NUCLEIC ACIDS

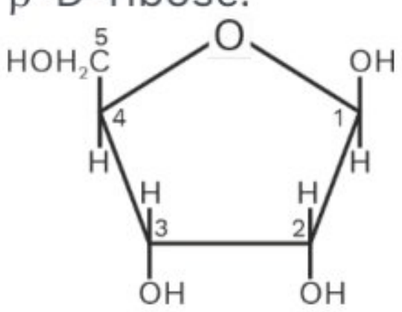
- For each and every species, every generation resembles its ancestors in many ways.
- For this transmission of inherent characters nucleus of a living cell is responsible, which is also termed as heredity.
- Chromosomes are particles made up of proteins and another type of biomolecules called nucleic acids and present in the nucleus of the cell is responsible for heredity.
- Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are two types of nucleic acids. They are also called polynucleotides as they are long chain polymers of nucleotide.
- Nucleic acids contain the elements nitrogen, carbon, oxygen, phosphorus and hydrogen.

Chemical Composition of Nucleic Acids

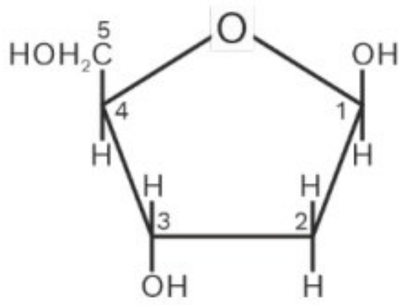
- The Complete hydrolysis of DNA (or RNA) yields a pentose sugar, phosphoric acid and nitrogen containing heterocyclic compounds (called bases).

Pentose Sugar

- In DNA molecules, the sugar moiety is β-D-2-deoxyribose whereas in RNA molecule, it is β-D-ribose.



β-D-ribose



β-D-2-deoxyribose

Bases

- The bases that occur in nucleic acids are derivatives of pyrimidine and purine.

Concept Ladder

Nucleic acids play an essential role in transmission of the hereditary characteristics and in the biosynthesis of proteins.

Rack your Brain

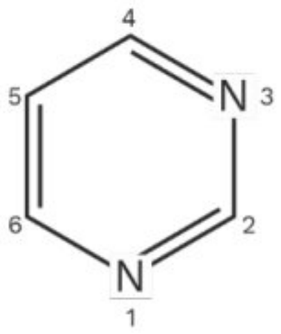
What are the main function of DNA and RNA in organisms?

Previous Year's Questions

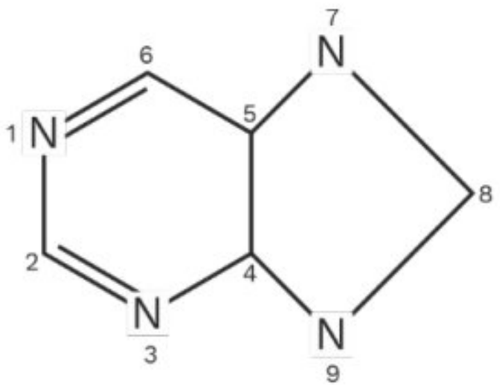
Deficiency of vitamin B_1 causes the disease

[AIPMT-2012]

(1) Convulsions (2) Beri-Beri
(3) Cheilosis (4) Sterility

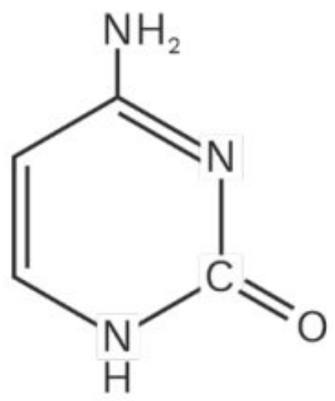


Pyrimidine

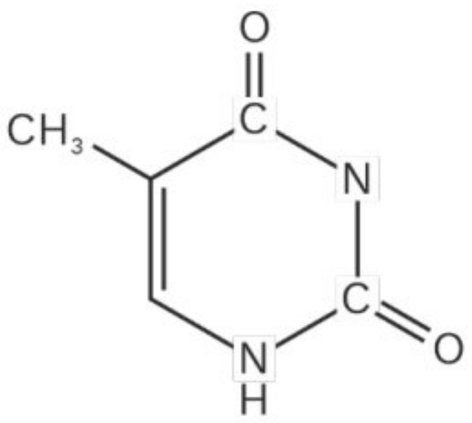


Purine

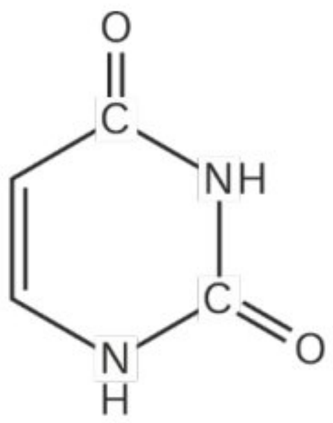
- Pyrimidine bases are uracil, thymine and cytosine.



