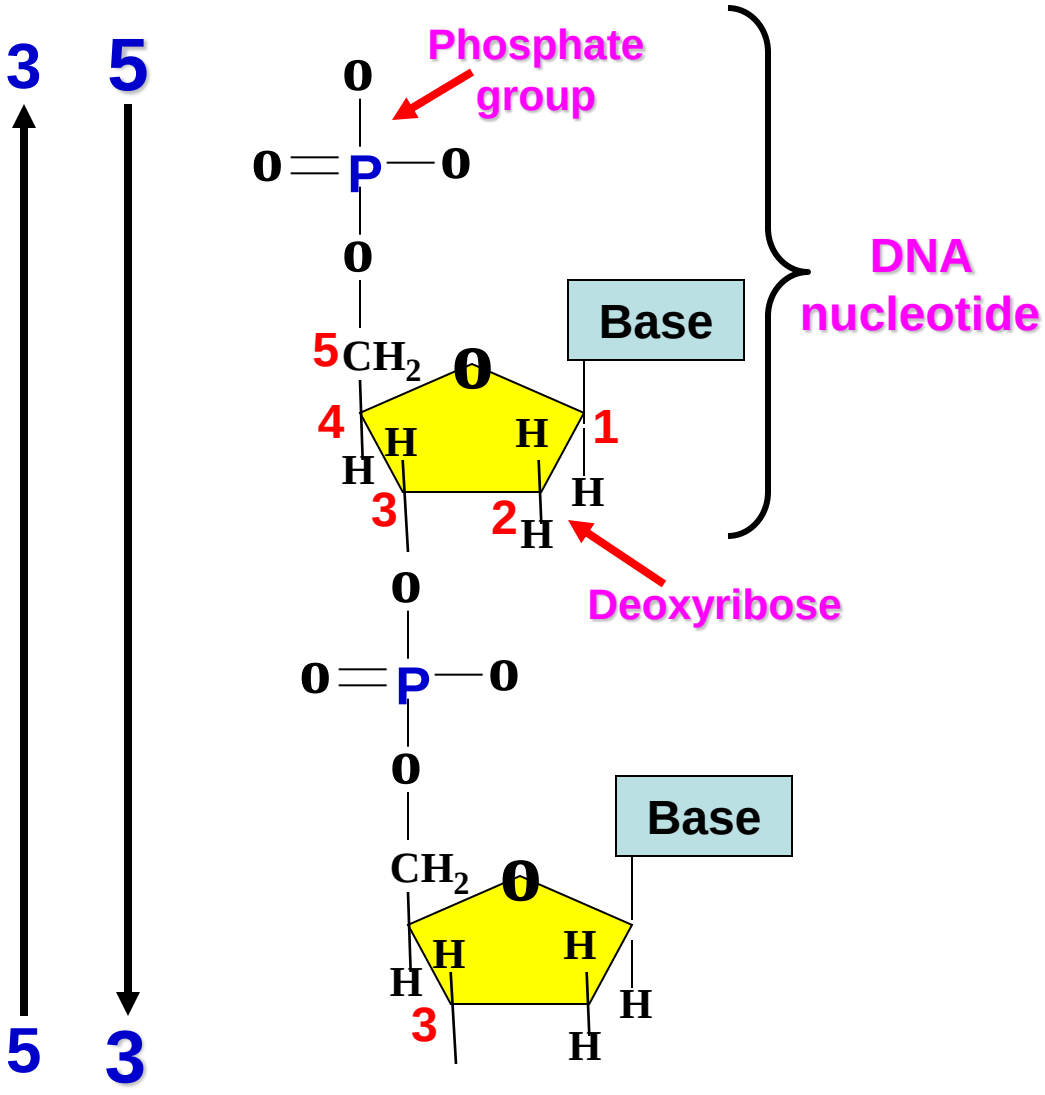
Structures of nucleic acids (DNA & RNA)



Bases

- Adenine (A) — Purine
- Guanine (G) — Purine
- Cytosine (C) — Pyrimidine
- Thymine (T) — Pyrimidine

