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Introduction to Medical Genetics: Molecules of Heredity

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At the end of this resource, you should be able to

- Describe the components, structure and formation of DNA and RNA

Topics

- Nucleic Acid
- DNA Structure
- Anatomy of DNA
- Nitrogenous Base
- DNA Synthesis
- Base Pairing
- Hydrogen Bond

Nucleic Acid

- Deoxyribonucleic acid (**DNA**)
  - In most organism
- Ribonucleic Acid (**RNA**)
  - In some viruses (find out what type of viruses?)
- Both DNA and RNA are known as **NUCLEIC ACID**
- Nucleic acid is one of the class of macromolecules (**What are the other macromolecules?**)

DNA structure

- **Watson-Crick model** proposed in 1953 (see orginal publication)
- Named as The Double Helix model
- Two sides/chains (known as **strands**)
- Twisted like a **spiral ladder** (what is a spiral ladder?)
- **Covalent bond** made by Sugar and Phosphate
- **Hydrogen bond** between phosphate from each strand

DNA structure

- **Anti-parallel** DNA strands
- **Nitrogenous base** point inwards
- **Complementary/specific purine-pyrimidine** nitrogenous base pairing
- **10 base pairs per helical turn**
- **Diameter of helix** is approximately **2 nm**
- DNA structure produces **major** and **minor groove** (What is the importance of this feature?)

DNA Structure

- Enables the molecule to be inherited
- Enables the molecule to produce RNA and Protein that determines all of our biological traits.

Anatomy of DNA

- DNA components
  - **Pentose Sugar** (Deoxyribose): it is a 5 carbon sugar molecule (The carbons found in this sugar are numbered 1’ through 5’ clockwise)
  - **Cyclic nitrogenous base**
  - **Phosphate group**
- Nucleo**s**ide = Pentose + Nitrogenous base
- Nucleo**t**ide = Nucleoside + Phosphate group

Nitrogenous bases

- There are two classes:
- **Purine** (**double**-ringed structure)
  - Adenine (A) and Guanine (G)
- **Pyrimidine** (**single**-ringed structure)
  - Cytosine (C) and thymine (T) (Distinguish thymine from tiamine)

DNA synthesis

- Covalent bond:
  - Each strand (polynucleotide chain) composes of repeating units of **Nucleotides**. The phosphate of one nucleotide is **covalently bound** to the sugar of the next nucleotide
  - A **free hydroxyl group** at the 3′ carbon on a growing DNA strand is required
  - Phosphodiester bond is established between the phosphate of one nucleotide and the hydroxyl group of the **3' carbon** of the next nucleotide

Base pairing

- Based on **Chargaff rule**: observation that there are equal molar concentration of A&T as well as G&C in most DNA.
- Chargaff rule of base pairing is:
  - **A with T** -> the purine Adenine (A) always pairs with the pyrimidine Thymine (T)
  - **G with C** -> the purine Guanine (G) always pairs with the pyrimidine Cytosine (C)
- Why not A-G and C-T or A-C and G-T base pairing?

Hydrogen bond

- **weak chemical bond** that occurs between hydrogen atoms and more electronegative atoms, like oxygen, nitrogen and fluorine.
- The hydrogen bond between phosphates cause the **DNA strands to twist**
- Hydrogen bond can occur between **inter strand or intra strand**

Summary

- DNA exists as a **right-handed double helix**, consists of **two anti-parallel** yet **complementary DNA strand** coiled around one another in a **spiral**.
- The **polynucleotide** chain composes of repeating units of **nucleotides**.
- The nucleotides are bonded by a strong **covalent bond (phosphodiester bond).**

Summary

- Each nucleotide consists of a **phosphate group, a pentose (deoxyribose) and a cyclic nitrogen base**.
- The two chains are held together by **hydrogen bonding** between the complementary purine-pyrimidine bases (A = T and G ≡ C).
- 3'OH end is important for adding nucleotide to the DNA strand