Department of biology

2025-2026

((MICROBIOLOGY))

Stage (2)

LEC- ((10))

Microbial genetics

By

Asst. Lecturer ALI ALAWADI

Nucleic acids types

- The genetic information of prokaryotic and eukaryotic microorganisms encoded within the **DNA (deoxyribonucleic acid)** molecule and sometimes (as in viruses) in the **RNA (ribonucleic acid)** molecule.
- These molecules are known as macromolecules and they are responsible for the transition of hereditary information from one generation to the other.
- Protein macromolecule is the result of the genetic code into its structural or functional form.

The structure of nucleic acids and their replication

- The genetic information of a cell forms a **GENOME**.
- The genome of a microorganism is divided into segments consisting of DNA nucleotides sequences known as a **GENE**.
- These genes may have structural or functional, metabolic functions.

DNA structure

The DNA is a double helix where each strand is composed of a sequence of nucleotides; phosphodiester bonds link these nucleotides to each other.

Each nucleotide is formed of

1. a deoxyribose sugar
2. a nitrogen base
3. a phosphate group

(Figure 1 a)

Four nitrogen bases are found in DNA:

1. adenine (A)
2. guanine (G)
3. cytosine (C)
4. thymine (T)

- A and G are purines, while C, T and U are pyrimidines (Figure 1 c).

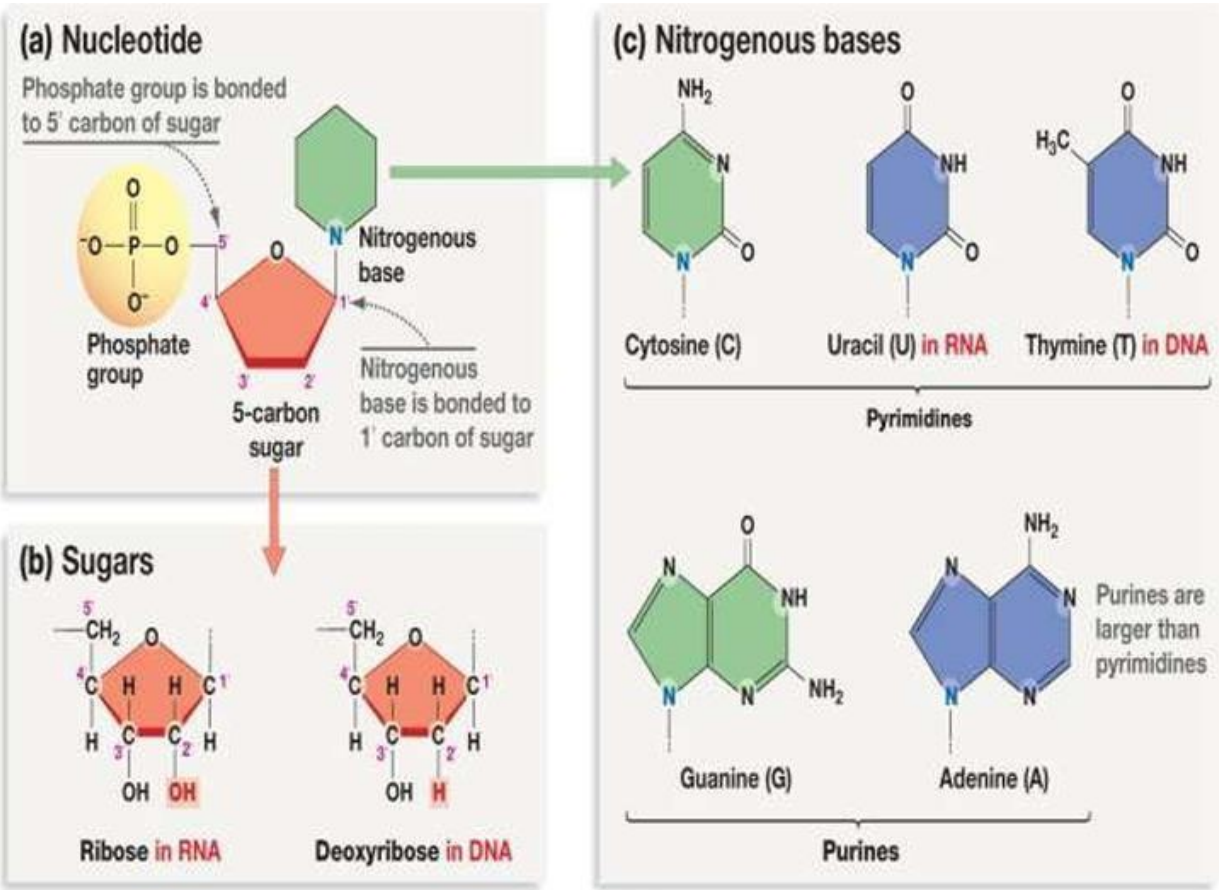


Figure 1: DNA structure

The primary structure of DNA

It is resembled by the sequence of nucleotides in a single strand.

