EUNOIA JUNIOR COLLEGE
JC1 Promotional Examinations 2019
General Certificate of Education Advanced Level
Higher 2

H2 Biology

Paper 1 Multiple Choice

9744/01

04 October 2019

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use paper clips, glue or correction fluid.
Write your name, civics group and registration number on the Answer Sheet in the spaces provided.

There are **thirty** Multiple Choice Questions in this paper.

Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **23** printed pages and **1** blank page.

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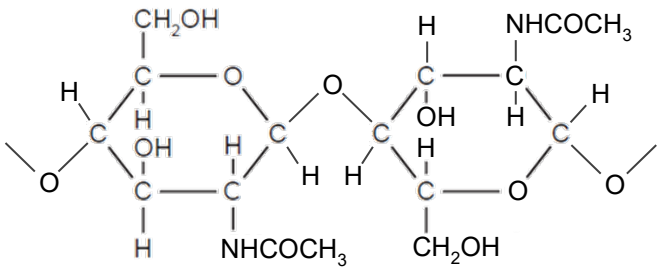
1 The following diagrams show short sections of some common polysaccharides and modified polysaccharides.

1



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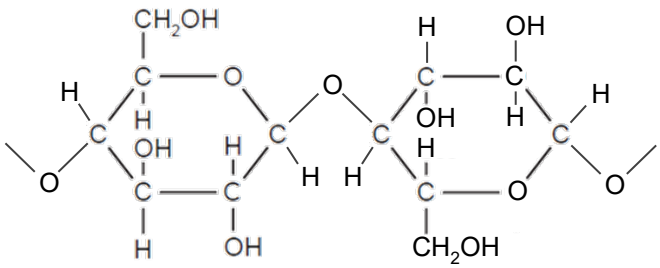

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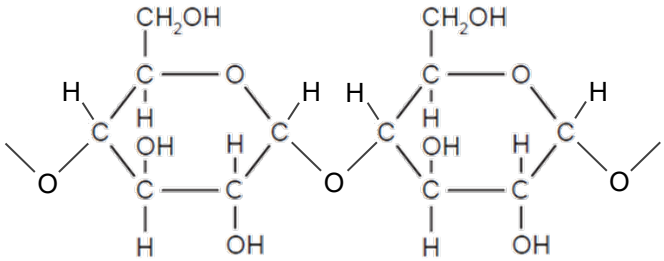

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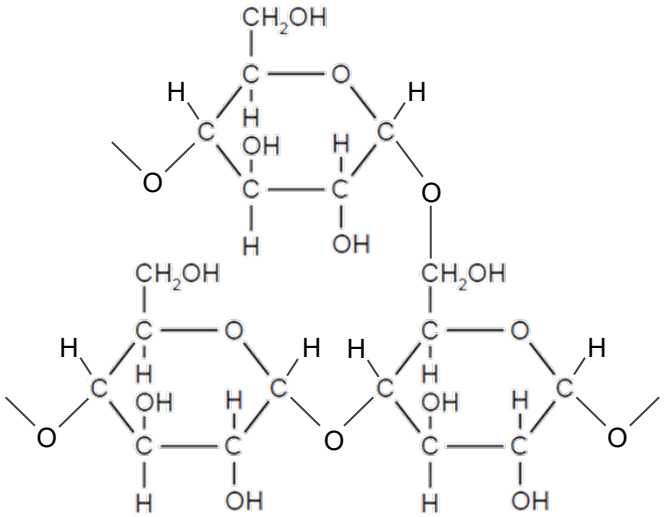


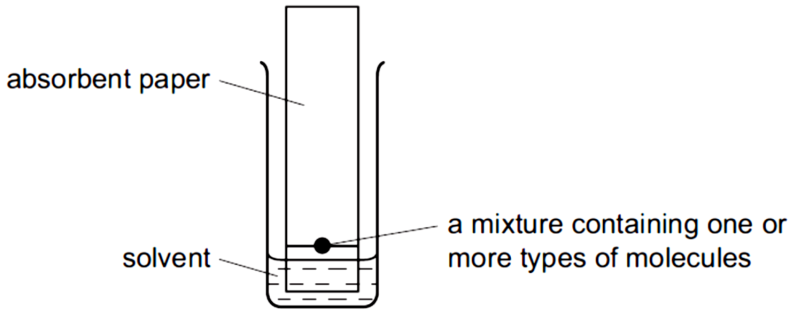
The four polysaccharides **P**, **Q**, **R** and **S** are described as follows:

- Polysaccharide **P** is composed of β-glucose monomers with 1,4 glycosidic bonds.
- Polysaccharide **Q** is composed of α-glucose monomers with 1,4 and 1,6 glycosidic bonds.
- Polysaccharide **R** is composed of α-glucose monomers with 1,4 glycosidic bonds.
- Polysaccharide **S** is composed of N-acetylglucosamine monomers with β-1,4 glycosidic bonds.

Which row correctly pairs the polysaccharide with its structure?

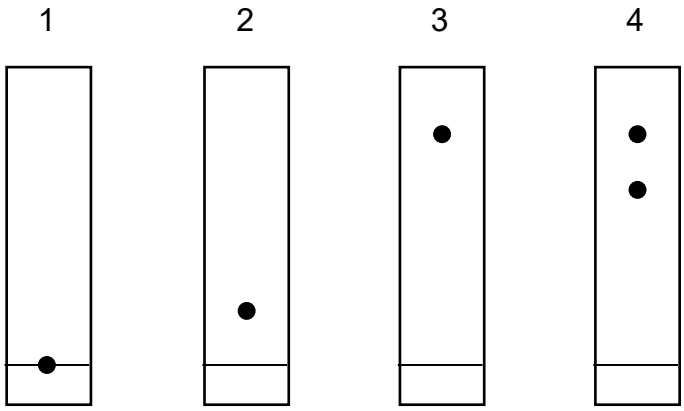
	Polysaccharide			
	P	**Q**	**R**	**S**
A	2	4	3	1
B	2	4	1	3
C	3	1	2	4
D	3	4	1	2

2 Chromatography is a technique used to separate molecules by their solubility. The diagram shows an apparatus used for this technique.



As the solvent rises up the paper, the molecules with the greatest solubility in the solvent travel the greatest distances up the paper. When the solvent reaches the top of the paper, the paper is removed, dried and sprayed with a dye. The different molecules appear as coloured spots

