Nucleic Acids

DNA and RNA

- The two nucleic acids are deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).
- DNA and RNA are composed of fundamental units (building blocks) called nucleotides. A nucleotide consists of three parts:
  - (1) a phosphate group,
  - (2) a five carbon (pentose) sugar, and
  - (3) a nitrogen-containing base.

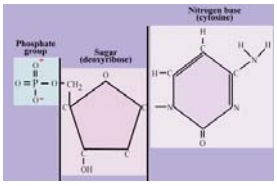


Fig 3D-1

Phosphate group

- The phosphate groups of DNA and RNA are structurally identical.
- The phosphate group of a nucleotide covalently bonds to the sugar of the adjacent nucleotide to form a linear polynucleotide strand.
- The phosphate-sugar units are the "backbone" of the polynucleotide strand.

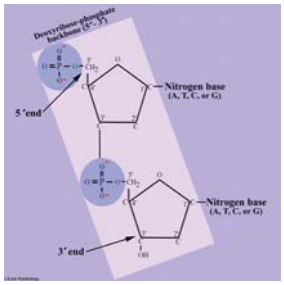


Fig 3D-2

Pentose Sugar

- The pentose sugar of RNA is called ribose. If an oxygen atom is removed then ribose is changed to deoxyribose, the pentose sugar of DNA. Conventional numbering of the carbon atoms (1'- 5') begins with the C-OH.

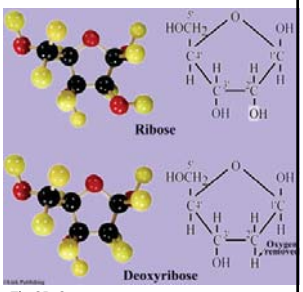


Fig 3D-3

Nitrogen Bases

- Nitrogen bases are nitrogen compounds that are characterized by their ring structure and containing the atoms C, H, O, and N. There are two groups of nitrogen bases that pertain to the nucleic acids, the purines and the pyrimidines. The purines include adenine and guanine. The pyrimidines include thymine, cytosine, and uracil.

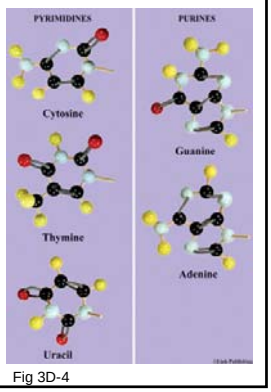


Fig 3D-4

Nitrogen Bases of DNA

- Nitrogen bases:
  - adenine (A) and guanine (G),
  - thymine (T) and cytosine (C),
- DNA complementary base pairing (hydrogen bonds):
  - C..G - cytosine (C) pairs with guanine (G)
  - T..A - thymine (T) pairs with adenine (A)

Nitrogen Bases of RNA

- Nitrogen bases:
  - adenine (A) and guanine (G),
  - uracil (U) and cytosine (C),
- RNA complementary base pairing (hydrogen bonds):
  - C..G - cytosine (C) pairs with guanine (G)
  - U..A - uracil (U) pairs with adenine (A)

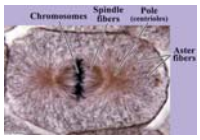
DEOXYRIBONUCLEIC ACID - DNA

Chromosome

Chromosomes are the most complex organizational form of DNA and consist of supercoiled molecular DNA and its associated proteins (histones).

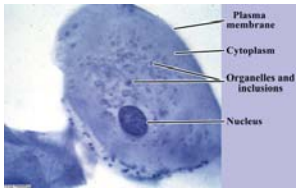
- In the human, the chromosome number for a somatic (body) cell is 46 (23 pairs). Chromosomes are observed in cells which are in cell division (mitosis and meiosis).

Fig 3D-9



Chromatin

- Chromatin is the dark stained DNA dispersed in the nucleus of non-dividing cells (interphase). Chromatin consists mostly of molecular DNA and associated proteins called histones.



Molecular DNA

- Molecular DNA
- Molecular DNA is the simplest structural form of DNA. In this form the genetic code is accessible and is used for
  - (1) self-replication (cell division) and
  - (2) transcription. Transcription is the process of using the DNA as the template for the assembly of the ribonucleic acids (RNAs).

