The DNA & RNA World

1 Mark Questions

1.What will happen if DNA replication is hot followed by cell division in a eukaryotic cell? [All India 2014 c]

Ans.If cell division is not followed after DNA replication then replicated chromosomes (DNA) would not be distributed to daughter nuclei. A repeated replication of DNA without any cell division results in the accumulation of DNA inside the cell.
This would increase the volume of the cell nucleus, thereby causing cell expansion,

2.Name the specific components and the linkage between them that form deoxyadenosine. [Delhi 2013c]

Ans.Adenine (N-glycosidic Linkage) + Deoxyribose -> Deoxyadenosine

3.Which one out of rho factor and sigma factor act as an initiation factor during transcription in a prokaryote? [Delhi 2013 C]

Ans.Sigma factor acts as an initiation factor during transcription in prokaryotes

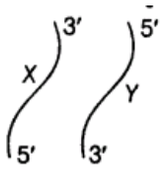
4.Name the enzyme involved in continuous replication of DNA strand. Mention the polarity of the template strand. [All India 2012]

Ans.Enzyme involved in continuous replication of DNA strand is DNA polymerase. Template strand has 3′->5′ polarity

5.Name the positively charged protein around which the negatively charged DNA wrapped.[All India 2012 C]

Ans. Histones are the positively charged proteins around which the negatively charged DNA wrapped.

6.A structural gene has two DNA strands X and Y shown below. Identify the template strand. [HOTS; All India 2010 C]



Ans.'X' is template strand. It is because the template strand has the polarity in 3′ -> 5′ direction.

7.Why is hnRNA required to undergo splicing? [HOTS; Delhi 2009]

Ans.hnRNA is required to undergo splicing because of the introns (the non-coding sequences). These are needed to be removed and the exons (the coding sequences) have to be joined in a specific sequence.

8.Mention the two additional processes, which hnRNA needs to undergo after splicing so, as to become functional. [Delhi 2009]

Ans.The additional processes bnRNA needs to undergo after splicing are capping and tailing.

9.When and at what end does the tailing of hnRNA takes place?[All India 2009]

Ans.When hnRNA is processed to make mRNA, tailing takes place at the 3′-end.

10.At which ends do capping and tailing of hnRNA occur respectively? [Foreign 2009]

Ans.Capping – At 5′-end Tailing -At 3′-end

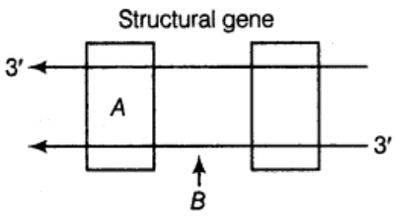
11.How is the length of DNA usually Calculated? [All India 2009 C]

Ans.Length of DNA can be calculated by simply multiplying the total number of base pair with distance between two consecutive bp,

i.e.6.6x 10^9bpx 0.34x 10^{-9}m/bp.

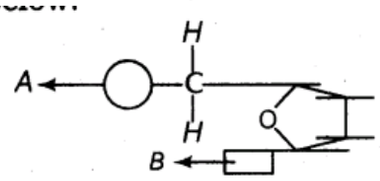
It comes about 2.2 m. (0.34 x 10^{-9} m is the distance between two consecutive base pairs)

12.Name the parts A and B of the transcription unvit given below.



Ans.A -Promoter, 8-Coding strand.

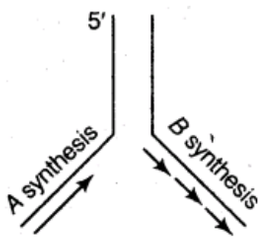
13.Name the components A and B in the nucleotide with a purine, given below.



[Delhi 2008; Foreign 2008]

Ans.A – Phosphate B-Any nitrogenous base (e.g. adenine, guanine, cytosine or thymine).

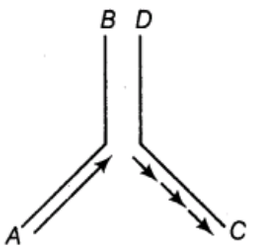
14.Name the type of synthesis A and B occurring in the replication fork of DNA as shown below. [Delhi 2008]



Ans.A – Continuous synthesis (Leading strand) B – Discontinuous synthesis (Lagging strand)

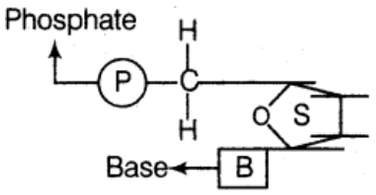
15.Mention the polarity of the DNA strands A-B and C – D shown in the replicating fork given below.

[Ail India 2008]



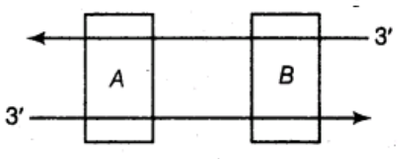
Ans. A – B = 3′ -> 5′ C – D = 5′ -> 3′

16.Mention the carbon positions to which nitrogenous base and the phosphate molecule are respectively linked in the nucleotide given below. [All India 2008]



Ans.Nitrogenous base at first C Phosphate molecule at 5thC

17.What are A and B in the transcription unit represented below?[Foreign 2008]



Ans.A – Promoter B – Terminator

2 Marks Questions

18.Explain the two factors responsible for conferring stability to double helix structure of DNA. [All India 2014]

Ans.Two factors responsible for conferring stability to double helix structure of DNA are

(i) Stacking of one base pair over other.

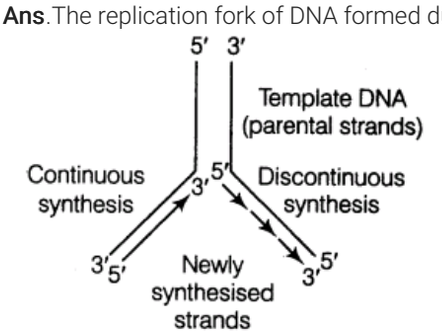
(ii) H-bond between nitrogenous base

19.State the difference between the structural genes in a transcription unit of prokaryotes and eukaryotes. [All India 2014]

Ans. Prokaryotic structural genes are found continuously with any non-coding region, while eukaryotic structural genes are divided into exons (coding DNA) and introns (non-coding DNA).

20.Show DNA replication with the help of a diagram only.[All India 2014 C; Delhi 2012]

Ans.The replication fork of DNA formed during DNA replication.



21.A template strand is given below. Write down the corresponding coding strand and the m-RNA strand that can be formed, along with their polarity.