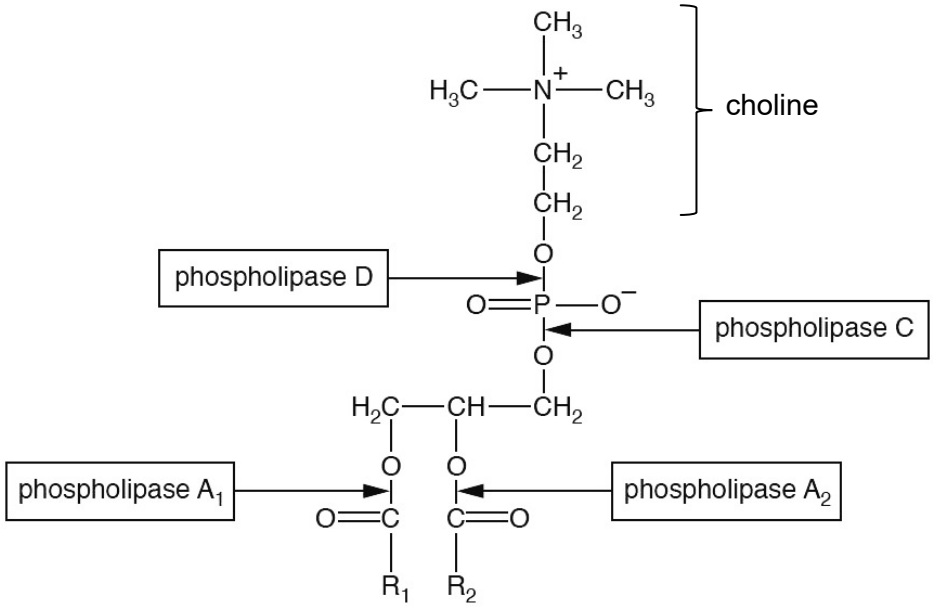
Chromatography was carried out on four different samples – lactose, cellulose, as well as the products of complete hydrolysis of lactose and cellulose. The diagram below shows the results for each sample.



Which row correctly identifies the chromatogram of each sample?

	lactose	cellulose	hydrolysed lactose	hydrolysed cellulose
A	4	3	1	2
B	3	4	2	1
C	1	2	3	4
D	2	1	4	3

3 Phosphatidylcholines make up a large proportion of phospholipids in red blood cell membranes. They are phospholipids that have choline as part of their polar head section, as shown in the diagram below. Four different phospholipases, A_1, A_2, C and D, act on different parts of the phosphatidylcholine molecule as indicated.



It is known that in phosphatidylcholines,

- saturated fatty acids are more commonly found in position R_1 than unsaturated fatty acids, and
- unsaturated fatty acids are more commonly found in position R_2 than saturated fatty acids.

The table shows the four most abundant fatty acids that form part of phosphatidylcholines.

fatty acid	molecular formulae	
palmitic acid	$C_{16}H_{32}O_2$	$CH_3(CH_2)_{14}COOH$
linoleic acid	$C_{18}H_{32}O_2$	$CH_3(CH_2)_4(CH{=}CHCH_2)_2(CH_2)_6COOH$
oleic acid	$C_{18}H_{34}O_2$	$CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$
steric acid	$C_{18}H_{36}O_2$	$CH_3(CH_2)_{16}COOH$

Which statement about phospholipase action on isolated phosphatidylcholines is correct?

A The action of phospholipase A_1 is likely to yield a higher proportion of oleic acid than stearic acid.

B The action of phospholipase A_2 is likely to yield a higher proportion of linoleic acid than palmitic acid.

C The action of phospholipase A_1, A_2 and D will cause an increase in the pH of the reaction medium.

D The products of the combined action of phospholipases A_1, A_2 and D will be free fatty acids, glycerol and choline.

4 Approximately half of the total protein in a pea seed consists of the storage protein vicillin.

- Each molecule of vicillin is made up of three identical polypeptide chains.
- Each polypeptide is made up of two β-pleated sheet regions with linking α-helix regions, folded into the shape shown in Fig 4A.
- This allows the three polypeptides to pack together into a compact, flat storage molecule, as shown in Fig 4B.

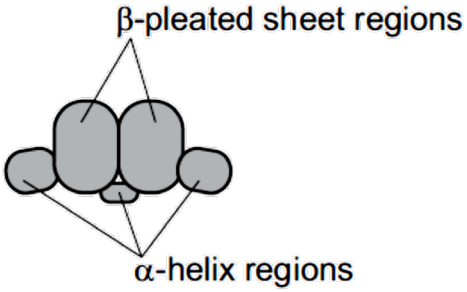


Fig 4A

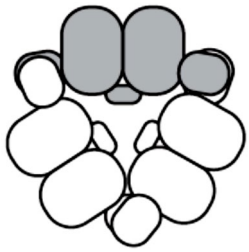
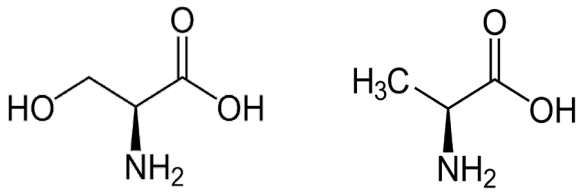


Fig 4B

Which row correctly describes the structure of vicillin?

	primary structure	secondary structure	tertiary structure	quaternary structure
A	sequence of mRNA codons coding for each polypeptide	amino acid sequence of one polypeptide	α-helix and β-pleated sheet regions of each polypeptide	further folding of each polypeptide
B	amino acid sequence of one polypeptide	α-helix and β-pleated sheet regions of each polypeptide	association of three polypeptides	further folding of each polypeptide
C	amino acid sequence of one polypeptide	α-helix and β-pleated sheet regions of each polypeptide	further folding of each polypeptide	association of three polypeptides
D	sequence of mRNA codons coding for each polypeptide	amino acid sequence of one polypeptide	α-helix and β-pleated sheet regions of each polypeptide	association of three polypeptides

5 The diagram below shows the structures of two amino acids that are found in a globular protein.



serine alanine

When placed in an aqueous medium, where are these amino acids most likely to be found?

A Both serine and alanine will be found in the interior of the globular protein.

B Both serine and alanine will be found on the exterior of the globular protein.

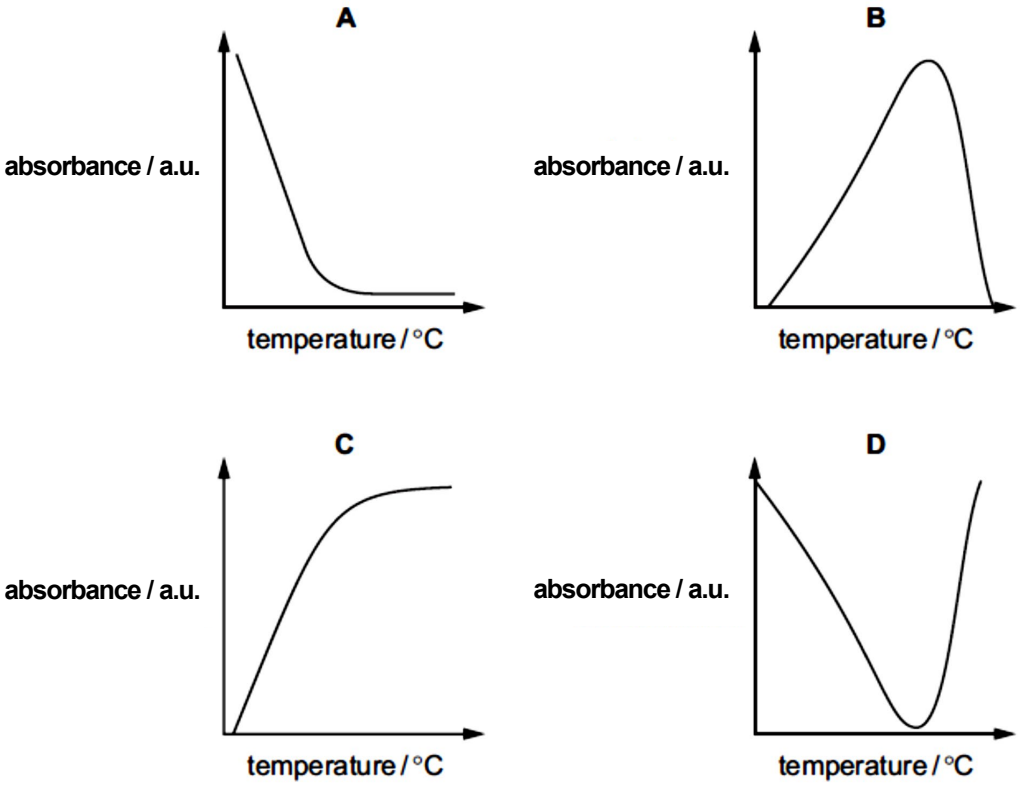
C Alanine will be found on the exterior, and serine in the interior of the globular protein.

