Biology · Molecular Biology · Nucleic Acids and Protein Synthesis

Molecular Technology (Genetic Engineering)

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questions	sets	pages

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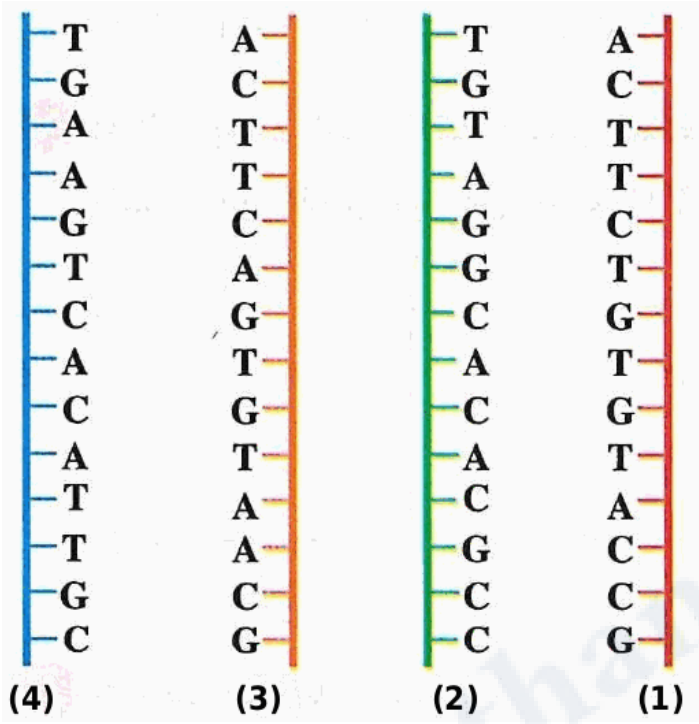
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Multiple choice questions — 61 questions

1 The opposite figure shows DNA strands from four different organisms that were mixed together. What is the purpose of using this technique?



(A) Producing a new strain of organisms

(B) Revealing the evolutionary relationships between organisms

(C) Producing recombinant DNA

(D) Gene therapy

---

2 When can the nitrogenous bases GAT pair with CUA?

(A) When the anticodon of tRNA binds to the codon of mRNA

(B) When two DNA strands bind

(C) During nucleic acid hybridization

(D) When some bases in a tRNA molecule bind

---

3 DNA hybridization depends on the presence of .....

(A) two DNA strands with the same nucleotide sequence

(B) a DNA strand and an RNA strand with the same nucleotide sequence

(C) two DNA strands of the same length

(D) complementary nitrogenous bases

4 Which of the following organisms have DNA strands that are more complementary when the temperature is lowered after mixing them together?

(1) Frog , (2) Hydra , (3) Spirogyra , (4) Anopheles mosquito , (5) Silverfish

(A) (1) , (2) (B) (2) , (3) (C) (4) , (5) (D) (4) , (2)

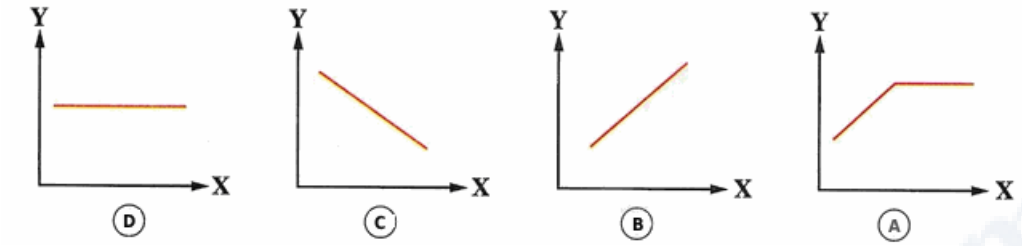
5 Using the DNA hybridization technique, the nucleotide sequences of four segments of DNA strands from four types of organisms were identified, as shown in the following table. Study it, then answer:

Which of the following organisms are the closest in evolutionary relationship?

A	T	T	C	C	G	G	A	T	A	Organism (1)
A	T	T	C	C	G	C	A	T	A	Organism (2)
A	G	T	G	C	G	G	A	T	A	Organism (3)
A	T	C	G	G	G	G	A	T	T	Organism (4)

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

6 Which of the following graphs represents the relation between the number of guanine bases (X) in two DNA strands and the temperature needed to separate these two strands from each other (Y)?



7 Which of the following statements is correct?

(A) The speed of separating the two DNA strands is directly proportional to the number of hydrogen bonds between the two strands

(B) The strength of hybridization depends on the strands carrying the largest number of identical bases

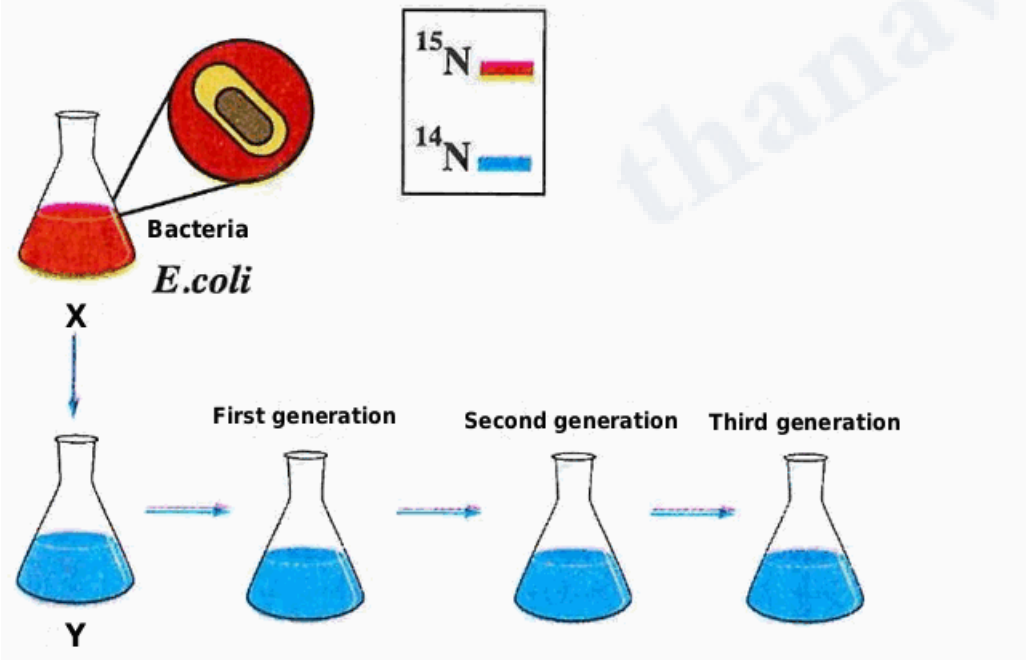
(C) The rejoining of two DNA strands after separating them by heat is a hybridization process

(D) Two strands, one DNA and the other RNA, can be hybridized

---

8 The opposite figure shows a practical experiment in which a researcher placed Escherichia coli bacteria in a nutrient medium (X) containing ^{15}N, then isolated a bacterial cell whose genome contains only ^{15}N and placed it in a nutrient medium (Y) containing ^{14}N. Study the figure, then answer:

What is the percentage of DNA molecules containing only ^{15}N in the first generation?

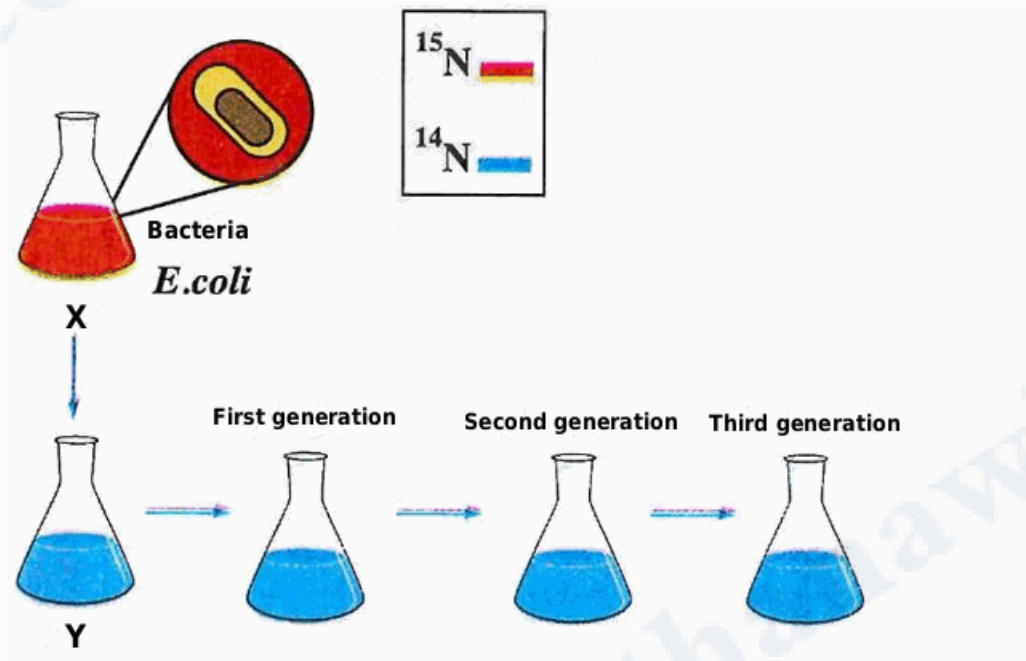


(A) Zero % (B) 50 % (C) 75 % (D) 100 %

---

9 The opposite figure shows a practical experiment in which a researcher placed Escherichia coli bacteria in a nutrient medium (X) containing ^{15}N, then isolated a bacterial cell whose genome contains only ^{15}N and placed it in a nutrient medium (Y) containing ^{14}N. Study the figure, then answer:

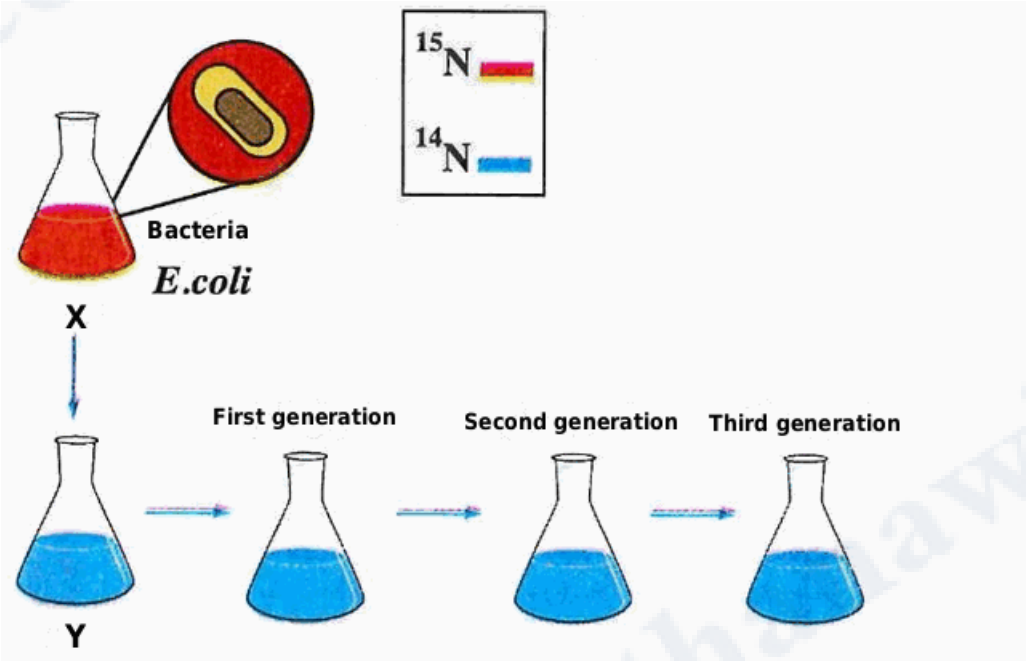
What is the percentage of DNA molecules containing only ^{14}N in the second generation?



(A) Zero % (B) 50 % (C) 75 % (D) 100 %

10 The opposite figure shows a practical experiment in which a researcher placed Escherichia coli bacteria in a nutrient medium (X) containing ^{15}N, then isolated a bacterial cell whose genome contains only ^{15}N and placed it in a nutrient medium (Y) containing ^{14}N. Study the figure, then answer:

In the third generation, how many bacterial cells have a genome with only ^{15}N?



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

11 From your study of the following diagram:

What is the percentage of DNA molecules that are exactly like the original DNA after the two replications?



(A) Zero % (B) 25 % (C) 50 % (D) 100 %

12 From your study of the following diagram:

What is the percentage of hybrid DNA molecules after replication?