3′ ATGCATGCATGCATGCATGCATGC 5′ [Foreign; 2014]

Ans.For the given template strand

3′ATGCATGCATGCATGCATGC A T G C 5′

Coding strand is

5′TACGTACGTACGTACGTACG T A C G 3′

And mRNA strand is

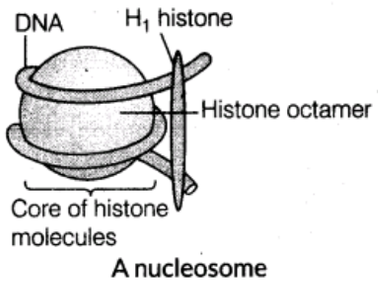
5′UACGUACGUACGUACGUA C G UA C G 3′

22.Draw a labelled diagram of a nucleosome. Where is it found in a Cell? [Foreign 2014, All India 2012]

or

How do histones acquire positive charge? [Delhi 2011]

Ans.Structure of a nucleosome

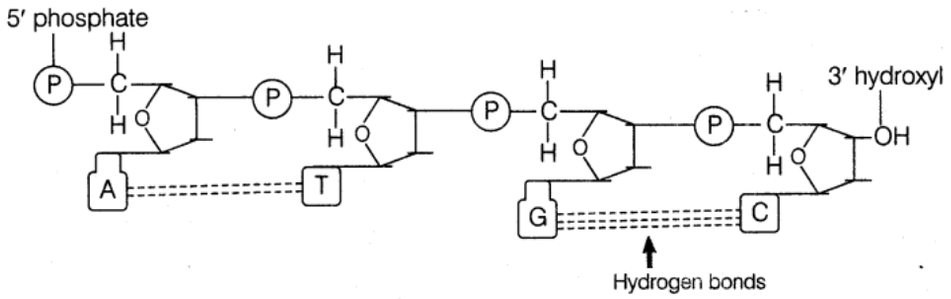


A nucleosome

A nucleosome is found in the nucleus of the cell. It contains histone proteins acquiring positive charge depending upon the abundance of amino acid residues, i.e. lysine and arginines, with charged side chains. Both these amino acids carry positive charges in their side chains.

23.Draw a schematic diagram of a part of double stranded dinucleotide DNA chain having all the four nitrogenous bases showing the correct polarity. [Delhi 2012]

Ans. Schematic diagram of a double stranded dinucleotide DNA chain having all the four nitrogenous bases (A,T,G,C) with polarity



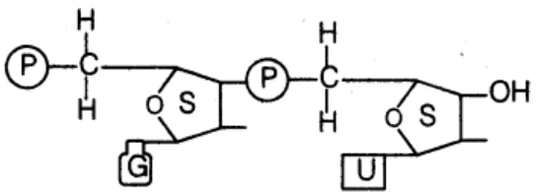
Double-stranded dinucleotide DNA

24.State the dual role of deoxyribonucleoside triphosphates during DNA replication. [Delhi 2011]

Ans. (i)The deoxyribonucleoside triphosphates are the building blocks for the DNA strand (polynucleotide chain) i.e. they act as substrates.

(ii) These also serve as energy source in the form of ATP and GTP.

25.Answer the questions based on the dinucleotide shown below



(i)Name the type of sugar guanine base is attached to.

(ii)Name the linkage connecting the two nucleotides.

(iii)Identify the 3′ end of the dinucleotide. Give a reason for your answer. [All India 2010c]

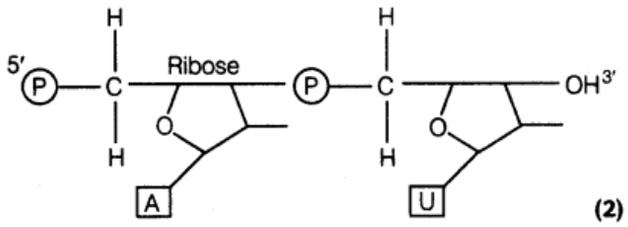
Ans.(i)Pentose sugar or deoxyribose sugar.

(ii) Two nucleotides are linked through 3′-5′ phosphodiester linkage to form a dinucleotide.

(iii) The polymer ribose has a free 3′ — OH group which is referred to as 3′ – end of the polynucleotide chain.

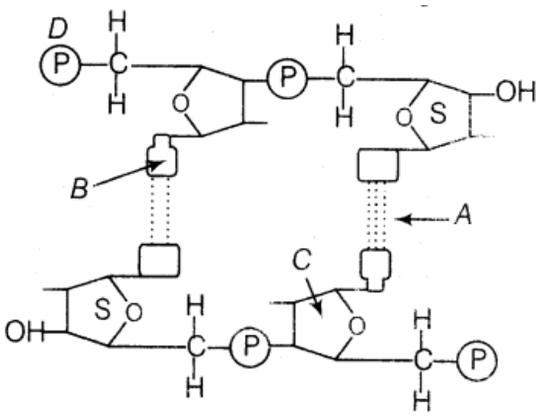
26.Make a labelled diagram of an RNA dinucleotide showing its 3′ ->5′ polarity. [All India 2010 c]

Ans.RNA dinucleotide.



(2)

27.Study the given portion of double stranded polynucleotide chain carefully. Identify A, B, C and the 5′ end of the chain. [All India 2009]



Ans.A – hydrogen bonds, B – purine base,
C – pentose (deoxyribose) sugar, **D – 5′** end.

28.Differentiate between a template strand and a coding strand of DNA.[Foreign 2009]

Ans.Differences between template strand and coding strand of DNA are:

Template strand	Coding strand
It is a DNA strand with 3′→5′polarity.	DNA strand with 5′→3′ polarity.
Acts as template for transcription and codes for RNA.	Does not code for any region of RNA during transcription.

29.Give one function each of histone protein and non-histone chromosomal protein in an eukaryotic nucleus,[All India 2009 C]

Ans.(i)**Histone proteins** help in packaging of DNA. These are organised to form a unit of eight molecules called as histone octamer. The negatively charged DNA is wrapped around the positively charged histone octamer to from a structure called nucleosome.
(ii) **Non-histone chromosomal proteins** helps in packaging of chromatin at higher levels.

30.

(i) A —(DNA $\xrightarrow{B}$ mRNA $\xrightarrow{C}$ Protein

Look at the above sequence and mention the event A,B and C
(ii)What does central dogma state in molecular biology? How does it differ in some viruses? [Delhi 2009 c]

Ans.(i) A – Replication of DNA B – Transcription C – Translation
(ii) Central dogma states that the genetic information flows from DNA to RNA to Proteins. In some viruses the flow of information is reverse in direction, i.e. RNA to DNA.