Cytosine (C)

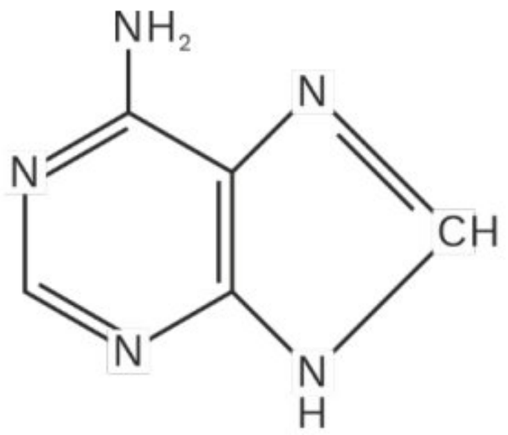


Thymine (T)

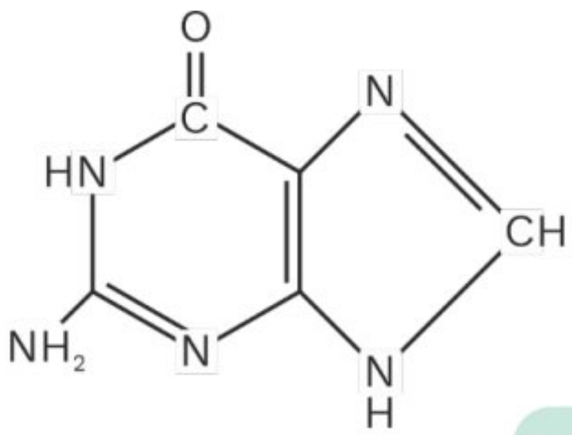


Uracil (U)

- The purine bases found in nucleic acids are adenine and guanine.



Adenine (A)



Guanine (G)

- DNA contains 4 bases viz. adenine (A), guanine (G), cytosine (C) and thymine (T).
- RNA also contains 4 bases, the first 3 bases (adenine (A), guanine (G), cytosine (C)) are same as in DNA but the fourth one is uracil (U).

Previous Year's Questions

In DNA, the linkages between different nitrogenous bases are **[NEET-2013]**

(1) Phosphate linkage
(2) H-bonding
(3) Glycosidic linkage
(4) Peptide linkage

Chargaff Rule

- In 1955 Erwin Chargaff given the Chargaff Rule. The rule states that 'For any given species in DNA, the ratio of adenine to thymine is equal to the ratio of cytosine to guanine. The ratio is termed as Chargaff's ratio.
- This rule was important for solving the structure of DNA.
- Chargaff's rule, [A] + [G] = [C] + [T]
- DNA from any species of any organism should have a 1:1 stoichiometric ratio of purine and pyrimidine bases.

Rack your Brain

What is the chargaff rule and why it is important?

Structure of Nucleic Acids

Nucleoside

- Nucleoside is a unit formed by the attachment of a base to 1 position of sugar.
  Sugar + Base = Nucleoside
- In nucleosides, for distinguish between bases from it, the sugar carbons are numbered as 1, 2, 3 etc.