(A) Zero % (B) 25 % (C) 50 % (D) 100 %

13 Which of the following statements correctly describes the sequences (X) and (Y)?

Y	X
3´ ... GCATTGACCGGAGGGACT ... 5´	3´ ... GGATTTCAATTACTTAAT ... 5´
5´ ... CGTAACTGGCCTCCCTGA ... 3´	5´ ... CCTAAAGTTAATGAATTA ... 3´

(A) Sequence (X) needs a higher temperature than sequence (Y) to separate the two strands

(B) Sequence (Y) needs a higher temperature than sequence (X) to separate the two strands

(C) Sequences (X) and (Y) need the same temperature to separate the two strands

(D) These strands cannot be separated by heat

---

14 The following table shows strands of different DNA samples and the temperatures needed to break the hydrogen bonds between the nitrogenous bases of each two strands. Which of the following choices shows the samples whose evolutionary relationship is the least (the most distant)?

(A) Samples (1) , (2) : 80 °C

(B) Samples (2) , (3) : 60 °C

(C) Samples (3) , (4) : 10 °C

(D) Samples (4) , (2) : 50 °C

---

15 In genetic engineering applications, which of the following can be used to break the covalent bonds in the sugar-phosphate backbone of a DNA molecule?

(A) Helicase enzyme

(B) The watery environment of the cell

(C) Raising the temperature to 100 °C

(D) Restriction enzymes

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16 Where are restriction enzymes found?

(A) All strains of bacteria and some strains of viruses

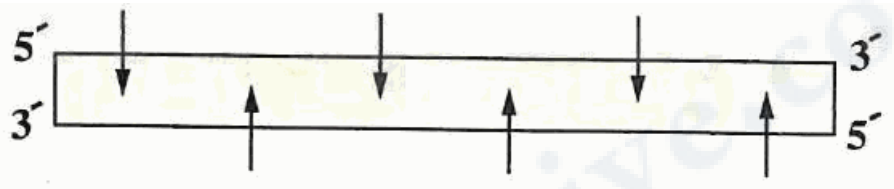
(B) Some strains of bacteria

(C) Some strains of bacteria and all strains of viruses

(D) All strains of viruses

---

17 If the vertical arrows show the cutting sites of a restriction enzyme, how many sticky ends were formed by using the restriction enzymes?



(A) 6 (B) 8 (C) 12 (D) 24

18 If the desired gene lies between two different recognition sites, which of the following is correct for joining this gene to the plasmid?

(A) Adding one type of cutting enzyme to both the gene and the plasmid

(B) Adding two types of cutting enzymes to the gene and one type to the plasmid

(C) Adding one type of cutting enzyme to the gene and two types to the plasmid

(D) Adding two types of cutting enzymes to both the gene and the plasmid

---

19 Which of the following represents a recognition sequence of a restriction enzyme?

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

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

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

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

---

20 When some strains of bacteria are infected with a virus, they produce .....

(A) restriction enzymes, then ligase enzymes

(B) modifying enzymes, then polymerase enzymes

(C) restriction enzymes, then modifying enzymes

(D) modifying enzymes, then restriction enzymes

---

21 The following figure shows the action of restriction enzymes on each of DNA molecules (1) and (2). Study it, then show which of the following choices is correct.



(A) (1) viral DNA , (2) bacterial DNA , (X) determining the amount of the gene in the bacterial genome

(B) (1) viral DNA , (2) bacterial DNA , (X) resisting the effect of restriction enzymes

(C) (1) bacterial DNA , (2) viral DNA , (X) repairing DNA defects

(D) (1) bacterial DNA , (2) viral DNA , (X) preventing the action of cutting enzymes

---

22 The opposite figure shows the action of two restriction enzymes E_1 and E_2 on viral DNA. The two enzymes are always similar in .....

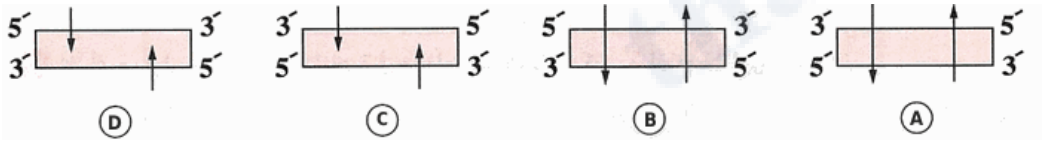


(A) the nucleotide sequence at the cutting site
(B) the type of bonds the enzymes break
(C) the length of the sticky ends
(D) the sequence of the sticky ends

23 Which enzymes inhibit the action of restriction enzymes?

(A) Deoxyribonuclease enzymes
(B) Helicase enzyme
(C) Polymerase enzymes
(D) Modifying enzymes

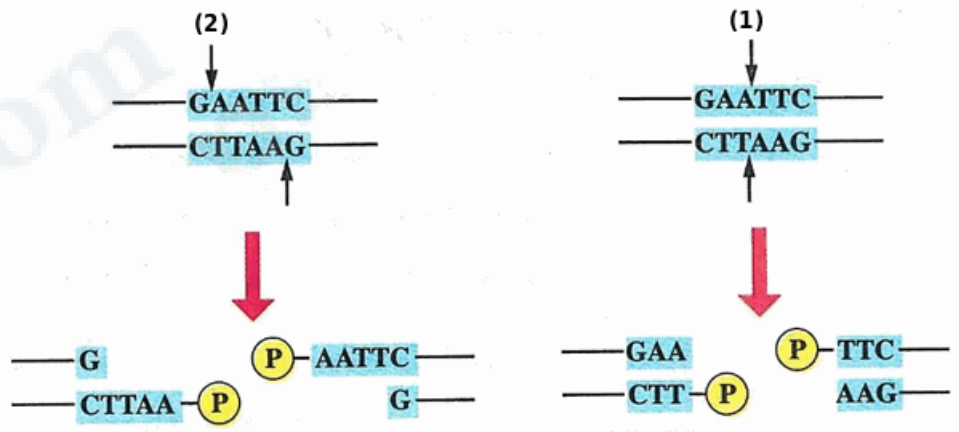
24 Which of the following represents the correct way a restriction enzyme works?



25 Restriction enzymes cannot cut the nucleic acid of which of the following organisms?

(A) Yeast fungus
(B) Bacteriophage
(C) Amoeba
(D) Influenza virus

26 In the following figure, which of the following is correct about enzymes (1) and (2) for use in DNA cloning?



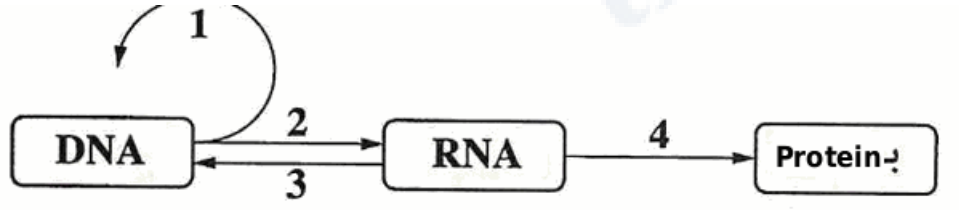
(A) Enzyme (1) is suitable for this process, while enzyme (2) is not

(B) Enzyme (2) is suitable for this process, while enzyme (1) is not

(C) Both enzymes (1) and (2) are suitable for this process

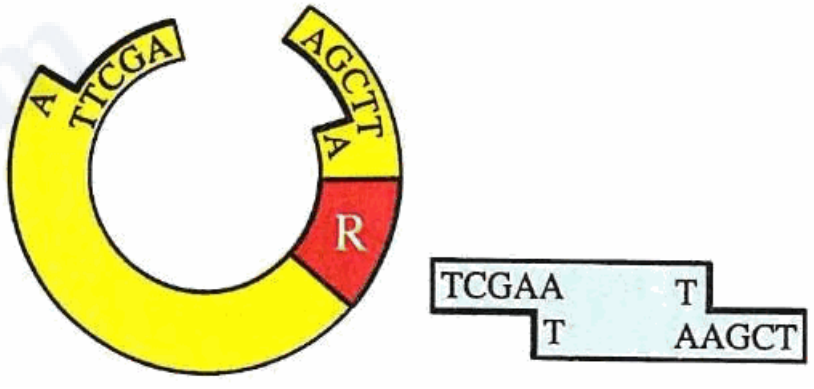
(D) Neither enzyme (1) nor (2) is suitable for this process

27 From the opposite diagram, which of the following choices expresses the processes that take place in eukaryotic cells under natural conditions?



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

28 Study the opposite figure, then deduce the reason that prevents the plasmid from joining directly to the gene.



(A) Not using suitable ligase enzymes

(B) Treating the gene and the plasmid with different restriction enzymes

(C) The DNA and the plasmid belong to genetically different organisms

(D) The difference in the length of the sticky ends

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29 Which of the following is one of the immune means in most bacterial strains for resisting viruses?

(A) The plasma membrane

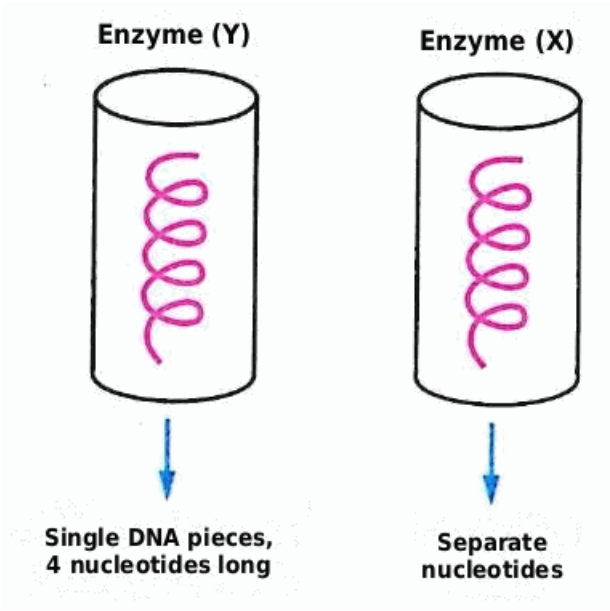
(B) Restriction enzymes

(C) The antigens on their surface

(D) Plasmids

---

30 Two DNA molecules of equal length were placed in two test tubes, and a different enzyme was added to each of them separately. The results were as shown at the bottom of the figure. What do enzyme (X) and enzyme (Y) represent, respectively?



(A) Deoxyribonuclease enzyme / Helicase enzyme

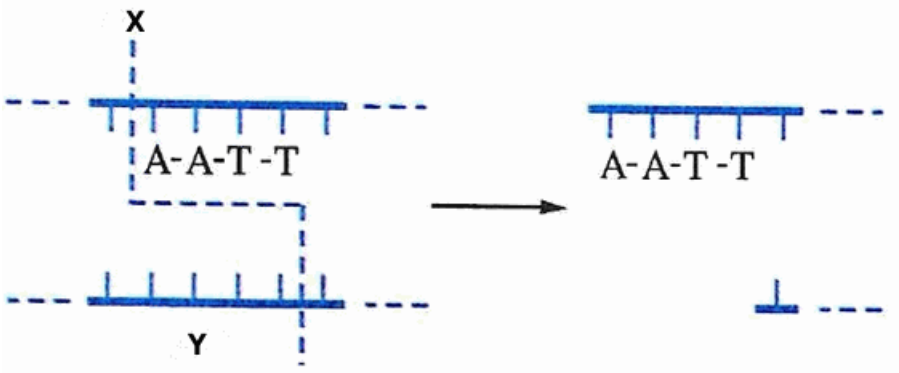
(B) Helicase enzyme / Bacterial restriction enzyme

(C) Deoxyribonuclease enzyme / Bacterial restriction enzyme

(D) Bacterial restriction enzyme / Deoxyribonuclease enzyme

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31 From the opposite figure, which of the following choices expresses enzyme (X) and sequence (Y)?