D Alanine will be found in the interior, and serine on the exterior of the globular protein.

6 A student investigated the hydrolysis of lipids in a sample using the enzyme lipase. These lipids consist of triglycerides with short-chain hydrocarbons between 1 to 5 carbons in length.

- 1 cm^3 of lipase solution was added to 4 cm^3 of liquid sample at a range of temperatures.
- At each temperature, the ethanol-emulsion test was conducted after 10 minutes.
- The absorbance of the resulting mixture was measured using a spectrophotometer.
- Distilled water gives an absorbance reading of 0 arbitrary units.
- All other variables were kept constant.

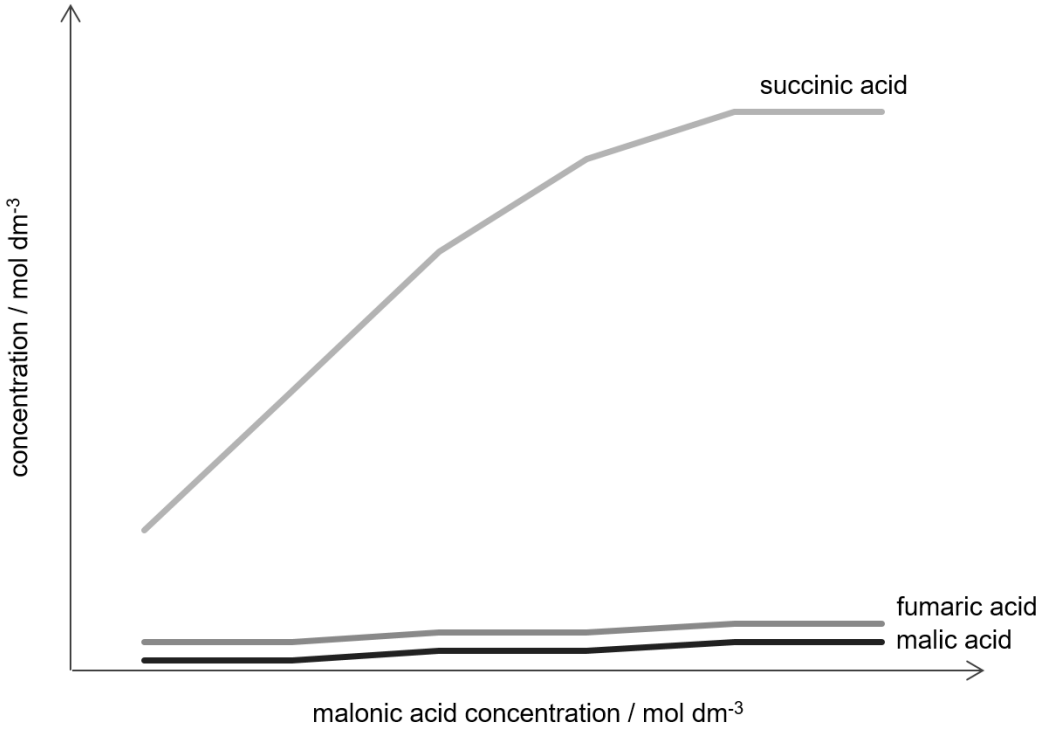
Which graph shows the effect of increasing temperature on absorbance?



7 Malic acid is produced by a series of enzyme-catalysed reactions.

$$\text{oxoglutaric acid} \xrightarrow{\text{enzyme 1}} \text{succinic acid} \xrightarrow{\text{enzyme 2}} \text{fumaric acid} \xrightarrow{\text{enzyme 3}} \text{malic acid}$$

A beaker was set-up with oxoglutaric acid and enzymes 1, 2, and 3. The addition of malonic acid results in changes to the concentrations of other intermediates and products as shown in the graph below.



Further addition of fumaric acid results in the formation of malic acid.

What does the above information indicate about malonic acid?

A It is a competitive inhibitor of enzyme 1.

B It is a competitive inhibitor of enzyme 2.

C It reacts with fumaric acid to form malic acid.

D It reacts with fumaric acid to form succinic acid.

8 Ethylene glycol is a chemical used to prevent water from freezing. If ethylene glycol is ingested by accident, it is metabolised by alcohol dehydrogenase and aldehyde dehydrogenase in liver cells to produce glycolic acid, which is a toxic product. Alcohol dehydrogenase and aldehyde dehydrogenase normally catalyse the oxidation of ethanol to ethanoic acid.

Individuals who have swallowed ethylene glycol may be treated with large doses of ethanol. This prevents formation of glycolic acid and allows the body to excrete the ethylene glycol harmlessly.

Which statement best describes why this treatment works?

A Ethanol denatures the tertiary and quaternary structure of alcohol dehydrogenase.

B Ethanol is more likely to bind to the active site of alcohol dehydrogenase.

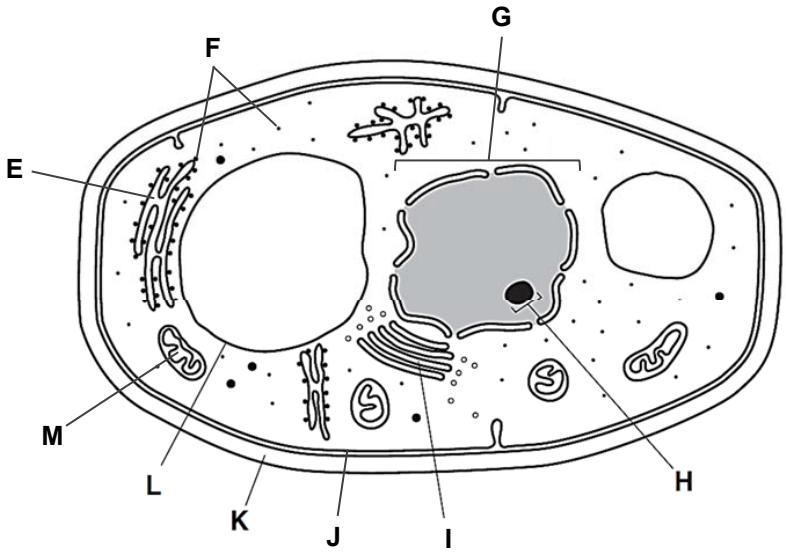
C Ethanol binds near the active site of alcohol dehydrogenase and alters its conformation.

D Ethanol binds permanently to the active site of alcohol dehydrogenase, blocking ethylene glycol from binding.