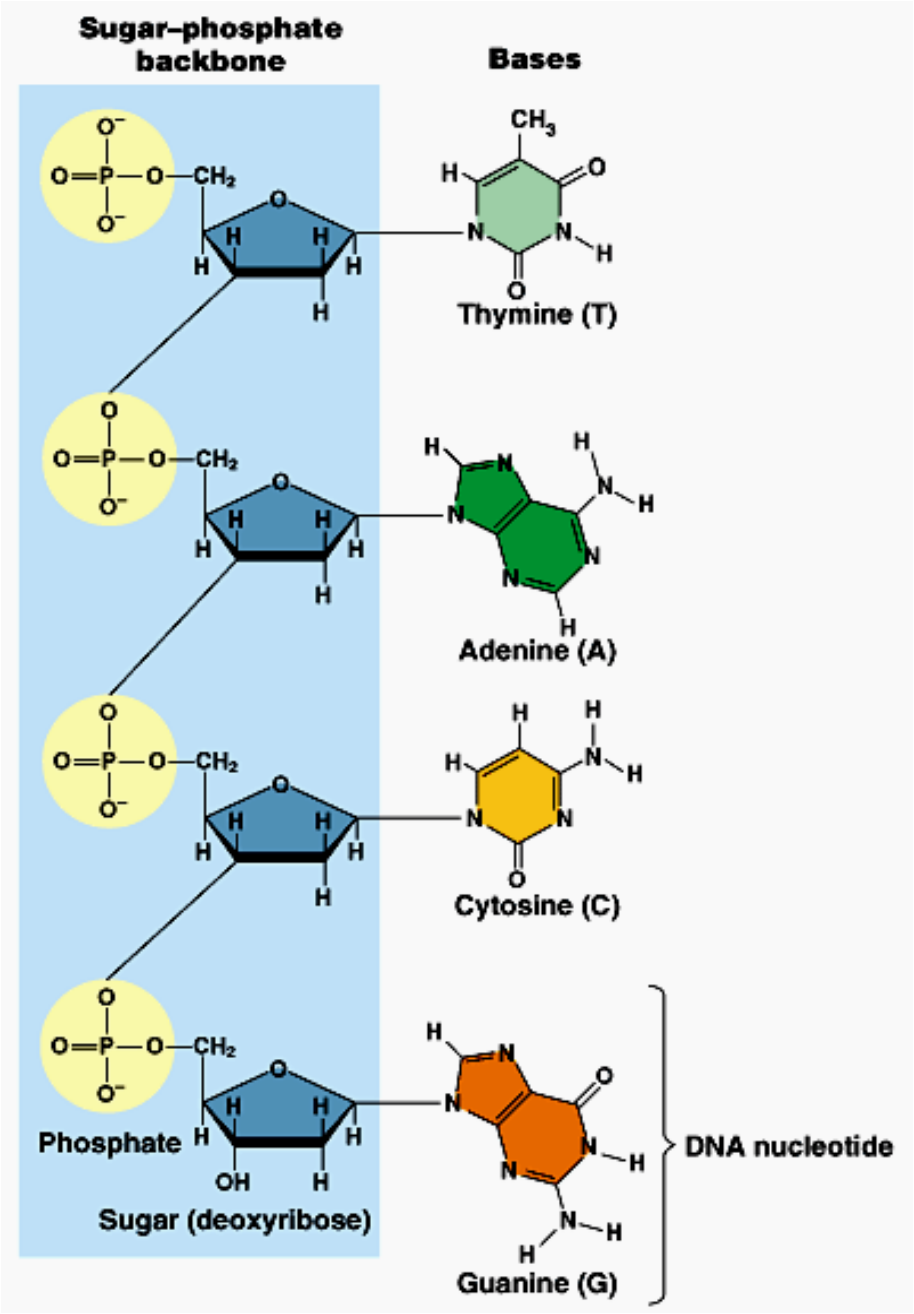
Structures of nucleic acids (DNA & RNA)



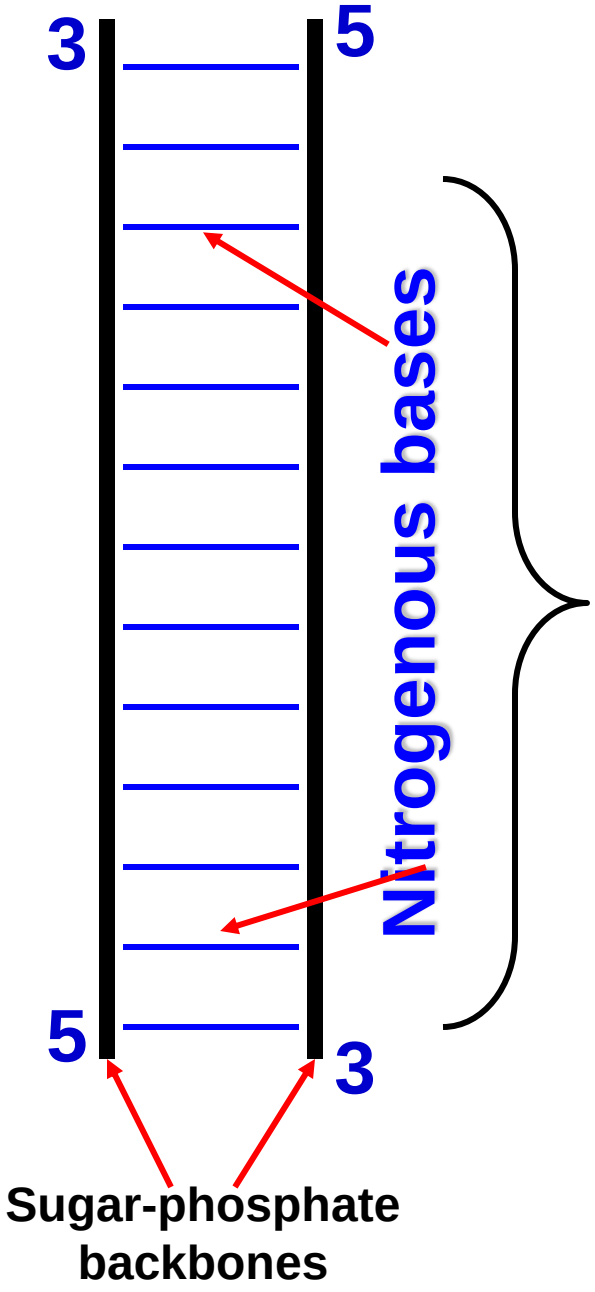
Bases

- Adenine (A) — Purine
- Guanine (G) — Purine
- Cytosine (C) — Pyrimidine
- Thymine (T) — Pyrimidine