(A) (X): ligase , (Y): TTAA

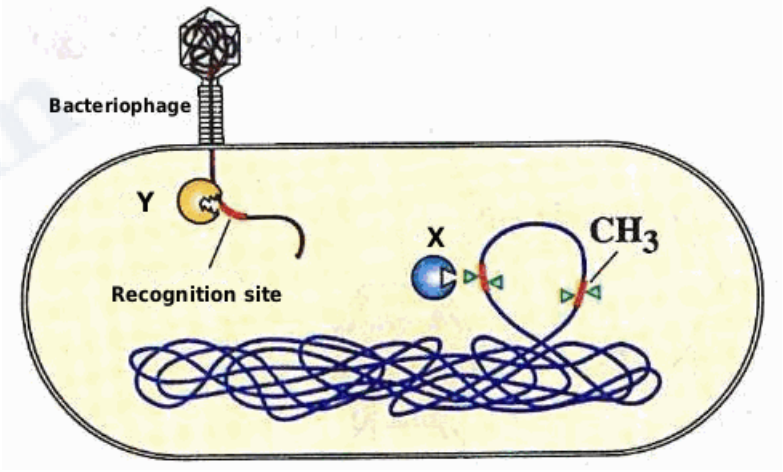
(B) (X): ligase , (Y): UUGA

(C) (X): restriction , (Y): TTAA

(D) (X): restriction , (Y): UUAA

---

32 In the opposite figure, what do the enzymes (X) and (Y) represent, respectively?



(A) Ligase enzyme / Restriction enzyme

(B) DNA polymerase / Modifying enzyme

(C) Modifying enzyme / Restriction enzyme

(D) Restriction enzyme / Ligase enzyme

---

33 Which of the following enzymes is the most specialized in separating nucleotides that are covalently bonded to each other?

(A) Helicase enzyme

(B) Restriction enzymes

(C) Taq polymerase enzyme

(D) Modifying enzymes

---

34 Why are E.coli bacteria used in genetic engineering experiments?

(A) Because they are unicellular organisms

(B) Because they are prokaryotes

(C) Because they reproduce asexually

(D) Because they contain plasmids

---

35 The Taq polymerase enzyme, used to replicate DNA segments in the PCR machine, is extracted from .....

(A) Penicillium fungus

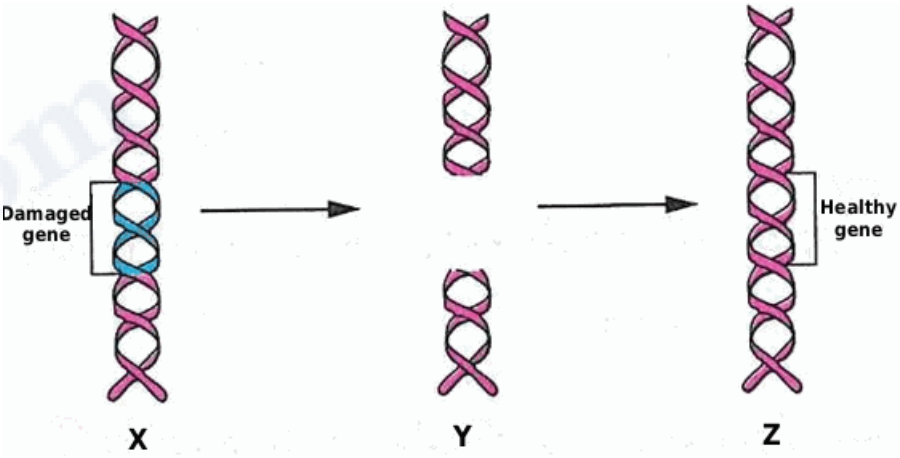
(B) E.coli bacteria

(C) thermophilic (heat-loving) bacteria

(D) yeast fungus

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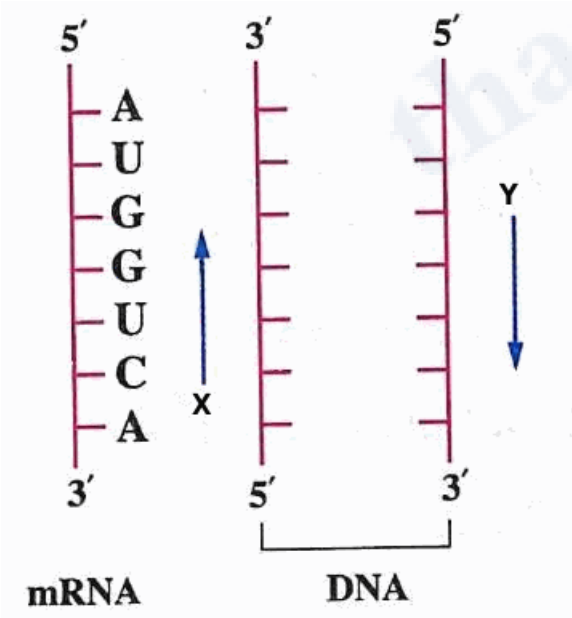
36 Which of the following represents the process shown in the figure?



(A) Gene therapy
(B) Diagnosing a genetic defect
(C) Studying evolutionary relationships
(D) Producing safe drugs

---

37 The opposite figure shows how the insulin gene is obtained from an mRNA strand. What do enzyme (X) and enzyme (Y) represent, respectively?



(A) DNA polymerase / RNA polymerase
(B) Reverse transcriptase / DNA polymerase
(C) DNA polymerase / Reverse transcriptase
(D) Reverse transcriptase / RNA polymerase

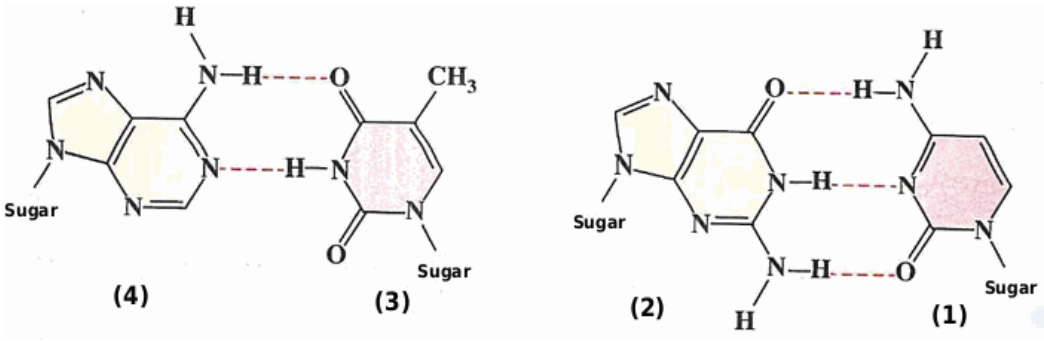
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38 The code for which of the following enzymes is NOT found in bacteria?

(A) Helicase
(B) Reverse transcriptase
(C) Polymerase
(D) Ligase

39 From the following figures:

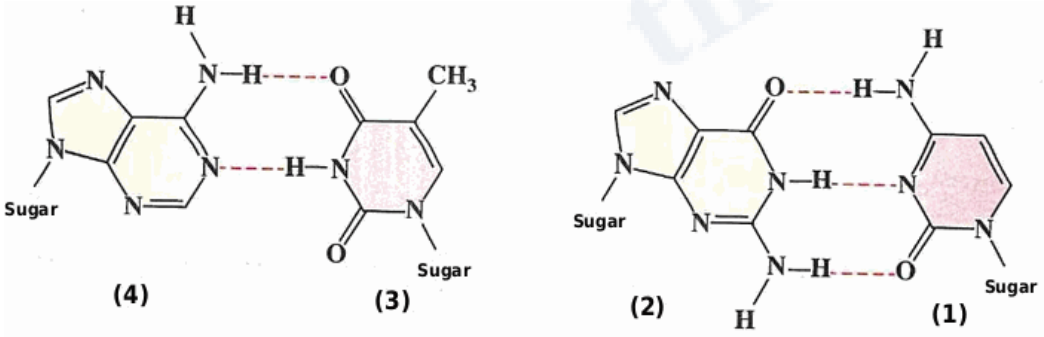
Which compound is repeated consecutively to protect a nucleic acid from breaking down?



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

40 From the following figures:

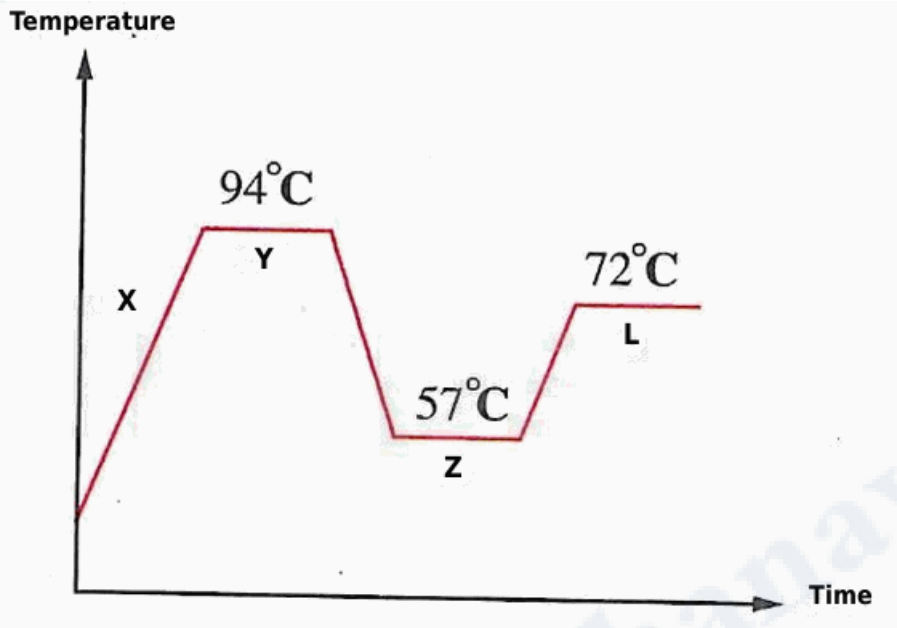
Which of the following enzymes can NOT separate (1) from (2)?



(A) Helicase
(B) Deoxyribonuclease
(C) Restriction
(D) Reverse transcriptase

41 The opposite figure shows the change in the temperatures needed for the PCR machine to work, given that the optimum temperature for the activity of the Taq polymerase enzyme is 72 °C:

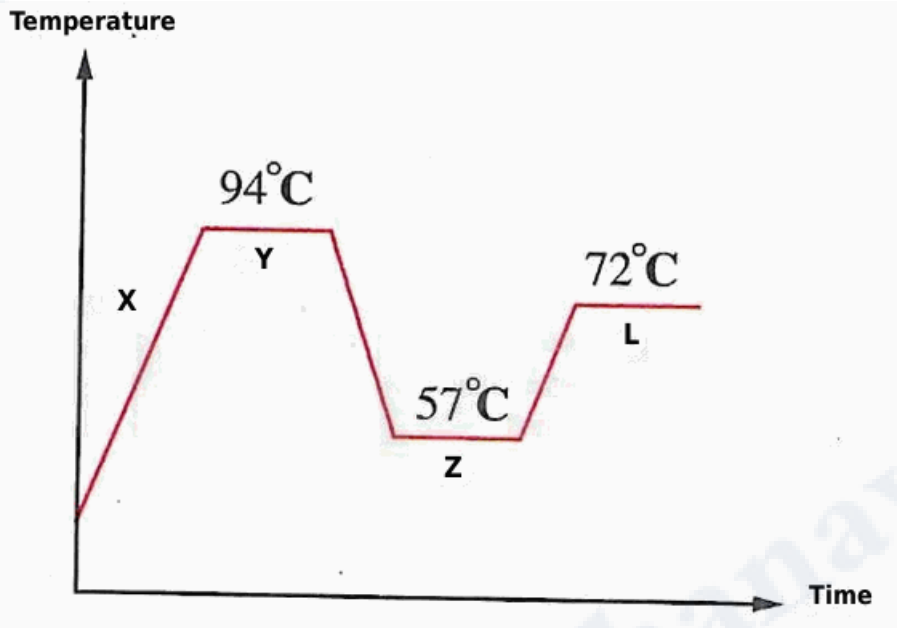
At which stage are new nucleotides added to the growing strand, pairing with the nucleotides of the original strand?



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

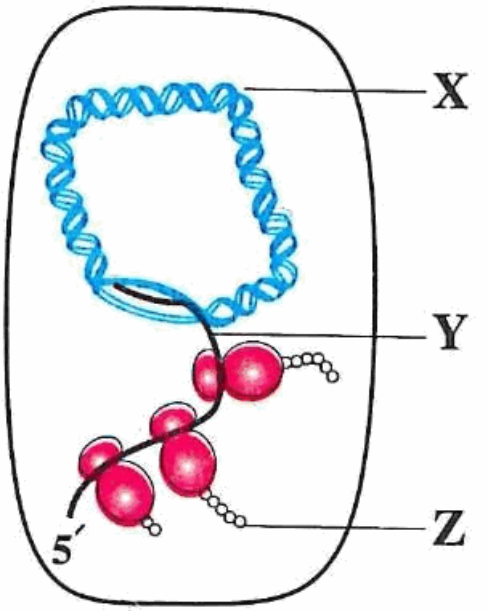
42 The opposite figure shows the change in the temperatures needed for the PCR machine to work, given that the optimum temperature for the activity of the Taq polymerase enzyme is 72 °C:

At which stage are the hydrogen bonds between the two strands of the DNA to be copied broken?



