Al- Mustaqbal University
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First Stage

General Biology

Lect 4: DNA (deoxyribonucleic acid)

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DNA

The two types of nucleic acids are DNA (deoxyribonucleic acid) and RNA (ribonucleic acid). Both DNA and RNA are polymers of nucleotides. Every nucleotide is a molecular complex of three types of subunit molecules

1. phosphate (phosphoric acid)
2. a pentose sugar
3. a nitrogen-containing base

Genes: are pieces of deoxyribonucleic acid (DNA) that contain a code for a specific protein that works in one or more cell types in the body.

Key Aspects of DNA

Structure

- DNA has a **double helix** structure resembling a twisted ladder.
- The **sides** of the ladder are formed by alternating **sugar and phosphate groups**.
- The **rungs** are made of pairs of nitrogenous bases.

Base Pairing Rule

- **Adenine (A)** pairs with **Thymine (T)** via **two hydrogen bonds**.
- **Cytosine (C)** pairs with **Guanine (G)** via **three hydrogen bonds**.
- This specific pairing ensures accurate replication of genetic information.

Chemical Bonds

- **Phosphodiester bonds:** Link nucleotides within the same DNA strand.
- **Hydrogen bonds:** Hold the complementary bases of the two strands together.

Directionality of DNA

- DNA strands have directionality: **5′ (five prime) to 3′ (three prime)**.
- During replication, DNA is synthesized only in the **5′ → 3′ direction**.
- This leads to the formation of:
    - **Leading strand** (continuous synthesis)
    - **Lagging strand** (discontinuous synthesis forming **Okazaki fragments**)

DNA Replication

DNA replication occurs before cell division and follows a **semi-conservative** model, meaning each new DNA molecule contains one original strand and one newly synthesized strand.

Key enzymes involved:

- **Helicase:** Unwinds the double helix.
- **Primase:** Synthesizes RNA primers.
- **DNA Polymerase:** Adds nucleotides to the growing strand.
- **Ligase:** Joins Okazaki fragments

Organization of DNA

- DNA is tightly packaged inside the **nucleus** of eukaryotic cells.
- It wraps around proteins called **histones** to form **nucleosomes**.
- Nucleosomes further coil to form **chromatin**, which condenses into **chromosomes** during cell division.
- **Humans have 46 chromosomes (23 pairs).**
- DNA is also found in **mitochondria**, while in **prokaryotic cells**, it is located in the **cytoplasm.**

Central Dogma of Molecular Biology

The flow of genetic information in a cell follows this pathway:

DNA → RNA → Protein

1. **Replication:** DNA makes an identical copy of itself.
2. **Transcription:** DNA is transcribed into RNA.
3. **Translation:** RNA is translated into a protein

Mutations

A **mutation** is a change in the DNA sequence that can affect protein function and lead to genetic diversity or disease.

Types of mutations:

1. **Substitution:** One base is replaced by another (Sickel cell anemia)
2. **Insertion:** Addition of one or more bases.
3. **Deletion:** Removal of one or more bases

Why it Matters ؟

- Heredity: It passes on traits from parents to offspring.
- Function: It governs cellular metabolism and protein production.
- Diversity: Small differences in the sequence of bases lead to the diversity of life.


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