- The PO_4^{3-} group of one nucleotide is attached to the sugar of the next nucleotide in line.
- The result is a "backbone" of alternating phosphates and sugars, from which the bases starts.



Nitrogenous bases القواعد النيتروجينية



Hydrogen bonds

Cytosine (C) ..... Guanine (G)

Thymine (T) ..... Adenine (A)

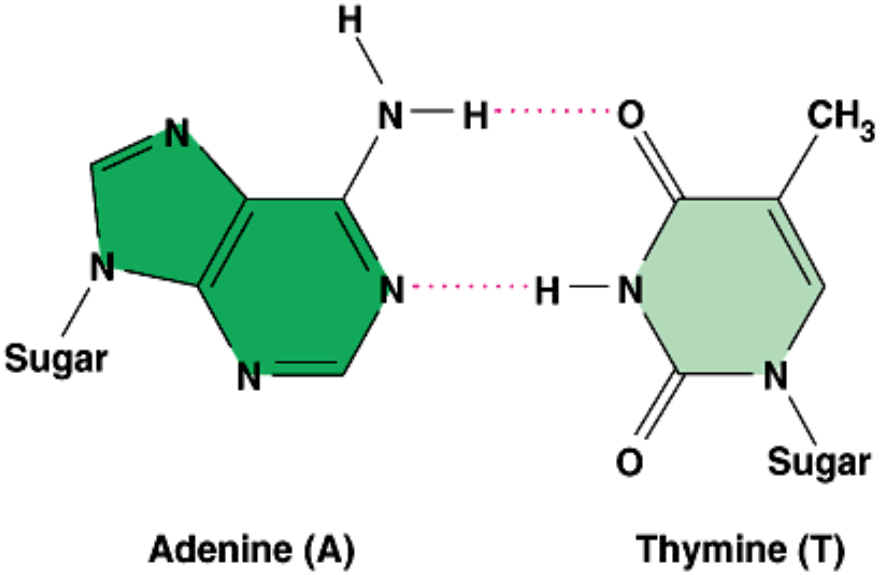
Uracil (U)

Pyrimidines

Purine

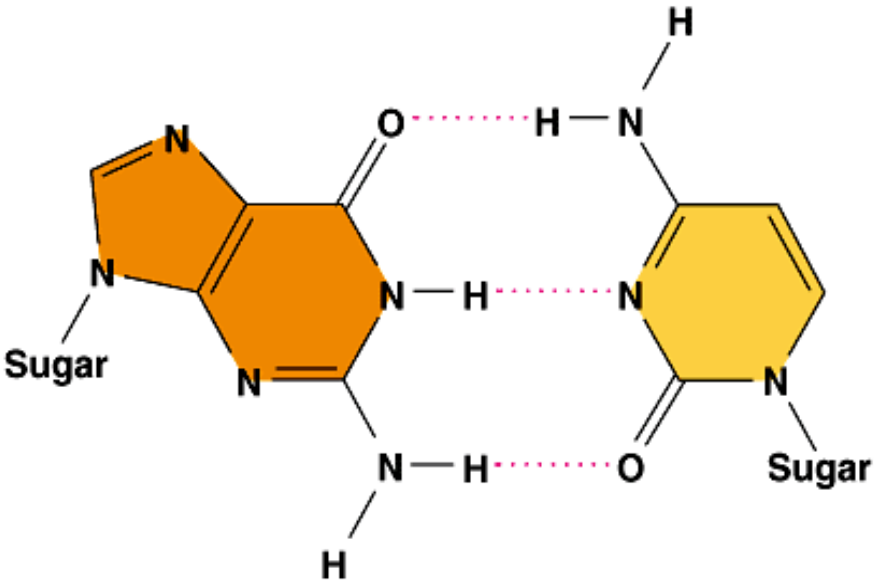
DNA

- **Adenine** (A) would form **2 hydrogen bonds** only with **thymine** (T)



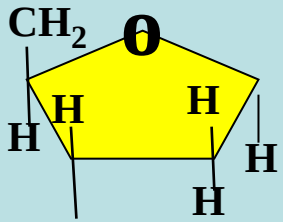
Adenine (A) Thymine (T)

- **Guanine** (G) would form **3 hydrogen bonds** only with **cytosine** (C).