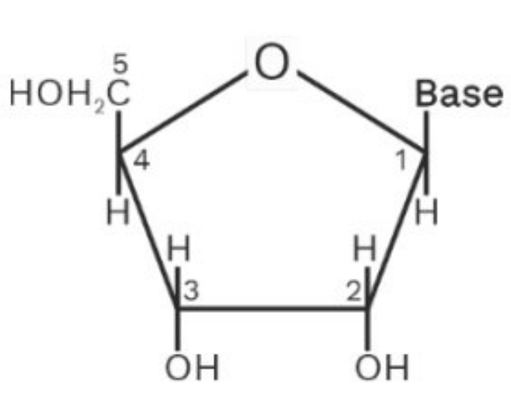
Previous Year's Questions

in DNA, the linkages between different nitrogenous bases are **[NEET-2013]**

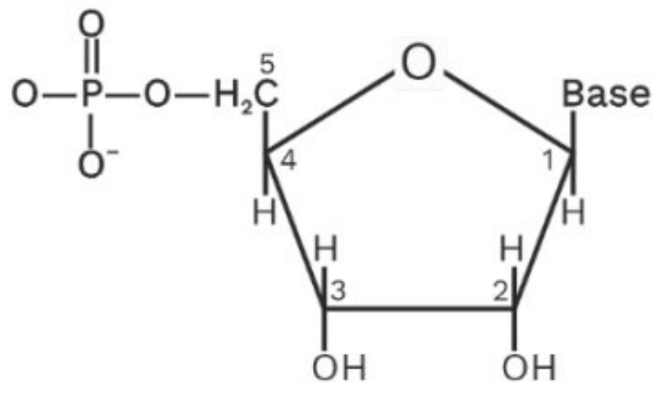
(1) phosphate linkage
(2) H-bonding
(3) glycosidic linkage
(4) peptide linkage

Nucleotide

- A nucleotide unit formed by the attachment of a base 1 position of sugar and attachment of phosphoric acid with 5 position of sugar.
  Sugar + Base + Phosphoric acid = Nucleotide