9 Tuberculosis and candidiasis are both opportunistic infections that can develop in AIDS patients.

Tuberculosis is caused by the bacterium *Mycobacterium tuberculosis*, while candidiasis is caused by *Candida albicans*, which is a yeast-like fungus that lives in the human gut and lungs.

The diagram below shows the structure of a *Candida* cell.



Which of the structures can also be found in the pathogen that causes tuberculosis?

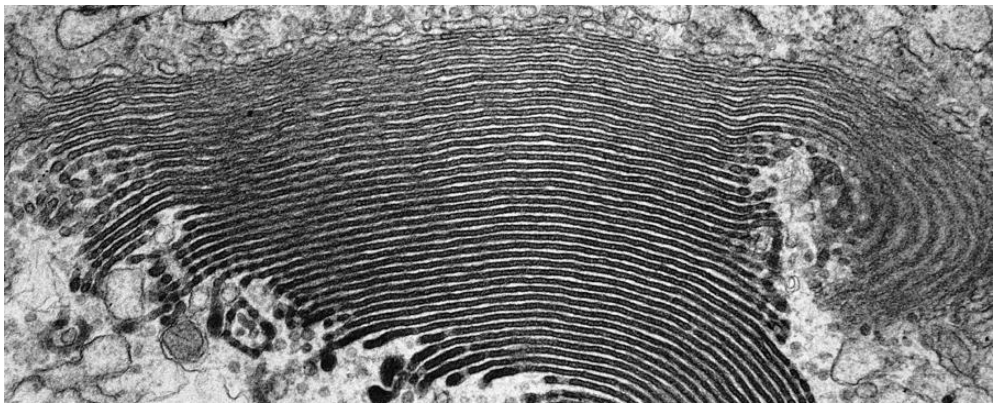
A **E**, **G** and **M** only

B **F**, **J** and **K** only

C **F**, **L** and **M** only

D **H**, **I** and **K** only

10 A mutation that occurs in the *Trip11* gene of animal cells results in the following organelle becoming non-functional.



Which of the following statements describe the most likely consequences for this animal cell?

1 The cell is unable to synthesise centrioles for cell division.

2 The cell is unable to export enzymes or peptide hormones.

3 The cell dies from accumulation of worn-out organelles within itself.

4 The cell dies from a lack of enzymes to digest food taken in by endocytosis.

5 The cell dies because it is unable to make glycoprotein receptors to detect stimuli from the surrounding environment.

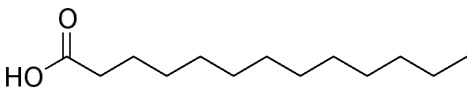
A 2, 4 and 5 only

B 1, 4, and 5 only

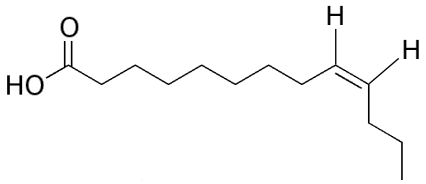
C 2, 3, 4 and 5 only

D All of the above

11 Fatty acid chains of membrane phospholipids may be saturated or unsaturated.



fatty acid chain A



fatty acid chain B

Which statements regarding fatty acid chains A and B are correct?

1 The presence of phospholipids with mainly fatty acid chain A in cell membranes have increased membrane viscosity.

2 Fatty acid chain B is unsaturated because it contains one double bond creating a kink in the fatty acid structure.

3 A membrane containing predominantly fatty acid chain B has a greater fluidity than one which predominantly contains fatty acid chain A.

4 The presence of phospholipids with fatty acid chain B eases the passage of small, non-polar molecules, such as oxygen through membranes.

A 1 and 2 only

B 2 and 4 only

C 1, 3 and 4 only

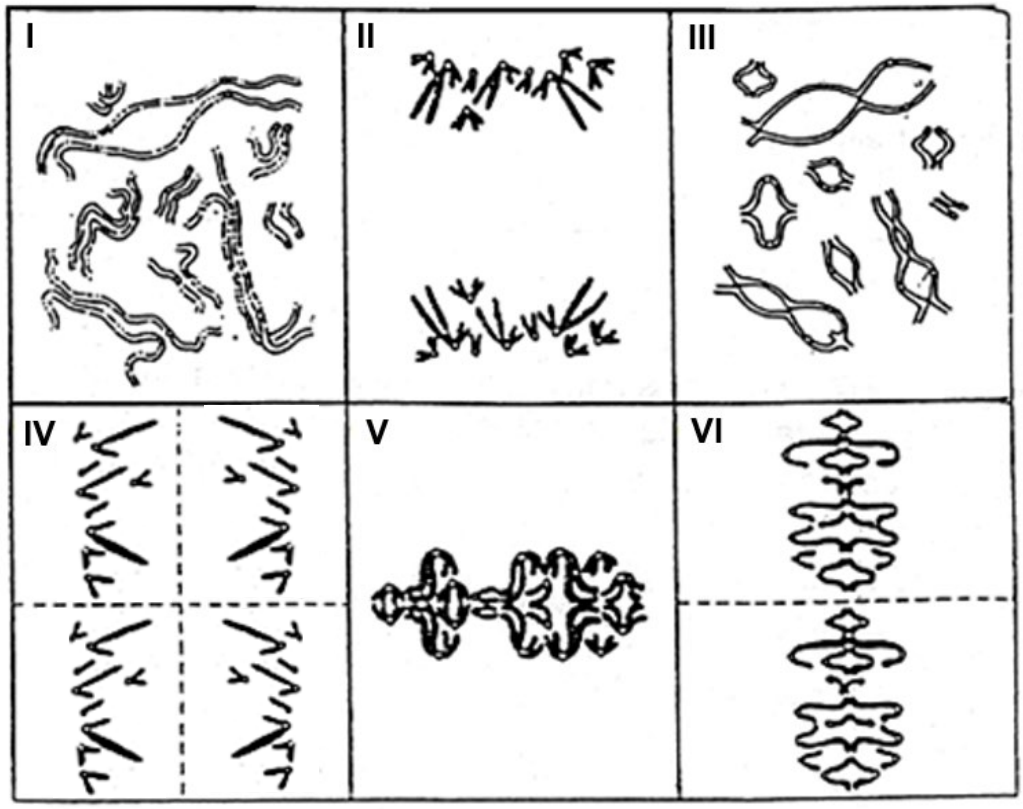
D All of the above

12 The amount of DNA present in a cell at the beginning of interphase is 3.6 picograms. It then undergoes one mitotic division, followed by one meiotic division.

Which of the following combinations reflects the amount of DNA, in pictograms, in each cell during the various stages of cell division?

	End of interphase	End of mitosis	End of meiosis I	Anaphase II
A	3.6	1.8	1.8	1.8
B	3.6	1.8	1.8	0.9
C	7.2	3.6	3.6	1.8
D	7.2	3.6	3.6	3.6

13 The diagrams I to VI below depict the behaviour of chromosomes at various stages of meiosis of the same cell.



Which of the following shows the correct order of the stages?