In this structure when the nitrogen base is bound to the sugar it is known as a **nucleoside**, when a phosphate group is linked to the nucleoside it is known as **nucleotide** (Figure 2).

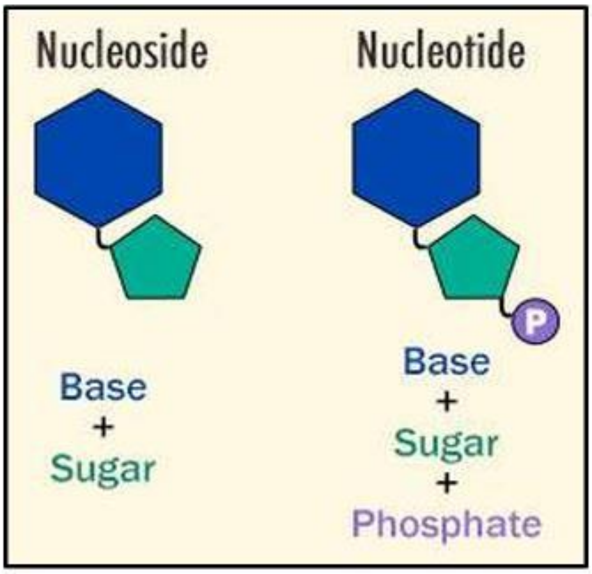


Figure 2: Nucleoside and Nucleotide structure

The secondary structure of DNA

- The two strands of the double - helix are complementary and antiparallel. They are complementary because A in one strand always connected by a double hydrogen bonds with T of the complementary strand (forming what is called a base pair); C always connected (base pair) by triple hydrogen bonds with G of the complementary strand (Figure 3).
- They are antiparallel because the 5' - 3' strand starts with a 5' -PO4= group and ends with a 3'–OH free group while the

complementary strand has inverse polarity starting with 3' -OH ending with 5'-PO4= (3' - 5')

This **DNA double-helix model** was proposed by Watson and Crick in 1953. In a DNA molecule, each turn in a double helix has 10 bases, and the diameter of a single turn is two nm (1 Kilobase = 1000 base pairs and has a molecular weight of 3.3 x 105 per strand).

A DNA molecule always carries a negative charge due to the PO4 groups. These charges are neutralized by alkaline proteins known as histones in eukaryotes, histone-like proteins in prokaryotes.