Guanine (G) Cytosine (C)

DNA



Deoxyribose sugar
(O on C2 is missed)

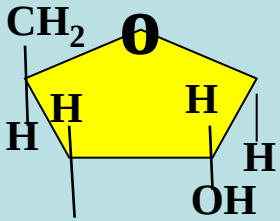
Deoxiribo-Nucleic-Acid

Double stranded nucleic acid

Bases: A, G, C, T

&

RNA



Ribose sugar
(no missed O)

Ribo-Nucleic-Acid

Single stranded nucleic acid

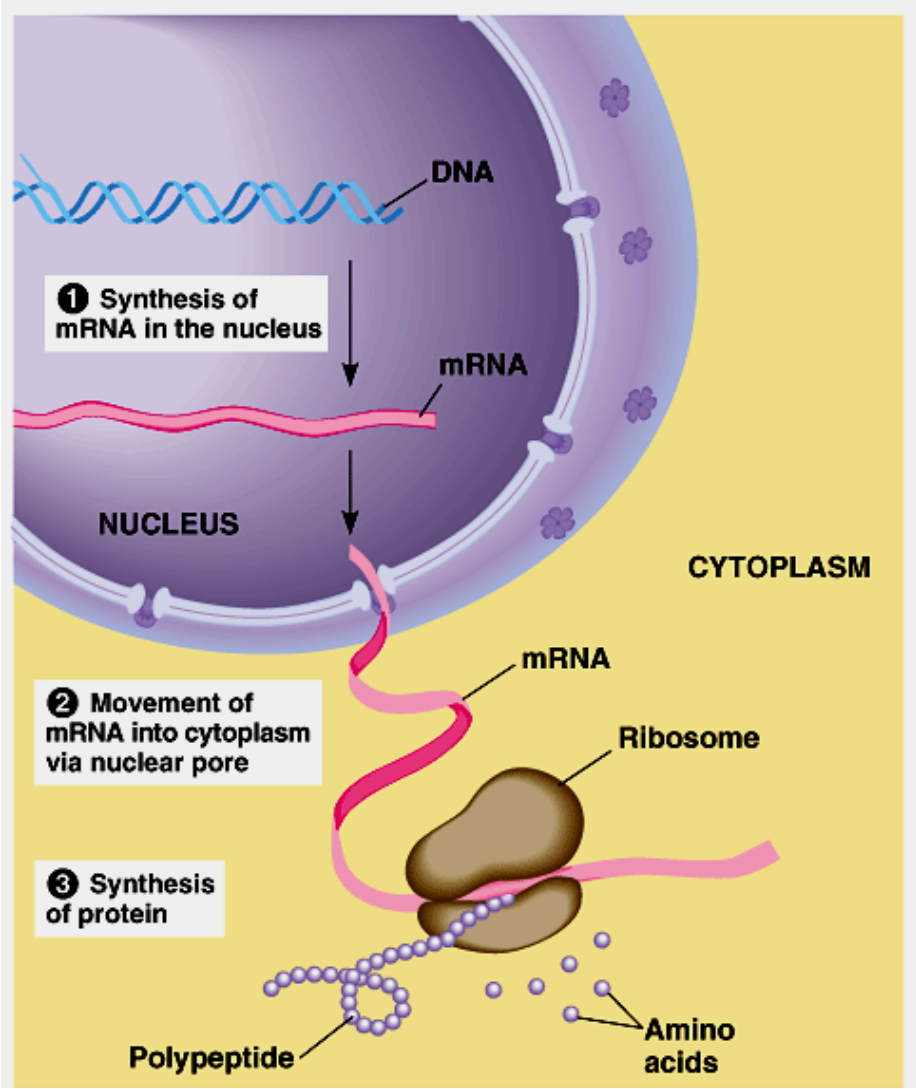
Bases: A, G, C, U

The nucleic acid strand is a polymer of nucleotides

- **Nucleic acids are polymers of monomers called nucleotides.**
- **Each nucleotide consists of three parts: a nitrogen base, a pentose sugar, and a phosphate group.**
- **The nitrogen bases (**rings of carbon and nitrogen**) come in two types: Purines and Pyrimidines.**
- **The pentose sugar joined to the nitrogen base is ribose in nucleotides of RNA and deoxyribose in DNA.**
- **The only difference between the sugars is the lack of an oxygen atom on carbon 2 in deoxyribose.**