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

43 In the opposite diagram, which shows a vital process in the cell:
Which of the following applies to structure (X) during this process?



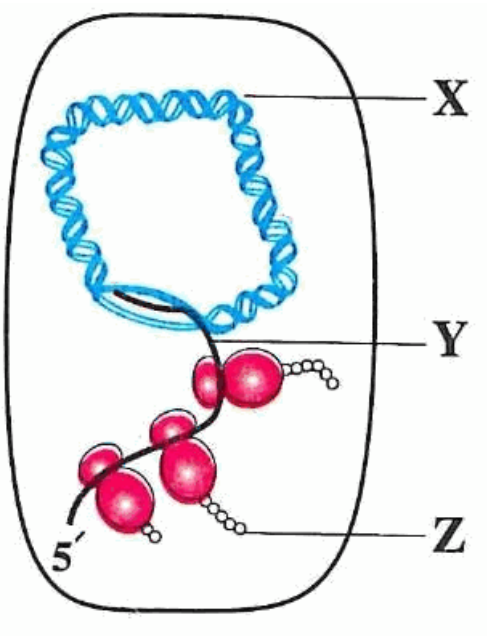
(A) It contains histone proteins

(B) It contains structural non-histone proteins

(C) It is not condensed

(D) It coils on itself several times

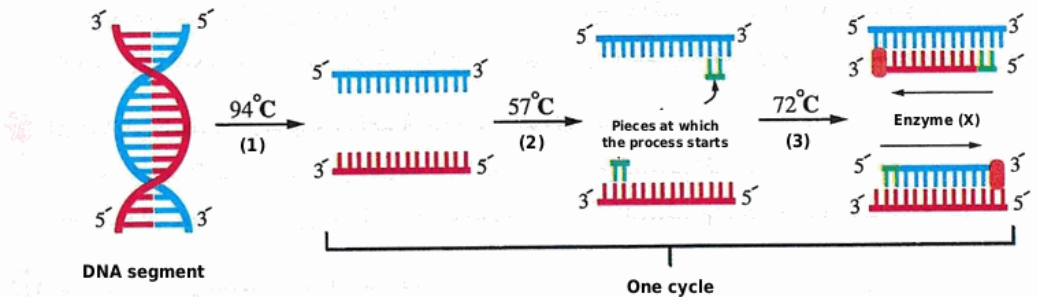
44 In the opposite diagram, which shows a vital process in the cell:
Which of the following statements is correct about the figure?



(A) (X) can be changed directly into (Z) in viruses
(B) (Y) can never be changed into (X)
(C) (Y) is formed from (X) by transcription and (Z) is formed from (Y) by translation
(D) Polymerase and ligase enzymes are used to form (Z)

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45 The following figure shows the steps of replicating a DNA segment using the PCR machine. Study it, then answer:
What is the aim of step (1)?

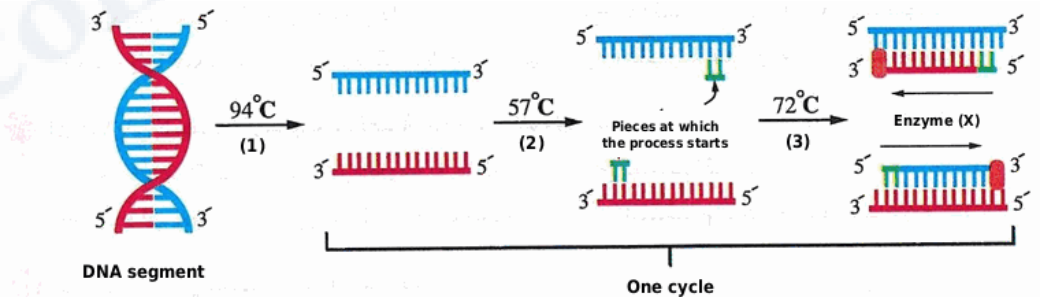


(A) Breaking hydrogen bonds
(B) Breaking covalent bonds
(C) Separating neighbouring nucleotides
(D) Joining opposite nucleotides

---

46 The following figure shows the steps of replicating a DNA segment using the PCR machine. Study it, then answer:

What is the name of the enzyme that does the same job as step (1) during DNA replication in body cells?

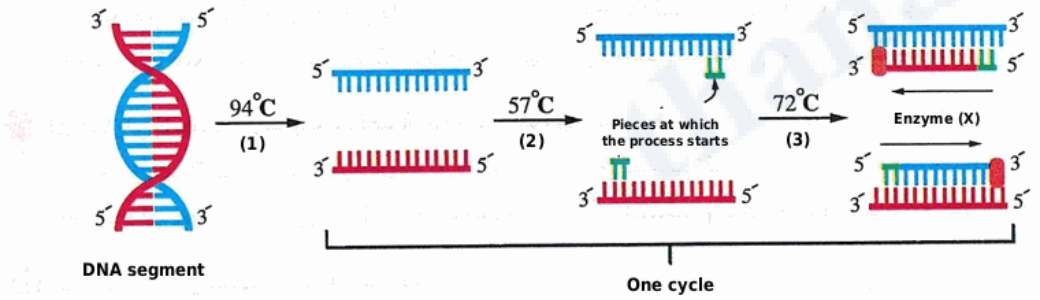


(A) Helicase enzyme (B) RNA polymerase (C) DNA polymerase (D) Ligase enzyme

---

47 The following figure shows the steps of replicating a DNA segment using the PCR machine. Study it, then answer:

What is enzyme (X)? And what type of bonds are formed during this step?



(A) Ligase enzyme / covalent bonds

(B) Helicase enzyme / hydrogen bonds

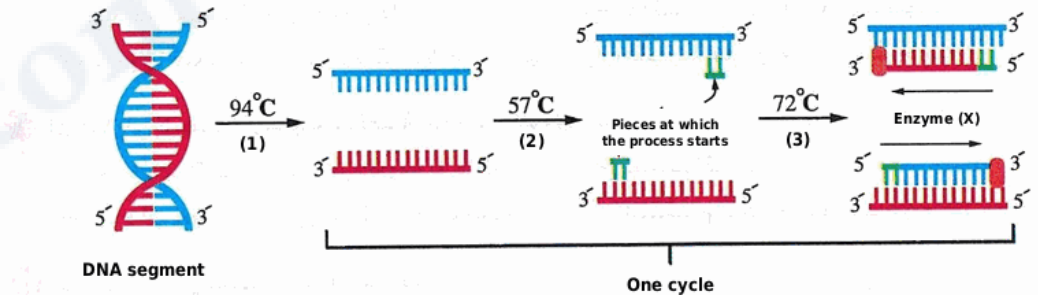
(C) Taq polymerase enzyme / covalent and hydrogen bonds

(D) DNA polymerase / covalent and hydrogen bonds

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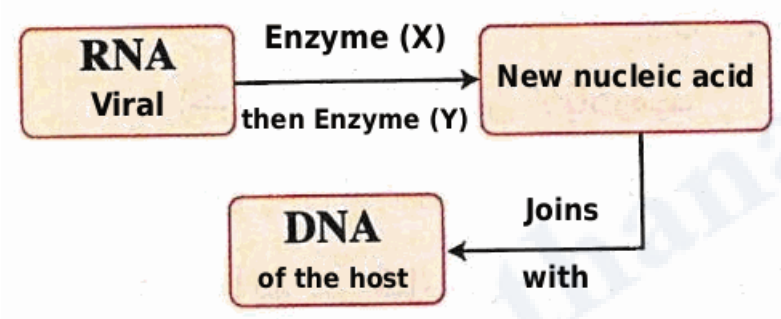
48 The following figure shows the steps of replicating a DNA segment using the PCR machine. Study it, then answer:

If the DNA segment shown is replicated for 3 cycles, how many DNA segments are produced?



(A) 4 (B) 8 (C) 16 (D) 32

49 From the opposite diagram, what do enzyme (X) and enzyme (Y) represent, respectively?



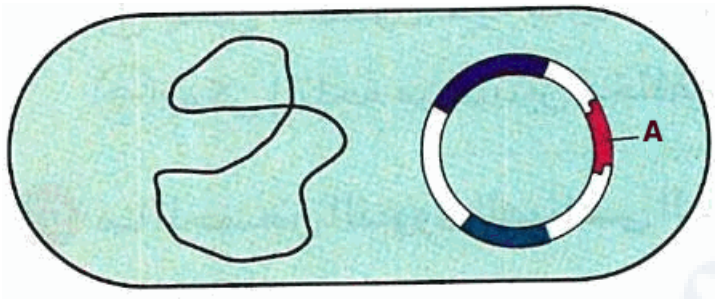
(A) RNA polymerase / DNA polymerase

(B) Helicase / Reverse transcriptase

(C) Ligase / RNA polymerase

(D) Reverse transcriptase / DNA polymerase

50 If the bacterial cell in the opposite figure is allowed to undergo five successive mitotic divisions, how many copies of gene (A) are formed after division?



(A) Zero (B) 16 (C) 32 (D) 64

51 Which of the following distinguishes human hormones produced by genetic engineering?

(A) They are of poor quality because they are formed by bacteria

(B) They have the same effect as the natural hormone

(C) Their effect is weak compared with chemically made hormones

(D) They are identical to the hormones extracted from cattle

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52 Which of the following is NOT an application of recombinant DNA technology?

(A) Modifying plants to make them more resistant to pests

(B) Making safe vaccines

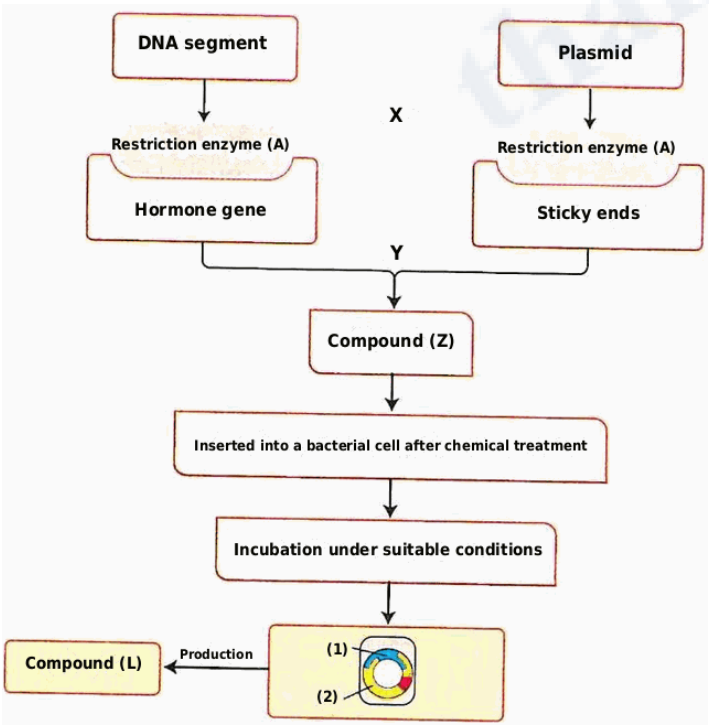
(C) Producing human proteins in bacterial cells

(D) Using bacteria to detect carcinogenic substances

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53 The opposite diagram shows one of the DNA techniques used to produce the hormone secreted by the beta cells of the pancreas. Study it, then answer:

What is the result of using the same restriction enzyme in stage (X)?



(A) Forming the same nucleotide sequence on both the plasmid and the DNA

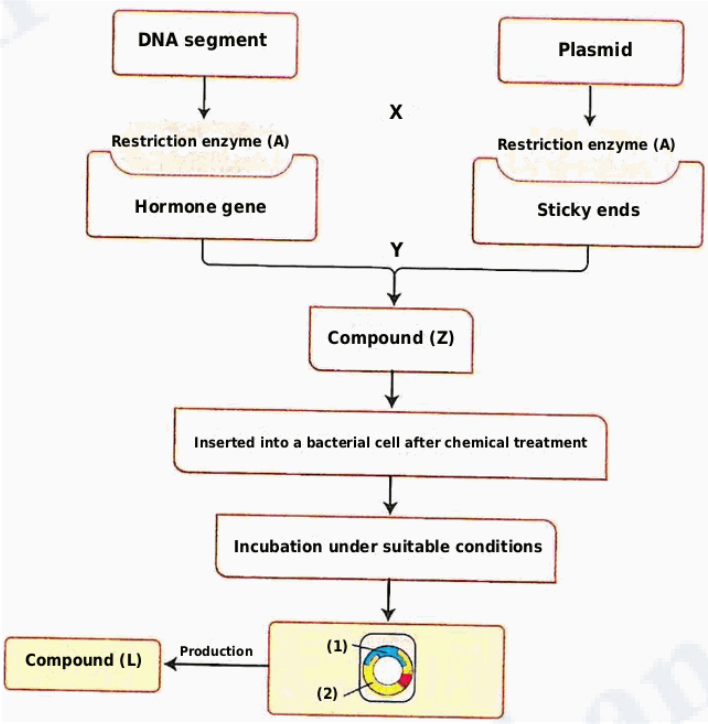
(B) Forming complementary sticky ends on both the gene and the plasmid

(C) Forming identical sticky ends on both the gene and the plasmid

(D) Producing a hybrid DNA molecule

54 The opposite diagram shows one of the DNA techniques used to produce the hormone secreted by the beta cells of the pancreas. Study it, then answer:

What do (1) and (2) refer to, respectively?