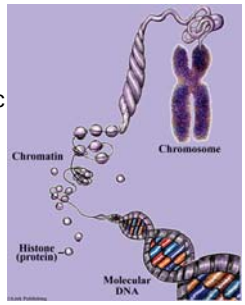


Fig 3D-10

Molecule of DNA

- A molecule of DNA consists of two polynucleotide strands that are organized into a double helix.
- Each polynucleotide strand is formed by the bonding of the phosphate group of one nucleotide to the sugar (deoxyribose) of the adjacent nucleotide.
- Each sugar is also covalently boned to a nitrogen base that extends toward the center of the helix.
- Each nitrogen base is hydrogen bonded to its complimentary nitrogen base (extending from the other polynucleotide strand).

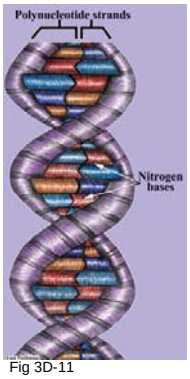


Fig 3D-11

Structure of DNA

- Nucleotides
- The building blocks of molecular DNA are nucleotides. A DNA nucleotide is formed from three components: (1) a phosphate group, (2) deoxyribose (a pentose sugar), and (3) one of four nitrogen bases - adenine (A), thymine (T), cytosine (C), or guanine (G). Since there are four nitrogen bases, there are four different nucleotides.

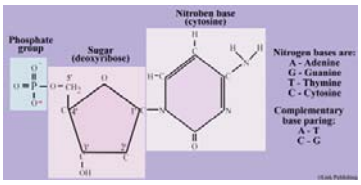


Fig 3D-12

RIBONUCLEIC ACID - RNA

Structure of RNA

Nucleotides

- Ribonucleic acid consists of fundamental structural units (building blocks) called nucleotides. The nucleotide structure of RNA consists of three fundamental parts: (1) a phosphate group, (2) ribose (a pentose sugar), and (3) one of four nitrogen bases, adenine (A), uracil (U), cytosine (C), or guanine (G).

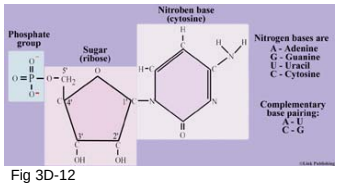


Fig 3D-12

Function of RNAs

- The ribonucleic acids (RNAs) function in the process of protein synthesis (translation) as three structural and functional types:
  - messenger RNA, mRNA,
  - ribosomal RNA, rRNA, and
  - transfer RNA, tRNA.

Messenger RNA (mRNA)

- Messenger RNA consists of a single strand of nucleotides. It is assembled in the nucleus from a template of DNA, a gene, a process called transcription.

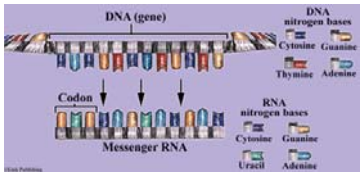


Fig 3D-24

- Messenger RNA carries the genetic information from the DNA (transcription occurs in the nucleus) into the cytoplasm of the cell.

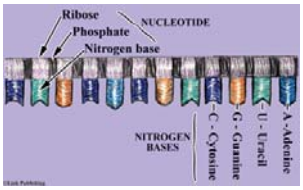


Fig 3D-23

Ribosomal RNA (rRNA)

- Ribosomal RNA (rRNA) and proteins are used in the construction of ribosomes, the sites where translation occurs. A ribosome consists of a large and a small subunit.

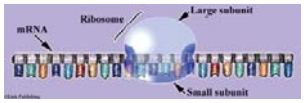


Fig 3D-25

Transfer RNA (tRNA)

- Transfer RNA (tRNA) is a highly folded molecule consisting mostly of RNA nucleotides. The folds of the molecule are produced by complementary base pairing of the RNA nucleotides. During translation, transfer RNA functions in the transfer of amino acids to mRNA

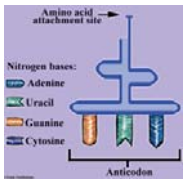


Fig 3D-26

- Each transfer RNA molecule has two functional sites; one site functions as the binding site for an amino acid and the other site, a region of three exposed nitrogen bases called an anticodon, recognizes (binds to) its appropriate code word (codon) of messenger RNA.

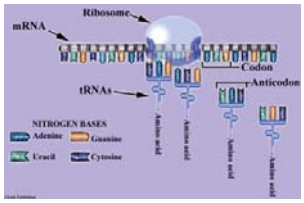


Fig 3D-27