Biology · Molecular Biology · DNA and Genetic Information

DNA

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Multiple choice questions — 102 questions

1 If a DNA sample contains 200 nucleotides with the bases adenine and guanine, how many nucleotides with the bases thymine and cytosine does it contain?

(A) 200 (B) 400 (C) 600 (D) 800

2 Watson and Crick considered that the DNA molecule is made of two strands. Which of the following evidence confirmed their view?

(A) DNA is found in the shape of a helix
(B) The amount of DNA is constant
(C) The sugar-phosphate backbone is not symmetrical
(D) C binds with G, and T binds with A

3 If one turn of DNA contains 26 hydrogen bonds, what is the ratio of the nitrogenous bases adenine to guanine, respectively?

(A) 1 : 1 (B) 4 : 1 (C) 2 : 3 (D) 1 : 4

4 The following choices give the numbers of nucleotides of a DNA molecule made of 5 turns. Which of them is NOT correct?

(A) 30 nucleotides (A) (B) 20 nucleotides (C)
(C) 30 nucleotides (G) (D) 30 nucleotides (T)

5 Knowing the total number of nucleotides of DNA, which of the following can NOT be found?

(A) The number of nitrogenous bases (B) The number of adenine nucleotides
(C) The number of sugar molecules (D) The number of phosphate groups

6 Which of the following is responsible for keeping the general shape of DNA stable?

(A) The pentose sugar (B) The phosphate groups
(C) The nitrogenous bases (D) The hydrogen bonds

7 What type of bonds is found in a DNA molecule?

(A) Covalent only (B) Hydrogen only
(C) Covalent and disulfide (D) Hydrogen and covalent

8 Which of the following is correct about DNA?

(1) The number of sugar molecules equals the number of phosphate molecules.

(2) The number of nucleotides equals the number of nitrogenous bases.

(3) It is made of two identical strands.

(A) (1) , (2) (B) (1) , (3) (C) (2) , (3) (D) (1) , (2) , (3)

9 Which of the following is correct about the percentage of cytosine bases in a DNA molecule?

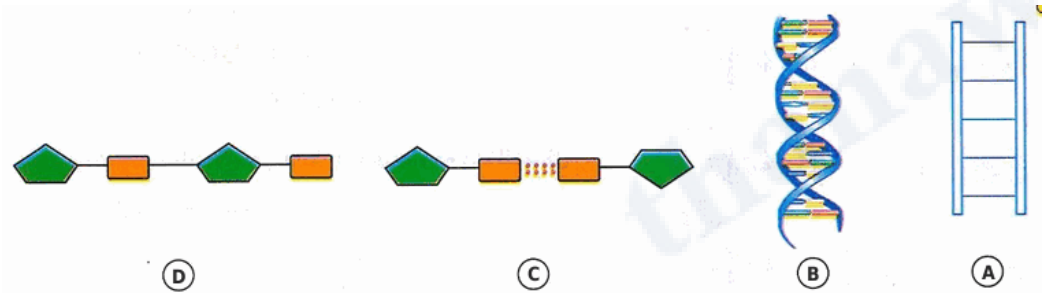
(A) It equals 50% of the number of guanine bases in the whole molecule

(B) It is the same as the percentage of guanine bases in one strand

(C) It is the same as the percentage of guanine bases in the whole molecule

(D) It is equal in both strands

10 Which of the following does NOT agree with the results reached by Watson and Crick?



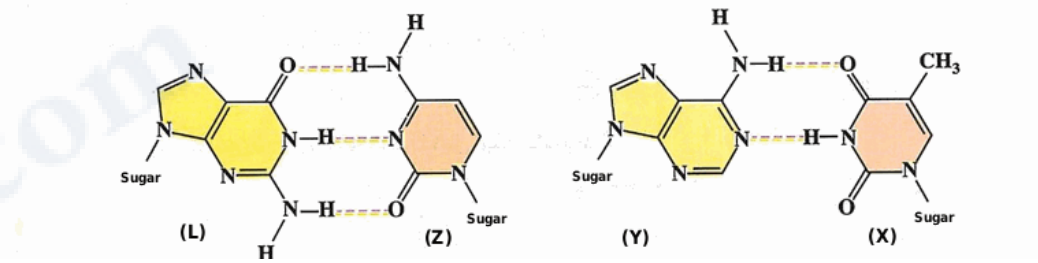
11 Which of the following is a pyrimidine base that binds with another base by two hydrogen bonds in a DNA molecule?

(A) Adenine (B) Thymine (C) Guanine (D) Cytosine

12 How many nucleotides are there in a piece of a DNA molecule made of two complete turns?

(A) 10 (B) 20 (C) 30 (D) 40

13 The following figure shows the four types of nucleotides that make up DNA. What do (X), (Y), (Z) and (L) represent, respectively?



(A) Adenine / Thymine / Guanine / Cytosine

(B) Guanine / Cytosine / Thymine / Adenine

(C) Thymine / Adenine / Cytosine / Guanine

(D) Cytosine / Guanine / Adenine / Thymine

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14 DNA samples were separated from a house cat and an English bulldog. Which of the following statements is NOT correct?

(A) The types of nucleotides in the DNA of both animals are the same

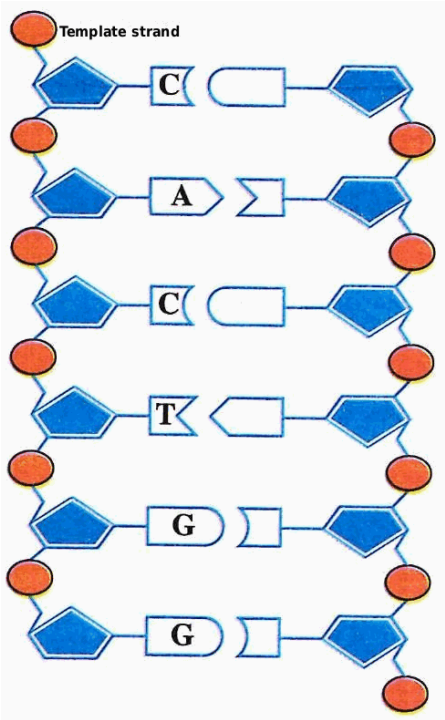
(B) The sequence of nucleotides in the DNA of both animals is identical

(C) The number of adenine-containing nucleotides in the cat's DNA equals the number of thymine-containing ones

(D) The number of phosphate groups in the dog's DNA equals the number of nucleotides

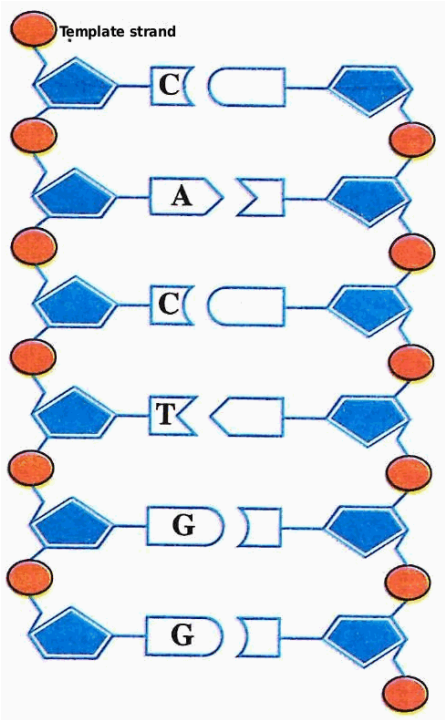
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15 From the opposite figure, which represents a segment of a DNA molecule:
Which of the following shows the sequence of nucleotides in the complementary strand?



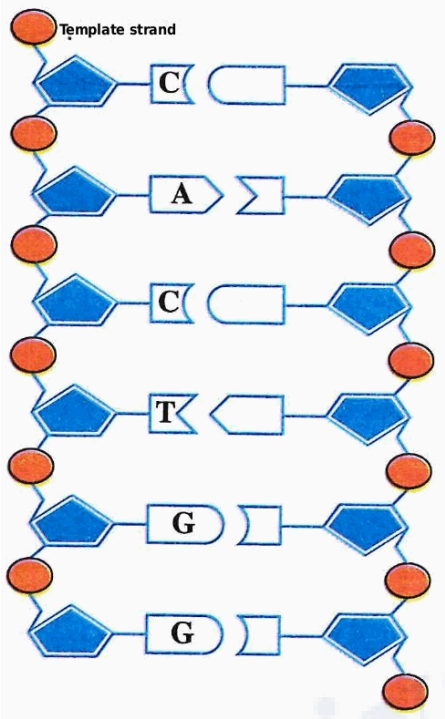
(A) 3´...C-A-C-T-G-G...5´
(B) 3´...C-C-A-G-T-G...5´
(C) 5´...G-T-G-A-C-C...3´
(D) 3´...G-T-G-A-C-C...5´

16 From the opposite figure, which represents a segment of a DNA molecule:
How many nucleotides does this figure need to form a complete turn?



(A) 2 (B) 4 (C) 6 (D) 8

17 From the opposite figure, which represents a segment of a DNA molecule:
How many hydrogen bonds are needed to join the two DNA strands in the opposite figure?



(A) 6 (B) 8 (C) 16 (D) 18

18 Study the order of the nitrogenous bases in the following part of a DNA strand, then answer:

3′... A-C-G-A-G-T-C-A-G-A-G-T-C-A-G-A-T-C... 5′

What is the percentage of adenine in the double helix of this gene?

(A) 10 % (B) 15 % (C) 20 % (D) 25 %

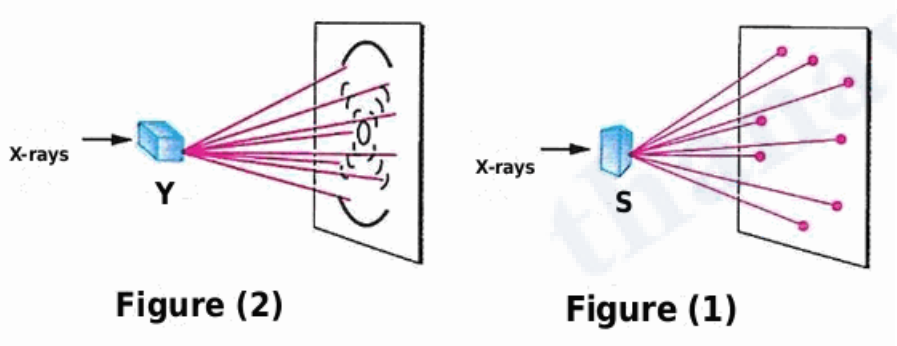
19 Study the order of the nitrogenous bases in the following part of a DNA strand, then answer:

3′... A-C-G-A-G-T-C-A-G-A-G-T-C-A-G-A-T-C... 5′

What is the percentage of thymine in the DNA strand complementary to this strand?

(A) 11.11 % (B) 22.22 % (C) 33.33 % (D) 44.44 %

20 The two opposite figures show the use of X-ray diffraction to tell apart the two substances that were disputed as the genetic material in human cells. Which of the following statements is correct?



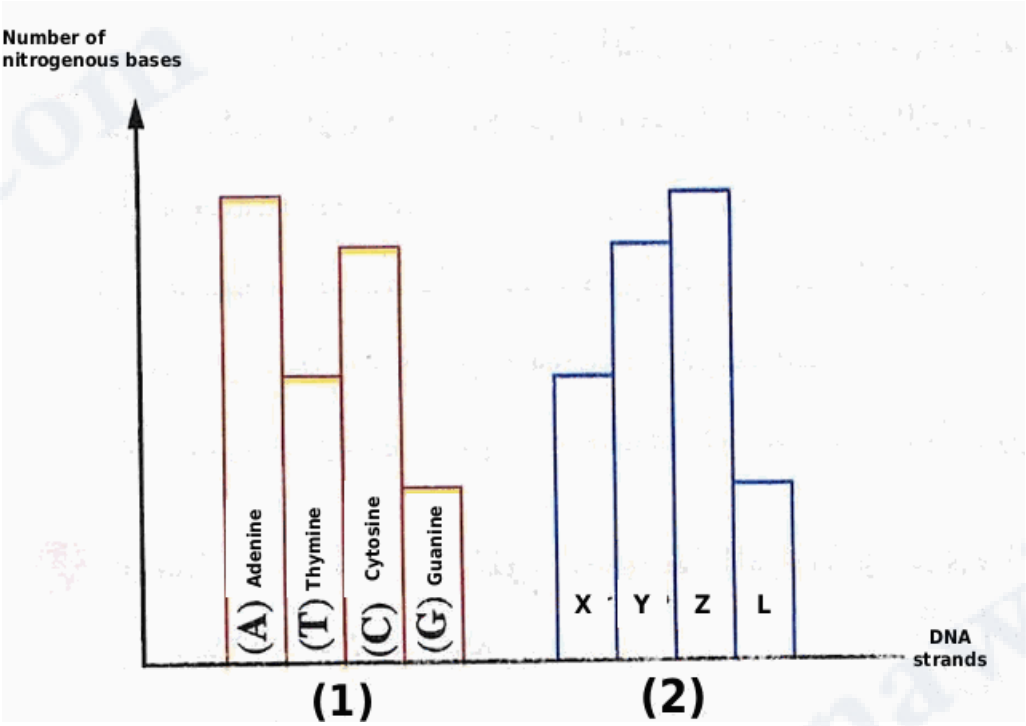
(A) Molecule (S) always contains phosphorus

(B) Molecule (S) is coiled in the shape of a double helix

(C) The diameter of molecule (Y) shows that it is made of more than one strand

(D) The nitrogenous bases in molecule (Y) are on the outside

21 Study the opposite graph, which shows the number of nitrogenous bases of DNA in strands (1) and (2). What do the letters (X), (Y), (Z) and (L) represent, respectively?



(A) Adenine / Thymine / Cytosine / Guanine

(B) Thymine / Cytosine / Adenine / Guanine

(C) Adenine / Guanine / Thymine / Cytosine

(D) Cytosine / Guanine / Adenine / Thymine

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22 Which of the following mathematical relations about the nitrogenous bases in a DNA molecule is NOT correct?

(A) A = T

(B) 1 = (A + C) / (T + G)

(C) 1 = (A + T) / (C + G)

(D) T + G ≃ 50 %

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23 Which of the following could happen if the two DNA strands became identical?

(A) The covalent bonds in the nucleotide would not form

(B) The hydrogen bonds between the nitrogenous bases would not form

(C) All adenine bases would bind with thymine bases

(D) All guanine bases would bind with cytosine bases

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24 Which of the following was NOT provided by Franklin's studies of the three-dimensional shape of the DNA molecule?

(A) The diameter of the molecule

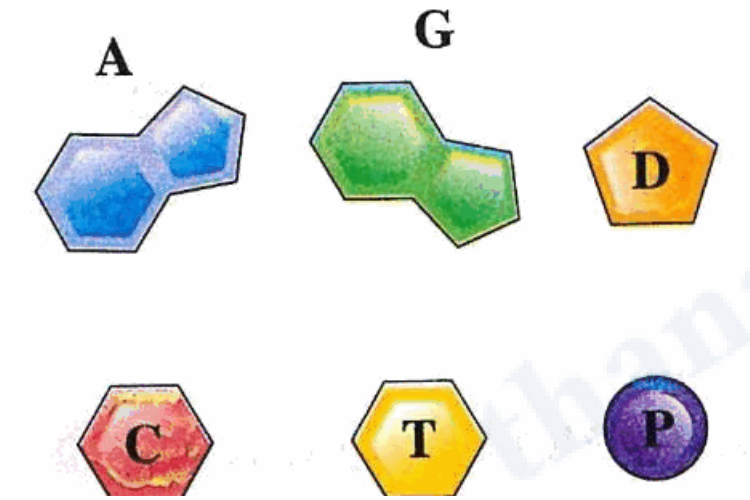
(B) The position of the nitrogenous bases in the molecule

(C) The shape of the molecule

(D) How the molecule is built

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25 The opposite figure shows the components of DNA. Which of the following statements is correct?



