Genetics and Molecular Biology: Lecture 2

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- DNA Function
  - What does DNA actually do?
  - Central Dogma:

$$\text{DNA} \rightarrow_{\text{transcription}} \text{RNA} \rightarrow_{\text{folding}} \text{Amino Acid Chain} \rightarrow_{\text{translation}} \text{Protein}$$
$$\text{DNA} \rightarrow_{\text{replication}} \text{DNA}$$

  - Most Ceullar Processes Depend on Proteins
    - Catalysis
    - Movement
    - Structure
    - Communication
    - Transport
  - Proteins are linear chains of amino acids which fold to make complex shapes capable of doing a specific task in the cell
  - Order of amino acids in proteins determins its shape and abilities
  - Sickle Cell Disease: A change in one amino acid causes clumping due to changes in folding
- DNA Structure
  - DNA: two strands of nucleotides, covalent bonds link within-strands, hydrogen bonds link between strands
  - Four difference nucleotides with four bases
    - Thymine, Cytosine (Pyrimidines)
    - Adeine, Guanine (Purines)
  - Nucleotides are linked in strands
  - Nucleotides and strands are asymmetric
    - 5' carbon atom o fthe sugar is where the phosphate group is attached
    - 3' carbon atom of the sugar has a hydroxyl group
  - Stands are made by attaching 5' phosphate to 3' hydroxyl of next nucleotide
  - Phosphodiester linkage
  - Information in DNA is stored in order of nitrogenous bases
- Erwin Chargaff - 1952
  - In organisms DNA:

Amount of Adenine = Amount of Thymine
Amount of Cytosine = Amount of Guanine
Amount of Purines = Amount of Pyrimidines

- Rosalind Franklin - 1953
  - X-ray crystallography of DNA

    $$\text{crystals} \rightarrow_{\text{x-rays}} \text{diffraction pattern} \rightarrow_{\text{phases}} \text{electron density map} \rightarrow_{\text{fitting}} \text{structure}$$

- James Watson and Francis Crick - 1953
  - Double helix model of DNA
- Base Pairing
  - (Purine) : (Pyrimidine)
  - Because of base pairing, DNA strands complement each other
- Anti-Parallel Strands
  - Key Features:
    - Anti-parallel strands: one strand runs 5' to 3', the other runs 3' to 5'
    - Sugar phosphate backbones
    - Bases glue strands together with H-bonds
    - A = T, G $\equiv$ C
- DNA can form different helix structures under different conditions
  - Common form is B-DNA
  - A-DNA and Z-DNA are also possible
- DNA Helices are mostly right-handed (B-DNA and A-DNA, Z-DNA is left-handed)
- Base Pairing angles have major and minor grooves
  - Major groove - more access to nitrogen bases
  - Minor groove - more access to sugar and phosphate
- Helices can be overwound or underwound causing supercoiling
  - Underwinding creates negative supercoils (right handed rossing)
    Can assist in strand separation
  - Overwinding creates positive supercoils (left handed crossing)
- Topoisomerase Enzymes Change Winding/Coiling
  - Type I: Separates one strand, twists, reconnects
  - Type II: Recognizes the entanglement and makes reverseable covalent attachment to the opposite strands, breaking a strand and forming a gate. Passes the other strand through the gate, then reseals the break
    Type II topoisomerase enzymes can decatenate circular DNA (circular chromosomes become catenated - interlocked - during replication)