31.Compare the roles of the enzymes DNA polymerase and DNA ligase in the replication fork of DNA.[All India 2008 C]

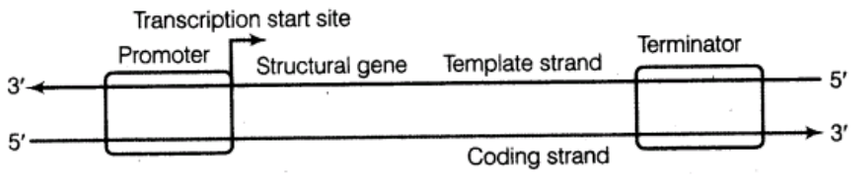
Ans. Differences between the roles of DNA polymerase and DNA ligase are:

DNA Polymerase	DNA Ligase
It is the main enzyme in the replication of DNA.	It is an additional enzyme in replication.
It uses a DNA template to catalyse the polymerisation of deoxynucleotides only, in one direction, i.e. 5′→3′, leading to one strand replication continuous and the other one as discontinuous.	DNA ligase joins the fragments of strand later which are discontinuously synthesised.

3 Marks Questions

32.With the help of a schematic diagram , explain the location and role of the following in a transcription unit.Promoter structural gene, terminator[All India 2014 c]

Ans.**Structure of a transcription unit**



The promoter and terminator flank the structural gene in a transcription unit. The promoter is located towards 5′-end (upstream) of the structural gene. The terminator is located toward 3′-end (downstream) of the coding strand and it usually defines the end of the process of transcription

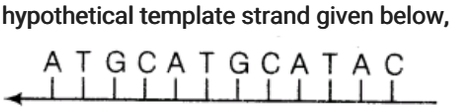
33.(i) What are the transcriptional products of RNA polymerase III?
(ii)Differentiate between'capping' and 'tailing'.
(iii)Expand ZmRNA. [All India 2014C]

Ans.(i)RNA polymerase III is responsible for transcription of tRNA, 55 rRNA and snRNAs (small nuclear RNAs).(ii) In capping process, an unusual nucleotide (methyl guanosine triphosphate) is added to 5′-end ofbnRNA.In tailing process, 200-300 adenylate residues are added at 3′-end in a template independent manner. It is now called as mRNA
(iii)**hn** RNA is heterogenous nuclear RNA.

34.It is established that RNA is the first genetic material. Explain giving three reasons [Delhi 2012,2008 C]

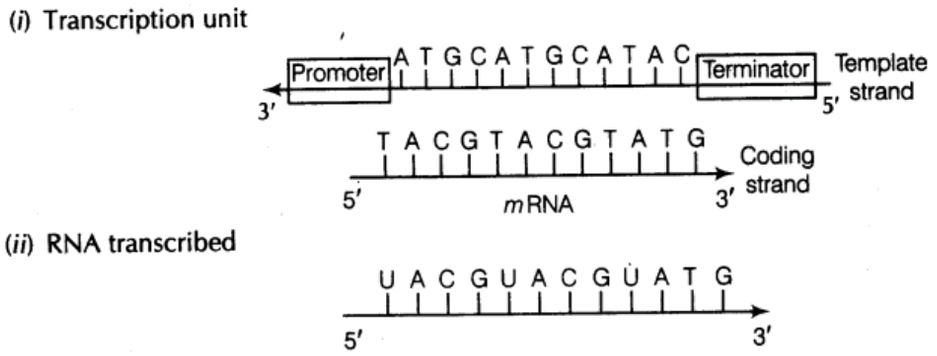
Ans.RNA is the first genetic material in cells because
(i) RNA is capable of both storing genetic information and catalysing chemical reactions.
(ii) Essential life processes (such as metabolism, translation, splicing, etc.), were evolved around RNA.
(iii) It shows the power of self-replication.

35.(i) Construct a complete transcription unit with promoter and terminator on the basis of hypothetical template strand given below,



(ii)Write the RNA strand transcribed from the above transcription unit along with its polarity. [Delhi 2012]

Ans.



36.List the salient features of double helix structure of DNA.[All India 2012]

Ans.Salient features of DNA double helix

(i) It is made up of two polynucleotide chains containing the backbone of sugar- phosphate and the bases project inside.

(ii) The two chains have anti-parallel polarity one of them is 5′-»3′, the other has 3′-* 5′ polarity.

(iii) The bases in two strands are paired through hydrogen bond (H—bonds) forming base pairs (bp). Adenine pairs through two hydrogen bonds with thymine from opposite strand and vice-versa. In the same way, guanine is bonded with cytosine through three H—bonds. Due to which, purine always comes opposite to a pyrimidine.

(iv)The two chains are coiled in a right-handed fashion. The pitch of the helix is 3.4 nm and there are roughly 10 bp in each turn. Consequently, the distance between base pair in a helix is about 0.34 nm.

(v)The plane of one base pair stacks over the other in double helix. This confers stability to the helical structure

37.How is hit RNA processed to form mRNA? [Foreign 2012,2008]

Ans.The precursor of mRNA transcribed by RNA polymerase II is called heterogenous nuclear RNA (hnRNA). It undergoes following changes:

(i) Splicing In this process, the non-coding introns are removed and coding sequences called exons are joined in a definite order. This is required because primary transcript contain introns and exons. (ii) Capping RNA polymerase III is responsible for transcription of tRNA, 55 rRNA and snRNAs (small nuclear RNAs).

(a) In capping process, an unusual nucleotide (methyl guanosine triphosphate) is added to 5′-end ofbnRNA.In tailing process, 200-300 adenylate residues are added at 3′-end in a template independent manner. It is now called as mRNA

(b)**hn** RNA is heterogenous nuclear RNA.

(iii) Tailing RNA polymerase III is responsible for transcription of tRNA, 55 rRNA and snRNAs (small nuclear RNAs).

(a) In capping process, an unusual nucleotide (methyl guanosine triphosphate) is added to 5′-end ofbnRNA.In tailing process, 200-300 adenylate residues are added at 3′-end in a template independent manner. It is now called as mRNA

(b)hn RNA is heterogenous nuclear RNA.

(iv) The fully processed mRNA is released from the nucleus into cytoplasm for translation.

