FOOD CHEMISTRY

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BIOCHEMISTRY

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NUCLEIC ACIDS (DNA & RNA)

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- **Nucleotides** are **building blocks** of **nucleic acids** as the proteins are made of amino acids.
- They are the energy currency in metabolic transactions
- Nucleotides are the **essential chemical links** in the response of cells to **hormones** and other extracellular stimuli.
- They are **structural components** of an array of **enzyme cofactors and metabolic intermediates**.
- **Structure of Nucleotides** Nucleotides have **three characteristic components** :
- • **A nitrogenous (nitrogen-containing) base**
- • **a pentose sugar**
- • **A phosphate**
- The **nitrogenous bases** in nucleotides are **derivatives of** two parent compounds, **pyrimidine** and **purine**.

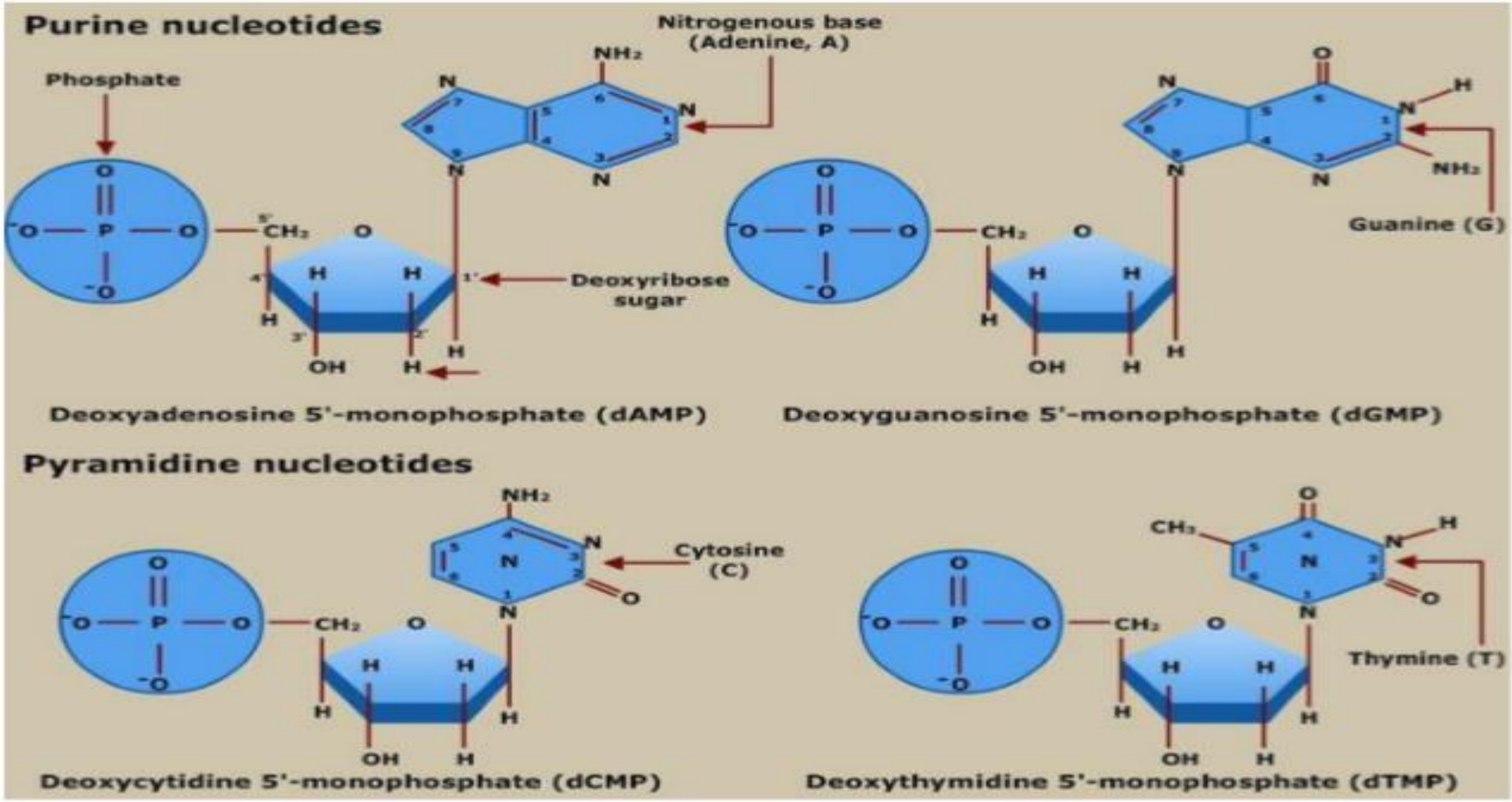

Fig. 5.1 Structure of nucleotides

• Both **DNA** and **RNA** contain two major **purine** bases, **Adenine** (A) and **guanine** (G),
• **Pyrimidines** in **DNA** are **cytosine** (C) and **thymine** (T).
• **Pyrimidines** in **RNA** are **cytosine** (C) and **uracil**

