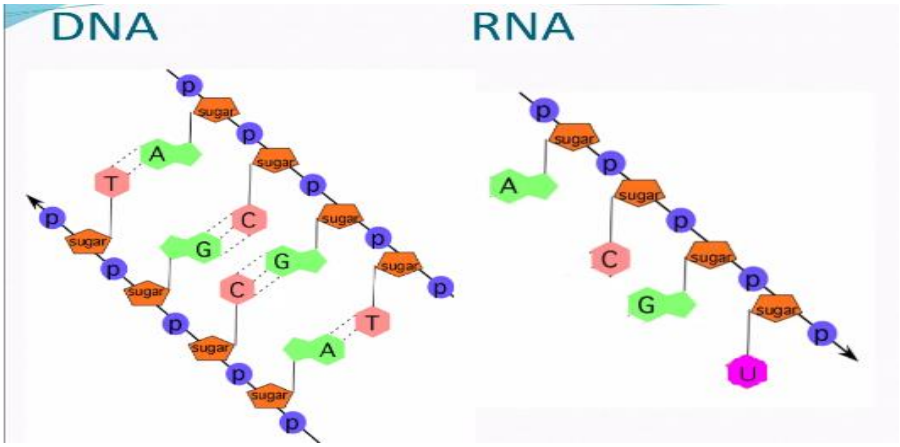
Overview of Nucleic acids

DNA and RNA



- ✓ Nucleic acids are the third class of biopolymers (polysaccharides and proteins being the others)
- ✓ Two major classes of nucleic acids deoxyribonucleic acid (DNA): carrier of genetic information ribonucleic acid (RNA): an intermediate in the expression of genetic information and other diverse roles.
- ✓ The Central Dogma (F. Crick):

- ✓ The monomeric units for nucleic acids are nucleotides.
- ✓ Nucleotides are made up of three structural subunits

1. Sugar: ribose in RNA, 2-deoxyribose in DNA
2. Heterocyclic base
3. Phosphate

Nitrogen Bases:

- There are two kinds of nitrogen-containing bases - purines and pyrimidines.
- **Purines** and **Pyrimidines** are nitrogenous bases that make up the two different kinds of **nucleotide** bases in **DNA and RNA**.
- The two-carbon nitrogen ring bases (adenine and guanine) are purines, while the one-carbon nitrogen ring bases (thymine and cytosine) are pyrimidines.
- A purine is a heterocyclic aromatic organic compound containing 4 nitrogen atoms. It contains two carbon rings, and is made of a pyrimidine ring fused to an imidazole ring.
- A pyrimidine is a heterocyclic aromatic organic compound containing 2 nitrogen atoms. It contains only one carbon ring.
- There are 4 purines and 4 pyrimidines that are of concern to us.

Purines

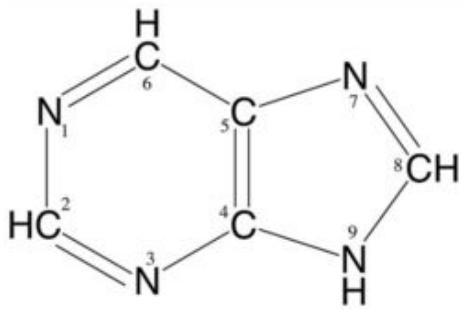
- Adenine = 6-amino purine
- Guanine = 2-amino-6-oxy purine

Adenine and guanine are found in both DNA and RNA..

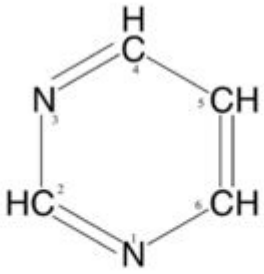
Pyrimidines

- Uracil = 2,4-dioxy pyrimidine
- Thymine = 2,4-dioxy-5-methyl pyrimidine
- Cytosine = 2-oxy-4-amino pyrimidine