(A) The number of (D) molecules equals the number of (C) molecules

(B) The sum of (A) and (T) molecules equals the sum of (G) and (C) molecules

(C) The sum of (D) and (P) molecules equals the sum of (G) and (C) molecules

(D) The number of (D) molecules equals the number of (P) molecules

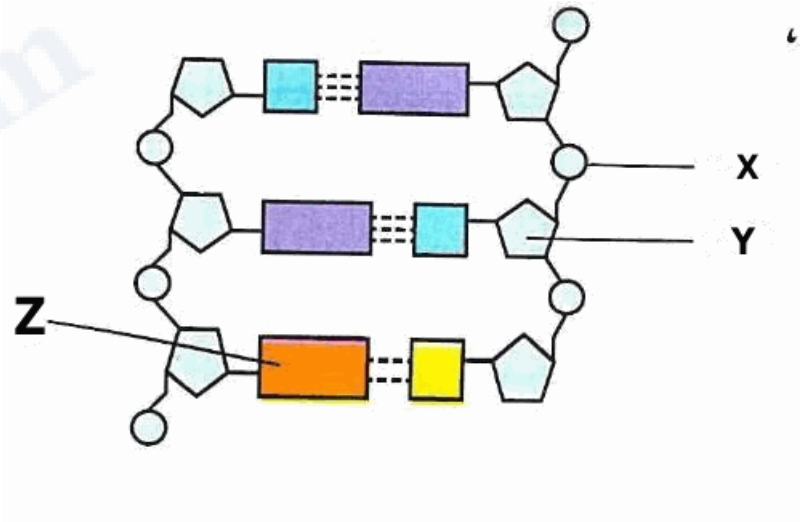
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26 Which single-ring nitrogenous base binds with the base opposite it by three hydrogen bonds in a DNA molecule?

(A) Cytosine (B) Adenine (C) Guanine (D) Thymine

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27 From the opposite diagram, which shows part of the structure of DNA, what do the structures (X), (Y) and (Z) represent, respectively?



(A) Phosphate group / Ribose sugar / Adenine

(B) Phosphate group / Deoxyribose sugar / Adenine

(C) Ribose sugar / Guanine / Phosphate group

(D) Deoxyribose sugar / Phosphate group / Cytosine

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28 Which of the following is responsible for the variety of genetic information in a DNA molecule?

(A) Deoxyribose sugar

(B) The types of nitrogenous bases

(C) The phosphate groups

(D) The order of the nucleotides

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29 If the number of adenine nucleotides in a DNA molecule is 300 nucleotides, which is 15% of the total number of nucleotides, how many turns does this molecule have?

(A) 50 (B) 100 (C) 150 (D) 200

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30 If a DNA sample of 300 nucleotide pairs contains 140 cytosine bases, how many other nucleotides are there?

(A) 140 (B) 160 (C) 280 (D) 460

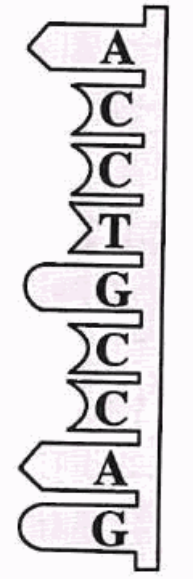
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31 How many free phosphate groups are there in the double helix of a DNA molecule in eukaryotes?

(A) Zero (B) 1 (C) 2 (D) 4

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32 How many purine bases are there in the double segment of the opposite DNA strand?



(A) 4 (B) 5 (C) 8 (D) 9

33 If a DNA molecule in a living organism is made of 210 thousand pairs of nitrogenous bases, answer:

How many nucleotides are there in this molecule?

(A) 210 (B) 210 thousand (C) 420 (D) 420 thousand

34 If a DNA molecule in a living organism is made of 210 thousand pairs of nitrogenous bases, answer:

How many turns are there in this molecule?

(A) 12 thousand (B) 21 thousand (C) 24 thousand (D) 42 thousand

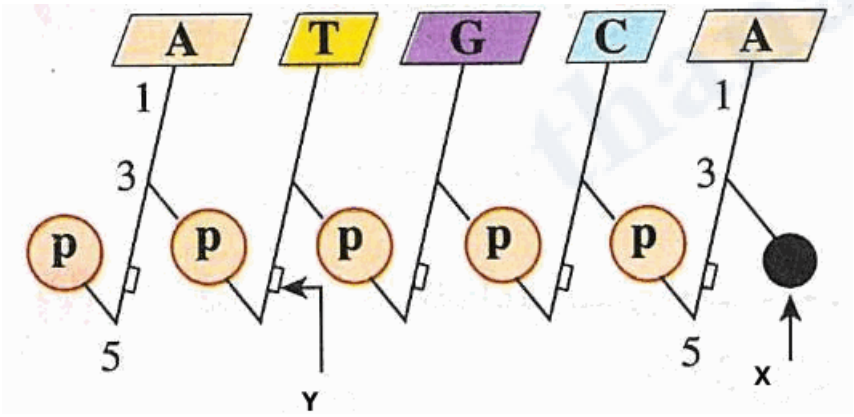
35 The opposite table shows the percentages of the nitrogenous bases in three different DNA samples as determined by a scientist. Which samples confirm base pairing in DNA?

Percentages of the bases in DNA samples				
T	A	C	G	Sample
15%	15%	35%	35%	(1)
10%	40%	10%	40%	(2)
24%	24%	26%	26%	(3)

(A) (1) , (2) (B) (1) , (3) (C) (2) , (3) (D) (1) , (2) , (3)

36 Study the opposite diagram:

What does the letter (X) represent?

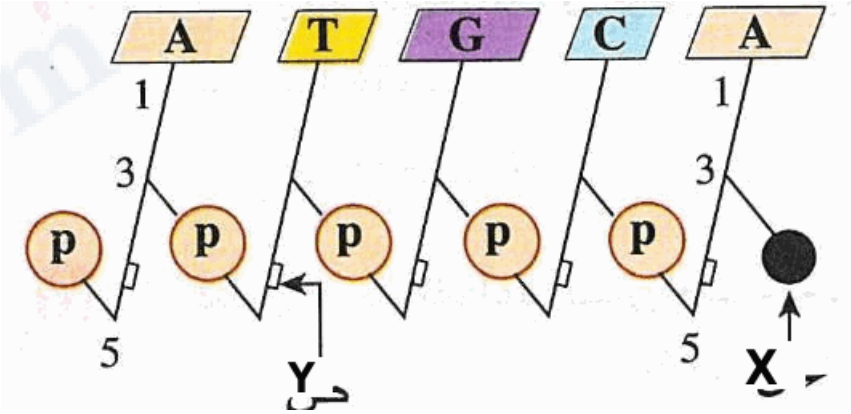


(A) Ribose sugar (B) Deoxyribose sugar

(C) Phosphate group (D) Hydroxyl group

37 Study the opposite diagram:

What does the letter (Y) represent?



(A) Ribose sugar
(B) Deoxyribose sugar
(C) Phosphate group
(D) Hydroxyl group

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38 If a DNA sample contains 400 purine nucleotides, how many pyrimidine nucleotides does it contain?

(A) 200 (B) 400 (C) 600 (D) 800

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39 If the percentage of guanine in a pure sample of a DNA molecule is 17%, what is the percentage of thymine in this sample?

(A) 17 % (B) 33 % (C) 34 % (D) 83 %

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40 Gene (X) is made of 84 pairs of nitrogenous bases. From the following table, which shows the number of some nitrogenous bases, how many cytosine bases are there in this gene?

T	C	G	A	
.....	.....	25	12	First strand
.....	.....	.....	29	Second strand

(A) 18 (B) 25 (C) 36 (D) 43

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41 What is the reason for the many types of genes on DNA?

(A) The sugar-phosphate backbone is not symmetrical

(B) The variety of chemical bonds

(C) The variety of the order of the nitrogenous bases

(D) DNA is found as a double helix

42 What is the main function of the hydrogen bonds in both the DNA molecule and the antibody molecule?

(A) Joining carbon atoms together

(B) Determining the structural shape of the molecule

(C) Joining the building units together

(D) Making it easier to break the molecule down into its building units

43 One turn of a DNA molecule contains 10 thymine bases. How many guanine bases does it contain?

(A) Zero (B) 5 (C) 10 (D) 20

44 How many nitrogenous bases form two hydrogen bonds with the bases of the following strand in a DNA molecule?

C - G - A - T - T - C - A - G - A

(A) 3 (B) 4 (C) 5 (D) 6

45 What type of chemical bonds is found in the sugar-phosphate backbone?

(A) Covalent only (B) Hydrogen only

(C) Covalent and disulfide (D) Covalent and hydrogen

46 When the percentages of the nitrogenous bases of the nucleic acid of a living organism were measured, they were as follows:

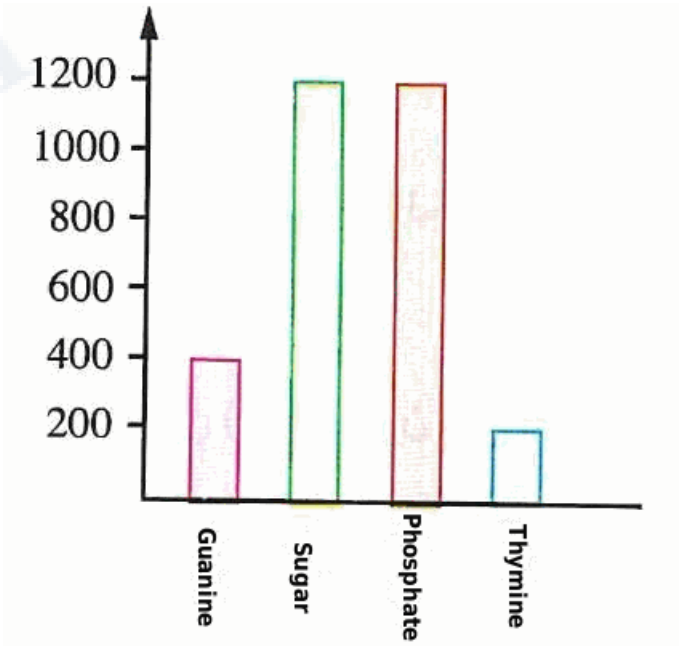
A = 18 % , G = 32 % , T = 18 % , C = 32 %

What does this nucleic acid represent?

(A) A DNA double helix (B) A single DNA strand

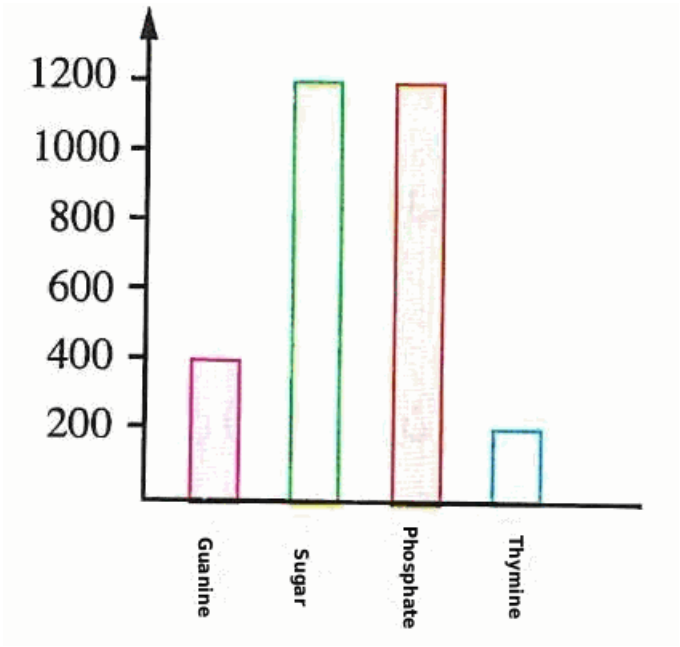
(C) An RNA double helix (D) A single RNA strand

47 The opposite figure shows some information about a DNA molecule:
How many nucleotides does the DNA molecule have?



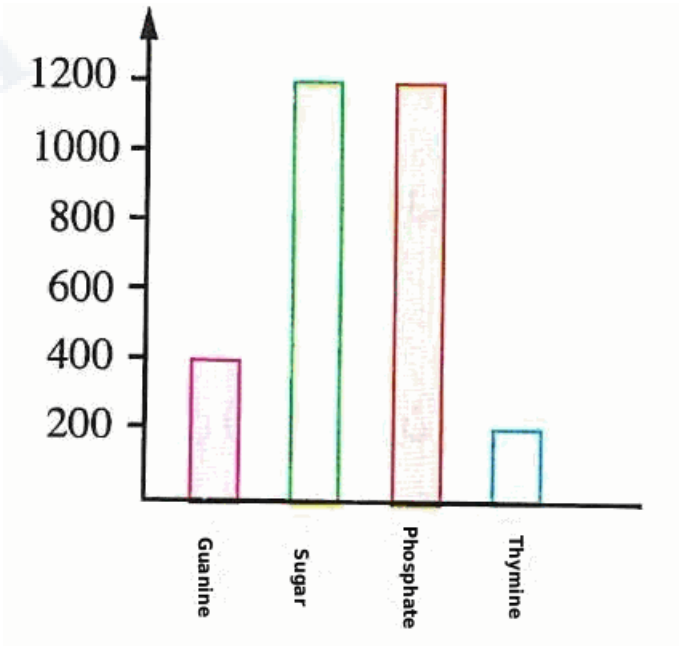
(A) 400 (B) 800 (C) 1200 (D) 2400

48 The opposite figure shows some information about a DNA molecule:
How many pyrimidines are there in this molecule?



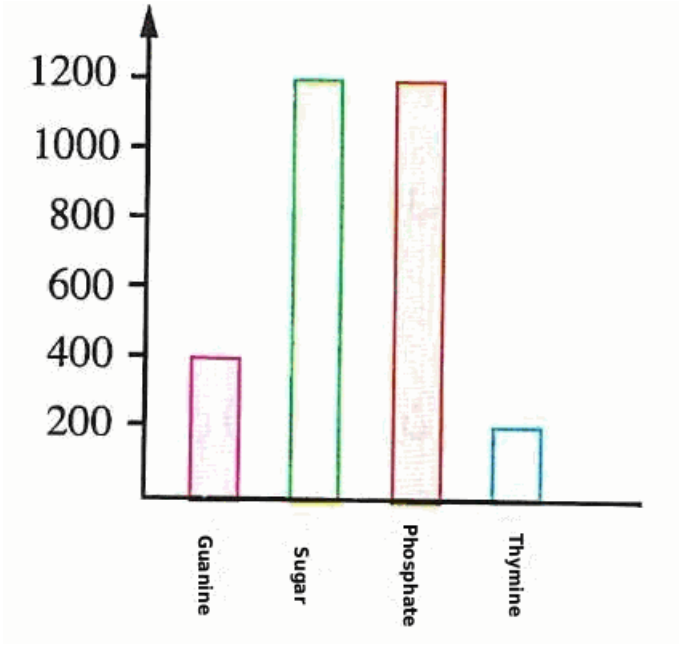
(A) 200 (B) 400 (C) 600 (D) 1200

49 The opposite figure shows some information about a DNA molecule:
How many hydrogen bonds are there?



(A) 400 (B) 1000 (C) 1200 (D) 1600

50 The opposite figure shows some information about a DNA molecule:
How many turns does this molecule have?



(A) 60 (B) 80 (C) 100 (D) 120

51 A piece of a DNA molecule is made of 6 turns. How many free phosphate groups does it have?

(A) 2 (B) 12 (C) 60 (D) 120

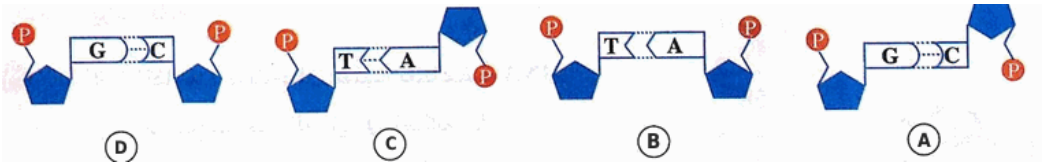
52 If the number of purine bases in a DNA molecule is 180 bases, how many turns does this molecule have?

