Molecular Biology

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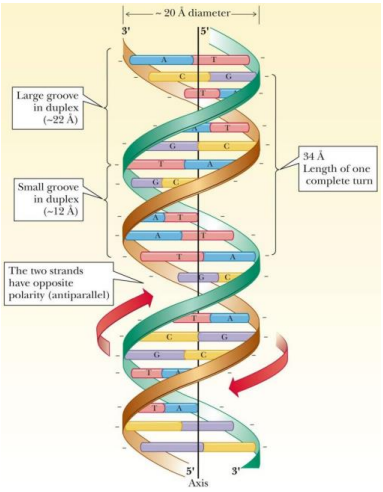
Deoxyribonucleic Acids (DNA)

- DNA is a polymer consisting of monomers called *nucleotides* linked by *phosphodiester bonds*
  - Each nucleotide contains a pentose sugar, phosphate groups and a nitrogenous base
  - DNA is a flexible molecule but yet a stable one due to the phosphodiester bond

- DNA is a **double helix** consisting of 2 strands (2 polynucleotide chains) wind around each other
  - Both strands are held together by H bonds
  - DNA helix is imperfect producing grooves of different sizes (**minor and major grooves**) which are important in the interaction and binding with proteins



- DNA strands are **complementary**
  - Base pairing occurs between a purine (A, G) with a pyrimidine (T, C)
  - **A** with **T** (**2** H-bonds)
  - **G** with **C** (**3** H-bonds)
  - Increased C-G content, increases H-bonds, so the DNA strands are held together stronger

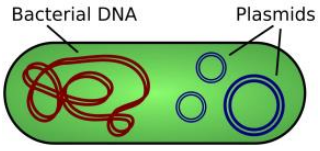
- DNA strand has a **back bone** consisting of the deoxyribose (sugar) and the phosphate, and it has **side chains** which include the nitrogenous bases which are perpendicular to the back bone

- Each DNA strand has 2 ends:
  - Free phosphate end (5' end)
  - Free hydroxyl (OH) end (3' end)
  - Writing, reading and synthesizing DNA occurs always from the **5' to 3'** end

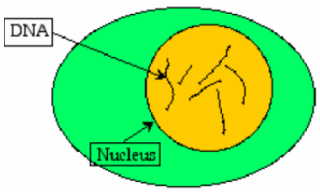
- DNA is **antiparallel** where both strands run in opposite direction to each other

Q) What is the complementary sequence of the following DNA strand "ATGGCCTGGACTTCA"

- Genome: The total genetic material of a living being, species, individual, or a cell
- Prokaryotic genome
  - **Single circular** DNA molecule with **multiple plasmids**
  - Plasmid: A small circular DNA molecule



- Eukaryotic genome
  - ***Nuclear genome:*** **Multiple linear chromosomes** in the nucleus
    - ✓ Chromosomes: Highly packaged form of chromatin
    - ✓ Chromatin: a Complex of DNA coiled around histone proteins
  - ***Mitochondrial genome:*** A **small circular DNA** in the mitochondria
    - ✓ mtDNA is less stable than the nuclear DNA

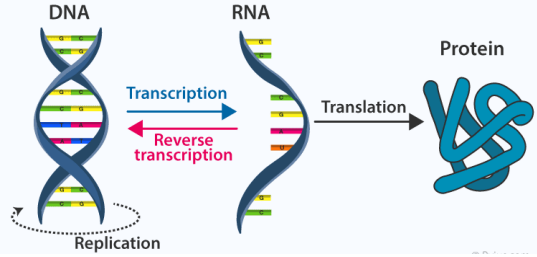


Ribonucleic Acids (RNA)

- It consists usually from a single stranded ribonucleotide chain
- Pentose sugar in RNA is a ribose
  - RNA: Ribose sugar **has** a hydroxyl group (OH) on the 2' carbon
  - DNA: Deoxyribose sugar **lacks** hydroxyl group (OH) on the 2' carbon
- It uses Uracil (U) instead of Thymine (T)
- There are many types of RNA:
  - mRNA (messenger) sends messages to the ribosome to produce proteins
  - tRNA (transfer) carry amino acids to the ribosome during protein synthesis
  - rRNA (ribosomal) which represent enzymatic and structural part of the ribosomes
  - miRNA (micro) regulates and repress translation
  - lncRNA (long non-coding) regulate transcription and mRNA processing

Central dogma

- Central dogma of molecular biology
  - DNA → DNA (Replication)
  - DNA → RNA (Transcription)
  - DNA ← RNA (Reverse Transcription)
  - RNA → Protein (Translation)



Past Papers

1) Which one of these statements about nitrogenous bases is TRUE?
   A) Adenine and thymine are purines
   B) Cytosine and guanine are pyrimidines
   C) Guanine is a purine and Adenine is a pyrimidine
   D) Adenine is a purine and uracil is a pyrimidine

2) The sequence GCAGGCCTAGT exist in human genome, one of the following is TRUE:
   A) It's part of a minor groove
   B) The opposite strand is CGTCCGGATCA
   C) That last T in the sequence in a monophosphate form
   D) It is made of telomeres (the ends of chromosome)
   E) The first G in the sequence represent the free pentose end

3) RNA molecules contain an additional oxygen atom compared to DNA molecules located on which carbon atom of the pentose sugar:

A) 1
B) 2
C) 3
D) 4
E) 5

4) A template of DNA is 5-ATCGGCTACAATGTA-3; what is the complimentary DNA sequence?

A) UACAUUGUAGCCGAU
B) TAGCCGATGTTACAT
C) TACATTGTAGCCGAT
D) TACAAAGTAGCCGAT
E) ATCGGCTACAATGTA

5) One strand of a DNA segment contains 33 A, 25 G, 12 T, and 41 C. how many each base is found in the original double- stranded DNA molecule?

A) A-46, G-50, C-50, T-46
B) A 66, G 53, C-53, 7-66
C) A-45, G-66, C-66 T-45
D) A-66, G-24, C-24 A 66
E) A-45, G-50, C50, T-45

6) Complementarity is a feature of DNA that indicates the following:

A) Bases are almost perpendicular to the side chains
B) DNA is anti-parallel
C) A minor groove is opposite to a major groove
D) DNA is helical
E) Number of (A+G) = number of (T+C)

7) Each nucleotide is attached to the other nucleotide by

A) ionic bonds
B) phosphodiester bonds
C) hydrogen bonds
D) glycosidic linkages
E) disulfide bridges

8) Major and minor grooves in DNA structures are formed because of

A) the anti-parallel nature of the tow strands of DNA
B) DNA packing by histones
C) the pattern of hydrogen bonding between nucleotides
D) DNA is not perfectly helical
E) the bending capability of DNA

9) Nitrogenous bases are attached to each other by:

A) Hydrogen bonds
B) Ionic bonds
C) Glycosidic linkages
D) Phosphodiester bonds
E) Disulfide bridges

10) What is the maximum number of phosphate groups that can be attached to pentose sugars in nucleotides?

A) 1
B) 2
C) 3
D) 4
E) There is no maximum number

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