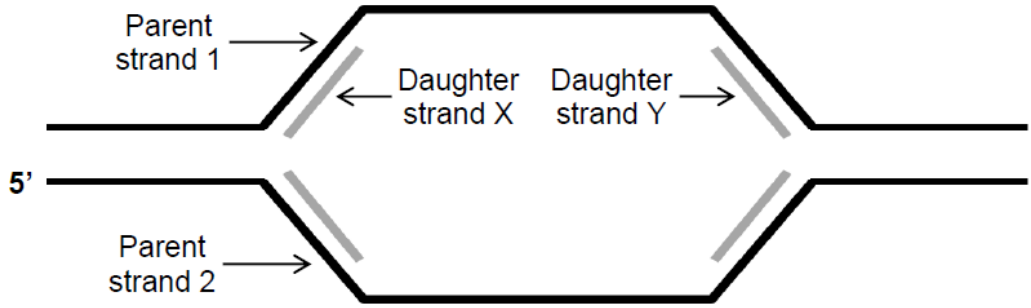
A I → III → V → II → VI → IV

B II → III → I → V → VI → IV

C III → I → II → V → VI → IV

D III → V → II → VI → IV → I

14 A simplified representation of a replication bubble is shown in the figure below. Parental strands 1 and 2 and the growing daughter strands X and Y are indicated.



Which of the following statements about the synthesis of daughter strands X and Y is correct?

A Daughter strands X and Y are synthesised away from their respective replication forks.

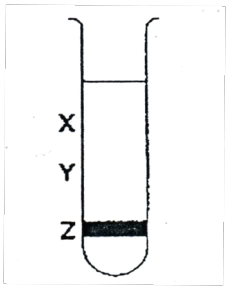
B Daughter strand X is synthesised in the 5' → 3' direction while daughter strand Y is synthesised in the 3' → 5' direction.

C Daughter strand X is synthesised continuously while daughter strand Y is synthesised in the form of Okazaki fragments.

D DNA ligase will eventually catalyse the fusion of daughter strands X with Y.

15 A culture of bacteria had all of its DNA labelled with the heavy isotope of nitrogen, ^{15}N. The culture was then allowed to reproduce using nucleotides containing normal ^{14}N. The DNA was then examined using a centrifuge after one generation and again after two generations.

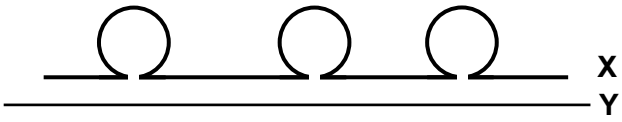
The diagram shows the position of the DNA band at **Z** in the centrifuge tube when the DNA was first labelled.



In which pattern would the DNA be found after the first and after the second cell generations?

	After first generation	After second generation
A	Half at **X** and half at **Y**	Quarter at **X** and at **Z** and half at **Y**
B	Half at **X** and half at **Z**	Quarter at **X** and at **Z** and half at **Y**
C	All at **X**	Half at **X** and half at **Y**
D	All at **Y**	Half at **X** and half at **Y**

16 The diagram below shows the result of hybridizing mature mRNA of ovalbumin to the ovalbumin template DNA strand.

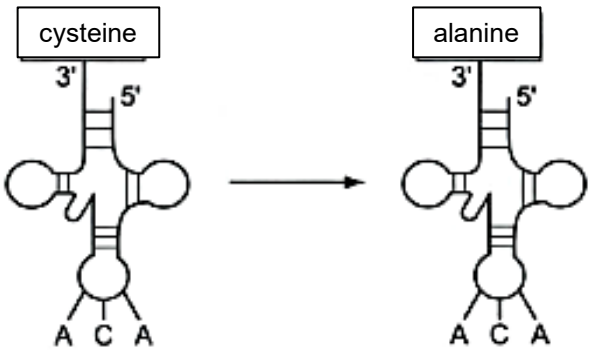


Which of the following is correct?

	X	Y	Number of exons	Number of introns
A	DNA	Mature mRNA	3	4
B	DNA	Mature mRNA	4	3
C	Mature mRNA	DNA	3	4
D	Mature mRNA	DNA	4	3

17 Transfer RNA combined with an amino acid is called amino-acyl tRNA. It is possible to chemically convert the amino acid cysteine into the amino acid alanine whilst it is still attached to its tRNA.

The altered amino-acyl tRNA still binds to UGU triplets on messenger RNA (mRNA), but now incorporates alanine into the resulting polypeptide instead of cysteine.



Which of the following statements is correct?

A A codon on the amino-acyl tRNA determines its specificity.

B The amino acid of an amino-acyl tRNA does not influence its binding to mRNA.

C The codon-anticodon interaction is influenced by the amino acid on an amino-acyl tRNA.

D Both the amino acid and the anticodon of an amino-acyl tRNA affect where it binds to mRNA.

18 Ribonuclease is an enzyme that digests RNA.

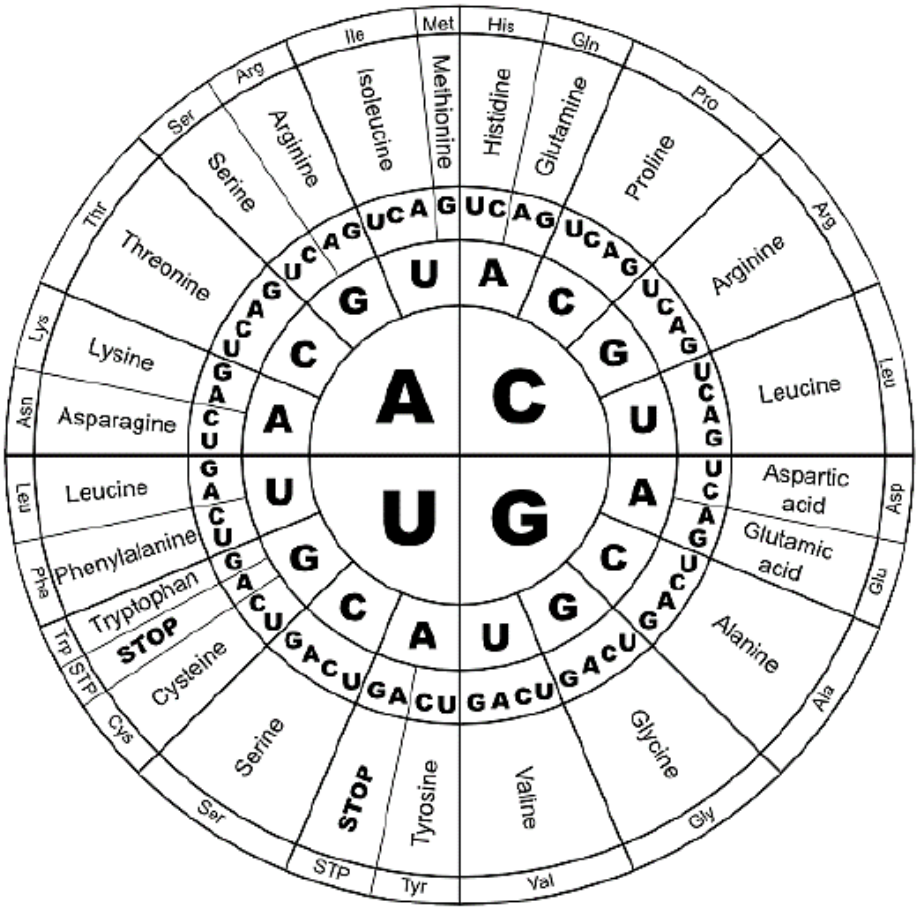
The first 15 nucleotides of the mRNA coding for a functional ribonuclease has the following sequence:

3’ AUG AGG UUA AAA GUA 5’

A non-functional molecule of ribonuclease has been isolated. The first three amino acids of this non-functional molecule of ribonuclease are:

met – lys – leu –

The genetic code table is shown below.



