

Class: 12
Subject: Biology
Topic: Molecular Basic of Inheritance
No. of Questions: 25

Q1. If a double stranded DNA has 20 per cent of cytosine, calculate the per cent of adenine in the DNA.

Ans. Taking total number of nitrogenous base to be 100 then number of cytosine will be 20. By base pairing rule we know in DNA segments a cytosine make pairs with a guanine by 3-H bonds. So, the no. of guanine will also 20. After 20 to cytosine and 20 to guanine, 60 are left. We know adenine and thymine pairs among themselves through 2-H bonds. So, 60 will be divided among adenine and guanine equally $(60 \div 2) = 30\%$. By the above calculation, it is clear that adenine amount would be 30%.

Q2. Make a brief note on RNA polymerase.

Ans. This enzyme can catalyse polymeration of RNA. They may be of different types for e.g. three types of RNA are found in bacteria, mRNA, tRNA, rRNA and these RNA are synthesized by single DNA dependent RNA polymerase. It catalyzes transcription of all three types of RNA in bacteria, which are needed in protein synthesis. In eukayotes, three RNA polymerases are present in nucleus and additional polymerases present in organelles. RNA polymerase 1 does transcription of rRNA (28s, 18s, 5.8s) RNA polymerase 2 transcribes precursor of mRNA, hnRNA and RNA polymerase 3 does transcription of tRNA, 5sRNA and snRNA.

Q3. Make a note on DNA Ploymerase.

Ans. It is a DNA dependent enzyme, along with additional enzymes. It catalyzes the polymerisation of deoxynucleotides by using DNA template. This enzyme can catalyze polymerization only in one direction from 5` to 3`. Because of this replication on strand from 3` to 5` is continuous but from 3` to 5` is discontinuous.

Q4. Explain the following terms.

Anticodon, transformation, transcription, translation, nucleosome.

Ans. **Anticodon** : A sequence of three nitrogenous bases on tRNA which is complementary to the codon on mRNA.

Transformation : The phenomenon by which the DNA isolated from one type of a cell, when introduced into another type, is able to express some of the properties of the former into the latter.

Transcription : The process of copying genetic information from one strand

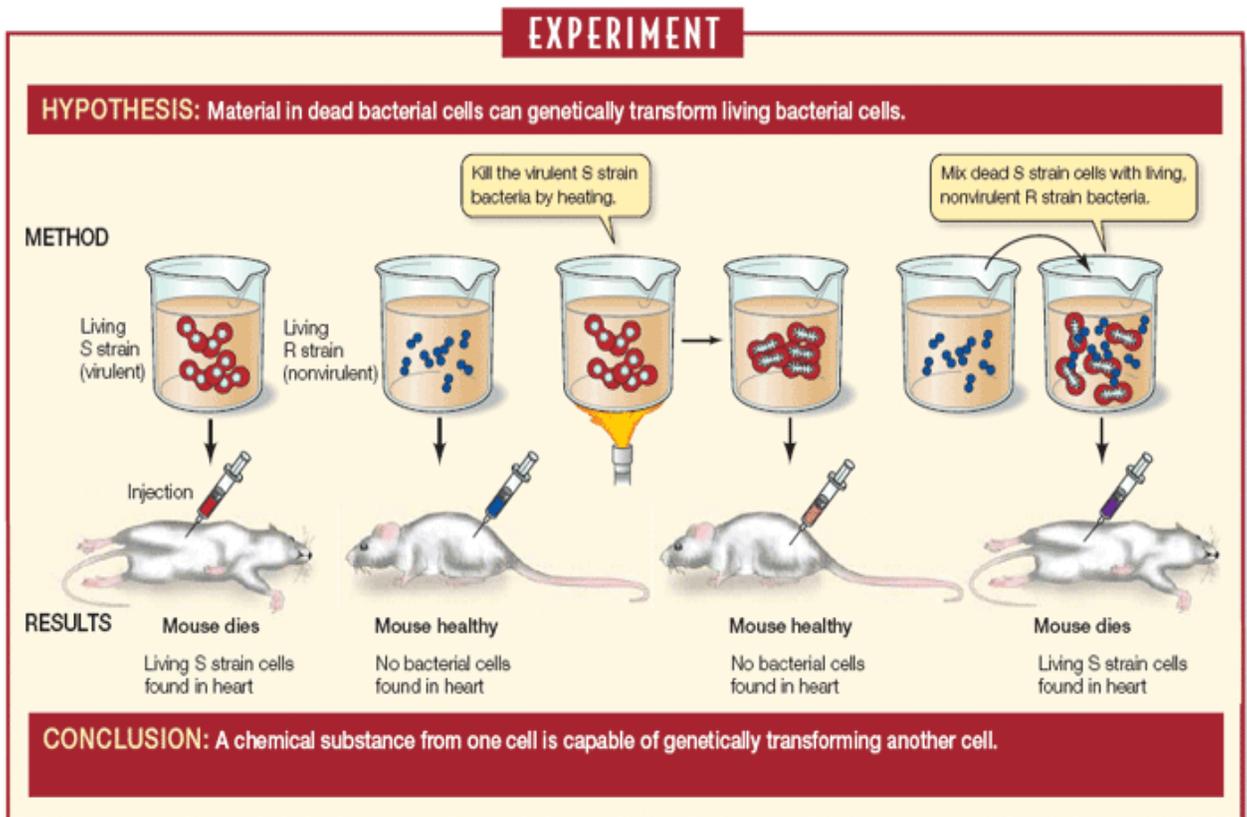
of DNA into RNA.