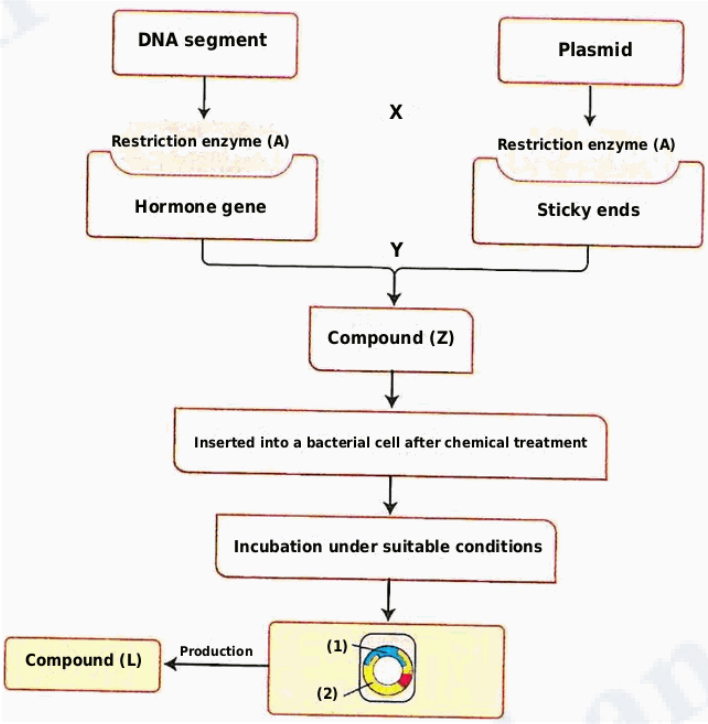
(A) Insulin hormone / Recombinant DNA

(B) Recombinant DNA / Glucagon gene

(C) Insulin gene / Plasmid

(D) Glucagon gene / Plasmid

55 The opposite diagram shows one of the DNA techniques used to produce the hormone secreted by the beta cells of the pancreas. Study it, then answer:
What do compound (Z) and compound (L) represent, respectively?



(A) Plasmid / Insulin gene
(B) Plasmid / Glucagon hormone
(C) Recombinant plasmid / Insulin hormone
(D) Recombinant plasmid / Glucagon gene

---

56 Which of the following statements is correct about recombinant DNA?
(A) It can be obtained without using enzymes
(B) We obtain it using the PCR machine
(C) It can be produced from two taxonomically different organisms
(D) It must be from two organisms of the same species

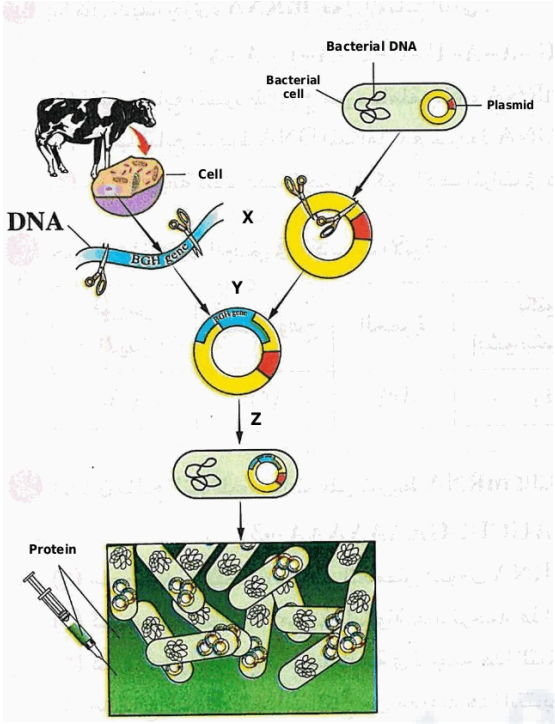
---

57 What is the artificial nucleic acid produced by joining two or more molecules that cannot normally exist together?
(A) Viral RNA
(B) Recombinant DNA
(C) Hybrid DNA
(D) The plasmid

---

58 The opposite figure shows one of the biotechnologies used to increase milk production. Study it, then answer:

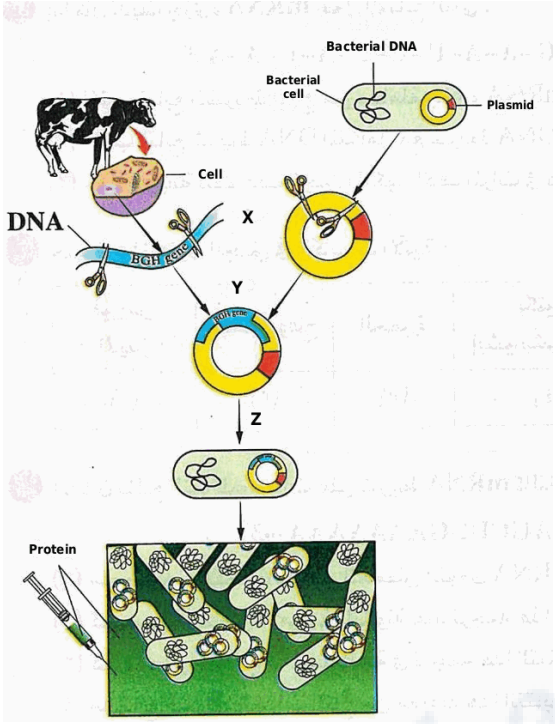
What is this process called?



(A) DNA hybridization
(B) DNA replication
(C) mRNA transcription
(D) DNA cloning

59 The opposite figure shows one of the biotechnologies used to increase milk production. Study it, then answer:

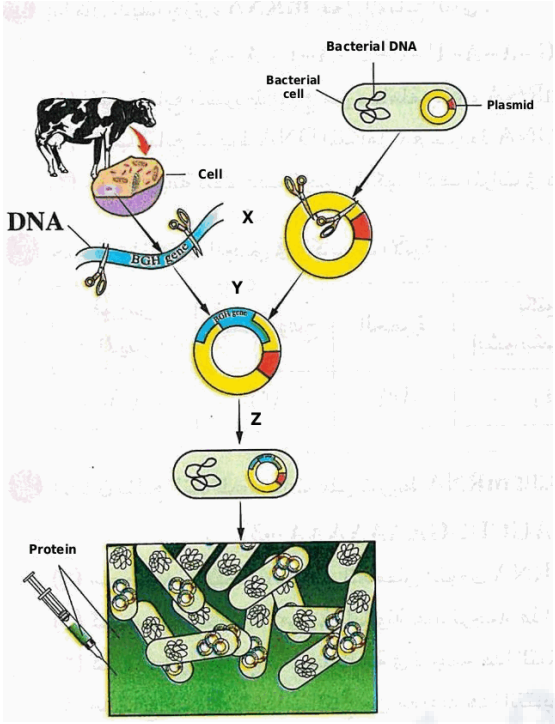
What enzyme is used in stage (Y)?



(A) Restriction enzyme
(B) Helicase enzyme
(C) Polymerase enzyme
(D) Ligase enzyme

60 The opposite figure shows one of the biotechnologies used to increase milk production. Study it, then answer:

What is the source of the enzyme used in stage (X)?



(A) One of the cow's cells

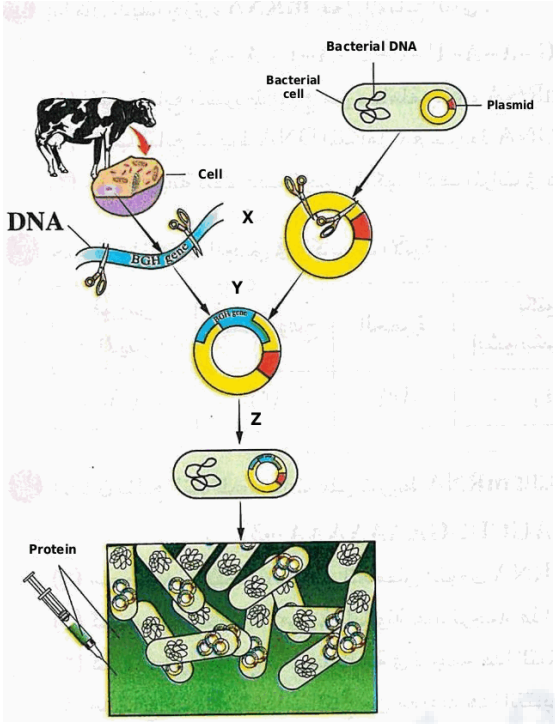
(B) A strain of Escherichia coli bacteria

(C) Viruses whose genome is RNA

(D) Viruses whose genome is DNA

61 The opposite figure shows one of the biotechnologies used to increase milk production. Study it, then answer:

In stage (Z), why is the bacterial cell treated chemically?



(A) To join the gene and the plasmid together

(B) To increase permeability to DNA

(C) To prevent the bacterial DNA from replicating with the plasmid

(D) To increase the rate of plasmid replication

Essay questions — 8 questions

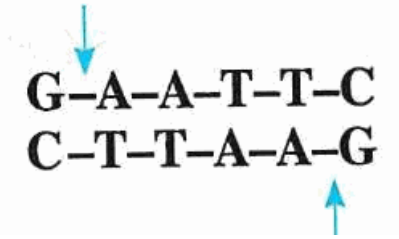
1 If the sequence of nucleotides in a segment of one of the two strands of DNA is as follows:

5′ ... C-T-G-A-A-T-T-C-A-G ... 3′

(1) Write this sequence and add to it the complementary sequence of nucleotides of the other strand of the same DNA segment.

(2) If you have a restriction enzyme whose recognition site is the one shown in the figure, show with arrows the recognition site of this enzyme on the two strands of the DNA segment.

(3) Write the nucleotide sequence of the segments produced by the action of this enzyme on the two strands of the DNA segment.



2 What happens when part of the insulin gene is inserted into an E.coli bacterial cell?

3 If you have an mRNA molecule carrying the following sequence:

5′ A-U-G-A-U-U-U-G-G-A-A-U-C-C-A-U-A-A 3′

(1) Write the sequence of the strand produced by treating the previous mRNA molecule with the reverse transcriptase enzyme.

(2) Write the sequence of the DNA strand complementary to the DNA strand formed, and the name of the enzyme used.

(3) Identify a way to replicate the gene formed thousands of times in a few minutes.

4 Identify the type of genome in the following organisms:

Influenza virus	Human	Polio virus	Escherichia coli bacteria	Yeast	Bacterio-phage	AIDS virus
(7)	(6)	(5)	(4)	(3)	(2)	(1)

5 If the sequence of nucleotides on an mRNA strand is as follows:

5′ ... GCUCCAAAACCAGCUUGAAAAAA ... 3′

(1) What are the anticodons on the nucleic acid tRNA?

(2) How many amino acids are formed when this sequence is translated?

(3) How many types of tRNA are used in translating this sequence?

(4) What is the nucleotide sequence produced by treating this sequence with the reverse transcriptase enzyme?

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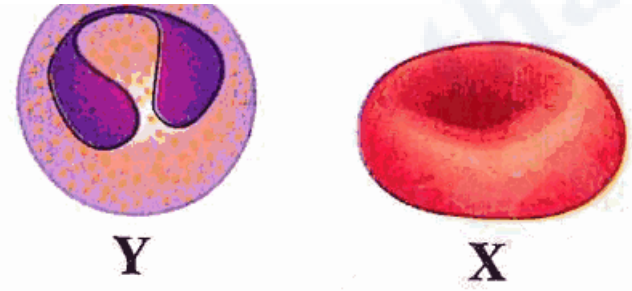
6 Given that the percentages of some bases in DNA molecules taken from four different organisms, carrying equal numbers of nucleotides, are as follows:

(1) (A) , (T) : 30% , (2) (G) , (C) : 60% , (3) (T) , (A) : 10% , (4) (C) , (G) : 30%

What is the order of the DNA molecules according to the amount of heat needed to separate the strands of the DNA molecules from each other, from the most to the least?