Based on the above information, which of the following correctly explains the change in amino acid in the non-functional ribonuclease?

A Two tRNAs have carried a different amino acid.

B A single base substitution has occurred, and this resulted in a non-functional ribonuclease.

C A single base deletion mutation has occurred, and this resulted in a frameshift mutation.

D A silent mutation occurs, but due to the degeneracy of genetic code, this resulted in different amino acids coded despite using the same mRNA codons.

19 The diagram represents part of a DNA molecule.

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

Mutation	Name
from purine to other purine	transition
from pyrimidine to other pyrimidine	transition
from purine to pyrimidine	transversion
from pyrimidine to purine	transversion

Which diagram shows the DNA molecule with only transversion mutations?

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

B
G A A A C A A
C T T T G T T

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

D
G A T A T C A
C T A T A G T

20 In a mouse model experiment, deletion of the multi-drug resistance (*mdr*) gene in liver cells leads to the development of liver cancer. Loss of *mdr* gene and its encoded protein leads to the accumulation of bile acids that initiates liver inflammation, a process that recruits white blood cells to the target site.

These white blood cells secrete Tumour Necrosis Factor-α (TNF-α) that binds to the corresponding receptor on liver cells, which in turn activates a specific transcription factor. Activation of this transcription factor has been shown to result in the elevated levels of an anti-apoptotic protein and a growth-promoting protein produced by liver cells. These proteins are involved in the progression of liver cells to turn cancerous.

Based on the information above, which of the following can be concluded?

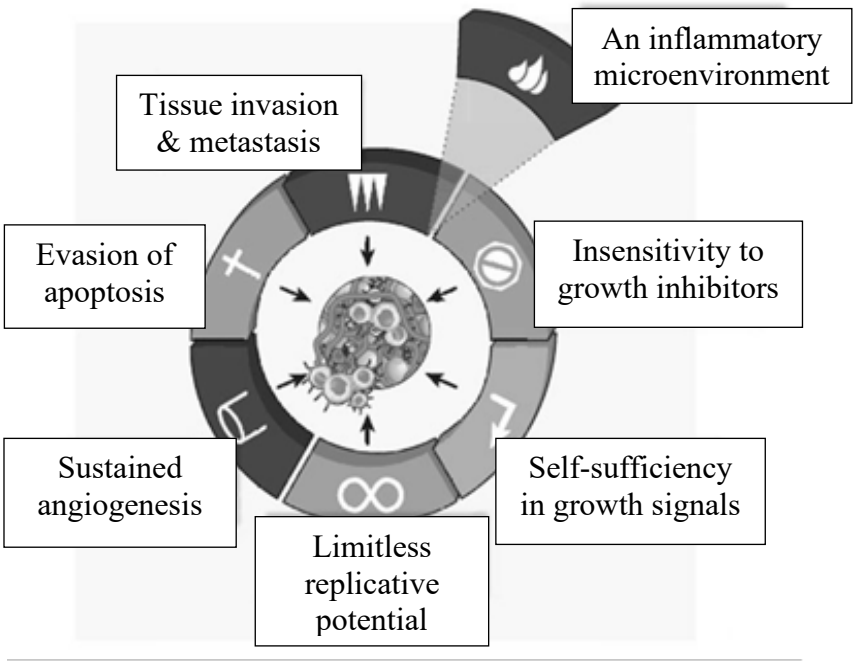
A *mdr* gene is a tumour suppressor gene which codes for a protein involved in apoptosis.

B The progression to liver cancer requires mutations in proto-oncogenes and tumour suppressor genes.

C The metastasis of liver cancer is accelerated with the recruitment of more white blood cells due to elevated levels of TNF-α.

D The progression to liver cancer can occur when a loss of the *mdr* gene results in the over-expression of the other proto-oncogenes.

21 The diagram below illustrates the hallmarks of cancer.



Which of the following statements correctly describe the changes in cancer cells?

1 Limitless replicative potential often results in the accumulation of chromosomal mutations in many cancer cells.

2 Cancer cells could overproduce signal molecules so that they become self-sufficient in growth signals.

3 Angiogenesis is the result of expression of oncogenes in a cell line that produces blood vessels.

4 Loss-of-function mutations in tumour suppressor genes can eventually lead to tissue invasion and metastasis.

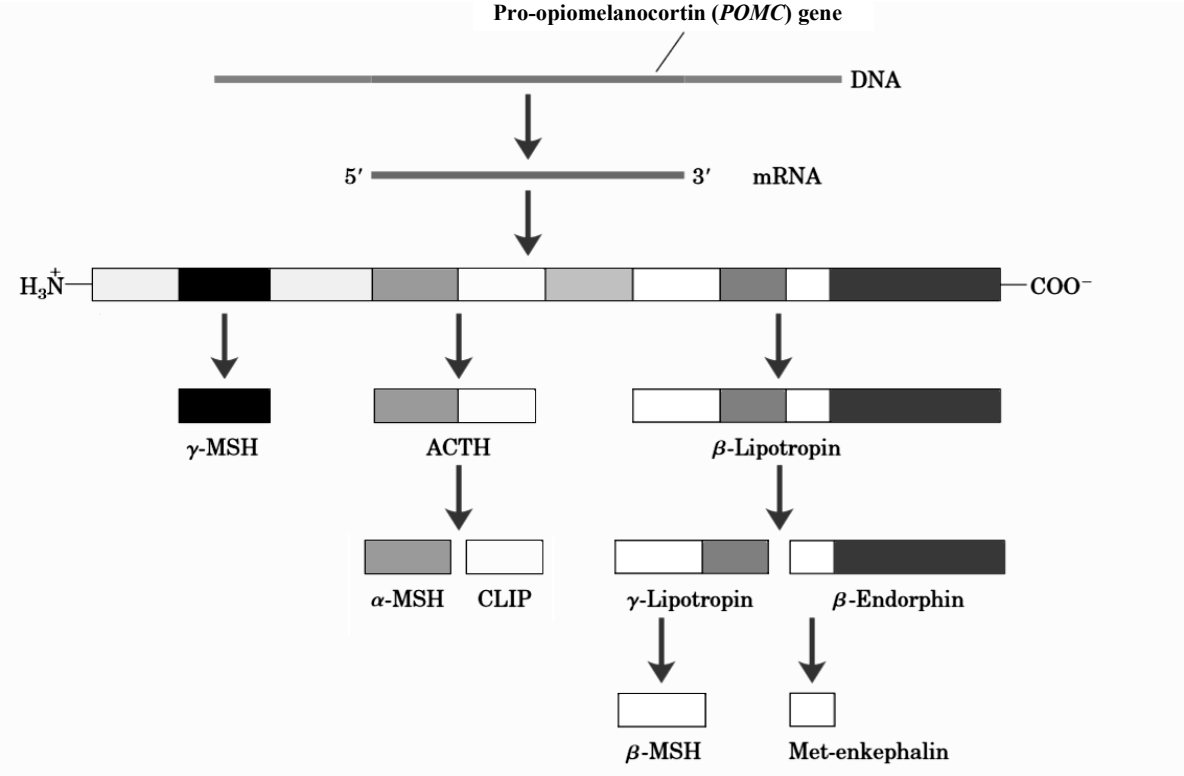
A 1 and 4 only

B 2 and 3 only

C 1, 2 and 4 only

D 2, 3 and 4 only

22 The pro-opiomelanocortin (*POMC*) gene is expressed in the pituitary gland, the hypothalamus, the skin and the reproductive organs. This gene codes for a 285-amino acid polypeptide that undergoes processing to form nine different peptide hormones as shown in the schematic diagram below.