38.Why is DNA considered a better hereditary material than RNA?[Foreign 2012]

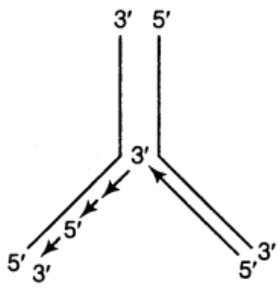
Ans.DNA is considered as a better genetic material because it is stable and does not change with age or change in physiology due to its double-stranded nature and presence of thymine.RNA is not considered as a better genetic material because

(i)2—-OH group of RNA nucleotide is a reactive group that make RNA labile and easily degradable.

(ii) RNA (23S r-RNA) is catalytic, i.e. it is reactive.

39.The base sequence in one of the strands of DNA is TAGCATGAT.
(i) Give the base sequence of the complementary strand.
(ii)How are these base pairs held together in a DNA molecule?
(iii)Explain the base complementarity rule. Name the scientist who framed this rule[Hots;Delhi 2011]
Ans.(i)ATCGTACTA
(ii) Base pairs are held together by weak hydrogen bonds, adenine pairs with thymine by two H —bonds and guanine pairs with cytosine forming three H—bonds.
(iii) Base complementarity rule For a double-stranded DNA, the ratios between adenine and thymine and guanine and cytosine are constant and equal to one. Erwin Chargaff framed this rule.

40.Why do you see two different types of replicating strands in the givenDNA replication fork? Explain.Name these strands, [hots; Delhi 2011]



Ans.Two different types of parent strands function as template strands.
On the template strand with 3′ ->5′ polarity, the new strand is synthesised as a continuous strand. The enzyme DNA polymerase can carry out polymerisation of the nucleotides only in 5′ -» 3′ direction. This is called continuous synthesis and the strand is called leading strand.
On the other template strand with 5′ -> 3′ polarity, the new strand is synthesised from the point of replication fork, also in 5′ -> 3′ direction. But, in short stretches, they are later joined by DNA ligases to form a strand, called lagging strand.

41.(i)Name the enzyme that catalyses the transcription of hnRNA.
(ii) Why does the hnRNA needs to undergo changes? List the changes hnRNA undergoes and
1 where in the cell such changes take place. [HOTS; All India 2011]
Ans.(i) RNA polymerase II catalyses the transcription of hnRNA.
(ii) hnRNA undergoes changes because it contains introns and exons and is non-functional.
Changes in hnRNA are:
The precursor of mRNA transcribed by RNA polymerase II is called heterogenous nuclear RNA (hnRNA). It undergoes following changes:
(i) Splicing In this process, the non-coding introns are removed and coding sequences called exons are joined in a definite order. This is required because primary transcript contain introns and exons. (ii) Capping RNA polymerase III is responsible for transcription of tRNA, 55 rRNA and snRNAs (small nuclear RNAs).
(a) In capping process, an unusual nucleotide (methyl guanosine triphosphate) is added to 5′-end ofbnRNA.In tailing process, 200-300 adenylate residues are added at 3′-end in a template independent manner. It is now called as mRNA
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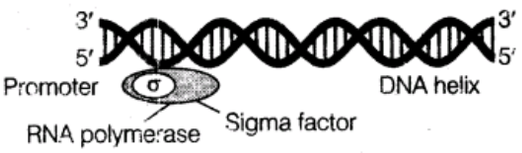
(b)hn RNA is heterogenous nuclear RNA.

(iv) The fully processed mRNA is released from the nucleus into cytoplasm for translation.

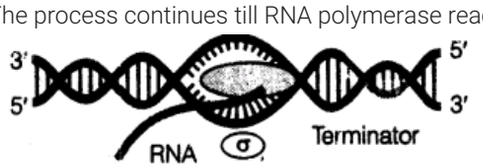
42.Answer the following questions based on Meselson and Stahl's experiment.
(i) Write the name of the chemical substance used as a source of nitrogen in the experiment by them.
(ii) Why did the scientists synthesise the light and the heavy DNA molecules in the organism used in the experiment?
(iii) How did the scientists make it possible to distinguish the heavy DNA molecule from the light DNA molecule? Explain.
(iv) Write the conclusion the scientists arrived at, after completing the experiment. [All India 2011]
Ans.(i)NH_4Cl (Ammonium chloride).
(ii) It is to show that after one generation **E.coli** with ^{15}N-DNA in a medium of ^{14}N, has DNA of intermediate density between the light and heavy DNAs. It shows that of the two strands, only one strand is synthesised newly, using the ^{14}N-nitrogen source in the medium.
(iii)The heavy and light DMA molecules can be differentiated by centrifugation in a cesium chloride (CsCI) density gradient. The ^{15}N-DNA was heavier than ^{14}N -DNA and the hybrid ^{15}N – ^{14}N -DNA was intermediate between the two.
(iv)Scientists concluded that the DNA replication is semiconservative, i.e. of the two strands of DNA, one is the parental strand while the other is newly synthesised.

43. Describe the initiation process of transcription in bacteria. [Delhi 2010]
Ans.Initiation process of transcription in bacteria RNA polymerase becomes associated transiently to an initiation factor (o) **and** binds to specific sequence on DNA **called** promoter to initiate transcription (initiation).



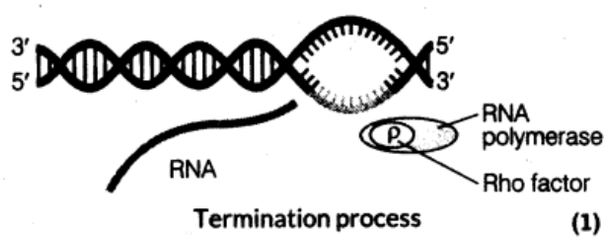
Initiation process

44. Describe the elongation process of transcription in bacteria. [Delhi 2010]
Ans.Elongation process of transcription in bacteria RNA polymerase facilitates opening of the DNA helix after binding to promoter it uses nucleoside triphosphates as substrate and polymerises the nucleotides in a template dependent fashion following complementarity.
The process continues till RNA polymerase reaches the terminator region on the DNA strand.



Elongation process (1)

45.Describe the termination process of transcription in bacteria. [Delhi 2010]
Ans.Termination occurs when RNA polymerase reaches the terminator region and the nascent RN A falls off. The RNA polymerase becomes transiently associated with termination factor (p) and falls off the transcription unit



Termination process (1)

46.In a series of experiments with Streptococcus and mice, F Griffith concluded that R-strain bacteria had been transformed. Explain.[All India 2010]

Ans.F Griffith's Experiment

(i) The two strains of bacterium Streptococcus pneumoniae (causing pneumonia) one forming smooth colonies with capsule (S-type) and the other forming rough colonies without capsule (R-type) were taken for the experiment.