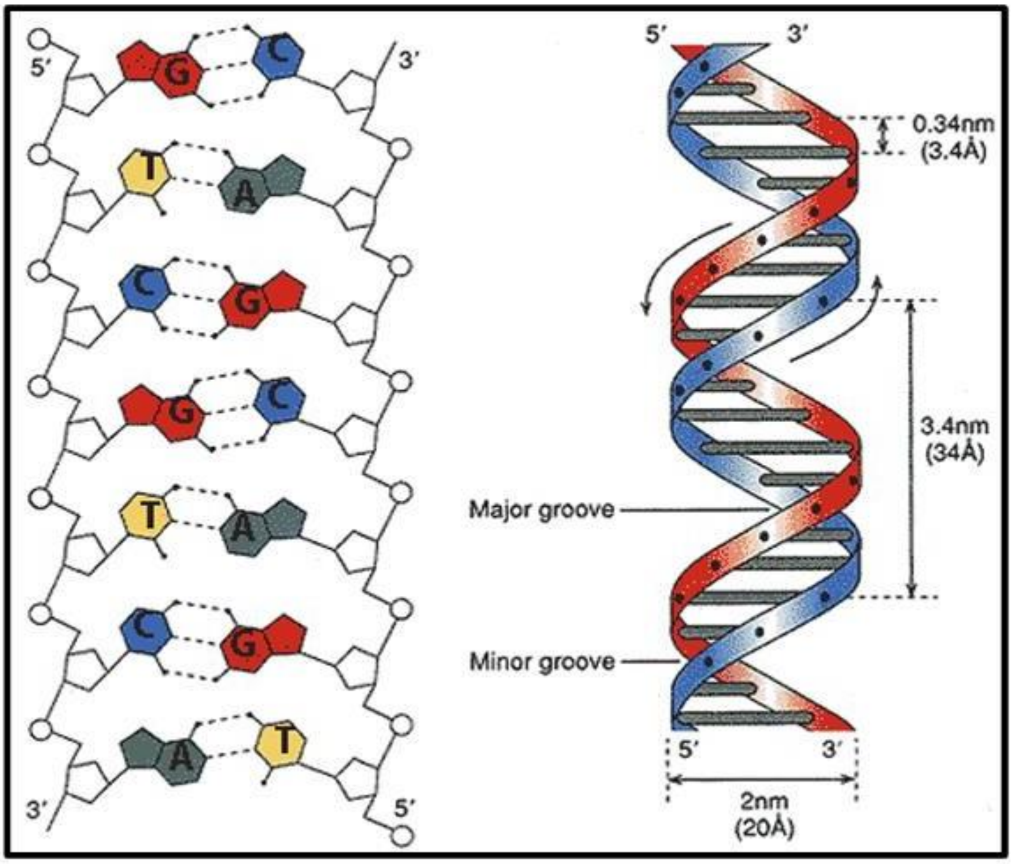


Figure 3: Secondary structure of DNA

Structure of RNA molecule

An RNA molecule is usually single stranded; it has a sequence of ribonucleotides each is formed of a ribose sugar, a nitrogen base (A, G, C, and Uracil (U) instead of thymine (Figure 4), and a phosphate group. A ribonucleoside is formed of a ribose (Figure 1 b) sugar and a nitrogen base.