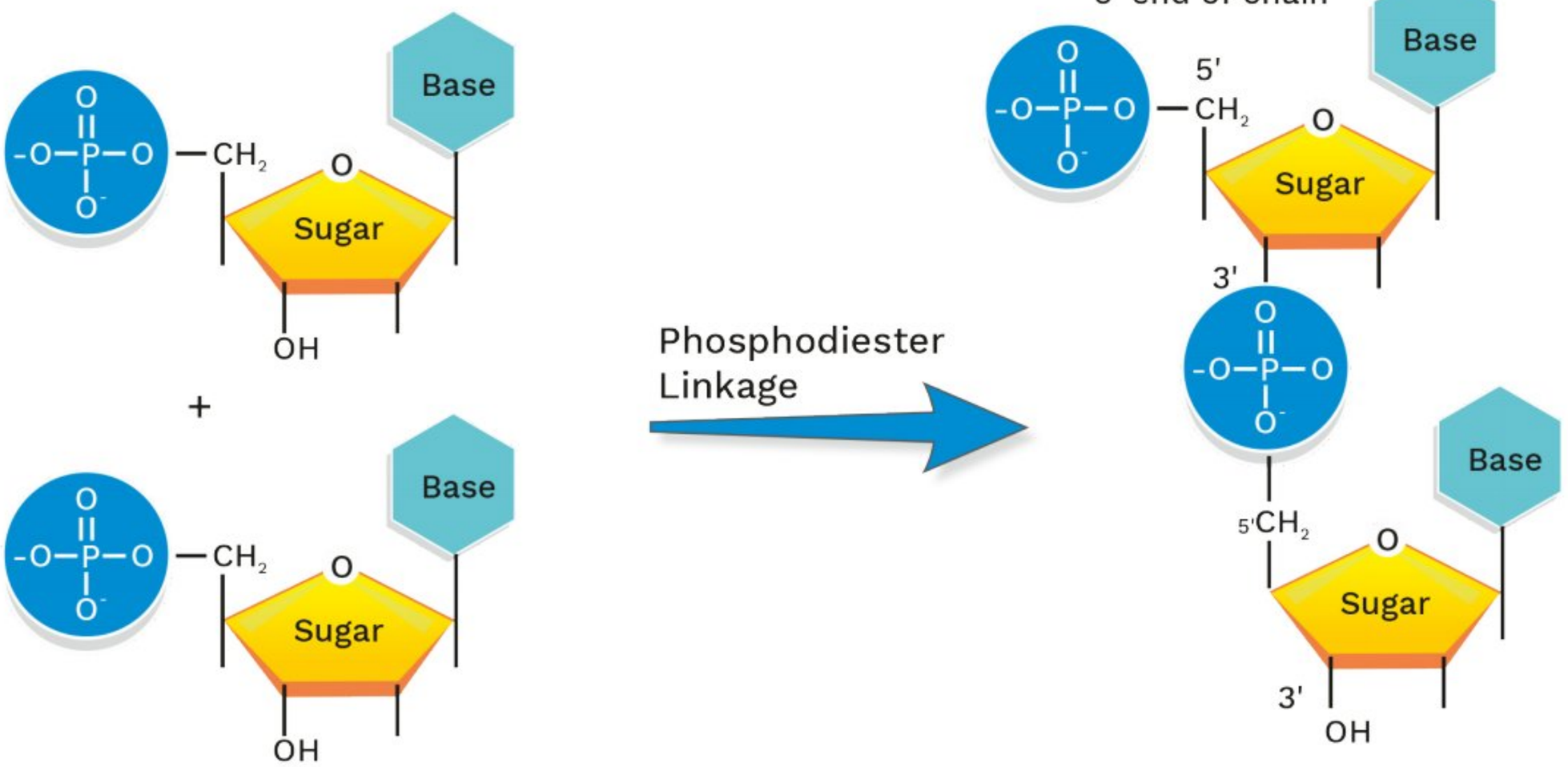


Nucleoside

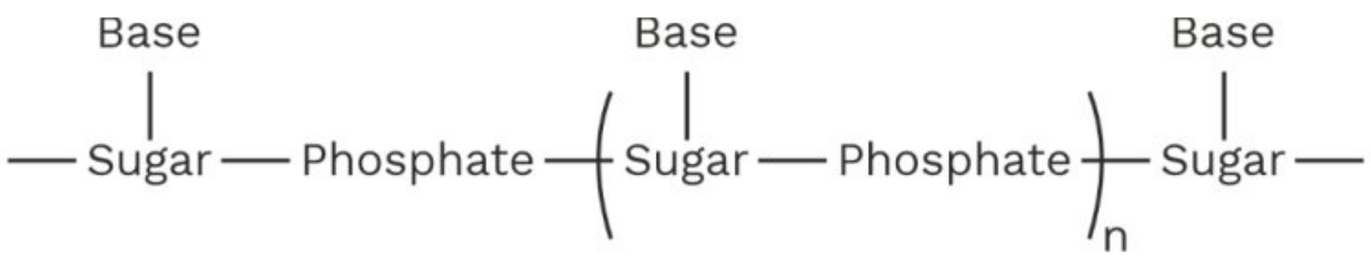


Nucleotide

- By phosphodiester linkage between 5 and 3 carbon atoms of the pentose sugar, nucleotides are joined together. The formation of a typical dinucleotide.



- A simplified version f nucleic acid chain is as shown below.



Double strand helix structure for DNA

- The sequence of bases along the DNA or RNA chain shows primary structures of these and it controls the specific properties of nucleic acids.
- An RNA molecule is usually a single chain of ribose containing nucleotides.
- DNA consists of 2 long strands of polynucleotides coiled around each other in the form of a double helix (Watson and Crick model) ladder like structure joint together by hydrogen bonding.
- Here, hydrogen bonding is in between the nitrogenous base molecules of the nucleotide monomer. Adenine with thymine forms two