(A) 9 turns (B) 18 turns (C) 27 turns (D) 36 turns

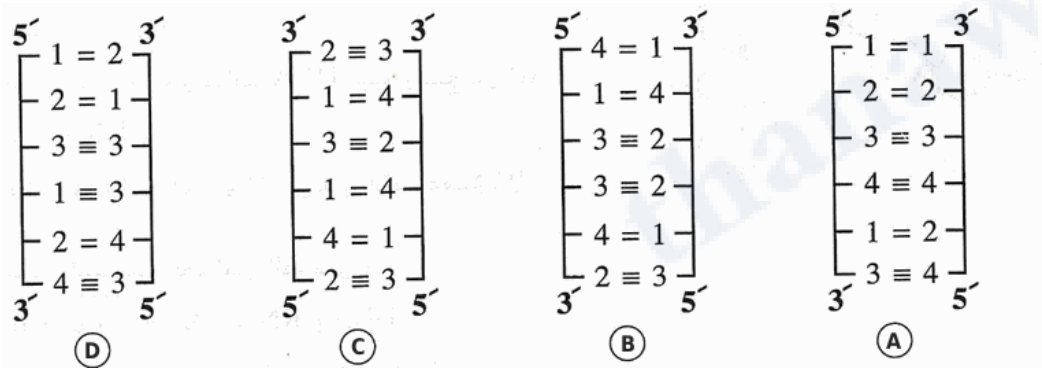
53 How many pairs of nitrogenous bases are there in a piece of DNA that has 150 turns?

(A) 150 (B) 300 (C) 1500 (D) 3000

54 Which of the following is correct?



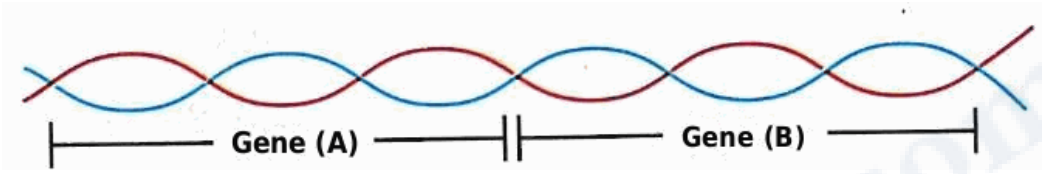
55 Which of the following figures can correctly represent a piece of a DNA molecule?



56 A piece of a DNA molecule contains 700 nitrogenous bases, 200 of which are adenine (A). How many hydrogen bonds are there in this piece of the molecule?

(A) 700 (B) 850 (C) 1400 (D) 1700

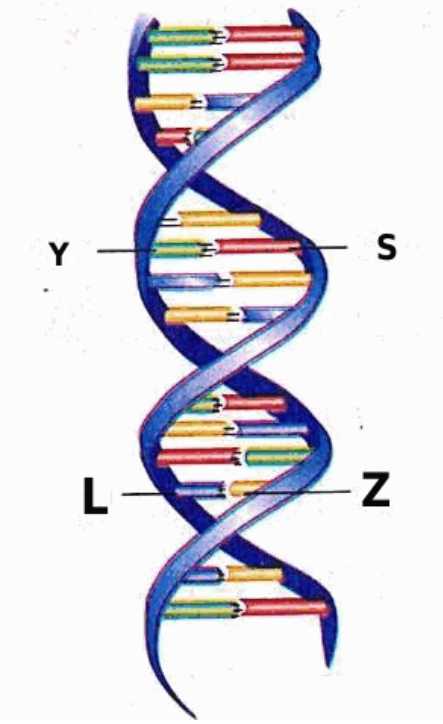
57 The figure in front of you shows a piece of DNA. If the number of purines in gene (A) equals the number of pyrimidines in gene (B), how does gene (A) differ from gene (B)?



(A) The number of nucleotides (B) The order of the nucleotides

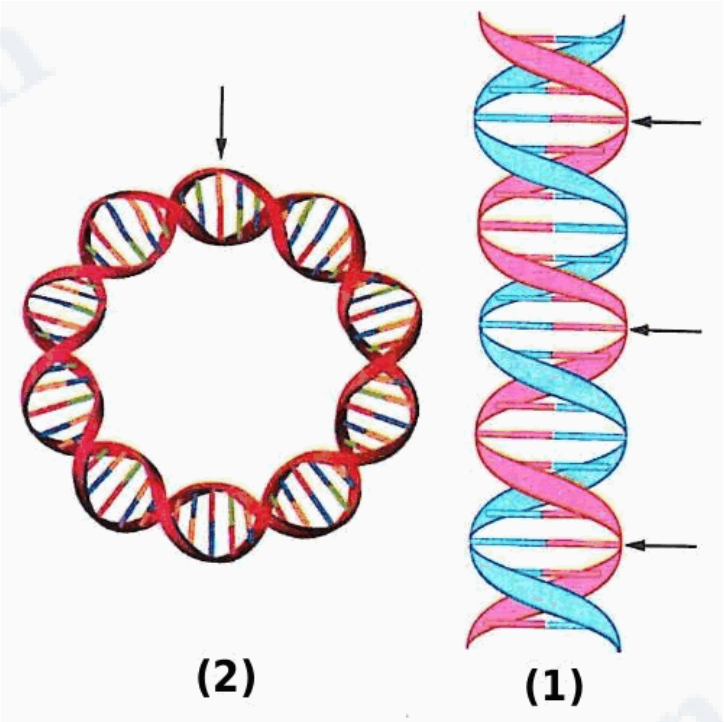
(C) The type of nucleotides (D) The number of hydrogen bonds

58 The opposite figure is a model of a DNA molecule. If the distance between points (S) and (Y) equals (X), what is the distance between points (Z) and (L)?



(A) ½ X (B) X (C) 2 X (D) 3 X

59 The two opposite figures show DNA replication. Which of the following is correct about this process in the two figures?



(A) (1) takes place in the cytoplasm, while (2) takes place in the nucleus

(B) The enzymes used in (1) differ from those used in (2)

(C) (1) produces 3 DNA molecules, while (2) produces one DNA molecule

(D) The start of replication in (1) differs from the start of replication in (2)

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60 Which of the following is NOT a characteristic of a virus?

(A) Its genetic material may be RNA or DNA

(B) It can replicate inside prokaryotic cells

(C) It can replicate inside eukaryotic cells

(D) It can replicate in the absence of a host

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61 The primers that are removed by one type of enzyme after the two DNA strands are copied do not contain the base .....

(A) Uracil (B) Thymine (C) Adenine (D) Cytosine

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62 DNA polymerase builds Okazaki fragments in the direction .....

(A) 5′ to 3′ of the leading strand (B) 3′ to 5′ of the lagging strand

(C) 5′ to 3′ of the lagging strand (D) 3′ to 5′ of the leading strand

63 Which of the following is NOT formed after DNA replication?

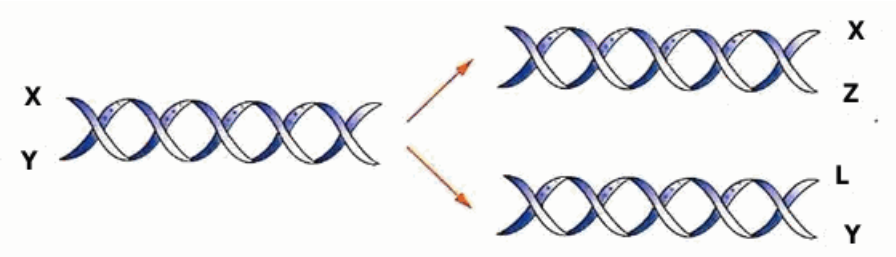
(A) Ova in the human female

(B) Pollen grains in the bean plant

(C) Ciliated swimmers in the gametophyte stage of the fern plant

(D) The motile stage inside the female Anopheles mosquito

64 From the opposite figure, which of the following are exactly identical?



(A) (X) and (Y) (B) (Z) and (L) (C) (X) and (L) (D) (Z) and (X)

65 During the replication of a DNA molecule, which of the following are separated from each other?

(A) Phosphate groups and deoxyribose sugar

(B) Cytosine and guanine

(C) Uracil and thymine

(D) Adenine and uracil

66 The primers added by the primase enzyme during DNA replication contain the base .....

(A) Adenine (B) Guanine (C) Thymine (D) Uracil

67 If the number of Okazaki fragments formed during the replication of a DNA molecule is X, the number of primers needed for replication is .....

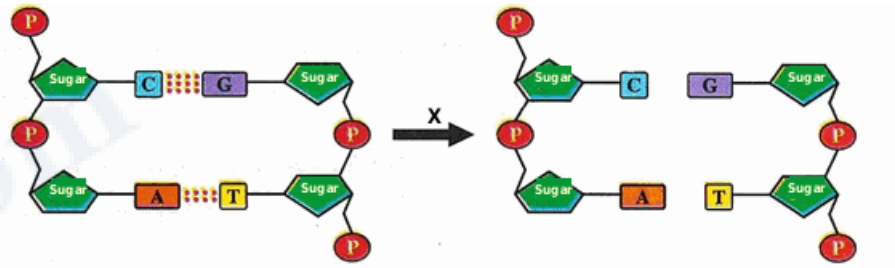
(A) X (B) X + 1 (C) X - 1 (D) 2 X

68 Which of the following must be plentiful in the cell before it starts to divide?

(A) Monosaccharides (B) RNA and DNA nucleotides

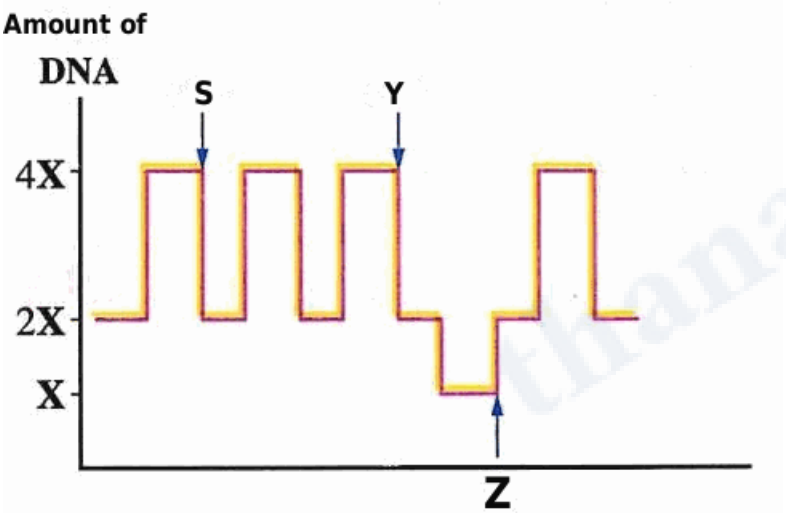
(C) Amino acids (D) Nitrogenous bases

69 Which of the following enzymes is enzyme (X) in the following reaction?



(A) Helicase
(B) Polymerase
(C) Deoxyribonuclease
(D) Ligase

70 From the opposite graph, what do (S), (Y) and (Z) represent, respectively?



(A) First meiotic division / Second meiotic division / Fertilization
(B) Mitotic division / First meiotic division / Second meiotic division
(C) First meiotic division / Mitotic division / Fertilization
(D) Mitotic division / First meiotic division / Fertilization

71 Which of the following shows the correct order in which the following enzymes work during DNA replication?

(A) Helicase → Primase → Polymerase → Ligase
(B) Primase → Helicase → Polymerase → Ligase
(C) Helicase → Polymerase → Primase → Ligase
(D) Primase → Polymerase → Helicase → Ligase

72 Which of the following is NOT a result of the work of the helicase enzyme during DNA replication?

(A) Forming the replication fork

(B) Separating the leading strand of replication from the lagging strand

(C) Allowing the polymerase enzymes to work

(D) Breaking the hydrogen bonds between the complementary nitrogenous bases

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73 The following table shows some events that take place during DNA replication:

(1) Each nitrogenous base binds with its complementary base

(2) The sugar of one nucleotide binds with the phosphate group of the next nucleotide

(3) Breaking the hydrogen bonds to separate the two DNA strands

(4) Forming two identical DNA molecules

Which of the following choices shows the correct order of these events?

(A) (3) → (4) → (2) → (1)

(B) (3) → (1) → (4) → (2)

(C) (3) → (1) → (2) → (4)

(D) (3) → (2) → (1) → (4)

---

74 Which of the following enzymes has no role in DNA replication?

(A) Polymerase

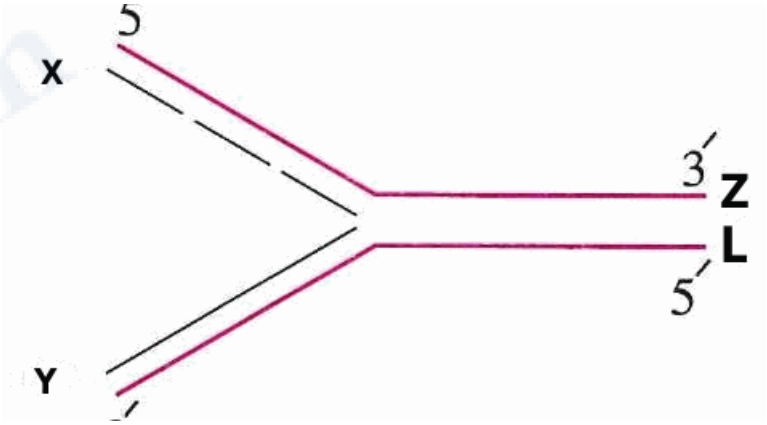
(B) Ligase

(C) Helicase

(D) Deoxyribonuclease

---

75 The opposite figure shows the replication of a DNA molecule. Which of the following statements is correct?



(A) Strand (X) and strand (Z) carry the same sequence of nucleotides

(B) The direction of strand (Y) is opposite to that of strand (L)

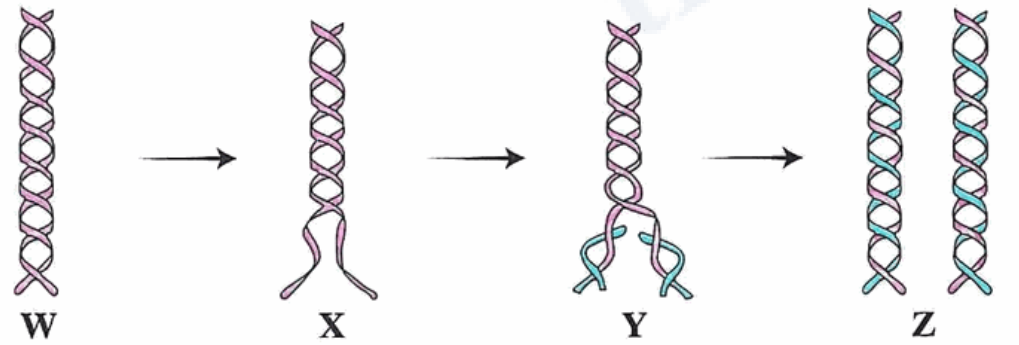
(C) Strands (X) and (Z) are joined to each other by covalent bonds

(D) After replication is complete, strands (Z) and (L) are joined by hydrogen bonds

---

76 Study the following figures, then answer:

Where does the process shown in these figures take place in eukaryotic cells?