---

7 Criminal investigators found a drop of a person's blood at the crime scene, and the microscopic sample showed the two opposite structures (X) and (Y). Which is suitable for identifying the person, structure (X) or structure (Y)? Why?

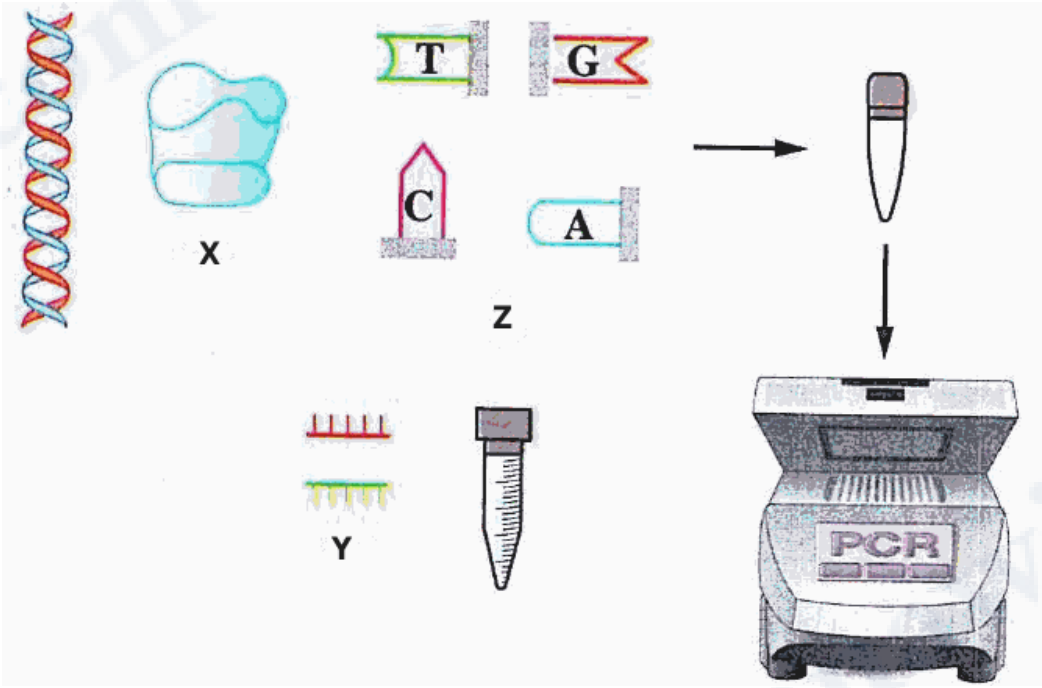


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8 Study the opposite figures, then answer:

(1) Which structures work first, (X) or (Y)? Explain.

(2) What is the importance of structures (Z)?



Past exam questions — 32 questions

1 Traditional classification divided living organisms into two kingdoms, but after studying the evolution of organisms they were classified into five kingdoms in modern classification. Which technique did scientists rely on to classify organisms into five kingdoms? (Trial exam / June 2021)

(A) DNA hybridization
(B) DNA cloning
(C) Recombinant DNA
(D) Producing artificial genes

---

2 Given that the DNA of insects and molluscs lacks the haemoglobin gene, if the genome of a cockroach cell is mixed with a radioactive strand of the haemoglobin gene, then the temperature of the mixture is raised and lowered again, which of the following can happen? (2nd session 2021)

(A) The original helix of the cockroach does not combine with any of the nucleotides of the radioactive strand
(B) The original DNA cannot pair again
(C) All the nucleotides of the radioactive strand pair with the cockroach DNA
(D) Pairing happens between some bases of both the radioactive strand and the cockroach DNA

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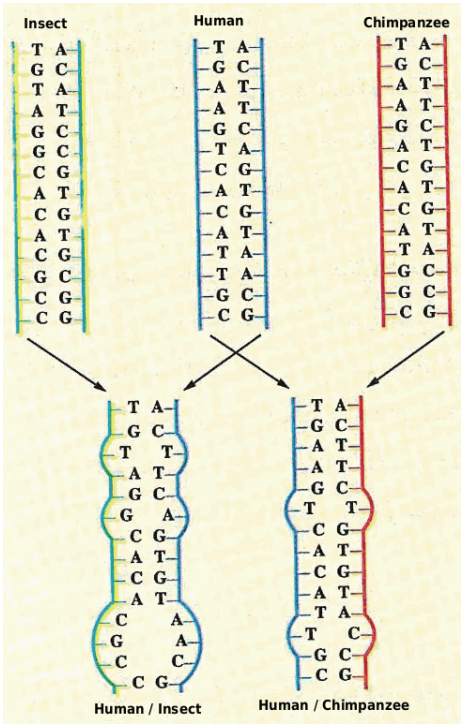
3 Rabbits were previously classified as a type of rodent, but after using modern techniques they were placed in a separate order known as lagomorphs. Which of the following was used for this purpose? (1st session 2022)

(A) Recombinant DNA
(B) Induced mutations
(C) Nucleic acid hybridization
(D) Bacterial transformation

---

4 Study the opposite figure of one of the techniques of molecular technology, then identify:

(1) What is the name of the technique shown in the figure? (2nd session 2024)



(A) Isolating a gene from a genome

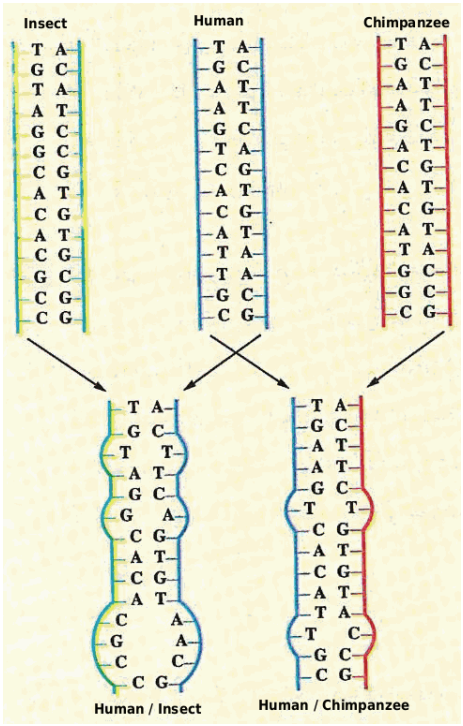
(B) Nucleic acid hybridization

(C) Recombinant DNA

(D) DNA cloning

5 Study the opposite figure of one of the techniques of molecular technology, then identify:

(2) What can be concluded from the experiment shown in the figure? (1st session 2024)



(A) The degree of hybridization between human DNA, insect DNA and chimpanzee DNA is about the same

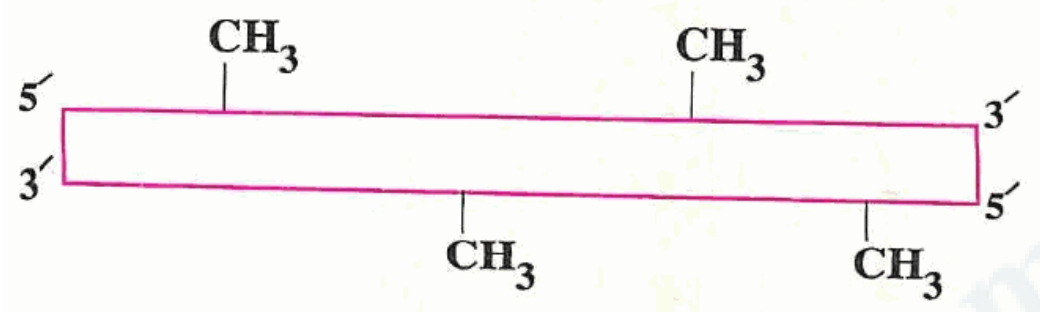
(B) The insect and the chimpanzee are closer to each other than to humans

(C) Humans are closer in evolution to the chimpanzee than to the insect

(D) There is no similarity between human DNA and insect DNA

---

6 The following figure shows part of a DNA molecule after treating it with a restriction enzyme: How many recognition sites are in this part of the DNA? (1st session 2021)



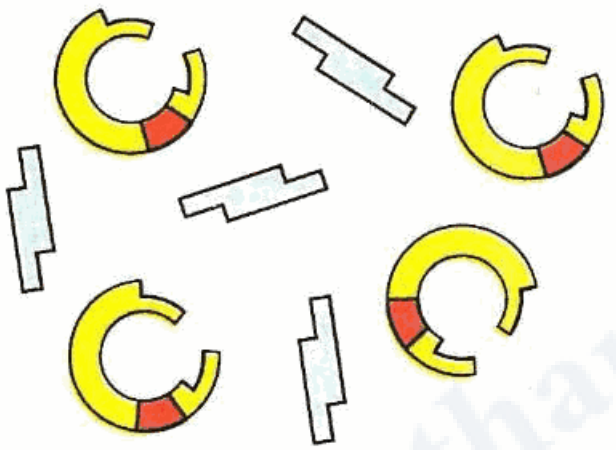
(A) 1 (B) 2 (C) 3 (D) 4

---

7 What is the ratio of free phosphate groups in a DNA molecule extracted from the nucleus of a human cell and a DNA molecule extracted from a bacterial cell that was treated with a restriction enzyme, respectively? (2nd session 2022)
(Given that this molecule contains one recognition site.)

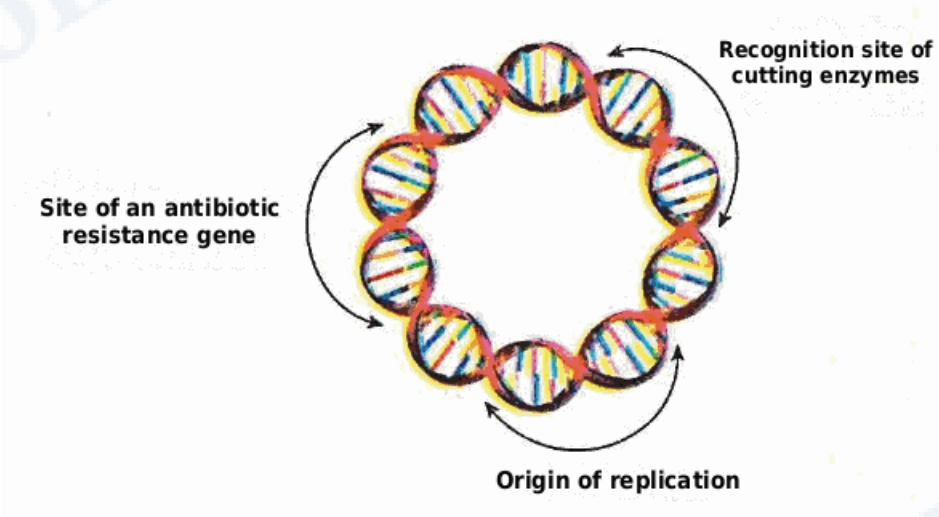
(A) 1 : 0 (B) 1 : 1 (C) 2 : 1 (D) 1 : 2

8 The opposite figure shows a group of plasmids and DNA segments (already treated with the same bacterial restriction enzyme). If ligase enzymes are not present during this process, what do you expect regarding the joining of these segments with the plasmids? (2nd session 2021)



(A) Only covalent bonds form
(B) Both covalent and hydrogen bonds form
(C) Only hydrogen bonds form
(D) No bonds form

9 The opposite figure shows a natural plasmid found in bacteria that can resist an antibiotic. If this plasmid is used to transfer the growth hormone gene into a strain of Escherichia coli (E.coli) bacteria with no plasmids, how many new traits will appear in the E.coli bacteria? (2nd session 2022)