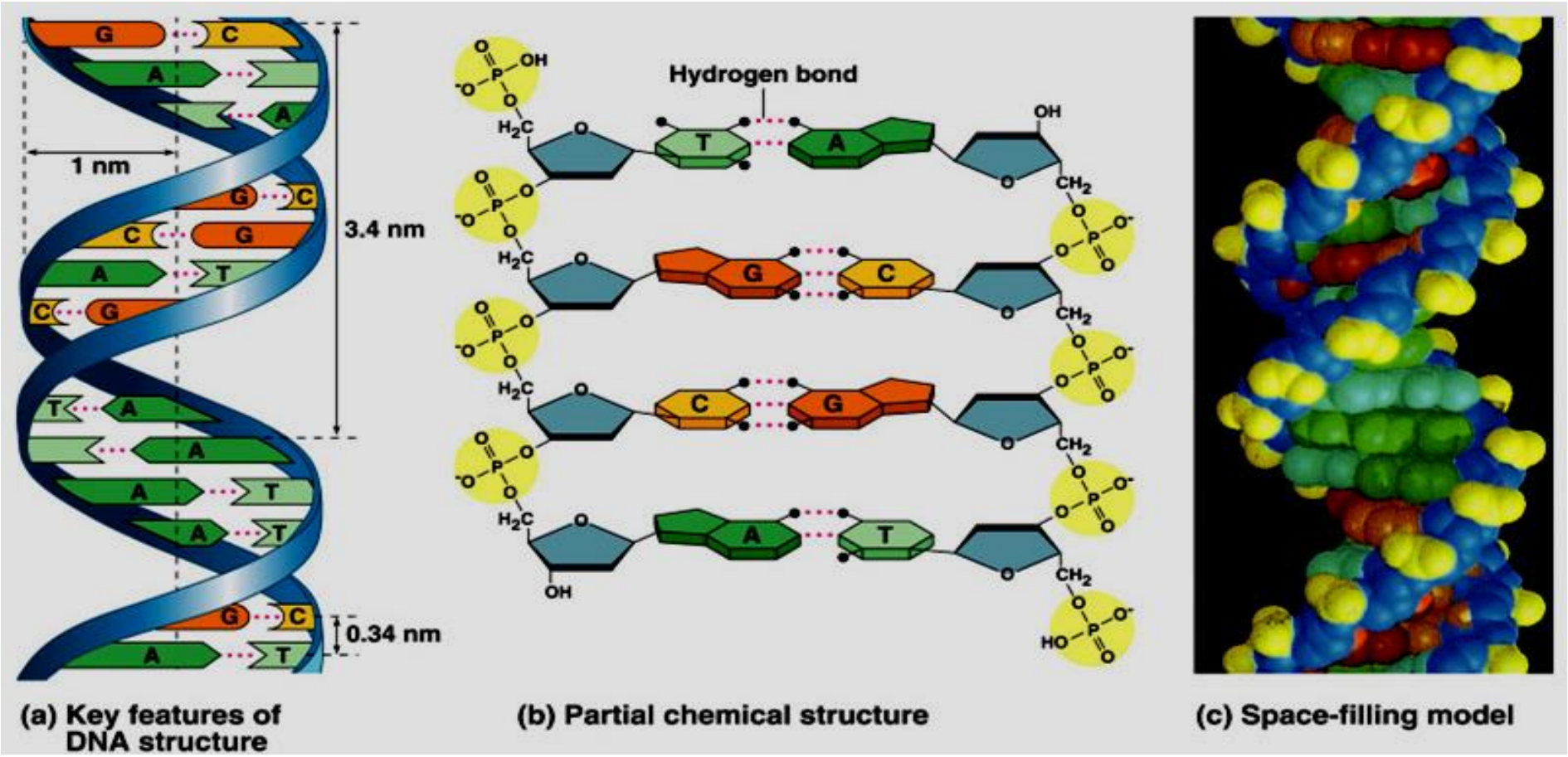
- Polynucleotides are synthesized by connecting the sugars of one nucleotide to the phosphate of the next with a phosphodiester link.
- This creates a repeating backbone of sugar-phosphate units with the nitrogen bases as appendages.
- The sequence of nitrogen bases along a DNA or mRNA polymer is unique for each gene.
- Genes are normally hundreds to thousands of nucleotides long.
- The linear order الترتيب التتابعي of bases in a gene specifies the order of amino acids (the monomers of a protein).

- **The flow of genetic information is from DNA → mRNA → protein.**
  - **Protein synthesis occurs in ribosomes.**
  - **In eukaryotes, DNA is located in the nucleus, but most ribosomes are in the cytoplasm with mRNA as an intermediary وسيط.**