Previous Year's Questions

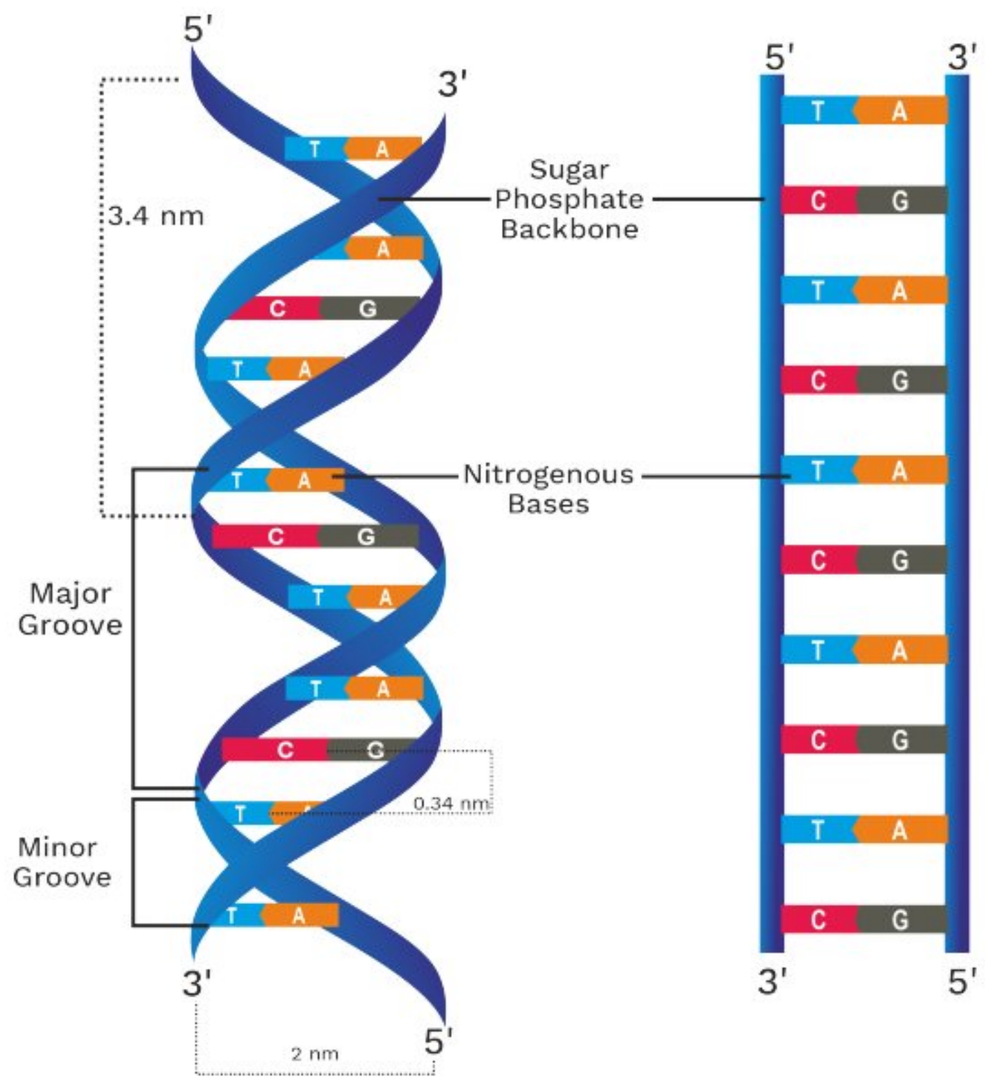
Which of the following is correct about H-bonding in nucleotide?

[AIPMT]

(1) A-T, G-C (2) A-G, T-C
(3) G-T, A-C (4) A-A, T-T

hydrogen bonds while guanine forms three hydrogen bonds with cytosine.

- Thymine combines only with deoxyribose sugar while uracil combines with only ribose sugar.



Rack your Brain

What type of linkage holds together the monomers of DNA?

Concept Ladder

Mutation is sudden change in base sequence of DNA due to radiations or chemicals.

Ribonucleic Acid (RNA)

- RNA single stranded helics is present which sometimes foldsback on itself.
- Its molecules are of 3 types and all three of them performs different functions.
- They are named as ribosomal RNA (r-RNA), messenger RNA (m-RNA), and transfer RNA (t-RNA).

Central Dogma

- Central Dogma was first proposed in 1958 by Francis Crick, discoverer of the structure of DNA.
- Transcription, Translation and Replication are the 3 main processes used by all cells

Previous Year's Questions

The central dogma of molecular genetics states that the genetic information flows from

[NEET-2016]

(1) Amino acids → Proteins

→ DNA

(2) DNA → Carbohydrates → Proteins

(3) DNA → RNA → Proteins

(4) DNA → RNA → Carbohydrates

for maitaining their genetic information and also for converting the genetic information encoded in DNA into gene products, which are either proteins or RNA, depending on the gene.

Definition

A sequence of bases on DNA is also unique for a person and information regarding this is called DNA fingerprinting.

Difference Between DNA and RNA

S.No.	Deoxyribonucleic Acid (DNA)	Ribonucleic Acid (RNA)
(i)	DNA occurs n the nucleus of the cell.	RNA occurs in the cytoplasm of the cell.
(ii)	The sugar present in DNA is D-(–)-2-deoxyribose.	The sugar present in RNA is D-(–)-ribose.
(iii)	DNA contains cytosine and thymine as pyrimidine bases and guanine and adenine as purine bases.	RNA contains cytosine and uracil as pyrimidine bases and guanine and adenine as purine bases.
(iv)	DNA has double-standard a-helix structure.	RNA has single standard a-helix structure.
(v)	DNA undergoes replication.	RNA usually does undergo replication.
(vi)	DNA controls the transmission of hereditary effects.	RNA controls the synthesis of proteins.

DNA Fingerprinting

- For cracking the genetic code Dr. Khorana, Marshall Nirenberg and Robert Holley won the Nobel Prize for Medicine and Physiology in 1968.