Nucleic acids have two kinds of **pentoses**
• **DNA** contains 2'-deoxy-D-ribose,
• **RNA** contains D-ribose.

The names of the **four** major **deoxyribonucleotides** (deoxyribonucleoside 5'-monophosphates)
• Deoxyadenylate (deoxyadenosine 5'-monophosphate) Symbols : A, dA, dAMP
• Deoxyguanylate (deoxyguanosine 5'-monophosphate) Symbols : G, dG, dGMP
• Deoxythymidylate (deoxythymidine 5'-monophosphate) Symbols: T,dT,dTMP
• Deoxycytidylate (deoxycytidine 5'-monophosphate) Symbols : C.dC,dCMP

The names of **four** major **ribonucleotides** (ribonucleoside 5'-monophosphates),

- Adenylate (adenosine 5'-monophosphate) Symbols : A, AMP
- Guanylate (guanosine 5'-monophosphate) Symbols : G, GMP
- Uridylate (uridine 5'-monophosphate) Symbols : U,UMP
- Cytidylate (cytidine 5'-monophosphate) Symbols : C,CMP

Nucleoside : The molecule **without the phosphate group** is called a **nucleoside**

DNA	**RNA**
• Deoxyadenosine	Adenosine
• Deoxyguanosine	Guanosine
• Deoxythymidine	Uridine
• Deoxycytidine	Cytosine

Phosphate "Bridges"

The successive nucleotides of both DNA and RNA are **covalently linked** through **phosphate-group "bridges,"**

• The 5'-phosphate group of one nucleotide unit is joined to the 3'-hydroxyl group of the next nucleotide, creating a **phosphodiester linkage**.

• Thus the **covalent backbones** of nucleic acids consist of **alternating phosphate and pentose residues**, and the **nitrogenous bases** may be regarded as **side groups** joined to the backbone at regular intervals.

• Each linear nucleic acid strand has a specific polarity and distinct 5' and 3' ends.