Inheritance is based on replication of the DNA double helix

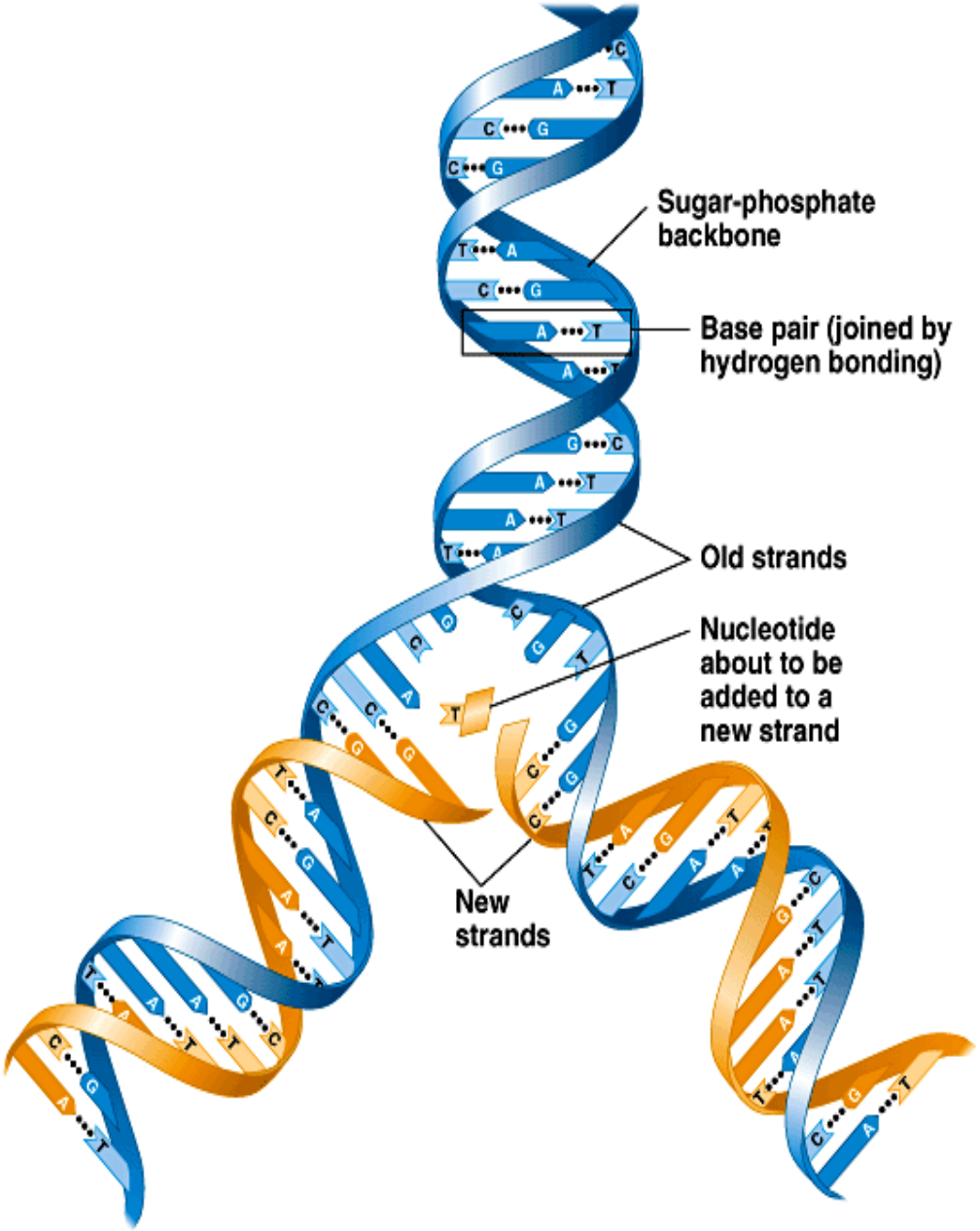
- **An RNA molecule is single polynucleotide chain** (single strand).
- **DNA molecules have two polynucleotide strands** (double strand) **that spiral around to form a double helix.**



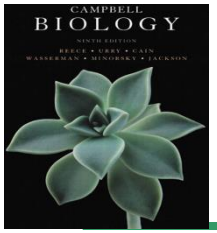
- **The sugar-phosphate backbones of the two polynucleotides are on the outside of the helix.**

- **Pairs of nitrogenous bases (one from each strand) connect the polynucleotide chains with hydrogen bonds.**

- **Most DNA molecules have thousands to millions of base pairs (bP).**



- **Because of their shapes, only some bases are compatible متوافقة with each other.**
  - **Adenine (A) always pairs with thymine (T) and guanine (G) with cytosine (C).**
- **With these base-pairing rules, if we know the sequence of bases on one strand, we know the sequence on the opposite strand.**
- **The two strands are *complementary*.**
- **During preparations for cell division each of the strands serves as a template قالب نسخ to order nucleotides into a new complementary strand.**
- **This results in two identical copies of the original double-stranded DNA molecule.**
  - **The copies are then distributed to the daughter cells.**
- **This mechanism ensures that the genetic information is transmitted to the new cells.**



Final hints

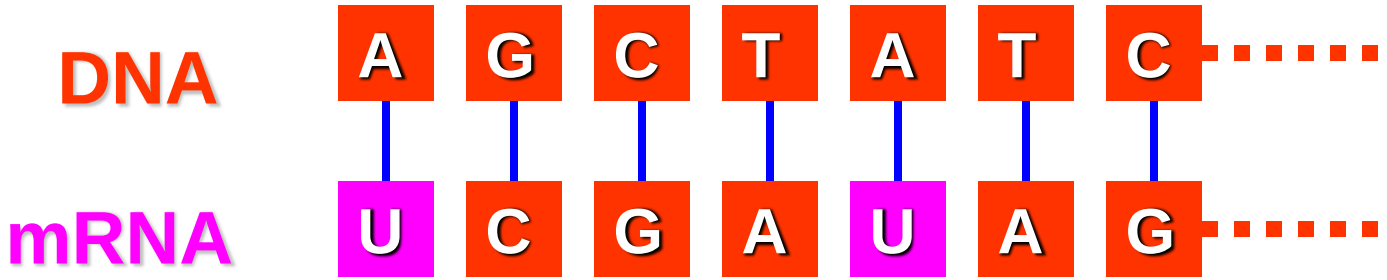
Repeated Sugar - Phosphate → DNA backbone