Translation : The process of polymerisation of amino-acids to form a polypeptide as dictated by mRNA.

Nucleosome : The structure formed when negatively charged DNA is wrapped around positively charged histone octamer.

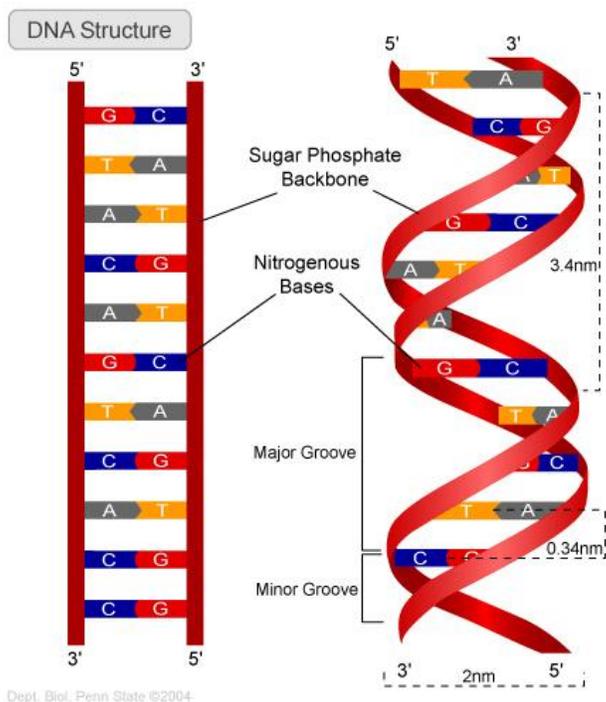
Q5. Diagrammatically explain Griffith experiment.

Ans.



Q6. Explain structure of DNA.

Ans.



- I. Two DNA strands form a helical spiral, winding around a helix axis in a right-handed spiral
- II. The two polynucleotide chains run in opposite directions
- III. The sugar-phosphate backbones of the two DNA strands wind around the helix axis like the railing of a spiral staircase
- IV. The bases of the individual nucleotides are on the inside of the helix, stacked on top of each other like the steps of a spiral staircase.

Q7. Explain types of DNA.

Ans.

	Helix type		
	A	B	Z
Shape	Broadest	Intermediate	Narrowest
Rise per base pair	2.3 Å	3.4 Å	3.8 Å
Helix diameter	25.5 Å	23.7 Å	18.4 Å
Screw sense	Right-handed	Right-handed	Left-handed
Glycosidic bond*	<i>anti</i>	<i>anti</i>	Alternating <i>anti</i> and <i>syn</i>
Base pairs per turn of helix	11	10.4	12
Pitch per turn of helix	25.3 Å	35.4 Å	45.6 Å
Tilt of base pairs from perpendicular to helix axis	19 degrees	1 degree	9 degrees

**Syn* and *anti* refer to the orientation of the N-glycosidic bond between the base and deoxyribose. In the *anti* orientation, the base extends away from the deoxyribose. In the *syn* orientation, the base is above the deoxyribose. Pyrimidine can be in *anti* orientations only, whereas purines can be *anti* or *syn*.