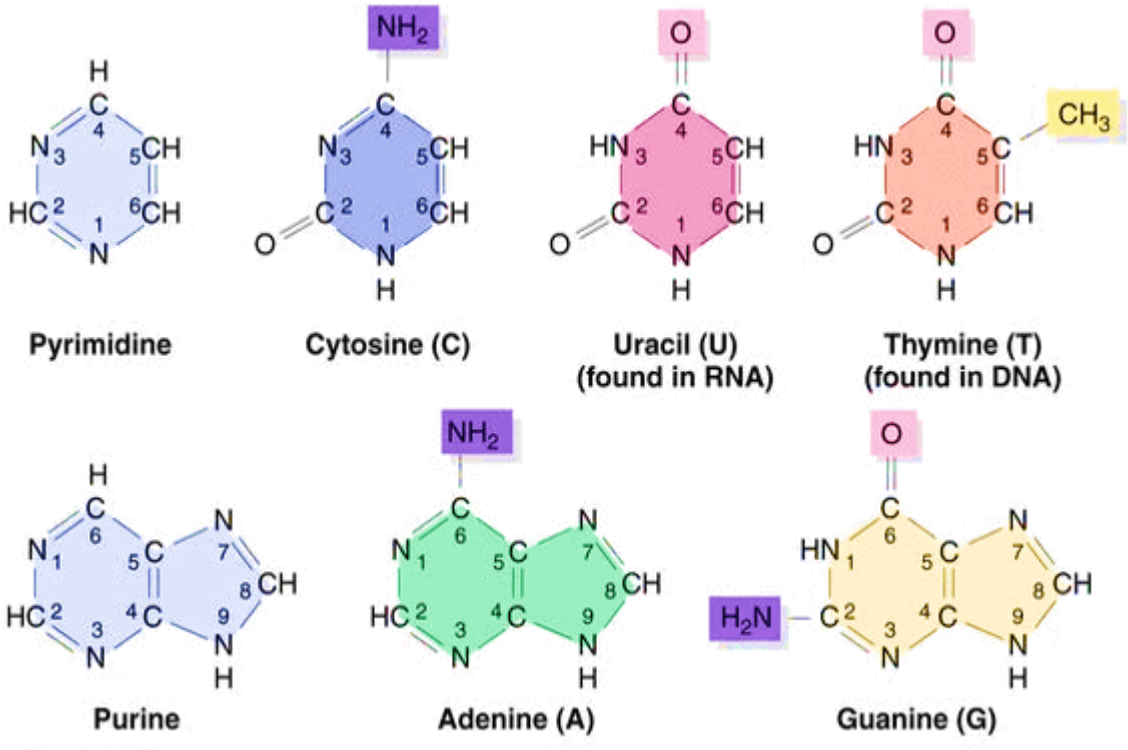
Cytosine is found in both DNA and RNA. Uracil is found only in RNA. Thymine is normally found in DNA. Sometimes tRNA will contain some thymine as well as uracil.



Structure of a purine



Structure of a pyrimidine



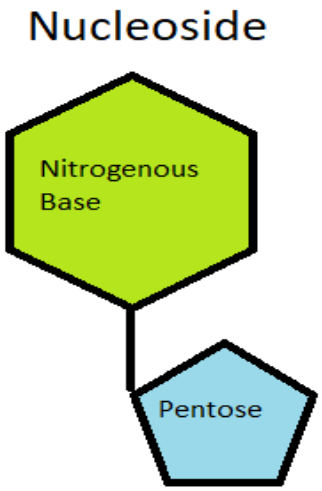
Nucleoside, nucleotides and nucleic acids:

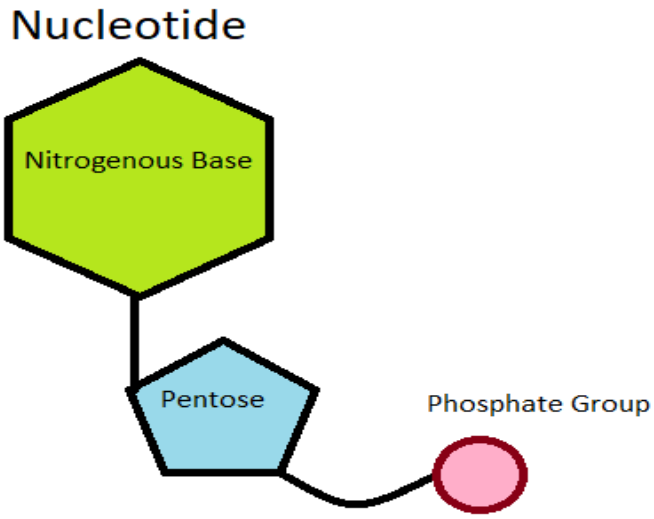
Nucleosides:

If a sugar, either **ribose** or **2-deoxyribose**, is added to a nitrogen base, the resulting compound is called a **nucleoside**. Carbon **1** of the sugar is attached to nitrogen **9** of a purine base or to nitrogen **1** of a pyrimidine base.