Sugar–Phosphate-Base → One nucleotide

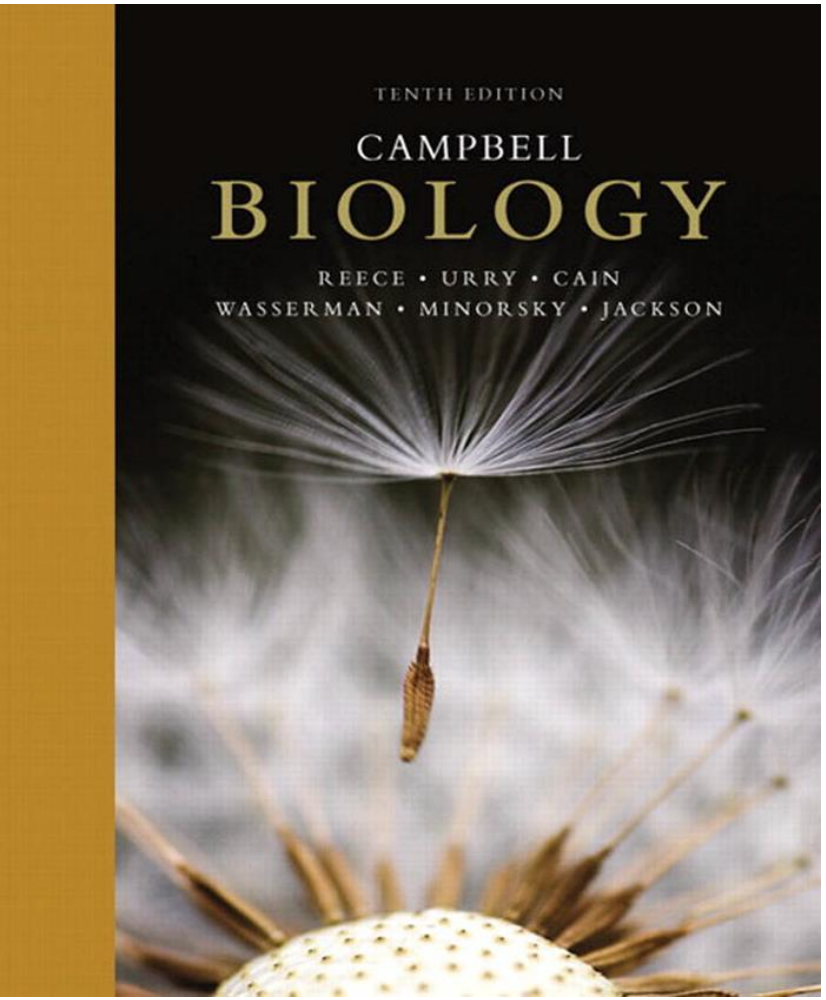
Polynucleotide → DNA Molecule

DNA Double stranded

RNA single stranded



Reference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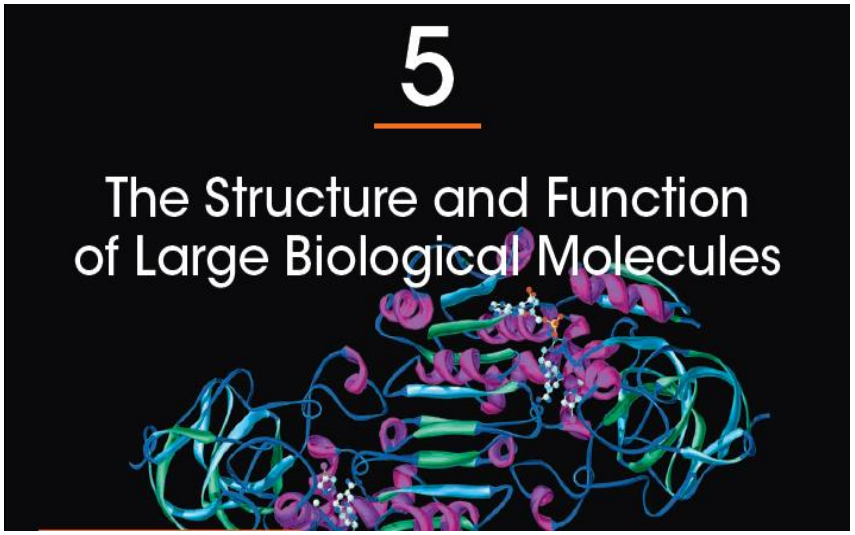