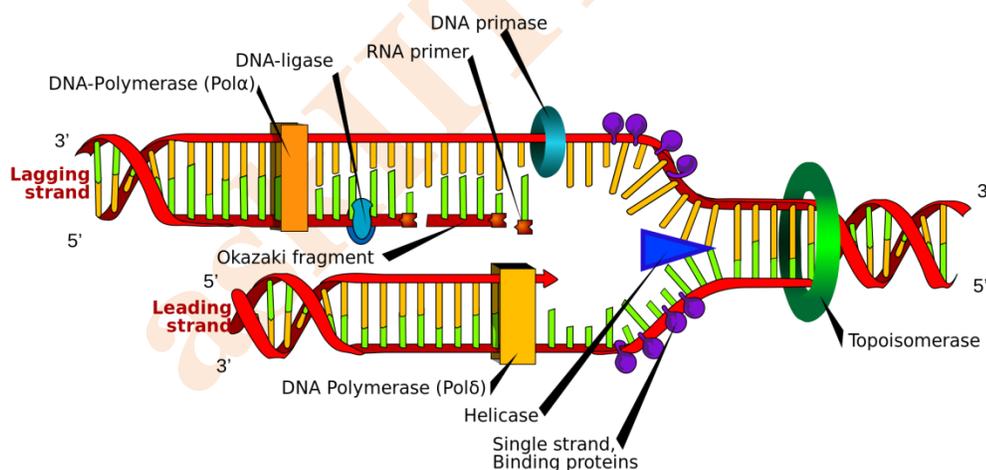
Q8. How DNA replication occur?

Ans. During the S phase of the cell cycle, DNA replicates. The synthesis of new DNA is a multistep process. In eukaryotes, it involves more than 20 enzymes and other proteins. The process can be divided into three major parts:

- 1.binding of enzymes to existing DNA
- 2.unwinding of the double helix
- 3.synthesis of a new matching strand for each existing strand.

First enzymes and other proteins involved in DNA synthesis bind to specific regions of chromosomes called replication origins. Each chromosome has more than one replication origin. The proteins include an enzyme that unwinds the double helix, an RNA-synthesizing enzyme, and DNA polymerase, the enzyme that catalyzes the formation of the new DNA strands.

In prokaryotes there is only one origin of replication. One is sufficient because bacteria contain only one small chromosome which can replicate quickly. Eukaryotes though have several chromosomes. These chromosomes contain much more DNA than bacteria do. Replication of a eukaryotic chromosome from a single origin would take an extremely long time.



DNA polymerase can add nucleotides only to the end of an existing nucleic acid strand. Once the DNA double helix at the origin separates an enzyme prepares each of the individual strands of DNA for synthesis of a matching strand. This enzyme synthesizes a short matching section of RNA that acts as a primer for DNA synthesis. The base sequence of the existing DNA determines the sequence of the matching strand, whether it is RNA or DNA. For example, wherever a thymine occurs in the existing strand, an adenine is added to the new strand.

Synthesis of the new matching strand occurs continuously on only one of the original strands. This is called the leading strand. The other original strand is called the lagging strand. On the

leading strand, DNA polymerase adds DNA nucleotides to the end of the RNA primer. AS the replisome moves away from the replication origin along the DNA, it unwinds more of the double helix. At the same time, DNA polymerase extends the matching strand along the leading strand. Later, another enzyme replaces the small RNA primer with DNA.

Meanwhile replication is discontinuous along the lagging strand because the double helix is antiparalle. but DNA polymerase can extend a primer in only one direction.

Each new double helix contains one strand of old DNA and one strand of new DNA. This type of replication is known as semiconservative replication because each of the two new double stranded DNA molecules conserves one strand of the original DNA, but adds one strand of new DNA.

Q9. What are the three types of RNA, where can they be found and what is their function in the cell?

- Ans.
1. mRNA (messenger RNA) - transcribes the genetic code from DNA into a form that can be read and used to make proteins, and carries genetic information from the nucleus to the cytoplasm of a cell.
 2. rRNA (ribosomal RNA) - rRNA is located in the cytoplasm, where ribosomes are found. rRNA directs the translation of mRNA into proteins.
 3. tRNA (transfer RNA) - transfers amino acids to the ribosome that correspond to each three-nucleotide codon of rRNA. The amino acids then can be joined together and processed to make polypeptides and proteins.

Q10. Describe the process of transcription. (three steps)

- Ans.
1. Initiation:
 - RNA polymerase binds at the promoter region
 - DNA unwinds
 - promoter is an important site of gene regulation
 2. Elongation:
 - RNA polymerase synthesizes RNA
 - DNA rewinds after polymerase passes
 3. Termination:

- RNA polymerase releases completed RNA
- RNA polymerase detaches from DNA

Q11. Describe the process of translation.

Ans. 1. Initiation: tRNA and mRNA bind to a ribosome

- initiation codon, AUG: codes for methionine
- initiation complex forms
- large ribosomal subunit joins complex: two binding sites on large subunit hold two tRNA's

2. Elongation:

- second tRNA binds in second binding site
- peptide bond forms
- complex moves one codon along mRNA
- this repeats until end of message is reached

3. Termination:

- stop codon reached
- special proteins bind
- ribosome releases complete protein
- ribosome and mRNA dissociate

Q12. During DNA replication what is the first process to occur?