(ii) The S-type cells were virulent and R-types were not virulent.

(iii) When live S-type cells were injected into the mice, they died.

(iv) When live R-type cells were injected into mice, they did not show pneumonia.

S-strain —– > Injected into mice ———- >Mice died

R-strain —– > Injected into mice ———- >Mice lived

(v)When S-strain bacteria were killed by heating and injected into the mice, they did not develop disease.

S-strain —– > (heat-killed) —– > Injected into mice—-> Mice lived

(vi)When a mixture of heat-killed S-type cells and live R-cells were injected into the mice, the mice died of pneumonia.

(vii)Griffith recovered living S-strain cells from the dead mice..

(viii) According to him, R-strain bacteria had somehow been transformed by the heat-killed S-strain bacteria. This may be due to some transforming principle. A factor may be transferred from the heat-killed S-strain, which enabled the R-strain to synthesise a smooth capsule and become virulent.

(ix) This transforming principle must be the genetic material.

47.Draw a schematic representation of a dinucleotide. Label the following.

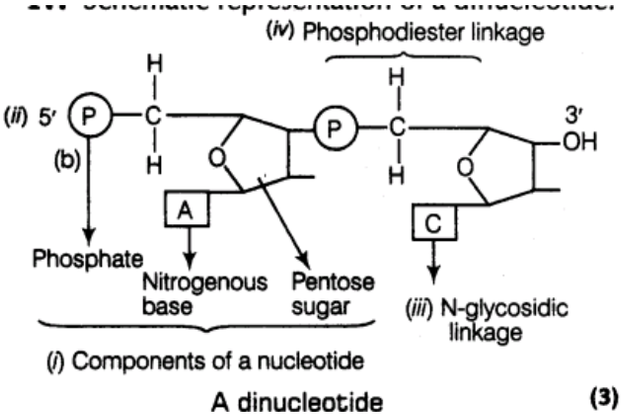
(i)The component of a nucleotide

(ii)5′ end

(iii)N-glycosidic linkage

(iv)Phosphodiester linkage[Foreign 2010]

Ans. Schematic representation of a dinucleotide.



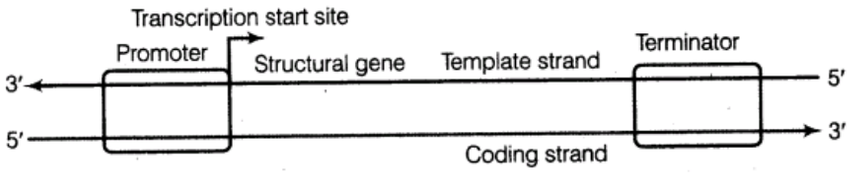
A dinucleotide (3)

48.(i) Draw a schematic representation of transcription unit showing the polarity of both the strands. Label the promoter gene and the template strand.

(ii)Mention the condition when template strand becomes coding strand.

(iii)Give the function of the promoter gene. [All India 2009 C]

Ans.(i)Structure of a transcription unit



The promoter and terminator flank the structural gene in a transcription unit. The promoter is located towards 5′-end (upstream) of the structural gene. The terminator is located toward 3′-end (downstream) of the coding strand and it usually defines the end of the process of transcription

(ii) The two strands in DNA have opposite polarity and the DNA-dependent RNA polymerase catalyses the polymerisationin only one direction, i.e. 5′-> 3′. The strand that has the polarity 3′-> 5′ acts as a template, called as template strand. The other strand which has the polarity (5′-» 3′) and the sequence same as RNA I (except thymine in place of uracil), is displaced during transcription. This strand which does not code for anything) is . called coding strand.

(iii) The promoter gene defines the template and coding strands. By switching its position with terminator, the definition of coding and template strands can be reversed

49.(i) Why does DNA replication occur in small replication fork and not in its entire length?
(ii)Why is DNA replication continuous and discontinuous in a replication fork?
(iii)Explain the importance of origin of replication in a replication fork.[HOTS; All India 2009 C]

Ans.(i)Because DNA molecule is very long, so two strands cannot be separated in its entire length, as it requires very high energy. The replication occurs within a small opening of I the helix called as replication fork.

(ii) DNA polymerase can catalyse the polymerisation of nucleotides only in 5′ —> 3′ direction. So, on the template strand with 3′ ->5′ polarity, DNA replication is continuous .On the template strand with 5′-> 3′ polarity, DNA synthesis occurs in short stretches as the opening of replication for,continues. Later, these short stretches are joined by the action of DNA ligases

(iii) Replication of DNA does not initiate randomly, and DNA polymerases on their own cannot initiate replication.So,there is a need of specific sequence can DNA, called origin of replication. DNA polymerase bind to it and continues the process.

50.The length of a DNA molecule in a typical mammalian cell is calculated to be approximately 2.2 m. How is the packaging of this long molecule done to accomodate it within the nucleus of the cell?[Delhi 2009,2008]

Ans.Eukaryotic cells have a set of positively charged basic proteins called histones. They are rich in lysine and arginine. The histones are organised to form a unit of eight molecules called histone octamer. The negatively charged DNA is wrapped around the positively charged histone octamer to form a nucleosome. The nucleosome contains 200 bp of the DNA helix and nucleosomes form the repeating units of a structure of the nucleolus, called chromatin.

5 Marks Questions

51.'DNA replication is semiconservative'. Name the scientists who proposed it and who proved it. How was it proved experimentally?[All India 2014C; Delhi 2008; Foreign 2008]
or
Who proposed that DNA replication is semiconservative? How did Meselson and Stahl prove it.
[Delhi 2008C]
or
Describe Meselson and Stahl's experiment and write the conclusion they arrived at. [Foreign 2014; Delhi 2012]

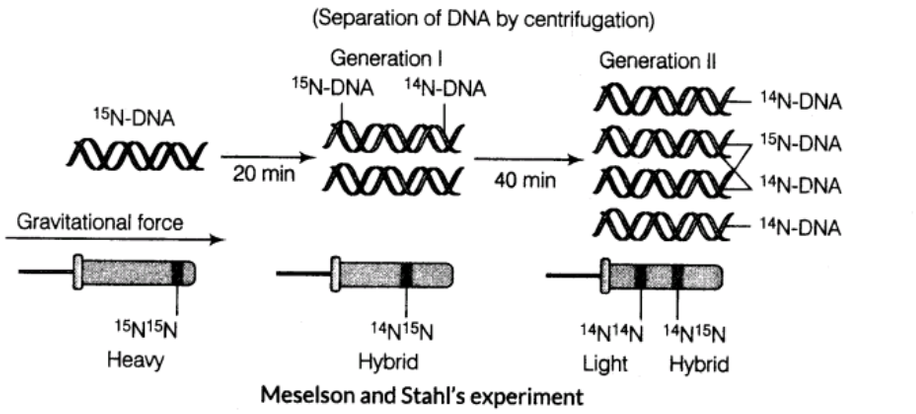
Ans. Watson and Crick proposed that DNA replication is semiconservative. Later in the year 1958, Meselson and Stahl proved this. The semiconservative nature of DNA suggests that, after the completion of replication, each DNA molecule will have one parental and one newly-synthesised strand.