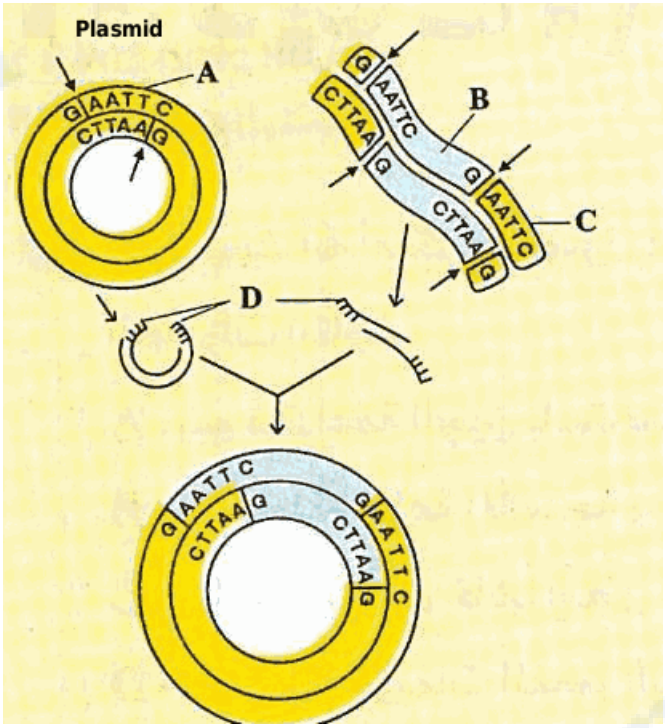


(A) 1 (B) 2 (C) 3 (D) 4

10 Which of the following can be used to clone DNA segments using only one enzyme? (Trial exam 2023)

(A) The phage
(B) Plasmids
(C) The PCR machine
(D) An mRNA molecule

11 Study the figure in front of you, then deduce how many enzymes are needed to insert the gene into the bacterial plasmid. (1st session 2023)



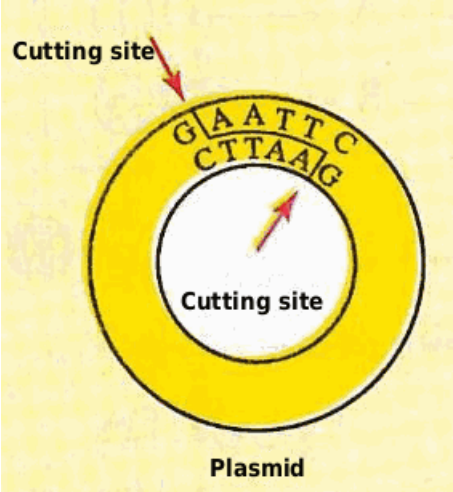
(A) One type of restriction enzyme

(B) One type of restriction enzyme, one type of ligase enzyme

(C) Two types of restriction enzymes

(D) Two types of restriction enzymes, one type of ligase enzyme

12 Study the opposite figure, which shows the action of a restriction enzyme on a bacterial plasmid, then deduce how many bonds are broken by the restriction enzyme in the plasmid shown in the figure. (2nd session 2023)



(A) 2 covalent , 4 hydrogen
(B) 2 covalent , 8 hydrogen
(C) 1 covalent , 4 hydrogen
(D) 1 covalent , 8 hydrogen

13 What is the similarity between cloning DNA segments using PCR and using the plasmid? (Sample exam 2025)

(A) The time to produce the DNA segments
(B) Using one enzyme in the cloning process
(C) The temperature at which cloning takes place
(D) The aim of the cloning process

14 Which of the following techniques depends on nucleic acid replication outside living cells? (1st session 2025)

(A) Pairing of two DNA strands from two different species as a result of base complementarity
(B) Inserting the haemoglobin gene into plasmids extracted from a type of bacteria
(C) Using the PCR machine to produce DNA segments thousands of times in minutes
(D) Producing an artificial gene from the building units of DNA

15 What is the chemical process / processes that the PCR machine depends on to produce DNA segments? (2nd session 2025)

(A) DNA replication and transcription
(B) DNA transcription only
(C) DNA transcription and translation
(D) DNA replication only

16 Given that golden rice grains were obtained by transferring the (alpha-carotene) gene from the carrot plant through the following steps:

A: The gene is replicated using the PCR machine.

B: Using tissue culture, many genetically modified plants can be obtained.

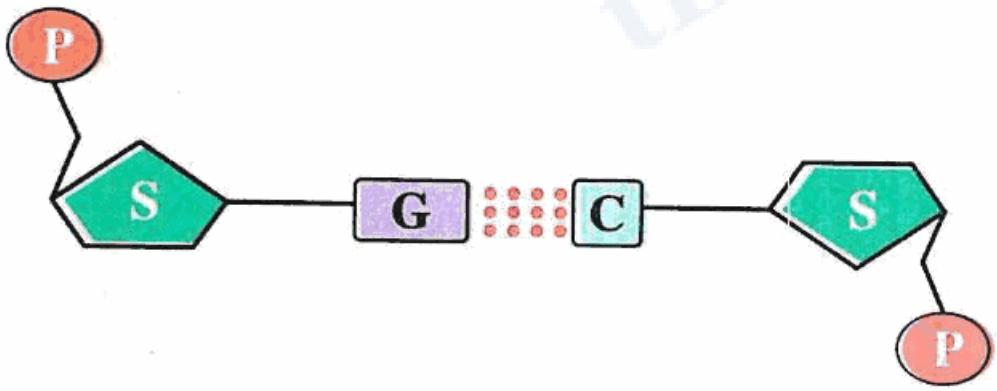
C: Growing the gene in the cells of some leaves.

D: Using bacterial restriction enzymes to separate the gene from the carrot DNA.

What is the correct order for obtaining genetically modified rice? (1st session 2021)

(A) D, then A, then C, then B
(B) B, then A, then D, then C
(C) D, then B, then C, then A
(D) D, then B, then A, then C

17 Study the opposite figure, then answer: in which type of nucleic acid can this pairing be seen? (1st session 2022)



(A) Sticky ends in DNA
(B) Recombinant DNA
(C) DNA at a temperature of 100 °C
(D) mRNA

18 Which of the following applications depends on recombinant DNA technology? (1st session 2022)

(A) Identifying the position of the insulin gene on the chromosome
(B) Transferring the host gene of nodule bacteria into the wheat plant
(C) Identifying the nucleotide sequence of the haemoglobin gene
(D) Isolating the ruby-red eye colour gene from the chromosomes of Drosophila

19 Genetically Modified Organisms (GMO) are organisms into whose genome genes from another, taxonomically different organism have been inserted. Which of the following organisms can be considered a genetically modified organism? (2nd session 2022)

(A) Pneumonia bacteria naturally transformed into a deadly strain

(B) Implanting a gene from one strain of fruit fly into the embryo of another strain

(C) Escherichia coli bacteria producing human insulin

(D) A human whose damaged genes were replaced with healthy genes from another human

---

20 Thalassaemia (Mediterranean anaemia) results from a defect in the polypeptide chains making up haemoglobin, which carries oxygen from the lungs to the body cells. Which of the following helps a couple who both have thalassaemia to have a child free of this disease? (2nd session 2022)

(A) Carrying out artificial fertilization with the couple's gametes genetically modified for this disease

(B) Inserting a modified mRNA for producing haemoglobin into the couple's gametes

(C) Using medicines containing iron for the mother during pregnancy

(D) Inserting the haemoglobin gene into the bone marrow stem cells of the parents

---

21 What is the difference between the DNA molecule in the tenth chromosome and the DNA molecule in the fifteenth chromosome in humans? (2nd session 2022)

(A) The type of bonds in the two sugar-phosphate backbones

(B) The type of bonds between the nitrogenous bases

(C) The type of sugar

(D) The number of genes

---

22 Which of the following is NOT a property of the human genome? (1st session 2023)

(A) The genome of nerve cells does not carry the genetic code

(B) The genome of liver cells does not differ from the genome of skin cells

(C) The number of genes responsible for producing ribosomes is equal in liver and pancreas cells

(D) Some adult human cells do not contain a genome

---

23 From which cells can the interferon genes be isolated so that they are cloned? (1st session 2023, Sample exam 2025)

(A) Virus-infected cells

(B) Phage-resistant Escherichia coli (E.coli) cells

(C) All human body cells that can be infected by viruses

(D) The cells next to the virus-infected cells

---

24 What is the similarity between the DNA molecule in the tenth chromosome and the DNA molecule in the fifteenth chromosome in a human body cell? (2nd session 2023)

(A) The number of nucleotides

(B) The length of the two sugar backbone strands

(C) The number of purine and pyrimidine bases

(D) The type of bonds between the nitrogenous bases

---

25 Studying the human genome helped identify disease-causing genes. Which diseases did not have their genes identified by studying the human genome? (2nd session 2023)

(A) Tuberculosis and diphtheria

(B) Cancer and diabetes

(C) Failure of some organs

(D) Colour blindness and haemophilia

---

26 Which of the following is NOT achieved by studying the human genome? (1st session 2024)

(A) Producing plants more resistant to diseases

(B) Knowing the genes that cause the failure of some organs

(C) Knowing the species closest in evolution to humans

(D) Producing drugs with no side effects on genes

---

27 Which of the following is NOT evidence of an evolutionary relationship between humans and other species? (2nd session 2024)

(A) Nucleic acid hybridization

(B) Studying the human genome

(C) The number of chromosomes in human gametes

(D) The codons of the genetic code

---

28 What is the similarity between DNA hybridization and recombinant DNA? (Sample exam 2025)

(A) In both, hydrogen and covalent bonds are broken

(B) Both happen when the temperature is raised to 100°C

(C) Both need ligase enzymes

(D) Both produce double strands of DNA

---

29 What happens if the ligase enzyme is not used in a DNA cloning experiment? (Sample exam 2026)

(A) The gene and the plasmid are joined when the temperature drops

(B) Covalent bonds form but hydrogen bonds do not form between the plasmid and the gene

(C) Hydrogen bonds form but covalent bonds do not form between the plasmid and the gene

(D) The gene and the plasmid join automatically without the need for the ligase enzyme

---

30 If you want to insert a human gene into a bacterial plasmid, what is the first step you must take? (Sample exam 2026)

(A) Cutting the gene and the plasmid with the same restriction enzyme

(B) Heating the gene to separate the two nucleic acid strands

(C) Cutting the gene and the plasmid with two different types of restriction enzymes

(D) Using the ligase enzyme to join the gene with the plasmid

---

31 Which of the following explains why genome size differs between eukaryotes even though the number of genes may be similar? (Sample exam 2026)

(A) The difference in the lengths of the DNA strands in the same organism

(B) The difference in the amount of non-coding DNA from one organism to another

(C) The difference in chromosome structure between species

(D) The difference in the order of DNA bases from one organism to another

---

32 What is the most important factor for making sure the gene and the plasmid join successfully after cutting in an experiment to produce recombinant DNA? (Sample exam 2026)

(A) The length of the plasmid

(B) The activity level of the restriction enzyme

(C) The complementarity of the sticky ends

(D) The type of bacteria used

Answer key and solutions

Multiple choice questions

1 B	2 C	3 D	4 C	5 A	6 B	7 D	8 A	9 B	10 A
11 C	12 C	13 B	14 C	15 D	16 B	17 A	18 D	19 A	20 D
21 B	22 B	23 D	24 D	25 D	26 B	27 A	28 B	29 B	30 C
31 C	32 C	33 B	34 D	35 C	36 A	37 B	38 B	39 D	40 D
41 D	42 B	43 C	44 C	45 A	46 A	47 C	48 B	49 D	50 C
51 B	52 D	53 B	54 C	55 C	56 C	57 B	58 D	59 D	60 B
61 B									

1 **Answer (B)**

Mixing DNA strands from different organisms and hybridizing them shows how complementary they are, and so the evolutionary relationships between them.

2 **Answer (C)**

GAT is from DNA and CUA is from RNA, and the bases are complementary (G with C, A with U, T with A).

This pairing between DNA and RNA happens during nucleic acid hybridization.

3 **Answer (D)**

In hybridization, the two strands bind by hydrogen bonds between complementary bases.

4 **Answer (C)**

The two organisms that are closest in evolution have similar DNA sequences, so their strands are more complementary.

These are (4) and (5), since both are insects.

5 **Answer (A)**

Organisms (1) and (2) differ in only one base (position 7), so they are the closest.

6 **Answer (B)**

Each G–C pair has three hydrogen bonds, so the greater the number of G, the higher the temperature needed to separate the two strands.

So the relation is direct.

7 **Answer (D)**

Hybridization takes place between any two complementary strands, even if one is DNA and the other RNA.

8 **Answer (A)**

Replication is semi-conservative, so each molecule in the first generation has an old ^{15}N strand and a new ^{14}N strand.

So there is no molecule with only ^{15}N.

9 **Answer (B)**

In the second generation 4 molecules are formed: 2 hybrid and 2 with only ^{14}N.

So the percentage is 50 %.

10 **Answer (A)**

Each cell in the third generation has at least one new strand with ^{14}N.

So there is no cell whose content is only ^{15}N.

11 **Answer (C)**

After the first replication: two hybrid molecules.

After the second: two molecules exactly like the original DNA and two hybrid molecules, so the percentage is 50 %.

12 **Answer (C)**

The second replication produces two hybrid molecules out of four.

So the percentage is 50 %.