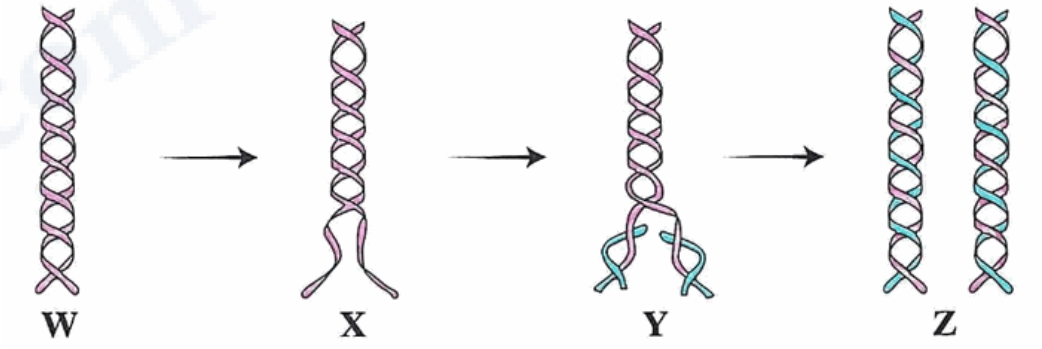


(A) The nucleus (B) The nucleolus (C) The cytoplasm (D) The ribosome

---

77 Study the following figures, then answer:

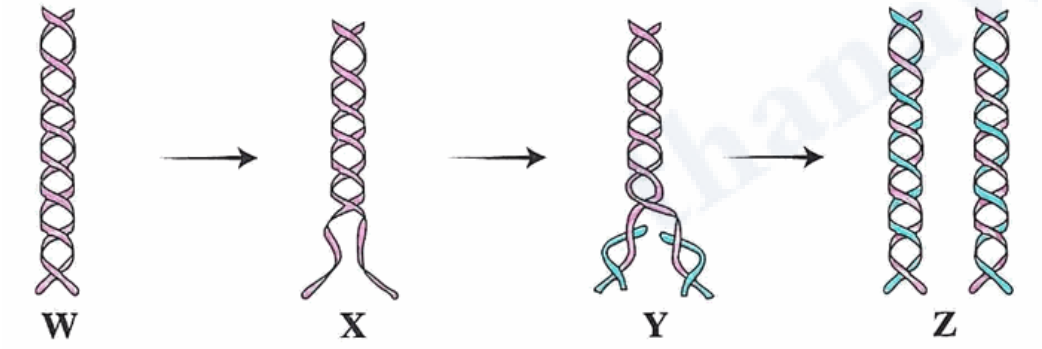
In which of the following stages are the helicase, primase and DNA polymerase enzymes all active at the same time?



(A) W (B) X (C) Y (D) Z

78 Study the following figures, then answer:

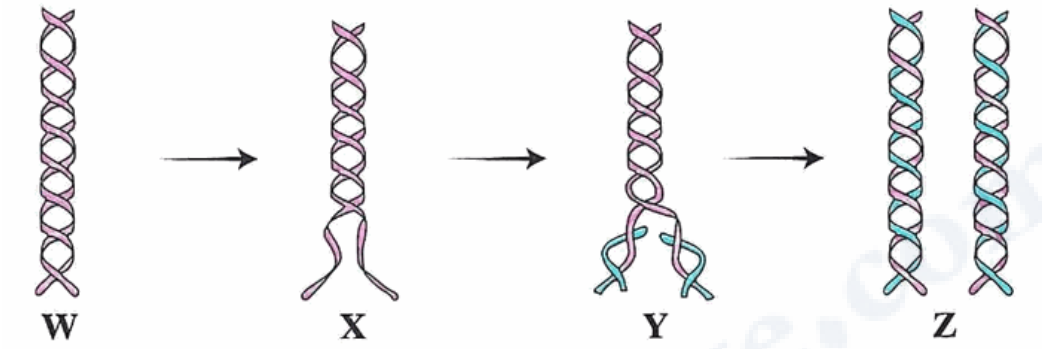
In which of the following stages are new bases added by pairing with the original bases?



(A) W (B) X (C) Y (D) Z

79 Study the following figures, then answer:

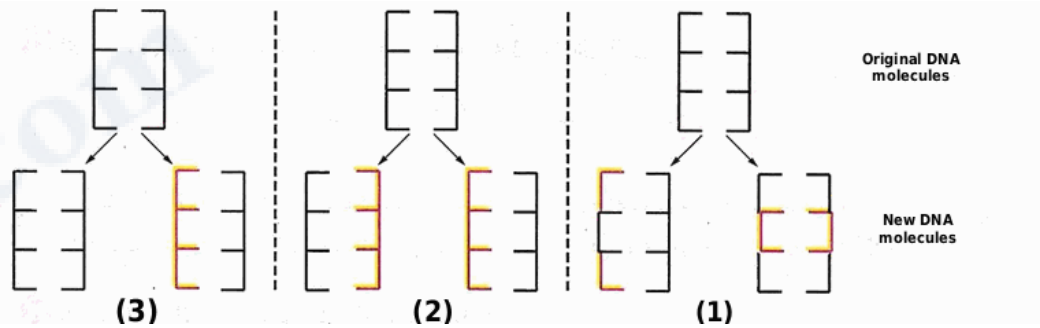
In which of the following organisms does the process shown in the figures differ from the other organisms?



(A) E. coli bacteria (B) Yeast fungus (C) Amoeba (D) Human

80 Study the following figures, then answer:

Which of the previous models represents the correct way of DNA replication?



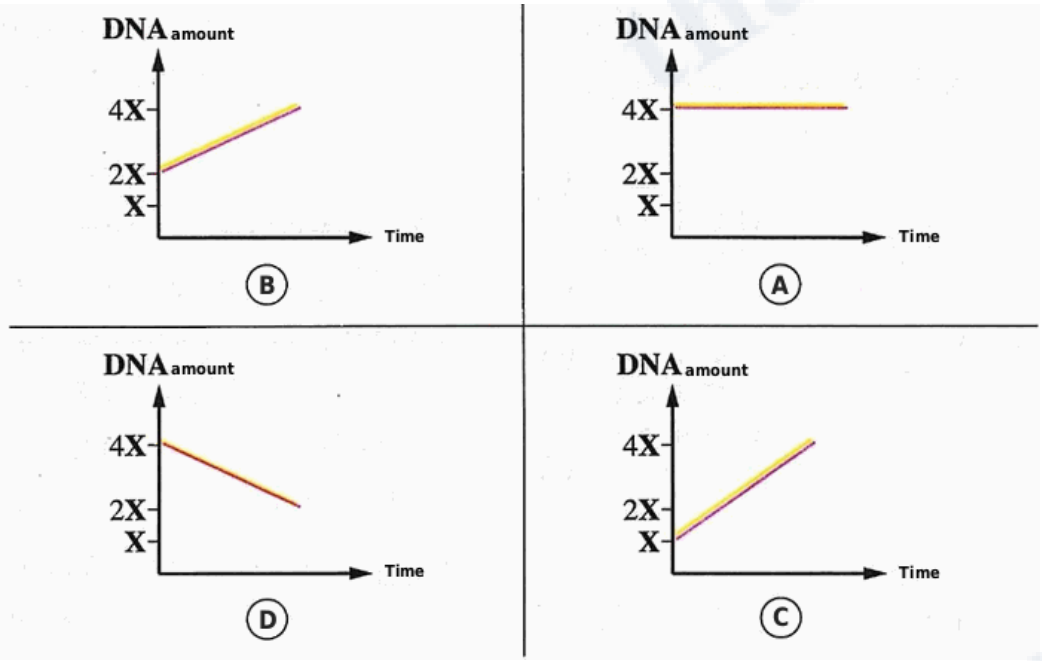
(A) (3) only (B) (1) , (2) (C) (2) only (D) (1) , (2) , (3)

81 Which of the following bonds does DNA polymerase form?

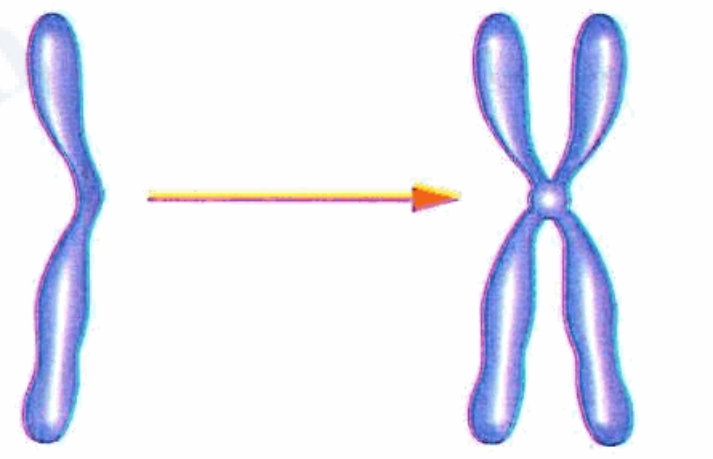
(A) Hydrogen only (B) Covalent only

(C) Ionic and covalent (D) Covalent and hydrogen

82 Which of the following graphs shows the change in the amount of DNA before the cell starts to divide?



83 The opposite figure shows one of the vital processes in eukaryotic cells. Which choice describes it?



(A) Process: binary fission , Products: two complementary DNA strands

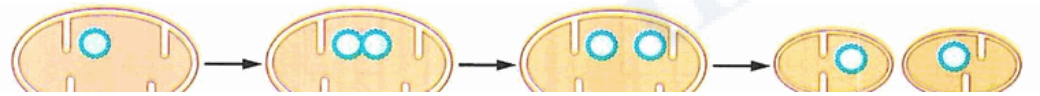
(B) Process: mitotic division , Products: two chromatids

(C) Process: fertilization , Products: a complete DNA molecule

(D) Process: DNA replication , Products: two chromatids

---

84 Which of the following must happen to start the process shown in the following figure?



(A) Unwinding DNA from a string of nucleosomes

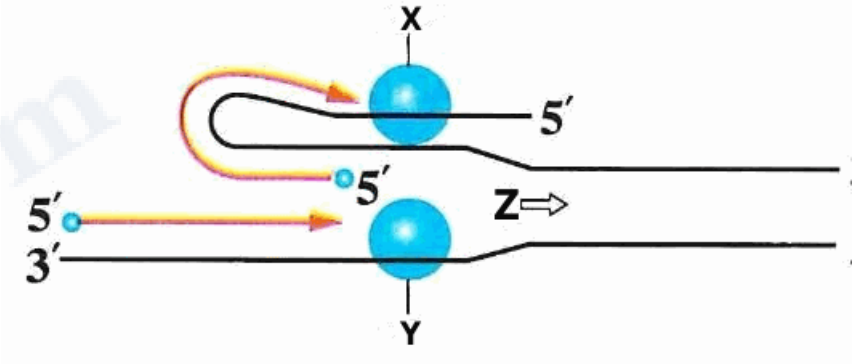
(B) Separating the two joined ends of the DNA molecule

(C) Shortening the DNA molecule using proteins

(D) The availability of DNA replication enzymes

---

85 Which of the following statements applies to the opposite figure?



(A) Letter (X) stands for the ligase enzyme and letter (Z) stands for the helicase enzyme

(B) Letter (X) stands for the ligase enzyme and letter (Y) stands for the polymerase enzyme

(C) Letter (Y) stands for the ligase enzyme and letter (Z) stands for the helicase enzyme

(D) Both letters (X) and (Y) stand for the polymerase enzyme

---

86 Which enzyme is used to build new DNA strands in the (5′ to 3′) direction for the bacteriophage?

(A) Viral helicase

(B) Bacterial ligase

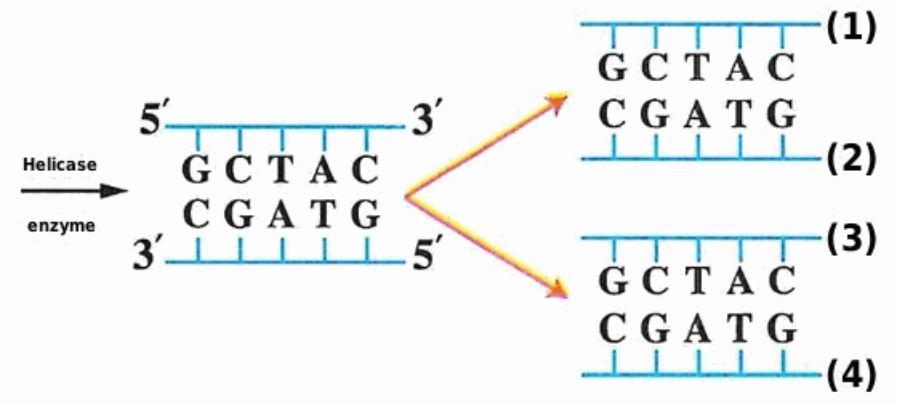
(C) Bacterial DNA polymerase

(D) Viral deoxyribonuclease

---

87 From the opposite figure:

If nucleotides labelled with radioactive nitrogen ^{15}N are used during replication, which of the opposite strands will contain ^{15}N?



(A) (1) , (3)

(B) (2) , (3)

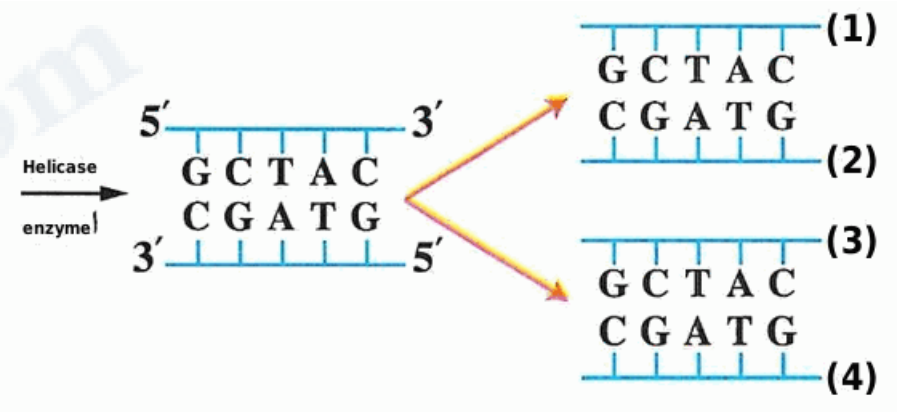
(C) (1) , (2)

(D) (1) , (4)

---

88 From the opposite figure:

Which strands need the work of ligase enzymes?



(A) (1) only (B) (1) , (3) (C) (2) , (4) (D) (2) only

---

89 Which of the following does NOT happen when one nitrogenous base in a DNA molecule is damaged?

(A) Ligase enzymes recognize the damaged site

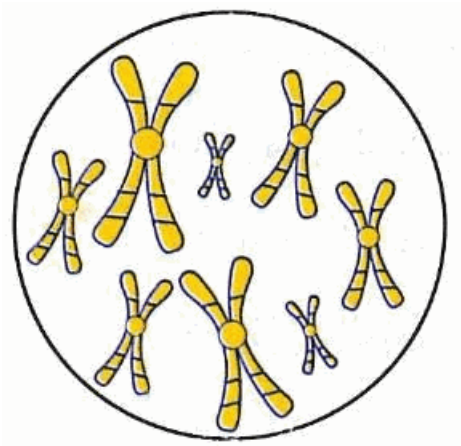
(B) The structure of DNA changes when it passes to the next generations

(C) The nucleotide with the damaged nitrogenous base is replaced by a sound one

(D) The new nucleotide pairs with the one on the opposite strand

---

90 The opposite figure shows the nucleus of a cell just before it enters mitotic division. Which of the following is the number of chromosomes in a daughter cell after division?



(A) 8 pairs of chromatids

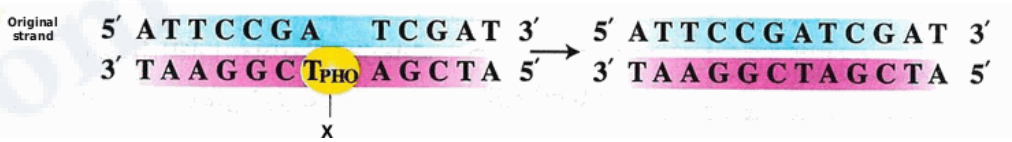
(B) 8 chromosomes, each containing one DNA molecule

(C) 4 chromatids

(D) 16 chromosomes, each containing one DNA molecule

91 From the following figure, which shows one of the steps of the replication of the two DNA strands:

Which of the following enzymes is (X)?