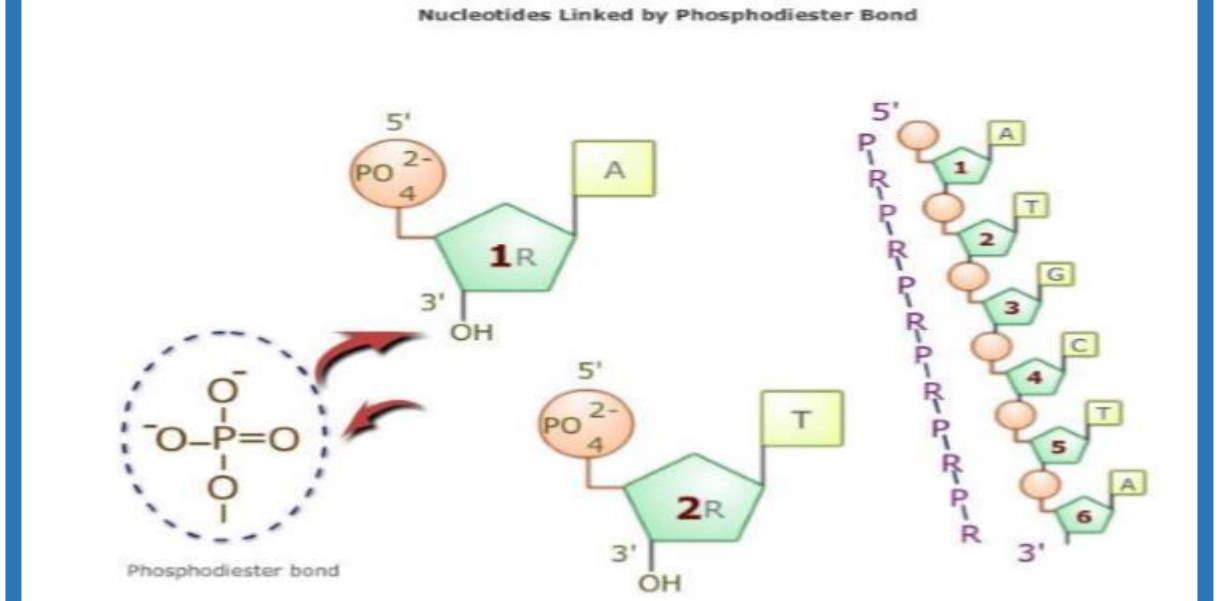

Fig. 5.2 Nucleotides linked by phosphodiester bond

Structure of DNA

• In 1953 **Watson and Crick** postulated a **three dimensional model** of DNA structure.

• In a DNA molecule, the different nucleotides are covalently joined to form a **long polymer chain** by covalent bonding between phosphates and sugars.

• The phosphate attached to the hydroxyl group at the 5'postion of the sugar is attached to hydroxyl group on the 3' carbon of the sugar of the next nucleotide.

• Thus the linkage between the **phosphate and hydroxyl bond** is an **ester linkage** and is called **3'5'posphodiester bond**.

• The DNA chain has the **polarity having 5'end and 3'end** because first nucleotide has a **5' phosphate** not bounded to any other nucleotide and last nucleotide has a free **3' hydroxyl** .

• DNA consists of **two helical chains** of nucleotides **wound around the same axis** to form **double helix**. The two DNA strands are organized in an **anti-parallel arrangement** i.e. one strand is oriented 5'-3' and other is oriented 3'-5'.

• The **hydrophilic backbones** of alternating deoxyribose and phosphate groups are on the **outside** of the double helix, facing the surrounding water.

• The **purine and pyrimidine** bases of both strands are stacked **inside the double helix**, with their **hydrophobic** and nearly planar ring structures very close together and perpendicular to the long axis.

• Each **nucleotide base** of one strand **is paired** in the same plane with **a base of the other strand**. **G with C** and **A with T**, are those that fit best within the structure. This is called **complementary base pairing**. **Three hydrogen bonds** can form between **G and C**, but only **two** can form between **A and T.**