Nucleotides

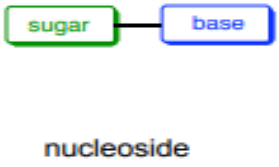
Adding one or more phosphates to the sugar portion of a nucleoside results in a **nucleotide**. Generally, the phosphate is in ester linkage to carbon 5' of the sugar.





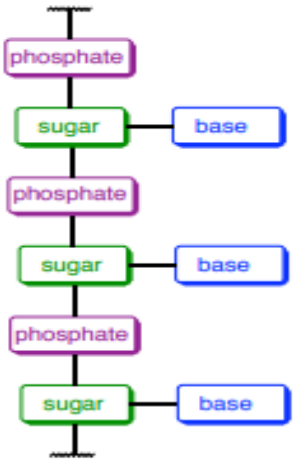
Polynucleotides

Nucleotides are joined together by 3'-5' phosphodiester bonds to form polynucleotides. Polymerization of ribonucleotides will produce an RNA while polymerization of deoxyribonucleotides leads to DNA.



nucleoside

nucleotides

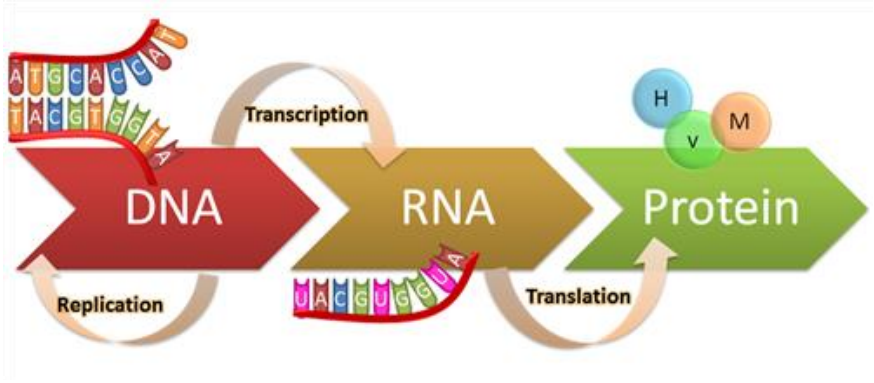


nucleic acids

The chemical linkage between monomer units in nucleic acids is a phosphodiester

DNA, RNA and protein synthesis:

- ✓ The processes of DNA Replication and Protein Synthesis are essential functions of DNA.
- ✓ DNA makes copies of itself in order to provide identical copies of DNA for new cells.
- ✓ Protein synthesis uses DNA to code for proteins necessary for life.
- ✓ Mutations may occur if the processes of DNA replication or protein synthesis malfunction.



DNA replication

Each time a cell divides, each of its double strands of DNA splits into two single strands. Each of these single strands acts as a template for a new strand of complementary DNA. As a result, each new cell has its own complete genome. This process is known as DNA replication.

Transcription

Transcription is the process by which DNA is copied (transcribed) to mRNA, which carries the information needed for protein synthesis.

Translation

- ✓ The mRNA formed in transcription is transported out of the nucleus, into the cytoplasm, to the ribosome (the cell's protein synthesis factory).
- ✓ Here, it directs protein synthesis. Messenger RNA is not directly involved in protein synthesis - transfer RNA (tRNA) is required for this.

✓ The process by which mRNA directs protein synthesis with the assistance of tRNA is called translation.

✓ The ribosome is a very large complex of RNA and protein molecules.

✓ Each three-base stretch of mRNA (triplet) is known as a codon, and one codon contains the information for a specific amino acid.

✓ As the mRNA passes through the ribosome, each codon interacts with the anticodon of a specific transfer RNA (tRNA) molecule by Watson-Crick base pairing.

✓ This tRNA molecule carries an amino acid at its 3'-terminus, which is incorporated into the growing protein chain.

✓ The tRNA is then expelled from the ribosome.