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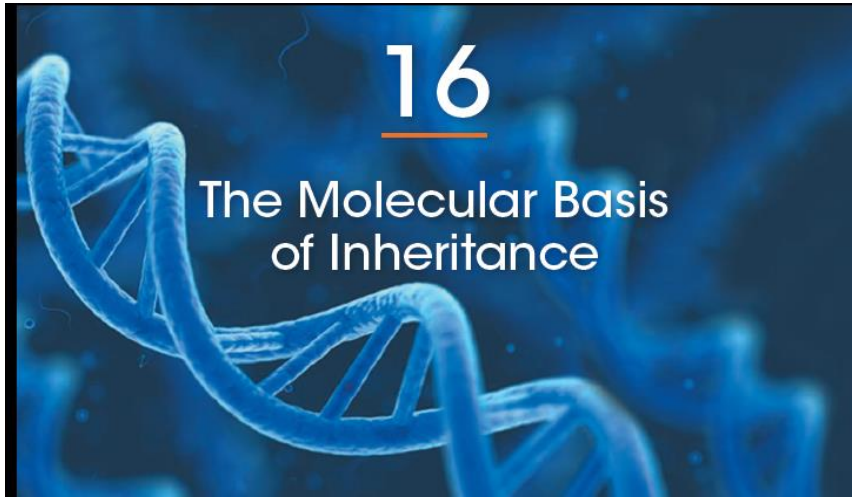
The Structure and Function of Large Biological Molecules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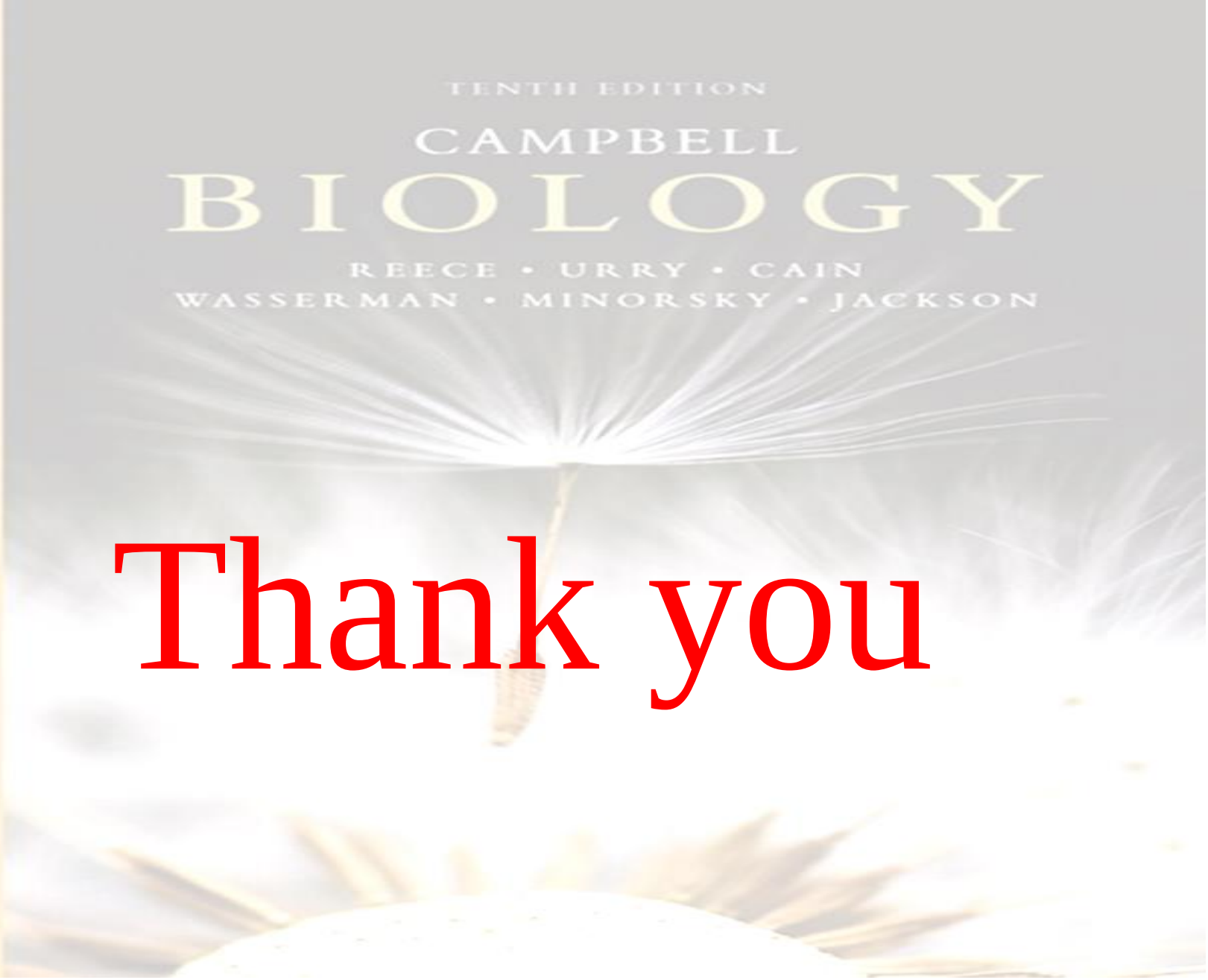
The Molecular Basis of Inheritance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Thank you