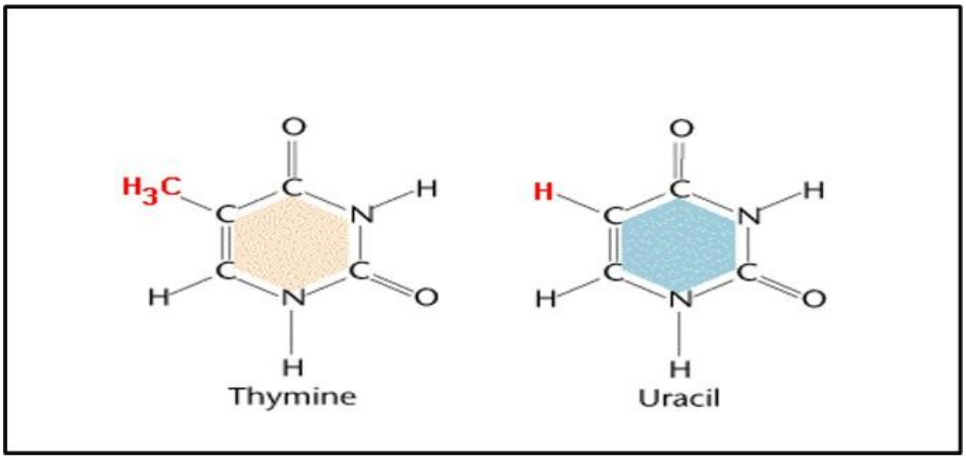


Figure 4: Uracil structure

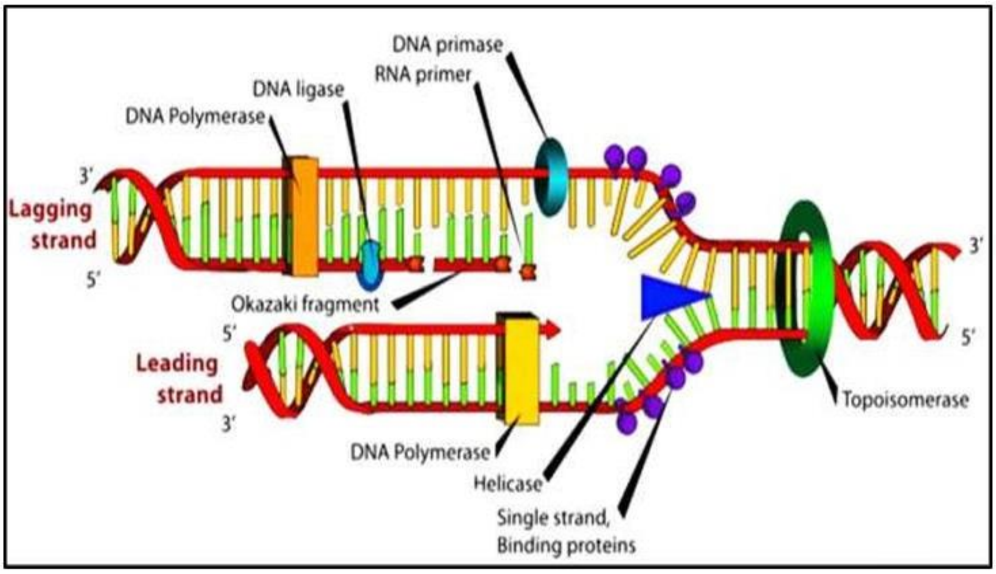


Figure 5: Semi-conservative DNA replication

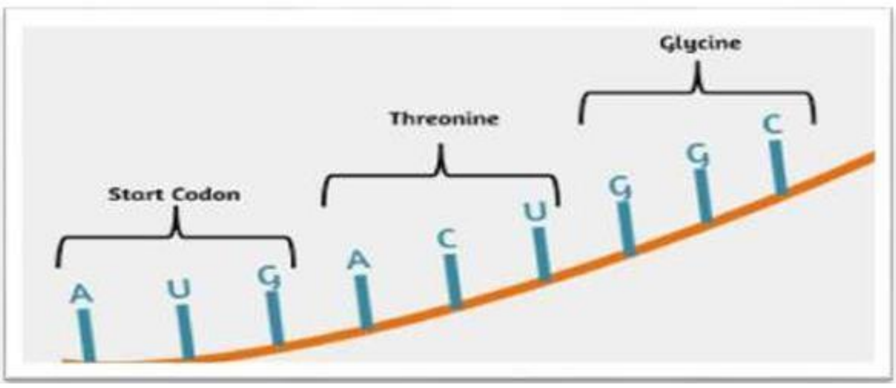
Types of RNA and steps in proteins synthesis

- There are three types of RNA (mRNA, tRNA, and rRNA). Their roles will be described within the process of protein synthesis.
- **1- Messenger RNA (mRNA):**

It is formed in the nucleus of eukaryotes and nuclear region of prokaryotes. It carries the information transcribed from the DNA to the ribosomes (in the cytoplasm) where protein is synthesized. It is transcribed from a single strand of DNA and is complementary to that strand.

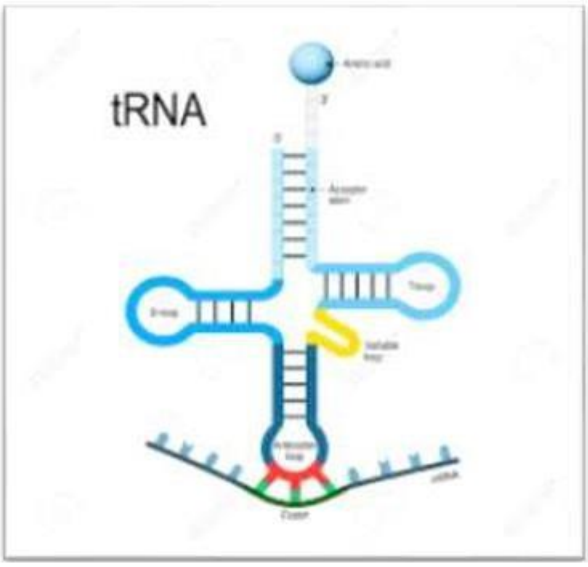
1-Messenger RNA (mRNA):

- **mRNA** is a single strand with a sequence of ribonucleotides to be translated by the ribosomes to the required protein.
- **Transcription** is the first step in protein synthesis.
- **Translation** is the second step in protein synthesis is; it requires the presence of the other two types of RNA; transfer RNA tRNA and ribosomal RNA (rRNA).



2-Transfer RNA (tRNA)

- It is also known as soluble RNA has a distinguished clover leaf structure and two recognition sites.
- one binds to an activated amino acid,
- the second is known as the anticodon that recognizes the codon on the mRNA.



3- Ribosomal RNA (rRNA)

- **rRNA** is a type of non-coding RNA that is a primary and permanent component of ribosomes.
- As non-coding RNA, rRNA itself is not translated into a protein, but it does provide a mechanism for decoding mRNA into amino acids and interacting with the tRNAs during translation by providing peptidyl transferase activity.