13 **Answer (B)**

Sequence (Y) is richer in the bases G and C (three hydrogen bonds per pair).

So it needs a higher temperature to separate its two strands.

14 **Answer (C)**

The least related have the least complementary strands, so they need a lower temperature to separate them.

The lowest temperature is 10 °C, for samples (3) and (4).

15 **Answer (D)**

Restriction enzymes break the covalent bonds in the sugar-phosphate backbone.

16 **Answer (B)**

Restriction enzymes are bacterial enzymes found in some strains of bacteria.

17 **Answer (A)**

There are three cutting sites, and each cutting site produces two sticky ends.

So the number is 6.

18 **Answer (D)**

For the sticky ends to be complementary, the gene and the plasmid must be cut with the same two types of enzymes.

19 **Answer (A)**

The recognition site reads the same sequence on both strands in the direction 5′ to 3′.

This applies to G-G-C-C.

20 **Answer (D)**

The bacteria produce modifying enzymes that protect their own DNA, then restriction enzymes that cut the DNA of the virus.

21 **Answer (B)**

The restriction enzyme cuts the viral DNA (1).

The bacterial DNA (2) is protected by CH3 groups, so it resists the effect of restriction enzymes.

22 **Answer (B)**

Both enzymes break the covalent bonds between nucleotides.

23 **Answer (D)**

Modifying enzymes add a methyl group to the bacterial DNA, which protects it from restriction enzymes.

24 **Answer (D)**

The restriction enzyme cuts the two strands at two staggered positions, so sticky ends are formed.
In (D), the cut is near the 5′ end of each strand.

25 **Answer (D)**

The genetic material of the influenza virus is RNA, and restriction enzymes cut DNA only.

26 **Answer (B)**

Cloning needs sticky ends.
Enzyme (2) makes a staggered cut, giving sticky ends, while (1) makes a straight cut.

27 **Answer (A)**

In eukaryotes: replication (1), transcription (2) and translation (4).
Reverse transcription (3) does not take place under natural conditions.

28 **Answer (B)**

Treating the gene and the plasmid with two different enzymes gives sticky ends that are not complementary, so they do not join.

29 **Answer (B)**

Restriction enzymes cut the foreign viral DNA, so they protect the bacteria from the viruses that attack them.

30 **Answer (C)**

Enzyme (X) breaks DNA down into separate nucleotides, so it is deoxyribonuclease.
Enzyme (Y) cuts at a specific recognition site (4 to 7 nucleotides), so it is a restriction enzyme.

31 **Answer (C)**

Enzyme (X) recognizes a specific site and cuts there, so it is a restriction enzyme.
Sequence (Y) is the complement of the sequence AATT, that is, TTAA.

32 **Answer (C)**

The modifying enzyme (X) adds CH3 to the bacterial DNA, which protects it.
The restriction enzyme (Y) recognizes the viral DNA and cuts it.

33 **Answer (B)**

The restriction enzyme recognizes specific sites and breaks the covalent bonds between the nucleotides there.

34 **Answer (D)**

The plasmids in E.coli are used as gene vectors.

35 **Answer (C)**

The Taq polymerase enzyme resists high temperatures, so it is extracted from thermophilic bacteria.

36 **Answer (A)**

Replacing a damaged gene with a healthy gene is gene therapy.

37 **Answer (B)**

Enzyme (X) is reverse transcriptase, which forms a DNA strand from mRNA.

Enzyme (Y) is DNA polymerase, which forms the complementary strand.

38 **Answer (B)**

Reverse transcriptase is an enzyme carried by some viruses, and its code is not found in bacteria.

39 **Answer (D)**

Adenine (4) is repeated in the poly-A tail, which protects mRNA from breaking down.

40 **Answer (D)**

41 **Answer (D)**

New nucleotides are added by Taq polymerase at 72 °C, which is stage (L).

42 **Answer (B)**

The hydrogen bonds are broken at 94 °C, which is stage (Y).

43 **Answer (C)**

The DNA is transcribed and translated at the same time, so it is not condensed.

44 **Answer (C)**

(X) is DNA, (Y) is mRNA and (Z) is a polypeptide.

(Y) is produced from (X) by transcription, and (Z) is produced from (Y) by translation.

45 **Answer (A)**

Step (1) is at 94 °C, so the hydrogen bonds between the two strands are broken.

46 **Answer (A)**

Helicase breaks the hydrogen bonds between the two DNA strands during replication in cells.

47 **Answer (C)**

Enzyme (X) is Taq polymerase; it forms covalent bonds between the nucleotides.
Hydrogen bonds form between the complementary bases.

48 **Answer (B)**

The number of segments doubles in each cycle: $2^3 = 8$.

49 **Answer (D)**

(X) is reverse transcriptase, which forms a single DNA strand from the viral RNA.
(Y) is DNA polymerase, which forms the complementary strand.

50 **Answer (C)**

Each division doubles the number, so after 5 divisions: $2^5 = 32$.

51 **Answer (B)**

The hormone produced by genetic engineering is a copy of the human hormone, so it has the same effect.

52 **Answer (D)**

The other choices are applications of recombinant DNA.

53 **Answer (B)**

Using the same restriction enzyme gives complementary sticky ends on the gene and the plasmid.

54 **Answer (C)**

(1) is the gene to be transferred, which is the insulin gene, and (2) is the plasmid.

55 **Answer (C)**

(Z) is a recombinant plasmid carrying the insulin gene.
(L), the product, is the hormone insulin.

56 **Answer (C)**

Recombinant DNA combines DNA from two taxonomically different organisms, such as humans and bacteria.

57 **Answer (B)**

Recombinant DNA combines two or more molecules that do not exist together in nature.

58 **Answer (D)**

Transferring a gene and inserting it into bacteria so that they produce its protein is DNA cloning.

59 **Answer (D)**

Joining the gene to the plasmid in stage (Y) is done by the ligase enzyme.

60 **Answer (B)**

The restriction enzyme in stage (X) comes from bacteria.

61 **Answer (B)**

Treating the bacterial cell chemically increases the permeability of the membrane so that DNA can enter.

Essay questions

1 **Model answer**

(1) 5′ … C-T-G-A-A-T-T-C-A-G … 3′

3′ … G-A-C-T-T-A-A-G-T-C … 5′

(2) The enzyme cuts the first strand between G and A in 5′ … C-T-G / A-A-T-T-C-A-G … 3′ and cuts the other strand between A and G in 3′ … G-A-C-T-T-A-A / G-T-C … 5′

(3) First segment: 5′ … C-T-G 3′ with 3′ … G-A-C-T-T-A-A 5′

Second segment: 5′ A-A-T-T-C-A-G … 3′ with 3′ G-T-C … 5′

2 **Model answer**

The bacteria do not produce the hormone insulin, because part of the gene does not carry the complete genetic code for building insulin; the whole gene must be inserted by joining it to the plasmid so that it is replicated and expressed inside the bacteria.

3 **Model answer**

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

(2) 5′ … A-T-G-A-T-T-T-G-G-A-A-T-C-C-A-T-A-A … 3′ / DNA polymerase

(3) By using the PCR machine, which replicates the DNA segment (the gene) thousands of times in a few minutes using the Taq polymerase enzyme, which works at a high temperature.

4 **Model answer**

(2), (3), (4), (6): the genome is DNA

(1), (5), (7): the genome is RNA

5 **Model answer**

(1) CGA - GGU - UUU - GGU - CGA

(2) 5 amino acids.

(3) 3 types of tRNA

(4) 3′ ... C-G-A-G-G-T-T-T-T-G-G-T-C-G-A-A-C-T ... 5′

6 **Model answer**

(3), then (1), then (2), then (4)

7 **Model answer**

Structure (Y) (an acidophil white blood cell) / because it has a nucleus containing the genetic material, while structure (X) (a mature red blood cell) has no nucleus and so has no genetic material.

8 **Model answer**

(1) Structures (Y), "the primers", because they bind to the template strand, then the Taq polymerase enzyme (X) forms the covalent bonds between neighbouring nucleotides, and so hydrogen bonds form between the complementary opposite bases in the two strands.

(2) Structures (Z) are free DNA nucleotides that act as building units used to produce new DNA molecules.

Past exam questions

1	2	3	4	5	6	7	8	9	10
A	D	C	B	C	B	B	C	B	C
11	12	13	14	15	16	17	18	19	20
B	B	D	C	D	A	B	B	C	A
21	22	23	24	25	26	27	28	29	30
D	A	C	D	A	A	C	D	C	A
31	32								
B	C								

1 **Answer (A)**

DNA hybridization measures the degree of similarity between the DNA of different organisms, so it was used to find out how related they are and to reclassify them.

2 **Answer (D)**

The cockroach DNA does not contain the haemoglobin gene, but some of its bases may be complementary to some bases of the radioactive strand, so partial pairing happens.

3 **Answer (C)**

Nucleic acid hybridization showed the degree of similarity between the DNA of rabbits and rodents, so rabbits were placed in a separate order.

4 **Answer (B)**

Mixing single DNA strands of two different organisms and pairing them according to base complementarity: nucleic acid hybridization.

5 **Answer (C)**

The hybrid strands of human and chimpanzee are more complementary (fewer unpaired regions) than those of human and insect.

So humans are closer in evolution to the chimpanzee.

6 **Answer (B)**

The modifying enzyme protects the recognition sites by adding a methyl group to each of the two strands of the site.

4 methyl groups (2 per site) mean two recognition sites.

7 **Answer (B)**

The human nuclear DNA molecule is linear with two 5′ ends, so it has two free phosphate groups.

The bacterial DNA is circular, and cutting it at one site turns it into a linear molecule with two free phosphate groups, so the ratio is 1 : 1

8 **Answer (C)**

The complementary sticky ends join by hydrogen bonds, but the covalent bonds between nucleotides need ligase enzymes.

9 **Answer (B)**

The bacteria gain two traits: resistance to the antibiotic (the plasmid gene) and producing growth hormone (the transferred gene).

10 **Answer (C)**

The PCR machine clones DNA segments using one enzyme, Taq polymerase.

11 **Answer (B)**

One type of restriction enzyme cuts the gene and the plasmid, forming complementary sticky ends, then one type of ligase enzyme joins them.

12 **Answer (B)**

The restriction enzyme breaks one covalent bond in each strand (2 covalent).
The two AATT sticky ends separate with four A-T pairs, each with two hydrogen bonds (8 hydrogen).

13 **Answer (D)**

The aim of both methods is the same: cloning (multiplying) DNA segments.

14 **Answer (C)**

The PCR machine replicates DNA outside living cells.

15 **Answer (D)**

The PCR machine depends on DNA replication only.

16 **Answer (A)**

First the gene is cut by restriction enzymes (D), then replicated by PCR (A), then grown in leaf cells (C), then tissue culture (B).

17 **Answer (B)**

The figure shows G binding with C by three hydrogen bonds between two complementary strands, which happens in double-stranded recombinant DNA.

18 **Answer (B)**

Transferring a gene from nodule bacteria into the wheat plant depends on recombinant DNA technology.

19 **Answer (C)**

A genetically modified organism carries a gene from a taxonomically different organism, such as E.coli producing human insulin.

20 **Answer (A)**

Genetically modifying the couple's gametes and then artificial fertilization produces a healthy embryo.

Modifying the bone marrow cells is not inherited.

21 **Answer (D)**

The DNA of the two chromosomes is the same in the type of sugar and bonds, and differs in the number of genes.

22 **Answer (A)**

The genome of nerve cells carries the genetic code like all cells, so statement (A) is not one of its properties.

23 **Answer (C)**

The interferon genes are found in all body cells that can be infected by viruses, so they can be isolated from them.

24 **Answer (D)**

The type of bonds between the bases (hydrogen) is the same in the DNA of both chromosomes, while the number of nucleotides and the length differ.

25 **Answer (A)**

Tuberculosis and diphtheria are infectious bacterial diseases that are not caused by human genes.

26 **Answer (A)**

Studying the human genome does not aim to produce disease-resistant plants.

27 **Answer (C)**

The number of chromosomes in the gametes is not evidence of an evolutionary relationship.

28 **Answer (D)**

DNA hybridization and recombinant DNA both produce double strands of DNA.

29 **Answer (C)**

Without the ligase enzyme, hydrogen bonds form between the sticky ends, but covalent bonds do not form between the plasmid and the gene.

30 **Answer (A)**

The first step is cutting the gene and the plasmid with the same restriction enzyme, so that complementary sticky ends form.

31 **Answer (B)**

Genome size differs because the amount of non-coding DNA differs from one organism to another.

32 **Answer (C)**

Successful joining depends on the complementarity of the sticky ends of the gene and the plasmid.