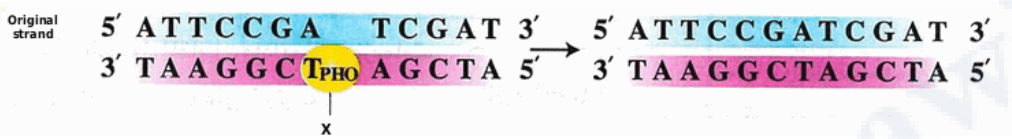


(A) Helicase only
(B) Ligase only
(C) Polymerase and helicase
(D) Polymerase or ligase

---

92 From the following figure, which shows one of the steps of the replication of the two DNA strands:

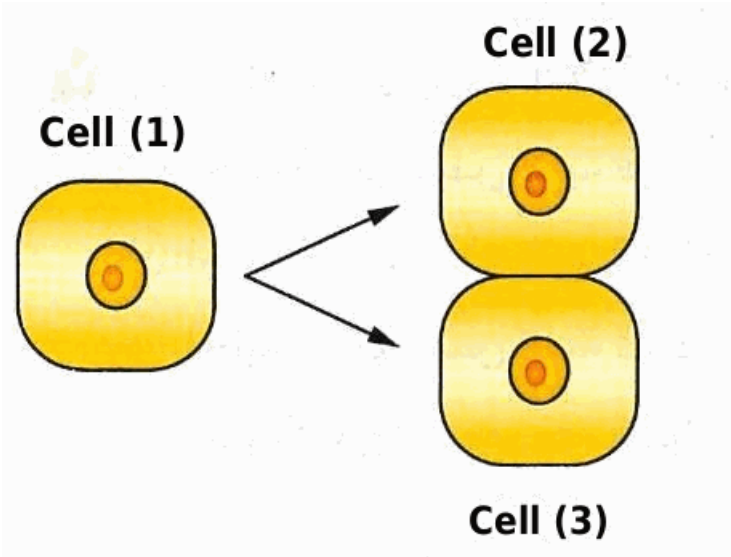
What bond does enzyme (X) form?



(A) Hydrogen only
(B) Covalent only
(C) Peptide and hydrogen
(D) Hydrogen and covalent

---

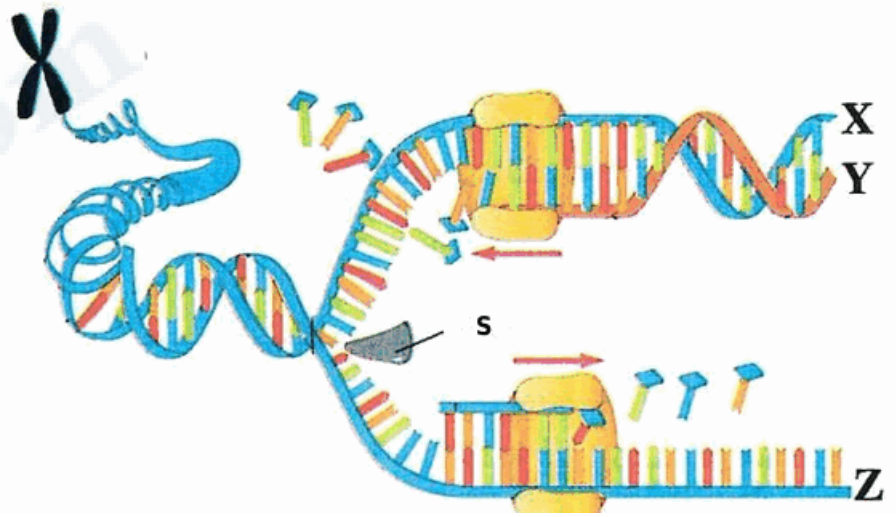
93 The opposite figure shows a human body cell just at the start of mitotic division, giving cells (2) and (3). How many DNA molecules are there in the nucleus of each of cells (1) and (2)?



(A) Cell (1): 46 , Cell (2): 23
(B) Cell (1): 46 , Cell (2): 46
(C) Cell (1): 92 , Cell (2): 23
(D) Cell (1): 92 , Cell (2): 46

---

94 The opposite figure shows the replication of a DNA molecule. Study it, then answer:
What is found at the letter (Y)?



(A) A free phosphate group
(B) A free hydroxyl group
(C) A phosphate or a hydroxyl group
(D) An amine group (NH_2)

95 The opposite figure shows the replication of a DNA molecule. Study it, then answer:
What does the letter (S) represent?



(A) The polymerase enzyme
(B) The helicase enzyme
(C) The ligase enzyme
(D) The primase enzyme

96 Which of the following ensures that the hereditary traits of most species of living organisms stay stable?

(A) Four different nucleotides in the structure of DNA

(B) The DNA molecule being double

(C) The number of purines being equal to the number of pyrimidines

(D) The difference in the sequence of nucleotides along the molecule

---

97 From the opposite table, what do the enzymes (X), (Y) and (Z) represent, respectively?

Breaks the covalent bonds between the nucleotides in a DNA molecule	**Enzyme (X)**
Forms covalent bonds in a DNA molecule	**Enzyme (Y)**
Breaks the hydrogen bonds in a DNA molecule	**Enzyme (Z)**

(A) Ligase / Helicase / Polymerase

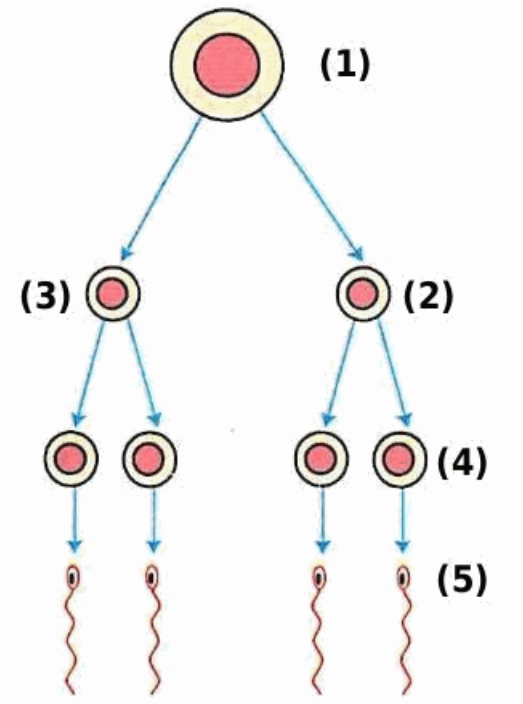
(B) Helicase / Ligase / Deoxyribonuclease

(C) Deoxyribonuclease / Polymerase / Helicase

(D) Polymerase / Helicase / Ligase

---

98 The opposite figure shows some stages of sperm formation in the human male. Which of the following statements must apply to the amount of adenine bases in the DNA of these cells?



(A) Cell (2) has the same amount of adenine bases as cell (1)

(B) Cell (2) has twice the amount of adenine bases in cell (3)

(C) Cell (4) has the same amount of adenine bases as cell (5)

(D) Cell (4) has twice the amount of adenine bases in cell (2)

---

99 The absence of which of the following enzymes causes the death of the zygote and failure of pregnancy?

(A) Helicase

(B) Deoxyribonuclease

(C) Hyaluronidase

(D) Cholinesterase

---

100 Study the following scheme:

DNA → (replication in a medium with radioactive sulfur) → 2(DNA) → (replication in a medium with radioactive sulfur) → 4(DNA)

What is the percentage of DNA molecules exactly identical to the original DNA after replication?

(A) Zero %

(B) 25 %

(C) 50 %

(D) 100 %

---

101 Why are some viruses affected by mutation at a faster rate than bacteria?

(A) Their genetic material is a single RNA strand

(B) They cannot change

(C) They use the metabolism of the host cell

(D) They are surrounded by a complex protein coat

---

102 In a laboratory experiment, a bacterial cell was placed in a nutrient medium containing radioactive thymine and was left to reproduce once, so .....

(A) Only one of the two daughter cells contains DNA with radioactive thymine

(B) The DNA in the two daughter cells has only radioactive thymine

(C) The DNA in the two daughter cells has a mixture of radioactive and non-radioactive thymine

(D) The bacterial cell cannot divide because radioactive adenine is absent

---

Essay questions — 10 questions

1 The opposite table shows the percentages of the nitrogenous bases of a DNA molecule in two cells of the same rabbit. What do you conclude from:

(1) comparing the percentages of the nitrogenous bases in the rabbit liver cell with their percentages in the rabbit skin cell? Explain your answer.

(2) comparing the percentages of the nitrogenous bases in the rabbit liver cell with each other? Explain your answer.

Percentages of the nitrogenous bases in DNA molecules				
Nitrogenous bases				
G	C	T	A	
21.6%	21.4%	28.3%	28.2%	Rabbit liver cell
21.6%	21.4%	28.3%	28.2%	Rabbit skin cell

2 If the sequence of the nitrogenous bases in a piece of one of the two strands of a DNA molecule is:

5′... C - A - G - G - T - A - C - T - G ...3′

(1) What is the sequence of the bases in the other strand of this piece?

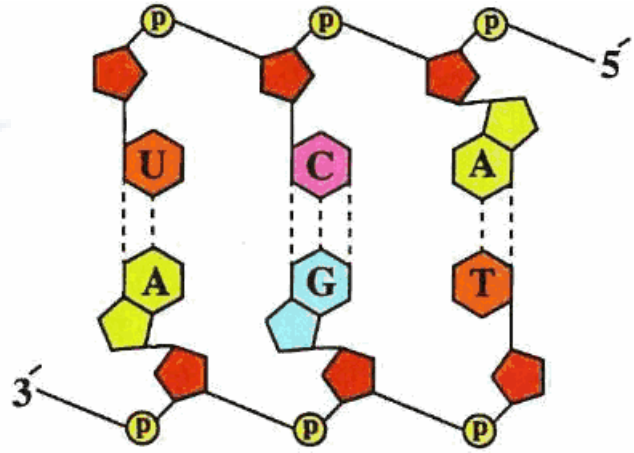
(2) What evidence did you rely on to determine the sequence of bases you gave?

3 If the percentage of adenine in one strand of a DNA molecule is 10% and the percentage of thymine in the same strand is 30%, what is the percentage of guanine in this molecule?

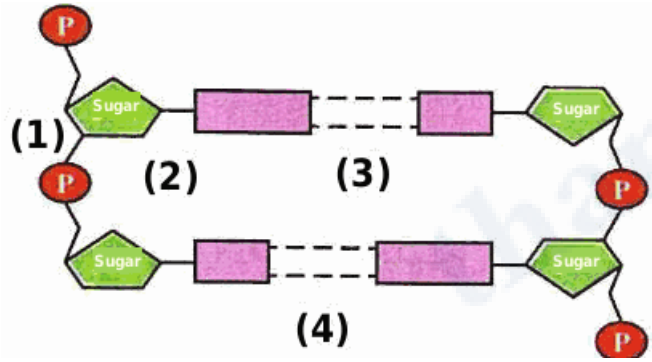
4 A gene is made of 36 nucleotides joined to each other by three hydrogen bonds and 18 nucleotides joined to each other by two hydrogen bonds. How many purine nucleotides are there in this gene?

5 A DNA molecule has 300 hydrogen bonds between adenine and thymine and 300 bonds between guanine and cytosine. How many turns does this molecule have?

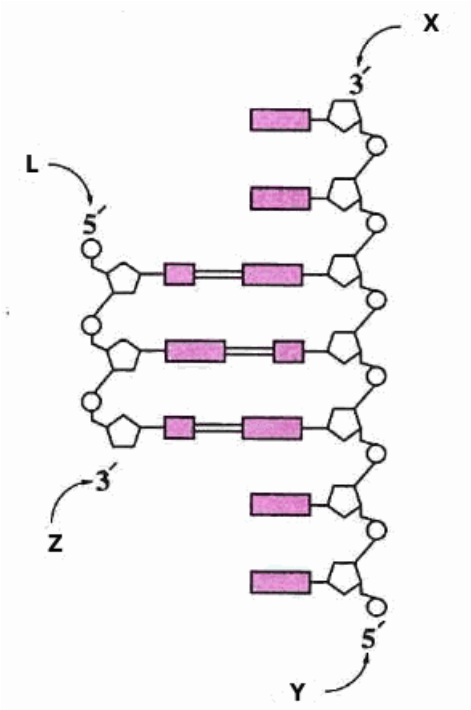
6 Identify two mistakes in the piece of DNA in front of you.



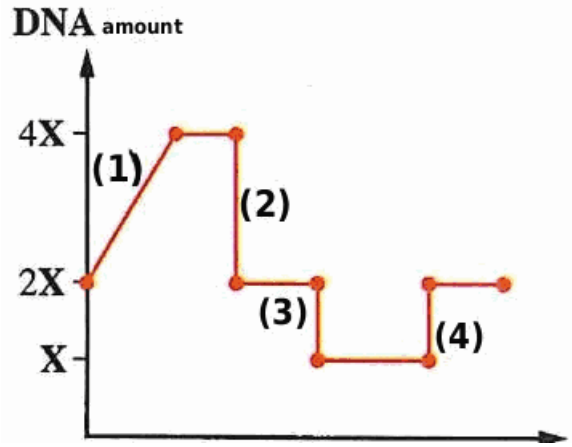
7 From the opposite figure, which bonds break when this molecule replicates? Explain your answer.



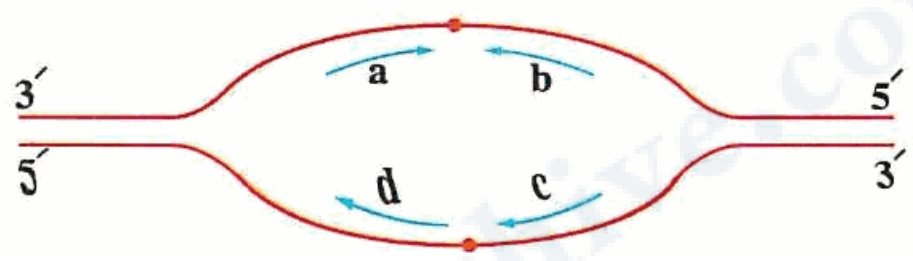
8 The opposite figure shows a DNA molecule during replication. At which part does the DNA polymerase enzyme add new nucleotides?