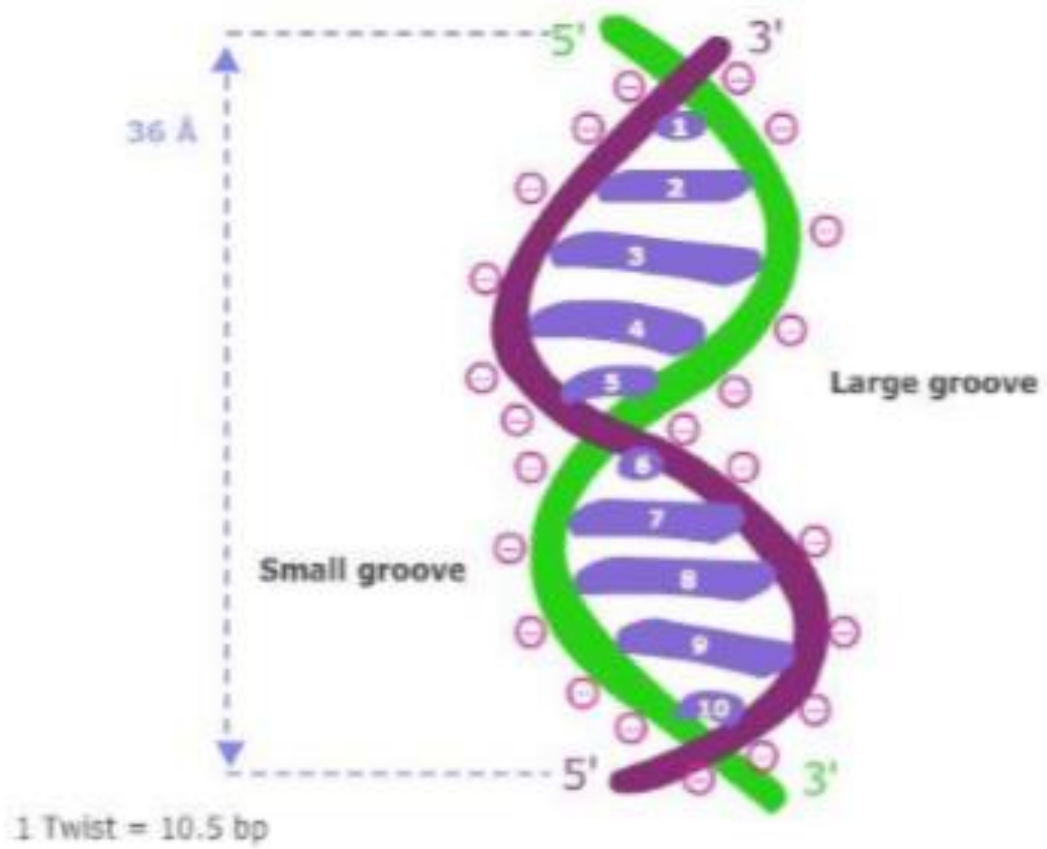

Fig. 5.3 Basic structure of nucleic acids

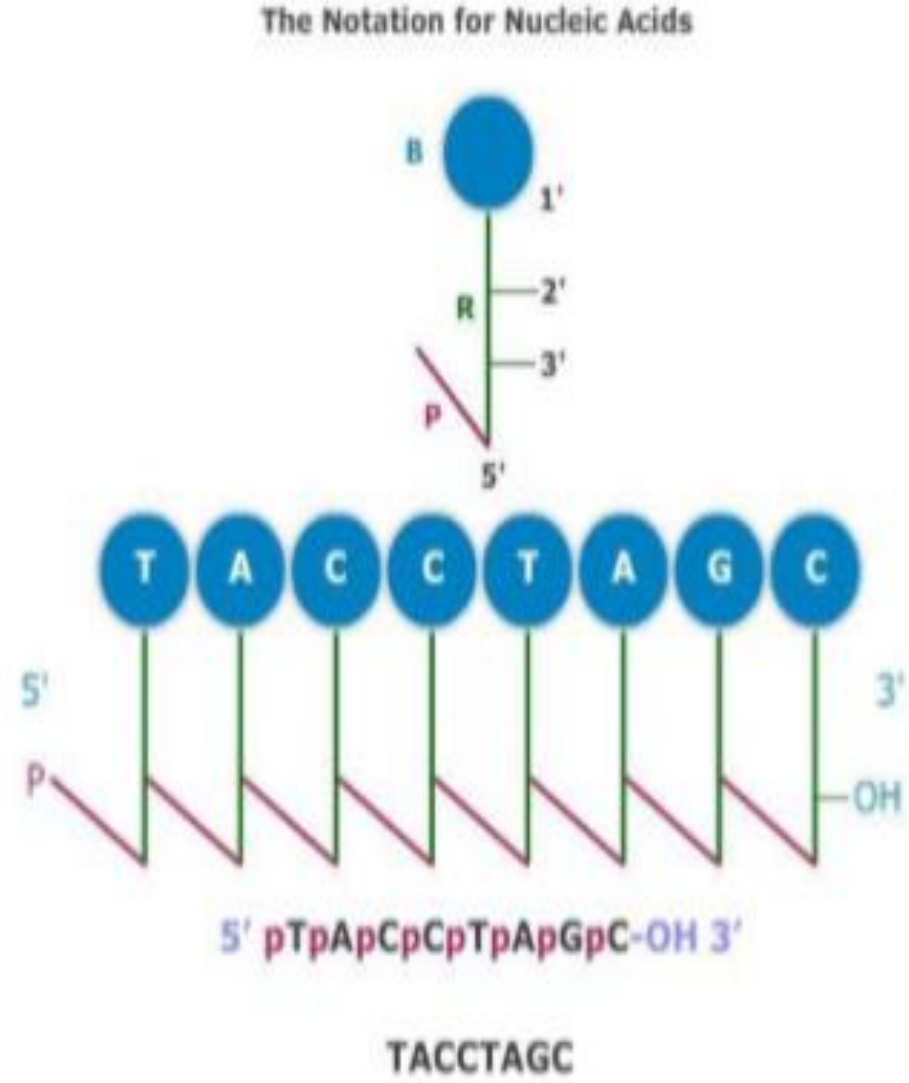

Fig. 5.4 The notation for nucleic acids

Structure of RNA

Most RNA molecules are **single stranded** but an RNA molecule may contain regions which can form complementary base pairing where the RNA strand loops back on it. If so RNA will have some double – stranded regions.

RNA molecules are of **three types** :

- **m RNA** (messenger RNA) – carries message in the form of codons from DNA
- **r RNA** (ribosomal RNA) – creates site where protein synthesis takes place
- **t RNA** (transfer RNA) - specific t RNA with specific anticodon carries amino acid