The processing of POMC polypeptide involves extensive proteolytic cleavage at sites shown to contain regions of basic amino acid sequences. The proteases that recognise these cleavage sites are tissue-specific. Multiple hormones are thus produced such as adrenocorticotropic hormone (ACTH) and β-lipotropin in the anterior pituitary under the stimulation of corticotropin releasing hormone, as well as γ-lipotropin and β-endorphin in the intermediate lobe of pituitary gland under the stimulation of dopamine. The terminal residues of these peptide hormones are often glycosylated or acetylated.

Which of the following statements is true?

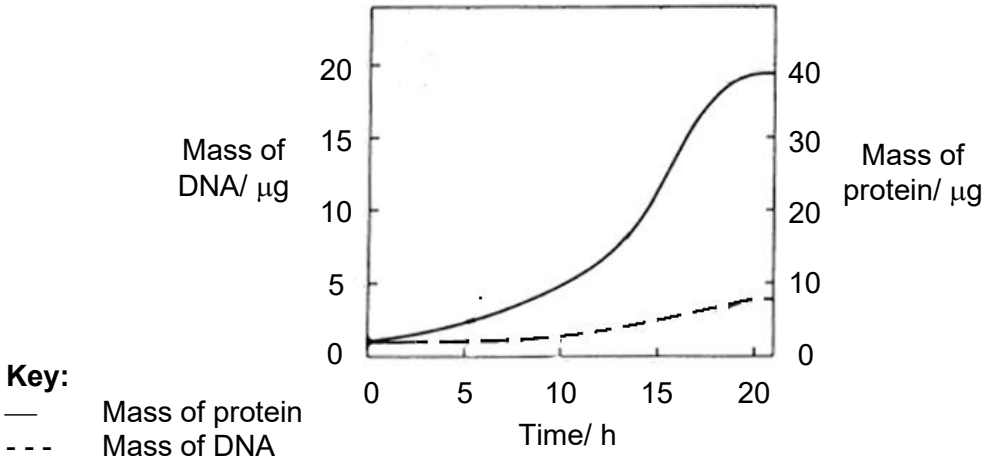
A The types of hormones formed in a specific tissue depend on the control of gene expression at the translational level.

B Specific chemical signals are required for the formation of unique peptide hormones in different tissues.

C The different hormones are formed by alternative splicing.

D Parts of the amino acid sequence of POMC polypeptide can undergo rearrangement to form peptide hormones of varying lengths.

23 During egg production in *Drosophila*, there is an increased production of eggshell proteins. The genes which code for the eggshell proteins are clustered on the X chromosome.



Which of the following best explains the trends observed in the graph?

A DNA replication has occurred, increasing the rate and duration of translation.

B Gene amplification has occurred, increasing the rate of transcription. The rate of degradation of poly(A) tail is slower, increasing the duration of translation.

C DNA replication has occurred. The abundance and activity of eukaryotic translation initiation factors are increased simultaneously, thereby increasing the rate of translation.

D Gene amplification has occurred, increasing the rate of mutation. The rate of degradation of poly(A) tail is slower, increasing the duration of translation.

24 Four different genes are regulated in different ways.

Gene E: regulatory gene whose product binds to an operator site

Gene F: product undergoes tissue-specific patterns of alternative splicing

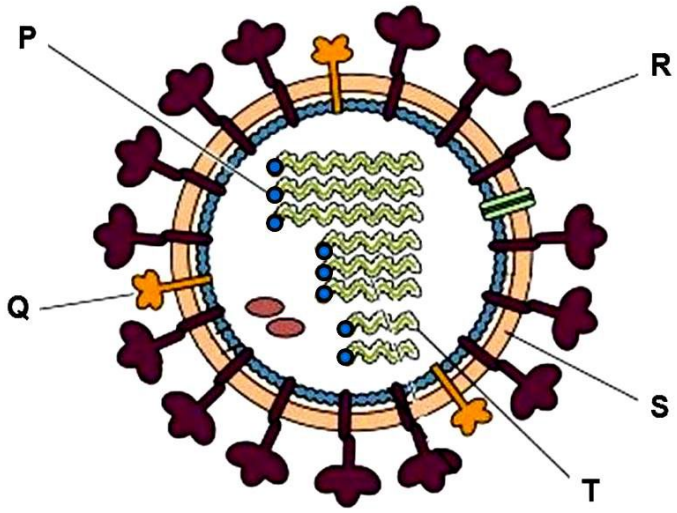
Gene G: acetylation and deacetylation occurs to proteins binding to the gene

Gene H: part of a group of structural genes controlled by the same regulatory sequence

Which combination correctly identifies which genes are prokaryotic and which are eukaryotic?

	Prokaryotic	**Eukaryotic**
A	E and G	F and H
B	E and H	F and G
C	F and G	E and H
D	F and H	E and G

25 The diagram shows the structure of an influenza virus.



Which of the following statements concerning the lettered components are correct?

I Mutations that disrupt the function of **P** will result in the inability of the virus to initiate replication of viral DNA genome.

II Different **Q** and **R** arise via antigenic drift which gives rise to genetic variation.

III **Q** and **R** are synthesized and then embedded in the host cell surface membrane before budding takes place.

IV **S** is synthesized in the host cell using the host cell enzymes as the last step of the assembly of the virus.

V Each influenza virus carries two identical copies of **T** that can be swapped with another virus through antigenic shift.

A I and II

B II and III

C III and IV

D III, IV and V

26 Two viruses **A** and **B**, one isolated from a prokaryote and another from eukaryote, have been identified.

It is found that treatment with reverse transcriptase inhibitors blocks the ability of **virus B** to infect cells but not **virus A**.

Which of the following conclusions can be drawn?

A Virus **A** is a bacteriophage while virus **B** is a retrovirus.

B Virus **A** is a retrovirus while virus **B** is a bacteriophage.

C Virus **A** has single-stranded RNA genome, while virus **B** has double-stranded DNA genome.

D Virus **A** has double-stranded RNA genome, while virus **B** has single-stranded DNA genome.

27 Some events that take place during generalised transduction are listed below.

1 Bacterial host DNA is fragmented

2 Bacterial DNA instead of viral DNA may be packaged in a phage capsid

3 Recombination between donor DNA and recipient DNA

4 Phage infects a bacterial cell

5 Phage DNA and proteins are made

6 Release of progeny virus

Which sequence of events is most accurate in describing generalized transduction?