9 From the opposite graph, identify the stage during which the helicase enzymes work. Explain your answer.



10 In the opposite figure, which arrow represents a wrong direction during DNA replication? Explain your answer.

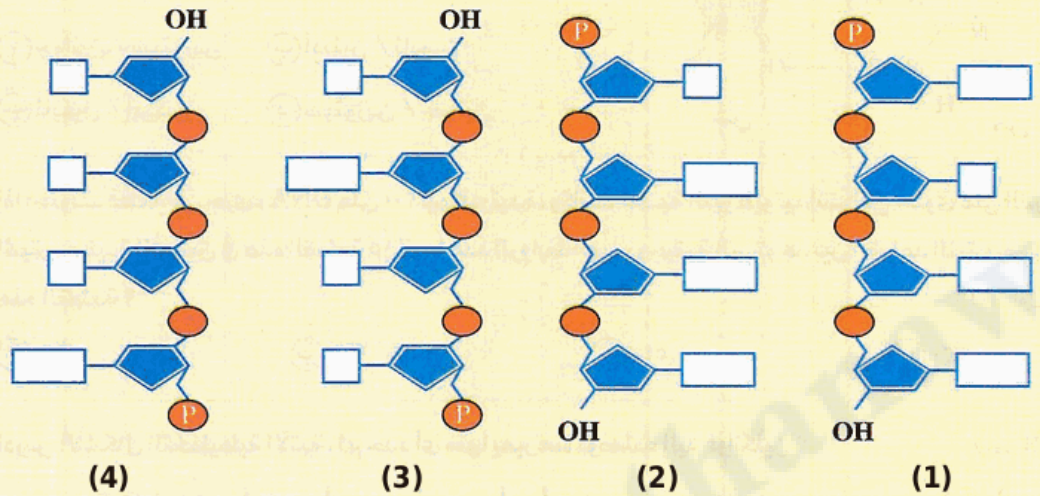


Past exam questions — 41 questions

1 If the percentage of thymine on one DNA strand is 20%, what is the percentage of adenine on the same strand? (Trial exam / June 2021)

(A) 20% (B) 30% (C) 80% (D) Unknown

2 Study the following figures, which show a number of nucleic acid strands, then identify:
Which two strands can be used to build a DNA helix? (1st session 2021)



(A) (1) , (3) (B) (1) , (4) (C) (2) , (3) (D) (2) , (4)

3 Which of the following organisms gives results different from what Franklin reached when the X-ray diffraction technique is used on its genetic material? (1st session 2021)

(A) Bacteriophage virus
(B) Pneumonia bacteria, strain (S)
(C) Pneumonia bacteria, strain (R)
(D) Polio virus

4 If the percentages of the nitrogenous bases in the template DNA strand are as follows:
A = 15% , G = 45% , C = 10% , T = 30%
Which nitrogenous base must be present at 30% to produce the strand complementary to this strand? (1st session 2021)

(A) A (B) G (C) C (D) T

5 By chemical analysis of DNA from different sources, Chargaff found that pyrimidine bases equal purine bases. Which of Watson and Crick's conclusions agrees with Chargaff's results? (2nd session 2021)

(A) One of the two DNA strands is in a position opposite to the other

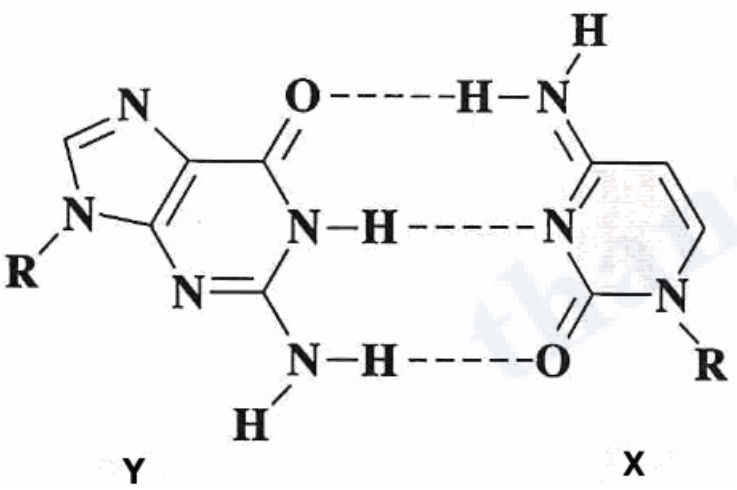
(B) (A) binds with (T), and (G) binds with (C)

(C) DNA makes one turn every 10 nucleotides on one strand

(D) The sugar-phosphate backbone forms the sides of the ladder and the bases form the rungs

---

6 The opposite figure shows two nitrogenous bases bound together. What do (X) and (Y) represent, respectively? (2nd session 2021)



(A) Guanine / Cytosine

(B) Adenine / Thymine

(C) Thymine / Adenine

(D) Cytosine / Guanine

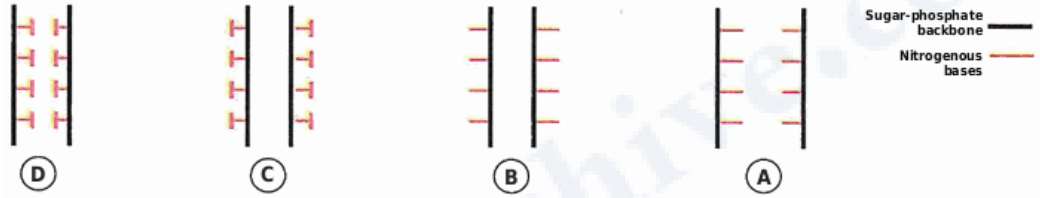
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7 If a piece of a DNA molecule contains 200 nucleotides, and the nucleotides containing the nitrogenous base adenine make up 15% of this piece, how many hydrogen bonds are there between the nitrogenous bases in this piece? (1st session 2022)

(A) 210 (B) 270 (C) 540 (D) 230

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8 Study the following diagrams, then identify which of them shows what Franklin found. (2nd session 2022)



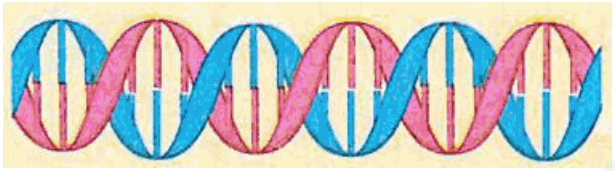
9 Which of the following organisms gives the following result when the X-ray diffraction technique is used on its genetic material (the nitrogenous bases are perpendicular to one side of a single sugar-phosphate backbone)? (Trial exam 2023)

(A) Bacteriophage
(B) Escherichia coli bacteria
(C) Polio virus
(D) Pneumonia bacteria, strain (S)

10 What is the ratio between the number of turns in a DNA molecule and the number of pairs of nitrogenous bases, respectively? (1st session 2023, Sample exam 2025)

(A) 20 turns : 1 pair (B) 1 turn : 20 pairs (C) 10 turns : 1 pair (D) 1 turn : 10 pairs

11 The opposite figure shows a piece of a DNA molecule. Study it, then deduce how many nitrogenous bases are found in this piece. (1st session 2024)



(A) 60 (B) 30 (C) 24 (D) 6

12 Which of the following is NOT one of the results of the X-ray diffraction images obtained by Franklin? (2nd session 2024)

(A) The sugar-phosphate backbone of the DNA molecule surrounds the nitrogenous bases from the outside
(B) The DNA molecule is made of more than one strand
(C) The DNA molecule is made of sugar, phosphate and nitrogenous bases
(D) The DNA molecule is found in the shape of a double helix

13 A short piece of DNA contains 80 thymine bases and 80 guanine bases. The total number of nucleotides in the piece of DNA is ..... (Sample exam 2025)

(A) 160 (B) 40 (C) 320 (D) 640

14 Which of the choices in the following table applies to the base guanine? (Sample exam 2025)

Number of rings	Number of hydrogen bonds	Attached to	Complementary base	
1	3	Carbon atom 1 of ribose	C	(A)
1	2	Carbon atom 3 of ribose	A	(B)
2	3	Carbon atom 1 of deoxyribose	C	(C)
2	2	Carbon atom 5 of deoxyribose	G	(D)

15 If the number of adenine bases in five turns of a piece of a DNA molecule is 20, how many ladder rungs, each containing three hydrogen bonds, are there in this piece of the DNA molecule? (1st session 2025)

(A) 20 (B) 30 (C) 40 (D) 60

16 Why is the width / diameter of the DNA double helix regular? (Sample exam 2026)

(A) Because the width of each base pair equals three carbon rings

(B) Because each base pair is in a position opposite to the other

(C) Because the number of hydrogen bonds between the bases is equal

(D) Because the width of each base pair equals two nitrogenous bases

17 What is the importance of having a complementary sequence of nitrogenous bases in the two DNA strands? (Sample exam 2026)

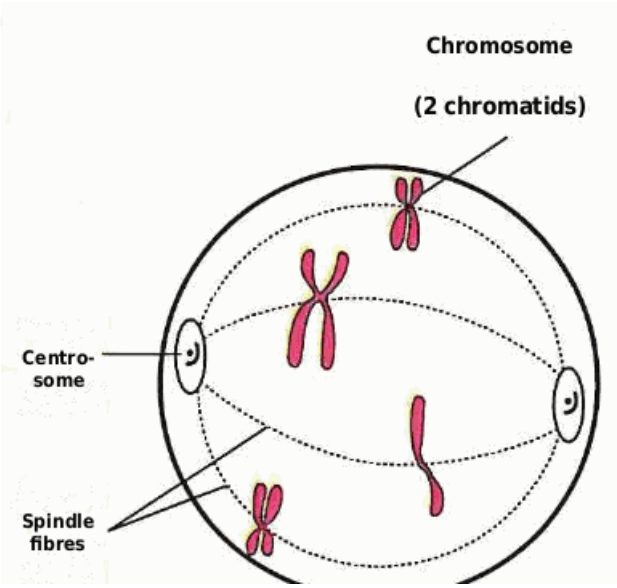
(A) It allows the molecule to coil and form a double helix whose ends are joined together

(B) It allows each strand to be a template for building the new strand

(C) It gives the sugar-phosphate backbone the position opposite to the other

(D) It increases genetic variation

18 Knowing that a chromosome is made of one chromatid before DNA replication, and after replication the chromosome is made of 2 chromatids, the opposite figure shows a cell at the start of division. What can be concluded from it? (1st session 2021)



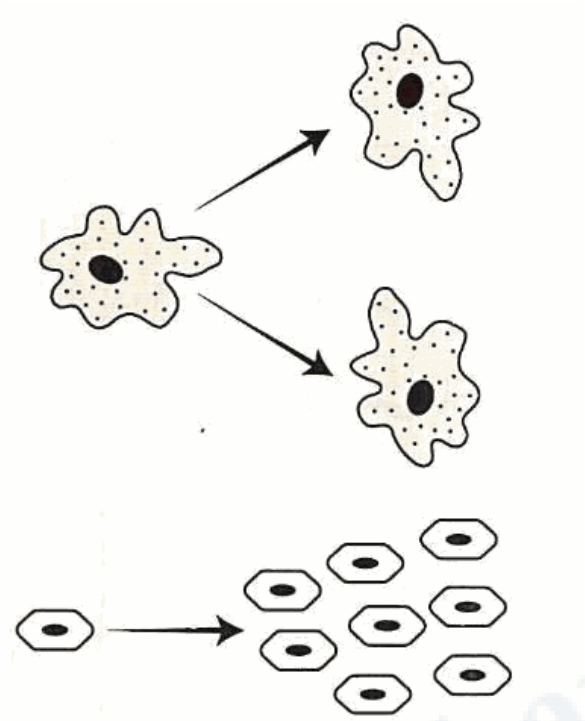
(A) The two resulting cells contain the same amount of DNA

(B) The two resulting cells contain the same number of chromosomes

(C) The genetic content was replicated before division

(D) There was a fault in DNA replication

19 Study the opposite drawing, which shows binary fission in amoeba and the division of liver cells in humans. What process do these cells carry out to produce cells exactly like the original in all genetic information? (1st session 2021)



(A) DNA replication before the division of the nucleus

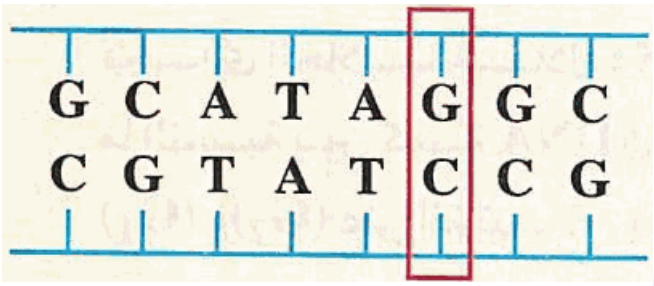
(B) Transcription of mRNA to produce the same proteins

(C) Activity of ligase enzymes to repair DNA defects

(D) Transcription of rRNA to form ribosomes

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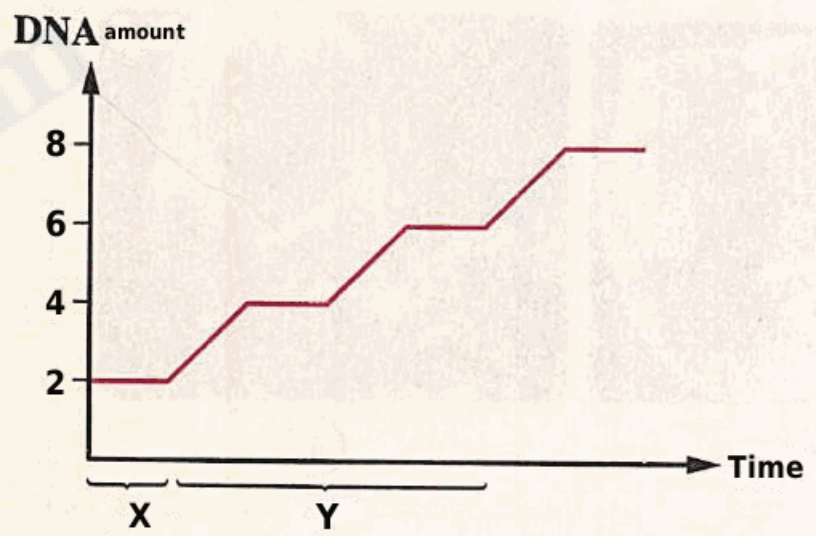
20 Study the opposite figure, which shows the loss of the marked bases at the same time during DNA replication. Assuming this damage was repaired by adding two nucleotides instead of the two damaged ones, what is the percentage of repairing this defect of the damaged bases so that they return to the original structure? (2nd session 2021)



(A) 75% (B) 100% (C) 25% (D) 0%

---

21 The opposite graph shows the amount of DNA inside a plant cell during the two periods (X) and (Y). How many cells will be formed at the end of period (Y)? (2nd session 2021)



(A) One cell with 3 times the genetic material of the original cell

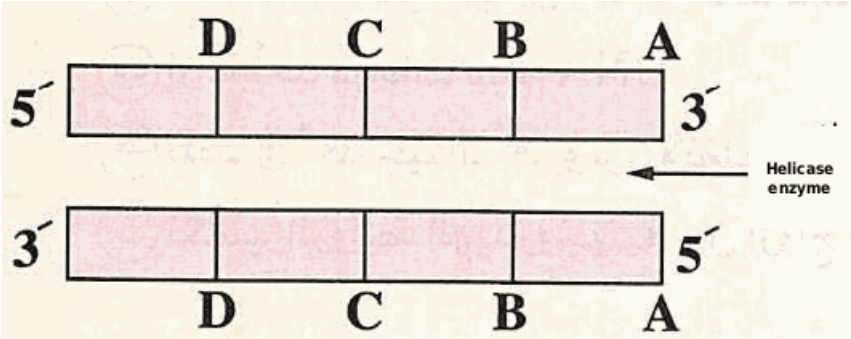
(B) One cell with 4 times the genetic material of the original cell

(C) 8 cells, each with 4 times the genetic material of the original cell

(D) 8 cells, each with the same amount of genetic material as the original cell

---

22 The opposite figure shows DNA replication. Assuming the helicase enzyme separates the two DNA strands starting from (A) to (D), what is the correct order of the direction of the polymerase enzyme's work on the template DNA strand $(3' \rightarrow 5')$ during replication? (2nd session 2021)



(A) B → A, then C → B, then D → C

(B) C → D, then B → C, then A → B

(C) A → B, then B → C, then C → D

(D) D → C, then C → B, then B → A

23 Which process will not stop when the deoxyribonuclease enzyme is added? (1st session 2022)

(A) Reproduction of the phage inside bacterial cells

(B) Bacterial transformation

(C) DNA replication

(D) Reproduction of the influenza virus inside body cells

24 Which of the following cases is NOT preceded by DNA replication? (1st session 2022)

(A) Replacing damaged skin cells

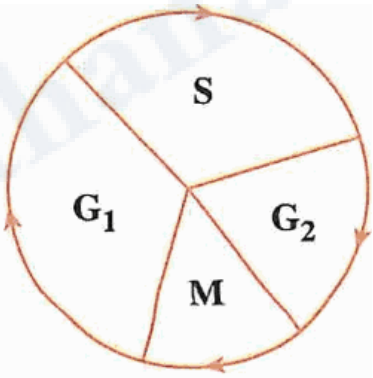
(B) Forming spermatogonia

(C) Forming primary spermatocytes

(D) Replacing red blood cells in the bone marrow

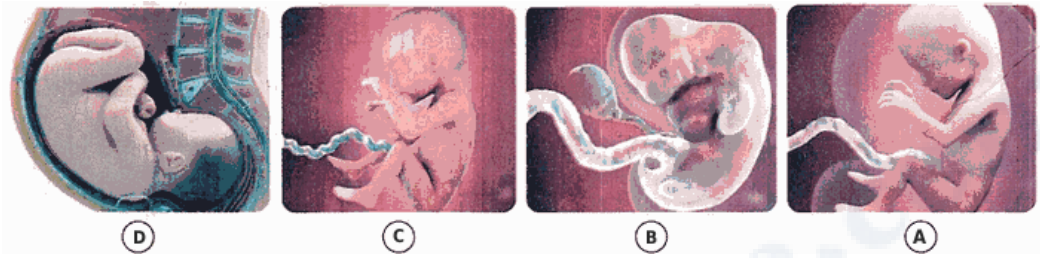
25 The opposite figure shows the cell cycle of a cell during 24 hours. What is the ratio between the amount of DNA in phases (G_1) and (G_2), respectively? (2nd session 2022)