Experimental Proof

(i) E. coli was grown in a medium containing $^{15}NH_4Cl$ (^{15}N is the heavy isotope of nitrogen) as the only nitrogen source for many generations. As a result, ^{15}N was incorporated into the newly-synthesised DNA. This heavy DNA could be distinguished by centrifugation in CsSl density gradient.

(ii) Then, these E. coli cells were transferred to a medium with normal $^{14}NH_4Cl$ and the DNA was extracted as double stranded helix. The various samples were separated on CsCl gradients for measuring the density of DNA (after 20 min).

The hybrid had intermediate density.



Meselson and Stahl's experiment

(iii)After 40 min, the DNA of the second generation was extracted from the $^{14}NH_4Cl$ medium and was found to have equal amounts of hybrid and light DNA.

(iv) This proves that after replication, each DNA molecule has one parental strand and one newly synthesised strand.

52.(i) Describe the various steps of Griffith's experiment that led to the conclusion of the 'transforming principle'.

(ii)How did the chemical nature of the 'transforming principle' get established? [All India 2014]

or

(i)Write the conclusion drawn by Griffith at the end of his experiment with Streptococcus pneumoniae.

(ii)How did O Avery, C MacLeod and M McCarty prove that DNA was the genetic material? Explain.

[All India 2013,2009]

or

Describe Frederick Griffith's experiment on Streptococcus pneumoniae. Discuss the conclusion he arrived at. [All India 2012]

or

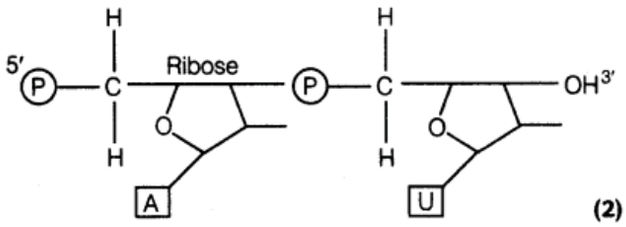
(i)Write the scientific name of the bacterium used by Frederick Griffith in his experiment.

(ii)How did he prove that some transforming principle is responsible for transformation of the non-virulent strains of bacteria into the virulent form?

(iii)State the biochemical nature of the transforming principle.

(iv)Name the scientists who proved it [Foreign 2011,2009,2008;Delhi 2009 C, 2008 C]

Ans.(i)RNA dinucleotide.



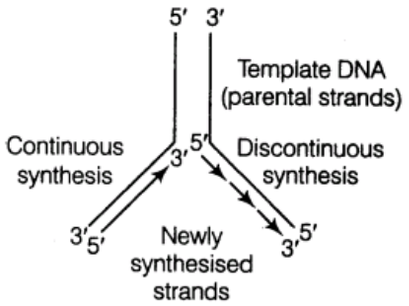
(2)

(ii)**Biochemical nature of transforming principle of Griffith's experiment.**

- Oswald Avery, Colin MacLeod and Maclyn McCarty (1933-44) worked to determine the biochemical nature of transforming principle in Griffith's experiment.
- They purified biochemicals (proteins, DNA, RNA, etc) from the heat-killed S-cel Is to see which ones could transform live R-cells into S-cel Is.
- They discovered that DNA alone from S-bacteria caused R-bacteria to become transformed.
- They also discovered that protein digesting enzymes (proteases) and RNA digesting enzyme (RNAse) did not affect transformation.
- Digestion with DNAase did inhibit transformation. It suggested that the DNA causes the transformation.
- They thus, finally concluded that DNA is the genetic material

53.Describe the Hershey and Chase's experiment. Write the conclusion drawn by the scientists after their experiment. [All India 2014]
or
Name the scientists, who proved experimentally that DNA is the genetic material. Describe their experiment.
or
(i)Describe Hershey and Chase's experiment.
(ii)Write the aim of the experiment. [Delhi 2010 C; All India 2010,2008 C]
Ans.Hershey and Chase's experiment Their experiment is to prove unequivocally that DNA is the genetic material and not the protein .They worked with T_2 bacteriophage, which attacks bacterium E. coli. They grew some viruses on a medium that contained radioactive phosphorus (^{32}P) and some others on medium that contained radioactive sulphur ($^{32}5$).
(i) Radioactive phages were allowed to attack E.coli bacteria. The infection proceeded, the viral coats were removed form the bacteria by agitating them in a blender. The virus particles were separated from the bacteria by spinning them in a centrifuge.
(ii)Bacteria which were infected with viruses that had radioactive DNA were radioactive, indicating that DNA was the material that passed from the virus to the bacteria.
(iii) Bacteria that were infected with viruses that had radioactive proteins were not radioactive. This indicates that proteins did not enter the bacteria from the viruses. Hence, DNA is genetic material that is passed from virus to bacteria.

54.(i) Explain the process of DNA replication with the help of a schematic diagram.
(ii) In which phase of the cell cycle does replication occur in eukaryotes? What would happen if cell division is not followed after DNA replication. [Delhi 2014]
Ans.(i)The replication fork of DNA formed during DNA replication.



(ii)DNA replication occurs in S-phase of cell cycle in eukaryotes. Refer to answer.

55.Name the major types of RNAs and explain their role in the process of protein synthesis in a prokaryote. [Foreign 2014]

Ans.There are major three types of RNAs in prokaryotes which helps in protein synthesis as follows:

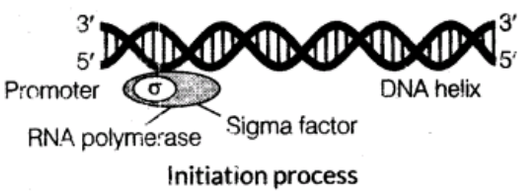
(i) Messenger RNA (mRNA) It is formed as a complementary strand on one of the two strands of DNA inside nucleus. Soon after its formation, mRNA comes out in cytoplasm. Formation of mRNA from DNA is called transcription. Function of mRNA is to carry the genetic information present in DNA (inside nucleus) to cytoplasm for protein synthesis.