First ⟶ Last

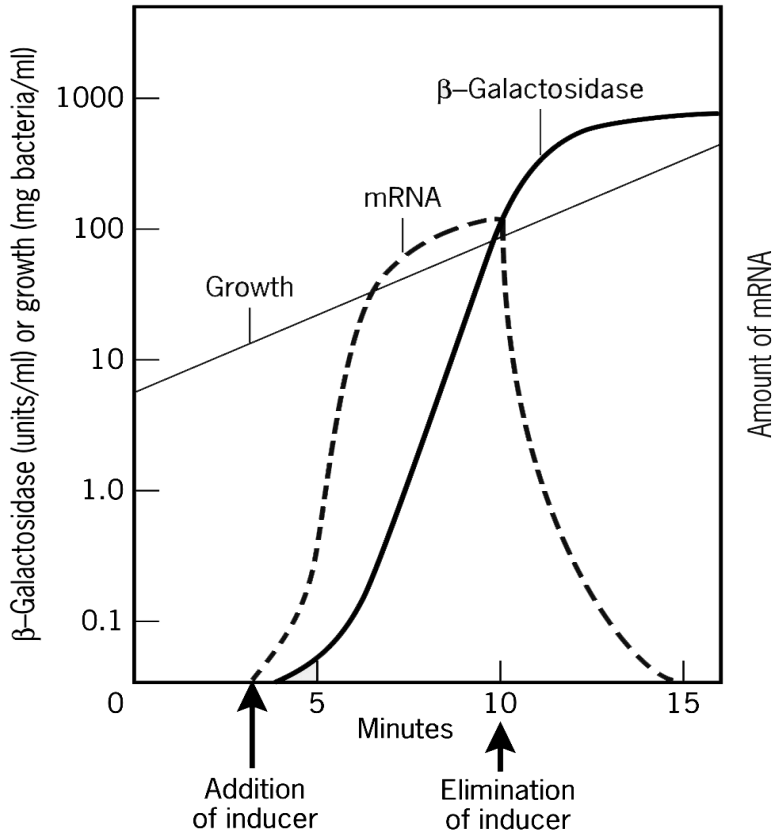
A 4, 1, 3, 5, 6, 2

B 4, 1, 5, 2, 6, 3

C 4, 3, 1, 5, 2, 6

D 4, 5, 1, 3, 2, 6

28 Prokaryotes such as *Escherichia coli* can be grown using culture medium containing essential elements and nutrients. The regulation of gene expression in prokaryotes can be examined by studying the kinetics of the inducible *lac* operon. The figure below shows the changes in the levels of β-galactosidase mRNA and enzyme, as well as the growth of bacteria when lactose (inducer) was added to and then removed from the bacterial culture.



Which of the following conclusions can be inferred from the above figure?

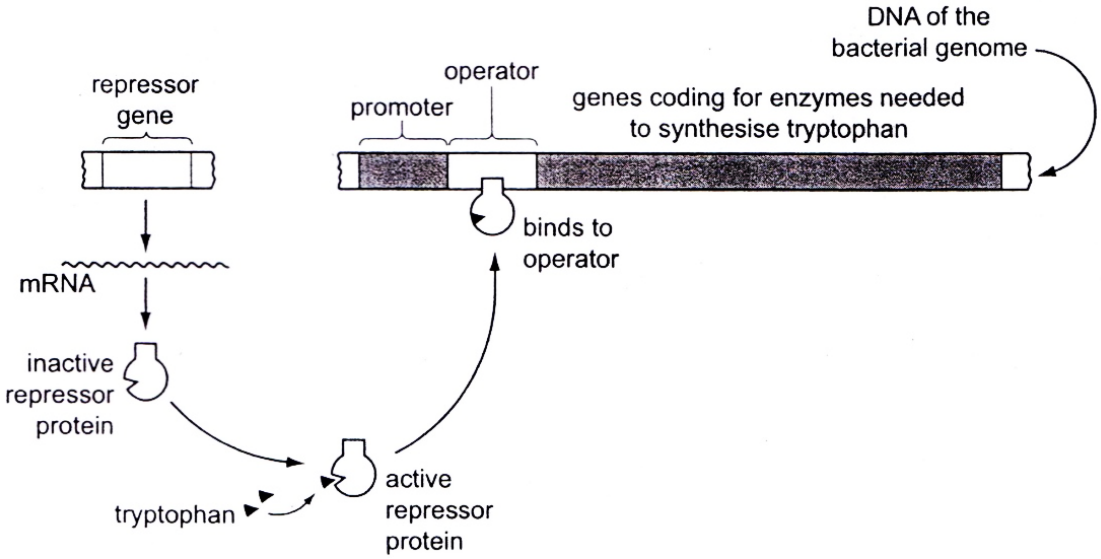
A The brief delay between the addition of lactose and increase of β-galactosidase mRNA levels is due to the need for conversion of lactose to allolactose, which will then bind to the *lac* repressor.

B A rapid decrease in the level of β-galactosidase mRNA upon removal of lactose suggests that RNA polymerase is still able to bind to the promoter and transcribe the gene coding for β-galactosidase at a much lower rate.

C The *lac* operon mRNA is polycistronic as it contains coding sequences for structural genes such as β-galactosidase, lactose permease and lactose transacetylase.

D The amount of β-galactosidase enzyme levels off upon removal of lactose, suggesting that the enzyme is stable and not degraded immediately even though it is no longer needed.

29 The diagram outlines the control of tryptophan production in *Escherichia coli*.



For a strain of *E. coli*, it was found that expression of *trp* operon was turned on in the presence of excess tryptophan.

Which of the following is a likely explanation for this observation?

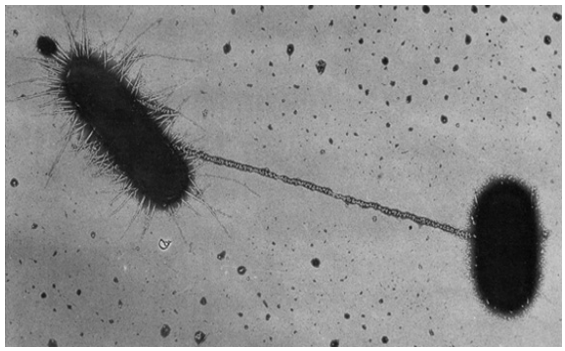
A A mutation occurred at the promoter of the *trp* operon.

B A mutation occurred at the gene coding for the *trp* operator.

C A repressor has bound to the promoter of the repressor gene.

D The *trp* repressor protein is permanently bound to tryptophan.

30 The micrograph below shows the transfer of genetic material between bacterial cells by a bridge-like connection.



Which of the following statements about the above process are incorrect?

I The transfer of the F plasmid is from the donor cell to recipient cell.

II For the transfer of plasmid DNA to occur, both strands of the double stranded F plasmid in the donor cell need to be nicked.

III After the sex pilus from the F^- cell attaches to the F^+ cells, it retracts.

IV Since DNA polymerase can only add nucleotides to the free 3'OH of a pre-existing strand, the end replication problem occurs during replication of the F plasmid.

V One strand of the F plasmid is transferred and the other remains in the original cell.

A I and V only

B II and III only

C IV and V only

D II, III and IV only

– END OF PAPER –