Features	Phase
Mitotic division	M
Duplication of the cell contents	G_1
DNA replication	S
Growth of the cell in size	G_2



(A) 2 to 1 (B) 1 to 1 (C) 1 to 4 (D) 1 to 2

26 During which of the following stages of human embryonic development does the highest rate of DNA replication take place in the cells of the embryo? (Trial exam 2023, Sample exam 2025)



27 Which damage can be repaired using DNA repair enzymes? (Trial exam 2023)

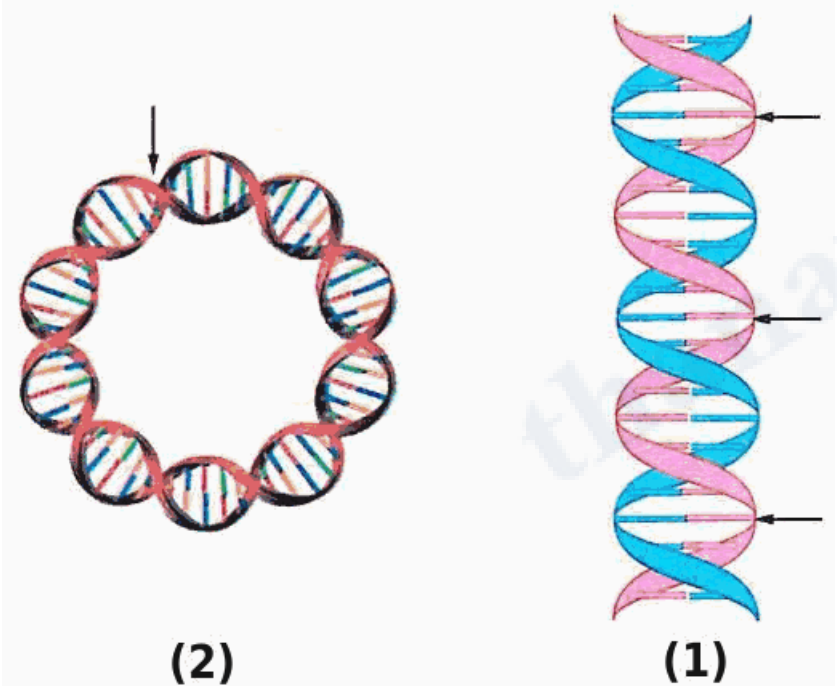
(A) Damage to a purine base in one of the rungs of the DNA ladder

(B) Removal of one of the rungs of the DNA ladder

(C) Damage to one of the genes of the influenza virus

(D) Breaking the hydrogen bonds between the pairs of nitrogenous bases

28 Study the two opposite figures, which show two forms of DNA molecules (1) and (2), where the arrows point to the sites where the same vital process takes place, then deduce the difference between the process in figures (1) and (2). (Trial exam 2023, Sample exam 2025)



(A) The final product of the process

(B) The type of enzymes used

(C) The purpose of the process

(D) The starting point of the process

29 Why is a defect in the genetic material of the polio virus not repaired inside the host cell? (1st session 2023, Sample exam 2025)

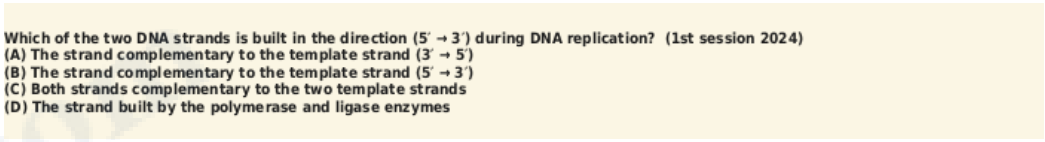
(A) Because ligase enzymes are absent inside the host cell

(B) Because the genetic material of the virus is made of a single strand

(C) Because ligase enzymes are specialized to repair defects in the host's genetic material only

(D) Because the genetic material of the virus does not enter the nucleus of the host cell

30 Which of the two DNA strands is built in the direction shown in the figure during DNA replication? (1st session 2024)



31 What is the structure of each chromosome in eukaryotes? (1st session 2024)

(A) 2 DNA molecules
(B) One DNA molecule
(C) One DNA strand
(D) A single-stranded DNA molecule

32 Study the following table, which shows four different types of viruses that differ from each other in the type of genetic material, then deduce:
Which of these viruses cannot have the defects of its genetic material repaired if a defect happens in one of the strands of this material? (1st session 2024)

Parvo virus	Herpes virus	Hepatitis (C) virus	Rice dwarf virus	Virus
DNA single-stranded	DNA double-stranded	RNA single-stranded	RNA double-stranded	Type of genetic material

(A) Herpes virus , Parvo virus
(B) Hepatitis (C) virus , Rice dwarf virus
(C) Hepatitis (C) virus , Parvo virus
(D) Herpes virus , Rice dwarf virus

33 Which of the following does NOT describe the work of the polymerase enzyme? (2nd session 2024)

(A) It forms covalent bonds between the two neighbouring nucleotides in the new strand
(B) It adds the 5′ end of the new nucleotide to the 3′ end of the previous nucleotide
(C) It adds a hydroxyl group of the new nucleotide to the previous phosphate group
(D) It adds nucleotides to the 3′ end of the new strands

34 A DNA molecule in which both strands contain radioactive thymine is allowed to replicate in an environment containing non-radioactive thymine. What is the correct number of DNA molecules containing some radioactive thymine after three replications? (Sample exam 2025)

(A) One molecule (B) Two molecules (C) 4 molecules (D) 8 molecules

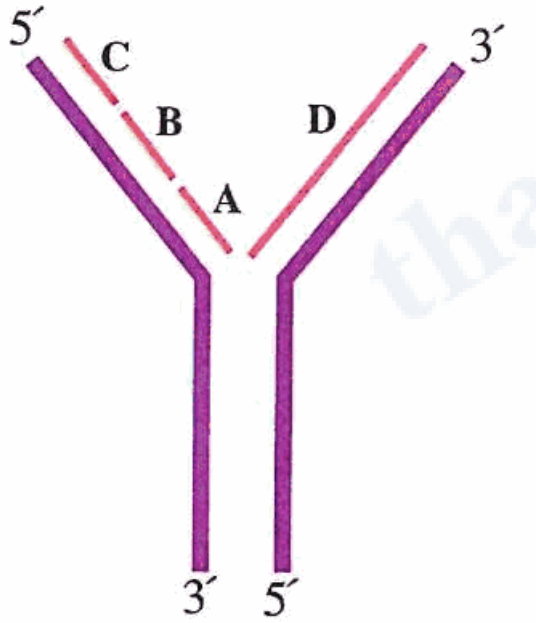
35 At which of the following ends does the primase enzyme start working during DNA replication? (1st session 2025)

(A) The (5′) end of the template strand
(B) The (5′) end of the new strand
(C) The (3′) end of the template strand
(D) The (3′) end of the new strand

36 If a cell contains 4 pairs of homologous chromosomes, how many DNA molecules make up these chromosomes and will be replicated before the cell divides? (2nd session 2025)

(A) 4 DNA molecules
(B) 8 DNA molecules
(C) Selected parts of 4 DNA molecules
(D) Selected parts of 8 DNA molecules

37 From the opposite figure, which of the fragments marked with the letters (A) to (D) are built (polymerized) by one type of enzyme? (2nd session 2025)



(A) (D) only
(B) (A) and (D)
(C) (A) and (B) and (C)
(D) (A) and (B) and (C) and (D)

38 How many primers are used while forming the lagging DNA strand? (Sample exam 2026)

(A) One
(B) A number equal to the number of genes
(C) A number equal to the number of Okazaki fragments
(D) An unlimited number

39 The lagging strand differs from the leading strand by having Okazaki fragments. What is the reason these fragments form during DNA replication? (Sample exam 2026)

(A) Because the polymerase enzyme works only in the 5′ to 3′ direction on the new strand

(B) Because the polymerase enzyme cannot start making a new strand without a primer

(C) Because one of the two template strands is in a position opposite to the other

(D) Because the helicase enzyme separates the two strands of the DNA molecule in one direction only

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40 If a cell is treated with a chemical compound that inhibits the ligase enzyme, which of the following is most likely in the cells resulting from division? (Sample exam 2026)

(A) Forming Okazaki fragments that are shorter and more numerous than usual

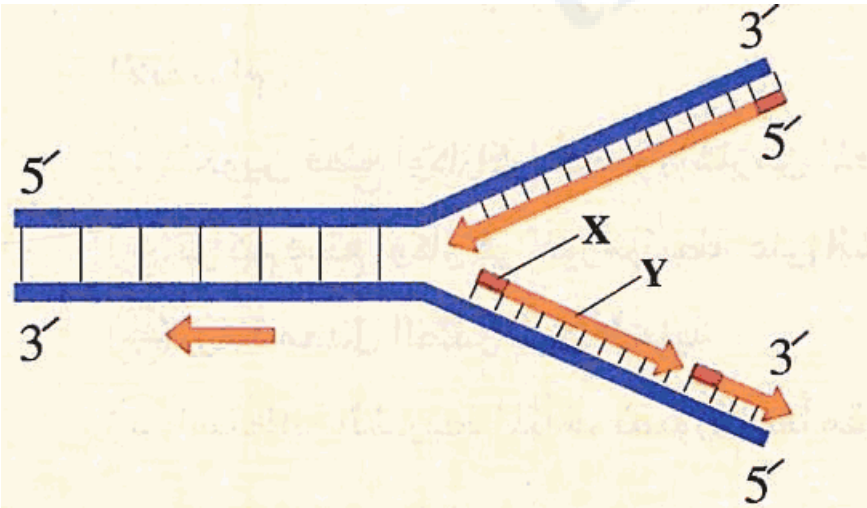
(B) Accumulation of unjoined Okazaki fragments on the lagging strand

(C) An increase in the mutation rate in the cell

(D) The lagging strand lengthening more slowly than the leading strand

---

41 What is the chemical difference between structure (X) and structure (Y) shown in the opposite figure? (Sample exam 2025)



Answer key and solutions

Multiple choice questions

1 A	2 D	3 C	4 C	5 B	6 D	7 D	8 A	9 C	10 D
11 B	12 D	13 C	14 B	15 D	16 D	17 C	18 D	19 C	20 C
21 C	22 C	23 B	24 D	25 D	26 A	27 B	28 D	29 B	30 D
31 C	32 D	33 D	34 B	35 B	36 D	37 B	38 B	39 B	40 D
41 C	42 B	43 A	44 C	45 A	46 A	47 C	48 C	49 D	50 A
51 A	52 B	53 C	54 A	55 B	56 B	57 B	58 B	59 D	60 D
61 B	62 C	63 D	64 C	65 B	66 D	67 B	68 B	69 A	70 D
71 A	72 B	73 C	74 D	75 B	76 A	77 C	78 C	79 A	80 C
81 B	82 B	83 D	84 D	85 D	86 C	87 B	88 D	89 B	90 B
91 B	92 B	93 D	94 A	95 B	96 B	97 C	98 C	99 A	100 D
101 A	102 C								

1 **Answer (A)**

$A = T$ and $G = C$.

If $A + G = 200$, then $T + C = 200$ as well.

2 **Answer (D)**

C binding with G and T binding with A is evidence of two complementary strands.

3 **Answer (C)**

One turn has 10 base pairs; A–T has two bonds and G–C has three bonds.

$2a + 3g = 26$, $a + g = 10$

$a = 4$, $g = 6$

The ratio is 2 : 3.

4 **Answer (C)**

5 turns = 50 pairs = 100 nucleotides.

$A + G = 50$, so if $A = 30$ then $G = 20$, not 30.

5 **Answer (B)**

The total number does not give the ratios of the bases, so the number of adenine nucleotides cannot be found.

6 **Answer (D)**

Hydrogen bonds join the two strands, so they keep the shape of the helix stable.

7 **Answer (D)**

Covalent within each strand, and hydrogen between the two strands.

8 **Answer (A)**

Number of sugars = number of phosphates = number of bases = number of nucleotides.

But the two strands are complementary, not identical.

9 **Answer (C)**

C = G in the whole molecule, so their percentages are equal.

10 **Answer (D)**

DNA has two complementary strands, and figure (D) is a single strand.

11 **Answer (B)**

Thymine binds with adenine by two bonds, while cytosine binds with guanine by three bonds.

12 **Answer (D)**

One turn has 10 pairs = 20 nucleotides, so two turns = 40.

13 **Answer (C)**

(X) has a CH3 group, so it is thymine, and it binds by two bonds with adenine (Y).

(Z) is cytosine, which binds by three bonds with guanine (L).

14 **Answer (B)**

The cat and the dog are two different species, so the sequence of nucleotides differs between them.

15 **Answer (D)**

The complementary strand is antiparallel to the template; opposite the template C-A-C-T-G-G is the strand G-T-G-A-C-C.

So it is 3´...G-T-G-A-C-C...5´

16 **Answer (D)**

A complete turn has 10 pairs, and the figure has 6 pairs.

4 more pairs are needed, i.e. 8 nucleotides.

17 **Answer (C)**

C and G are joined by three bonds, and A and T by two bonds.

$3 + 2 + 3 + 2 + 3 + 3 = 16$

18 **Answer (D)**

Adenine in the double helix = A + T in this strand = 6 + 3 = 9 out of 36 bases.

$9/36 = 1/4$, i.e. 25 %.

19 **Answer (C)**

T in the complementary strand = A in this strand = 6 out of 18.

$6/18 = 1/3$, i.e. 33.33 %.

20 **Answer (C)**

21 **Answer (C)**

The number of each base in strand (2) equals the number of its complementary base in strand (1).

(X) equals the number of T, so it is A, and (Y) equals the number of C, so it is G.

(Z) equals the number of A, so it is T, and (L) equals the number of G, so it is C.

22 **Answer (C)**

$A = T$ and $C = G$, so the ratio $(A+C)/(T+G) = 1$ always.

But $(A+T)/(C+G)$ differs from one organism to another.

23 **Answer (B)**

Hydrogen bonds need complementary bases, so they do not form between two identical strands.

24 **Answer (D)**

Franklin's studies showed the shape and the diameter of the molecule; how it is built was proposed by Watson and Crick.

25 **Answer (D)**

Each nucleotide has one sugar (D) and one phosphate group (P), so their numbers are equal.

26 **Answer (A)**

Cytosine is a single-ring pyrimidine base, and it binds with guanine by three bonds.

27 **Answer (B)**

(X) is a phosphate group, and (Y) is deoxyribose sugar.

(Z) is a two-ring base joined by two bonds, so it is adenine.

28 **Answer (D)**

Genetic information varies with the order of the nucleotides.

29 **Answer (B)**

Total number of nucleotides: $300 \div 0.15 = 2000$

One turn is 20 nucleotides: $2000 \div 20 = 100$ turns.

30 **Answer (D)**

$300 \times 2 = 600$ nucleotides.

$600 - 140 = 460$

31 **Answer (C)**

Each strand has a 5′ end with a free phosphate group, so the total is 2.

32 **Answer (D)**

The given strand A C C T G C C A G has 4 purines.

The complementary strand T G G A C G G T C has 5 purines.

The total is 9.

33 **Answer (D)**

$210000 \times 2 = 420000$ nucleotides.

34 **Answer (B)**

One turn is 10 pairs: $210000 \div 10 = 21000$ turns.

35 **Answer (B)**

Pairing means $A = T$ and $C = G$.

This holds in samples (1) and (3), but not in sample (2).

36 **Answer (D)**

The free 3′ end has a hydroxyl group.

37 **Answer (B)**

The letter (Y) points to deoxyribose sugar.