Ans. Unwinding of parental DNA. First the DNA is unwound partly then synthesis of the leading and lagging strands occurs simultaneously, although the leading strand is quicker (hence the names). Sealing of the nicks is what occurs as part of replication of the lagging strand, because this strand runs in the opposite direction to DNA synthesis so must be generated in short sections as the DNA unwinds.

Q13. What is the name given to the short stretches of DNA formed on the lagging strand?

Ans. Okazaki fragments. Each strand of DNA has two ends. One is known as the 5' end, whilst the other is known as the 3' end. DNA replication always occurs in the 5' to 3' direction, however as the two DNA strands run in opposite directions only one strand can be replicated contiguously in that direction. For this reason short sections of DNA are constructed 5' to 3' on the lagging strand. Then the enzymes wait until the DNA has unwound a bit more, then they construct another fragment. These are known as Okazaki fragments.

Q14. What is the function of DNA polymerase III?

Ans. It adds single nucleotides to the growing DNA strand. DNA polymerase III recognises the short (approximately 10 nucleotide) RNA primers and begins to add nucleotides to the strand. If it reads a T it will add an A, or if it reads a C it will add a G and vice versa.

Q15. Which three people were awarded the Nobel Prize for the discovery of the structure of DNA: the double helix?

Ans. James Watson, Francis Crick and Maurice Wilkins. Watson and Crick were awarded it for their construction of the model of the DNA double helix. Wilkins was responsible for initiating the X-ray crystallography work on DNA. Rosalind Franklin took the superb X-ray photographs upon which Watson and Crick based their model.

Q16. What are pentoses? To what organic group do pentoses belong? Are nucleotides formed of only one type of pentose?

Ans. Pentoses are carbohydrates made of five carbons. Deoxyribose is the pentose that constitutes DNA nucleotides and ribose is the pentose that is part of RNA nucleotides.

Q17. Bacteria are prokaryotic cells, i.e., they do not have a membrane-delimited nucleus. Eukaryotes have cells with a delimited nucleus. Where in these types of cells can DNA be found?

Ans. In eukaryotic cells DNA is found within the cell nucleus. In prokaryotic cells DNA is found dispersed in the cytosol, the fluid space inside the cell.

Other DNA molecules can also be found within mitochondria and chloroplasts, specialized organelles of eukaryotic cells.

Q18. What is the numeric relation between pyrimidine and purine bases in the DNA molecule? Is that relation valid in RNA molecules?

Ans. The DNA molecule is made of two bound polynucleotide chains that form a helical structure (the double helix). The binding of the two chains is between their nitrogen-containing bases and it always obeys the following rules: adenine (A), a purine base, binds with thymine (T), a pyrimidine base, and guanine (G), a purine base, binds to cytosine (C), a pyrimidine base. Therefore in one molecule of DNA there will be the same number of adenine (A) and thymine (T) and same number of cytosine (C) and guanine (G). The quantities of purine and of pyrimidine bases then will also be the same in a 50% proportion for each type. The relation $A = T$ and $C = G$, or $A/T = C/G = 1$, is called Chargaff's relation and the pairing rules described above are known as Chargaff's rules.

In RNA there are not two nucleotide chains. RNA is a simple chain molecule and there is no necessary proportionality of nitrogen-containing bases to form it.

Q19. What are the chemical bonds of the DNA molecule that are broken for the replication process to occur?

Ans. During the DNA replication process, hydrogen bonds between nitrogen-containing bases of the polynucleotide chains are broken.

Q20. Is there any situation in which DNA is made based on a RNA template? What is the enzyme involved?

Ans. The process in which DNA is synthesized having as template a RNA chain is called reverse transcription. In cells infected by retroviruses (RNA viruses, like the AIDS or SARS viruses) reverse transcription occurs and DNA is made from information contained in the viral RNA.

Viral RNA within the host cell produces DNA with the help of an enzyme called reverse transcriptase. Based on that DNA the host cell then makes viral proteins, new viruses are assembled and viral replication occurs.

Q21. Satellite DNA is useful tool in

- a. Genetic engineering
- b. Organ transplantation
- c. Sex determination
- d. Forensic science

Ans. d

Q22. If the total amount of adenine and thymine in a double-stranded DNA is 45%, the amount of guanine in this DNA will be

- a. 22.5%
- b. 27.5%
- c. 45%
- d. 55%

Ans. b.

Q23. In history of biology, human genome project led to the development of?

- a. Bioinformatics
- B. Biosystematics
- b. Biotechnology
- c. Biomonitoring

Ans. a.

Q24. Okazaki is known for his contribution to the understanding of

- a. Transcription
- b. Translation
- c. DNA replication
- d. Mutation

Ans. c.

Q25. Through which enzyme can RNA give rise to DNA

- a. Restriction enzyme
- b. DNA polymerase
- c. RNA polymerase
- d. Reverse transcriptase

Ans. d.

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