(ii) Ribosomal RNA (rRNA) It is formed in nucleolus and it forms 80% of total RNA present inside the cell. It is also the moststable type of RNA. rRNA is associated with structural organisation of ribosomes (rRNA forms about 60% of weight of ribosomes), which are seats of protein synthesis.

(iii) Transfer RNA (tRNA) It is also called soluble RNA (sRNA) or adapter RNA or adaptive RNA. tRNA forms 10-15% of total RNA present in the cell. It acts as adapter molecule which carries amino acids to the site of protein synthesis i (i.e. ribosomes).

56.Describe the process of transcription in bacterium. [All India 2014 C]

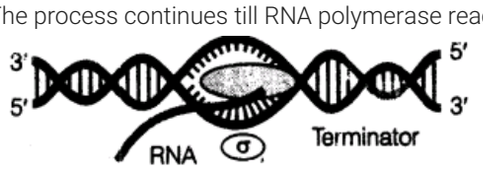
Ans.Initiation process of transcription in bacteria RNA polymerase becomes associated transiently to an initiation factor (o) **and** binds to specific sequence on DNA **called** promoter to initiate transcription (initiation).



Initiation process

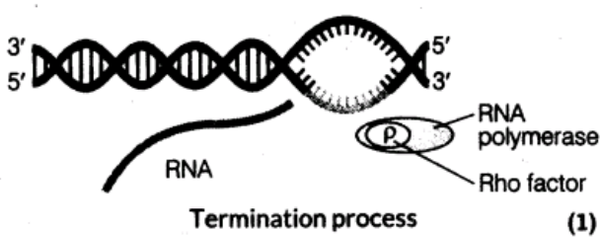
Elongation process of transcription in bacteria RNA polymerase facilitates opening of the DNA helix after binding to promoter it uses nucleoside triphosphates as substrate and polymerises the nucleotides in a template dependent fashion following complementarity.

The process continues till RNA polymerase reaches the terminator region on the DNA strand.



Elongation process (1)

Termination occurs when RNA polymerase reaches the terminator region and the nascent RN A falls off. The RNA polymerase becomes transiently associated with termination factor (p) and falls off the transcription unit



Termination process (1)

57.(i)Explain the role of DNA dependent RNA polymerase in initiation, elongation and termination during transcription in bacterial cell.
(ii) How is transcription a more complex process in eukaryotic cells? Explain. [Foreign 2011]
Ans.(i)Role of DNA dependent RNA polymerase.
(a) RNA polymerase becomes associated transiently with initiation factor and binds to the promoter site on DNA and initiates transcription.
(b) It uses the nucleoside triphosphate as substrates and polymerises them in a template-dependent fashion following the base complementarity rule in the 5′-> 3′direction.
(c) It also facilitates the opening of the DNA helix and continues the elongation process.
(d) When the polymerase falls off a terminator region on the DNA, the nascent RNA separates. This results in termination.
(ii) Reasons that transcription is more complex in eukaryotes are:
(a)The three types of RNA polymerases in ᵀ the nucleus show division of labour

- RNA polymerase I transcribes rRNAs (28S, 18S and 5.8S).
- RNA polymerase II transcribes the precursor of mRNA, called hnRNA
- RNA polymerase III transcribes tRNA, 5 srRNA and snRNAse.

(b)hnRNA contains both coding sequences called exons and non-coding sequences called introns. So, it undergoes a process called splicing, in which the non-coding sequences (introns) are removed and the coding sequences (exons) are joined together in a defined order.
(c)In capping, unusual nucleotide,methyl guanosine triphosphate residues are added at the 5-end of the hnRNA.
(d)In tailing, 200-300 adenylate residues are added at the 3-end of the hnRNA.

58.Study the flow chart given below and answer the questions that follow :

(*i*) S-strain ⟶ into mice ⟶ mice die
(*ii*) R-strain ⟶ into mice ⟶ mice live
(*iii*) Heat killed S-strain + live R-strain ⟶ into mice ⟶ A
(*iv*) Heat killed S-strain + DNase + live R-strain ⟶ into mice ⟶ B

(a)Name the organism and differentiate between, its two strains R and S respectively.
(b)Write the result A and B obtained in step (iii) and (iv) respectively.
(c)Name the scientist who performed the steps (i), (ii) and (iii)
(d)Write the specific conclusion drawn from the step (iv).[Ail India 2010 C]
Ans.(a)The organism is bacterium Streptococcus pneumoniae. Differences between S-type cells and
R-type cells are:

S-type Cells	R-type Cells
They form smooth colonies protected by a capsule	They form rough colonies without a capsule
They are virulent	They are non-virulent

(b) A – Mice died B – Mice lived.

(c)Frederick Griffith performed these steps.

(d)This indicates that DNA is the transforming principle. When DNase is added to the medium, the DNA of the heat killed cells get denatured and is unable to carry transformation.

59.(i)What did Meselson and Stahl observed? When

(a)They cultured coli in a medium containing $^{15}NH_4Cl$ for a few generations and centrifuged the content?

(b)They transferred one such bacterium to the normal medium of NH_4Cl and cultured for two generations.

(ii)What did Meselson and Stahl conclude from his experiment? Explain with the help of diagrams.

(iii)Which is the first genetic material? Give reasons in support of your answer.

[Delhi 2009; Foreign 2009 ;Delhi 2008 C]

Ans.(i) (a)Meselson and Stahl observed that the ^{15}N was incorporated into the newly synthesised strand of DNA and also other nitrogen containing compounds. This heavy DNA could be distinguished from the normal DNA by centrifugation in a cesium chloride (CsCI) density gradient.

(b) DNA from such bacterium had a hybrid or intermediate density, one generation after the transfer from ^{15}N to ^{14}N. After another generation, it is composed of equal amount of this hybrid DNA and of light DNA

(ii)Meselson and Stahl concluded that replication of DNA is semiconservative.