38 **Answer (B)**

$A + G = T + C$, so the number of purines equals the number of pyrimidines.

39 **Answer (B)**

$G = C = 17\%$, so $A + T = 66\%$

$T = 33\%$

40 **Answer (D)**

$A = 12 + 29 = 41$, so $T = 41$

$G + C = 168 - 82 = 86$

$C = 86 \div 2 = 43$

41 **Answer (C)**

Genes vary with the order of the nitrogenous bases.

42 **Answer (B)**

Hydrogen bonds determine the structural shape of both the DNA molecule and the antibody molecule.

43 **Answer (A)**

One turn has 20 bases, and $A = T = 10$ make up the whole number.

So there are no G or C bases.

44 **Answer (C)**

A and T are the bases that are joined by two bonds.

The strand has 5 of them (A, T, T, A, A).

45 **Answer (A)**

The bonds of the sugar-phosphate backbone are covalent only.

46 **Answer (A)**

$A = T$ and $C = G$, so it is DNA in the form of a double helix.

47 **Answer (C)**

Number of nucleotides = number of sugars = number of phosphates = 1200.

48 **Answer (C)**

$G = C = 400$, $T = A = 200$

Pyrimidines $= T + C = 200 + 400 = 600$

49 **Answer (D)**

A–T: $200 \times 2 = 400$

G–C: $400 \times 3 = 1200$

The total is 1600.

50 **Answer (A)**

$1200 \div 20 = 60$ turns.

51 **Answer (A)**

Each strand has a 5′ end with a free phosphate, so the total is 2.

52 **Answer (B)**

Number of purines = number of pairs = 180.

$180 \div 10 = 18$ turns.

53 **Answer (C)**

$150 \times 10 = 1500$ pairs.

54 **Answer (A)**

55 **Answer (B)**

Base (1) binds with (4) by two bonds, and base (2) binds with (3) by three bonds.

And the two strands run in opposite directions (5′ to 3′, then 3′ to 5′), so figure (B) is the correct one.

56 **Answer (B)**

$A = T = 200$, $G = C = (700 - 400)/2 = 150$

A–T: $200 \times 2 = 400$ bonds

G–C: $150 \times 3 = 450$ bonds

The total is $400 + 450 = 850$

57 **Answer (B)**

The two genes are alike in the number and type of nucleotides and in the number of hydrogen bonds.

They differ in the order of the nucleotides because they are two different genes.

58 **Answer (B)**

The width of the ladder rungs is constant along DNA, so the distance between the two strands is the same and equals X.

59 **Answer (D)**

In (1) replication starts at several points (3 arrows), and in (2) at one point.

60 **Answer (D)**

A virus replicates only inside a living host cell.

61 **Answer (B)**

Primers are made of RNA, which has uracil instead of thymine.

62 **Answer (C)**

Okazaki fragments are built on the lagging strand, in the 5′ to 3′ direction.

63 **Answer (D)**

64 **Answer (C)**

Strand (L) was copied on strand (Y), so it is identical to strand (X).

65 **Answer (B)**

The complementary bases separate when the hydrogen bonds between them break, including cytosine and guanine.

66 **Answer (D)**

Primers are made of RNA, which has uracil instead of thymine.

67 **Answer (B)**

The leading strand needs one primer, and the lagging strand needs one primer for each Okazaki fragment (X).

So the number is X + 1.

68 **Answer (B)**

Replication needs DNA nucleotides, and forming the primers needs RNA nucleotides.

69 **Answer (A)**

The reaction breaks the hydrogen bonds between the bases, which is the job of the helicase enzyme.

70 **Answer (D)**

(S) is a drop from 4X to 2X, so it is mitotic division.

(Y) is a drop from 4X to 2X and then to X, so it is the first meiotic division (followed by the second meiotic division).

(Z) is a rise from X to 2X, so it is fertilization.

71 **Answer (A)**

Helicase separates the two strands, then primase adds the primer, then polymerase builds the new strand, then ligase joins the fragments.

72 **Answer (B)**

Helicase separates the two parent DNA strands, so the replication fork forms and polymerization starts.

Separating the leading strand from the lagging strand is not its job.

73 **Answer (C)**

The order is: (3) separating the two strands, then (1) binding of the complementary bases, then (2) joining sugar to phosphate, then (4) forming the two molecules.

74 **Answer (D)**

Deoxyribonuclease breaks DNA down and does not take part in its replication.

75 **Answer (B)**

Strand (L) was copied on strand (Y), and two complementary strands run in opposite directions.

76 **Answer (A)**

DNA replication in eukaryotes takes place in the nucleus.

77 **Answer (C)**

In stage Y the two strands separate, the primers are added and the new strand is built at the same time.

78 **Answer (C)**

Adding the bases complementary to the original bases takes place in stage Y.

79 **Answer (A)**

The figures show DNA replication in eukaryotes; prokaryotic bacteria differ from them.

80 **Answer (C)**

Replication is semi-conservative: each new molecule has one old strand and one new strand.

This is shown by model (2) only.

81 **Answer (B)**

The polymerase enzyme forms only covalent bonds between the nucleotides.

82 **Answer (B)**

Before division, DNA replicates gradually from 2X to 4X.

83 **Answer (D)**

The figure shows DNA replication, so the chromosome becomes two chromatids.

84 **Answer (D)**

The process is DNA replication in the mitochondria, and it needs the replication enzymes.

85 **Answer (D)**

The two blue balls on the two strands are the polymerase enzyme.

86 **Answer (C)**

The phage uses the enzymes of its bacterial host, including DNA polymerase.

87 **Answer (B)**

Replication is semi-conservative: each molecule has one old strand and one new strand.

The two new strands (2) and (3) are the ones that contain ^{15}N.

88 **Answer (D)**

Strand (2) is a lagging strand built in fragments, so it needs the ligase enzyme.

Strand (3) is a leading strand built continuously.

89 **Answer (B)**

The cell repairs the damage, so the structure of DNA does not change in the next generations.

90 **Answer (B)**

Mitotic division gives cells with the same number, 8 chromosomes.

And each chromosome in them carries one DNA molecule.

91 **Answer (B)**

The figure fills the gap between two nucleotides, which is the job of the ligase enzyme.

92 **Answer (B)**

The ligase enzyme forms a covalent bond between the two nucleotides.

93 **Answer (D)**

Cell (1) at the start of division has replicated its DNA: 92 molecules.

Cell (2) after division has 46 molecules.

94 **Answer (A)**

95 **Answer (B)**

The letter (S) is at the fork of the two strands; it is the helicase enzyme, which separates them.

96 **Answer (B)**

Being double allows DNA damage to be repaired using the opposite strand.

97 **Answer (C)**

(X) breaks the covalent bonds between nucleotides: deoxyribonuclease.

(Y) forms covalent bonds: polymerase.

(Z) breaks hydrogen bonds: helicase.

98 **Answer (C)**

Cells (4) and (5) are both haploid, so the amount of DNA in them is equal.

99 **Answer (A)**

Without helicase, DNA replication stops, so the cells do not divide and the zygote dies.

100 **Answer (D)**

Sulfur is not part of the structure of DNA, so replication is not affected.

So the percentage is 100 %.

101 **Answer (A)**

Their genetic material is single-stranded RNA, so there is no template strand to repair the error.

So they change at a faster rate.

102 **Answer (C)**

Replication is semi-conservative: each daughter cell has an old non-radioactive strand and a new radioactive strand.

Essay questions

1 **Model answer**

(1) We conclude that DNA is the genetic material, because different body cells of the same organism contain the same amount of nitrogenous bases, i.e. the amount of DNA in different types of body cells of the same organism is equal.

(2) We conclude that adenine is paired with thymine because their amounts are almost equal (A = T), and cytosine is paired with guanine because their amounts are almost equal (C = G), which shows that DNA is double.

2 **Model answer**

(1) 3′... G - T - C - C - A - T - G - A - C ...5′

(2) The bases in the sequence given for the other strand are paired with and complementary to the bases of the original strand, as adenine (A) binds with thymine (T) and guanine (G) binds with cytosine (C).

3 **Model answer**

Adenine in the strand is 10%, so thymine in the complementary strand is 10%; thymine in the same strand is 30%, so adenine in the complementary strand is 30%.

Adenine in the whole molecule = (10% + 30%) ÷ 2 = 20%, and thymine in the whole molecule = 20%

Cytosine + guanine in the strand = 60%, so cytosine in the molecule = 30%, and guanine in the whole molecule = 30%

4 **Model answer**

Nucleotides joined by three bonds = 36, so the number of guanine = the number of cytosine = 18

Nucleotides joined by two bonds = 18, so the number of thymine = the number of adenine = 9

Number of purine nucleotides (guanine and adenine) = 18 + 9 = 27 nucleotides.

5 **Model answer**

Adenine binds with thymine by two bonds: number of A = number of T = 300 ÷ 2 = 150 bases.

Cytosine binds with guanine by three bonds: number of G = number of C = 300 ÷ 3 = 100 bases.

Number of nucleotides = 150 + 150 + 100 + 100 = 500 nucleotides.

Number of turns = 500 ÷ 20 = 25 turns.

6 **Model answer**

The phosphate group is found at the (3′) end of the lower strand.

The nitrogenous base uracil is present, which is not found in the structure of DNA.

The phosphate group is attached to carbon atom number (4). (Two are enough.)

7 **Model answer**

(3) , (4) / because during DNA replication the helicase enzymes separate the two DNA strands from each other by breaking the hydrogen bonds (3) , (4) between the paired nitrogenous bases of the two strands.

8 **Model answer**

Part (Z).

9 **Model answer**

(1) / because stage (1) represents the replication of the genetic material (DNA molecules) from 2X to 4X before the cell starts to divide, so that each new cell (after division) receives an exact copy of the genetic information of the mother cell.

10 **Model answer**

b / because direction (b) represents building a new DNA strand in the (3′ → 5′) direction, in which the polymerase enzyme does not work, so this is wrong.

Past exam questions

1	2	3	4	5	6	7	8	9	10
D	A	D	A	B	D	B	A	C	D
11	12	13	14	15	16	17	18	19	20
A	D	C	C	B	A	B	D	A	C
21	22	23	24	25	26	27	28	29	30
A	C	D	C	D	B	A	D	B	C
31	32	33	34	35	36	37	38	39	40
B	C	C	B	B	B	D	C	C	B
41									
—									

1 **Answer (D)**

The percentage of adenine on the same strand is not determined by the percentage of thymine on it; we only know that adenine in the complementary strand = 20%

2 **Answer (A)**

Two complementary strands are in opposite positions (the phosphate at the top in one and at the bottom in the other), and their bases complete each other in length (long opposite short).
This is true for strands (1) , (3).

3 **Answer (D)**

Franklin found that DNA is a helix of more than one strand; the genetic material of the polio virus is a single RNA strand, so it gives a different result.

4 **Answer (A)**

Adenine binds with thymine, so adenine in the complementary strand = thymine in the template = 30%

5 **Answer (B)**

Purines being equal to pyrimidines is explained by A binding with T and G binding with C

6 **Answer (D)**

(X) is a pyrimidine base (one ring) joined by three hydrogen bonds: cytosine.

(Y) is a purine (two rings): guanine.

7 **Answer (B)**

A = T = 15% × 200 = 30 , and G = C = 70

Number of bonds = 30 × 2 + 70 × 3 = 60 + 210 = 270

8 **Answer (A)**

Franklin found that the sugar-phosphate backbone is on the outside and the nitrogenous bases point inwards.

9 **Answer (C)**

Bases on one side of a single backbone: single-stranded genetic material, which is found in the polio virus (RNA).

10 **Answer (D)**

One turn contains 20 nucleotides, i.e. 10 base pairs, so the ratio is 1 turn : 10 pairs.

11 **Answer (A)**

The piece has 3 turns, and each turn has 10 base pairs (20 bases).

Number of bases = 3 × 20 = 60

12 **Answer (D)**

Franklin's images showed that DNA is a helix of more than one strand and that the sugar and phosphate are on the outside.

That it is a double helix is the conclusion of Watson and Crick.

13 **Answer (C)**

T = A = 80 and G = C = 80

Total number = 80 × 4 = 320

14 **Answer (C)**

Guanine is complementary to C and is attached to carbon atom number one of deoxyribose, there are 3 hydrogen bonds between them, and guanine is a purine with two rings.

15 **Answer (B)**

5 turns = 50 base pairs, 20 of which are A - T pairs

Number of G - C pairs (three bonds) = 50 - 20 = 30

16 **Answer (A)**

Each base pair is made of a purine (two rings) and a pyrimidine (one ring), so its width is always three rings.

17 **Answer (B)**

Base complementarity makes each strand a template for building the new strand during replication.

18 **Answer (D)**

One of the chromosomes in the figure is made of one chromatid although division has started, so there was a fault in DNA replication

19 **Answer (A)**

To produce cells identical to the original, DNA replicates before the division of the nucleus, so each cell gets a complete copy.

20 **Answer (C)**

Losing the two opposite bases together loses the template, so any one of the four nucleotides is added together with its complement.

The probability that it is the original base = 1 in 4 = 25%

21 **Answer (A)**

In period (Y) the amount of DNA increased from 2 to 6 without division (the curve does not go down).

So it remains one cell with 3 times the original genetic material.

22 **Answer (C)**

The polymerase enzyme works on the template strand $(3' \rightarrow 5')$ continuously in the same direction as the helix opens: from A to B, then B to C, then C to D

23 **Answer (D)**

The deoxyribonuclease enzyme breaks down DNA; the genetic material of the influenza virus is RNA, so its reproduction is not affected.

24 **Answer (C)**

Primary spermatocytes form by the growth of spermatogonia without division, so DNA replication does not precede them

25 **Answer (D)**

In (G_1) the amount of DNA is normal; it doubles in (S), so in (G_2) it is twice as much.
The ratio (G_1) : (G_2) = 1 to 2

26 **Answer (B)**

In the early stages of embryonic development the cells divide at the highest rate, so DNA replication is at its maximum.

27 **Answer (A)**

Repair enzymes repair damage to a base in one strand with the help of the complementary strand. They do not repair the removal of a whole rung or the genes of an RNA virus

28 **Answer (D)**

In (1) a linear molecule has several starting points, and in (2) a circular molecule has one starting point, so the difference is in the starting point of the process.

29 **Answer (B)**

The genetic material of the polio virus is a single strand (RNA), so there is no complementary strand to be used as a template for repair.

30 **Answer (C)**

Each new strand is built in the 5′ to 3′ direction, and this applies to both complementary strands.

31 **Answer (B)**

Each chromosome in eukaryotes is made of one (double-stranded) DNA molecule bound to proteins.

32 **Answer (C)**

Repair needs a complementary strand, so it does not take place in single-stranded genetic material: hepatitis (C) and Parvo.

33 **Answer (C)**

The polymerase enzyme joins the phosphate of the new nucleotide to the hydroxyl group at the 3′ end of the previous one, not the opposite.

34 **Answer (B)**

After each replication the two original radioactive strands are found in two molecules only.
So after three replications the number of molecules containing radioactive thymine stays = 2

35 **Answer (B)**

The primase enzyme places the primer at the start of the new strand, i.e. at its 5′ end

36 **Answer (B)**

4 pairs = 8 chromosomes, and each chromosome is one DNA molecule, so 8 molecules are replicated.

37 **Answer (D)**

Fragments (A) , (B) , (C) are on the lagging strand and fragment (D) is on the leading strand, and all of them are built by the polymerase enzyme.

38 **Answer (C)**

Each Okazaki fragment starts with a primer, so the number of primers = the number of Okazaki fragments.

39 **Answer (C)**

The two template strands are antiparallel, and polymerization takes place in one direction (5′ to 3′), so one of the two strands is built in fragments.

40 **Answer (B)**

The ligase enzyme joins the Okazaki fragments, so when it is inhibited, unjoined fragments accumulate on the lagging strand.

41 **Model answer**

Structure (X): RNA nucleotides containing ribose sugar and the base uracil.
Structure (Y): DNA nucleotides containing deoxyribose sugar and the base thymine.