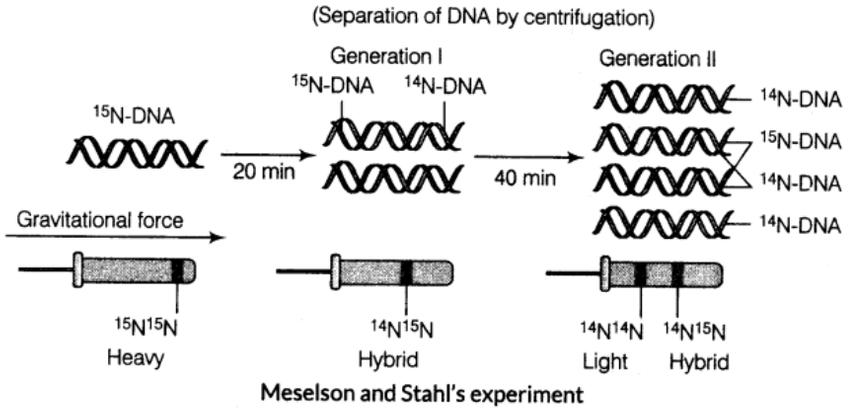
Watson and Crick proposed that DNA replication is semiconservative. Later in the year 1958, Meselson and Stahl proved this. The semiconservative nature of DNA suggests that, after the completion of replication, each DNA molecule will have one parental and one newly-synthesised strand.

Experimental Proof

(i) E. coli was grown in a medium containing $^{15}NH_4Cl$ (^{15}N is the heavy isotope of nitrogen) as the only nitrogen source for many generations. As a result, ^{15}N was incorporated into the newly-synthesised DNA. This heavy DNA could be distinguished by centrifugation in CsSI density gradient.

(ii) Then, these E. coli cells were transferred to a medium with normal $^{14}NH_4Cl$ and the DNA was extracted as double stranded helix. The various samples were separated on CsCI gradients for measuring the density of DNA (after 20 min).

The hybrid had intermediate density.



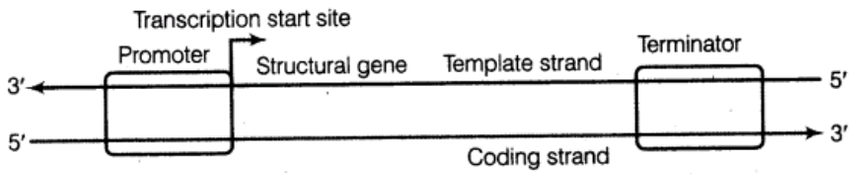
Meselson and Stahl's experiment

(iii)After 40 min, the DNA of the second generation was extracted from the $^{14}NH_4Cl$ medium

and was found to have equal amounts of hybrid and light DNA.
(iv) This proves that after replication, each DNA molecule has one parental strand and one newly synthesised strand.
(iii)RNA is the first genetic material in cells because
(a) RNA is capable of both storing genetic information and catalysing chemical reactions.
(b) Essential life processes (such as metabolism, translation, splicing, etc.), were evolved around RNA.
(c) It shows the power of self-replication.

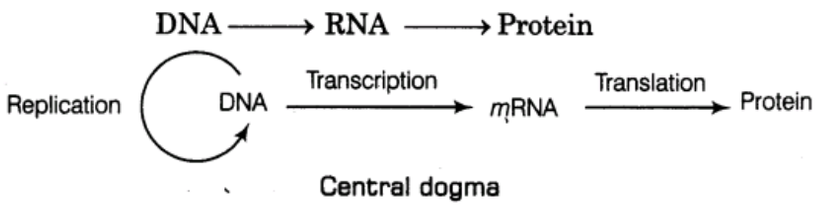
60.Why is DNA molecule more stable genetic material than RNA? Explain. [All India 2008]
Ans.DNA is more stable genetic material because
(i) The 2′— OH group in the nucleotides of RNA is a reactive group and makes RNA labile and easily degradable. But, DNA is chemically less reactive and structurally more stable.
(ii) The presence of thymine in place of uracil also confers more stability to DNA.
(iii)Two strands of DNA are complementary to each other and even if separated by heat, come together, when suitable conditions are created on the other hand, RNA is usually single stranded

61.Draw the labelled schematic structure of a transcription unit. Explain the function of each component of the unit in the process of transcription. [All India 2008]
Ans.Structure of a transcription unit



The promoter and terminator flank the structural gene in a transcription unit. The promoter is located towards 5′-end (upstream) of the structural gene. The terminator is located toward 3′-end (downstream) of the coding strand and it usually defines the end of the process of transcription
Functions of components of transcription unit
(i) **Promoter** (DNA sequence) Provides binding site for the RNA polymerase.
(ii) **Structural genes** Code for enzymes/ proteins and transcribe the mRNA for the same.
(iii)**Terminator** (sequence of bases) Defines the end of transcription process
(iv)DNA strand with 3′ – 5′ polarity – Acts as the template for transcription of mRNA.
(v)DNA strand with 5′ – 3′ polarity – Coding strand; it does not code for RNA, but all reference points regarding transcription are made with this strand

62.(i) State the central dogma in molecular biology. Who proposed it? Is it universally applicable? Explain.
(ii)List any four properties of a molecule to be able to act as a genetic material. [All India 2008 C]
Ans.(i) Francis Crick proposed the central dogma in molecular biology, which states that the genetic information flows from



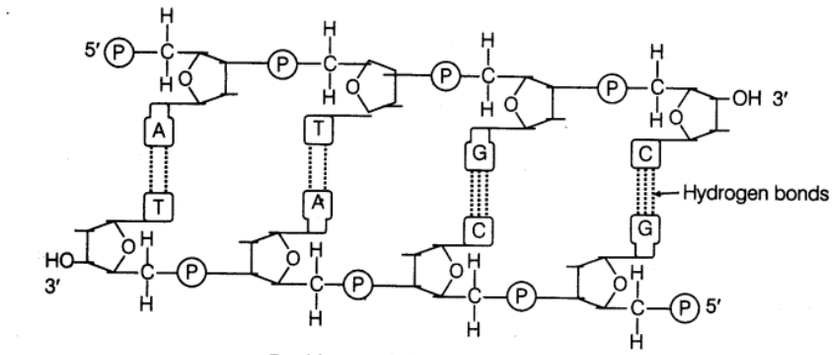
It is not universally applicable. In some viruses, the flow of information is in reverse direction, that is from RNA to DNA.

(ii) Properties of a molecule to act as a genetic material

- It should be able to generate its replica.
- It should chemically and structurally be stable.
- It should provide scope for slow changes (mutation) that are required for evolution.
- It should be able to express itself in the form of Mendel ian characters

63.Diagrammatically represent a portion of the double stranded polynucleotide chain sequence in a DNA molecule involving all the four nitrogenous bases.[All India 2008 C]

Ans. Double stranded polynucleotide chain sequence in a DNA molecule involving all the four nitrogenous bases, i.e. A, T, G, C is represented below



Double stranded polynucleotide chain

A nucleotide has three components a nitrogenous base, a pentose sugar and a phosphate group. (5)