NAME: _____ CLASS: _____ INDEX: _____

CATHOLIC JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION
Higher 2

BIOLOGY
Paper 1 Multiple Choice

9744/01
18 September 2023
1 hour

Additional Materials: Answer Sheet (Multiple Choice Optical Mark Sheet)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your **name (as per NRIC), class,** and **index number** on this booklet.

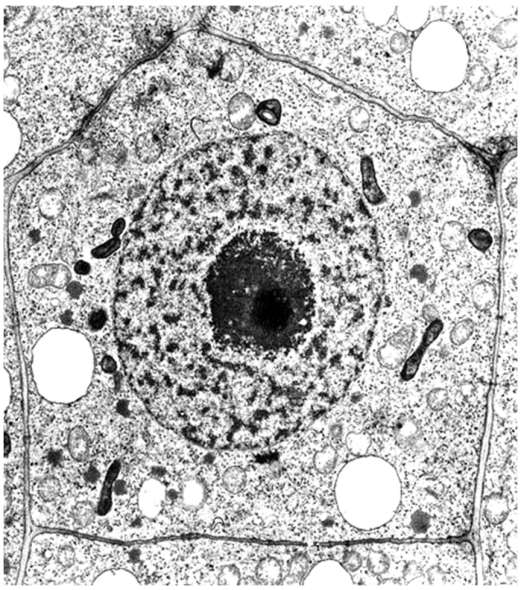
Write and shade your **name (as per NRIC)**, **NRIC / FIN number** and **class** on the Answer Sheet (Multiple Choice Optical Mark Sheet) in the spaces provided.

There are **30 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 shade your choice in **soft pencil** on the Answer Sheet (Multiple Choice Optical Mark Sheet).

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.

1 The diagram shows two electron micrographs of cells.



F

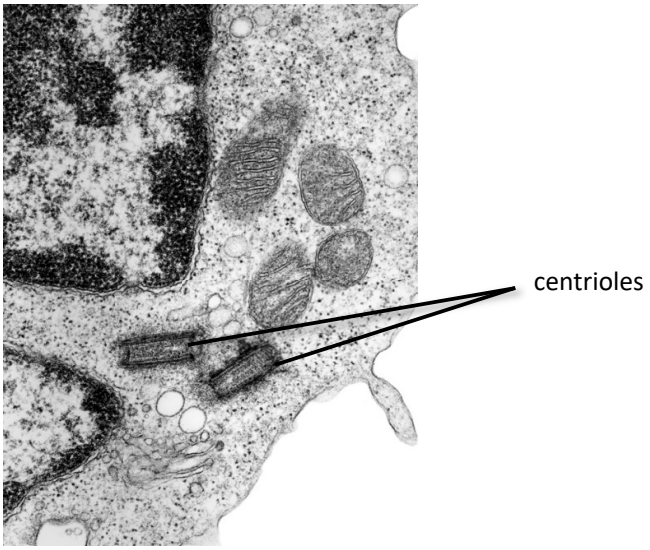
G

Which organelles are visible in each of the cells **F** and **G**?

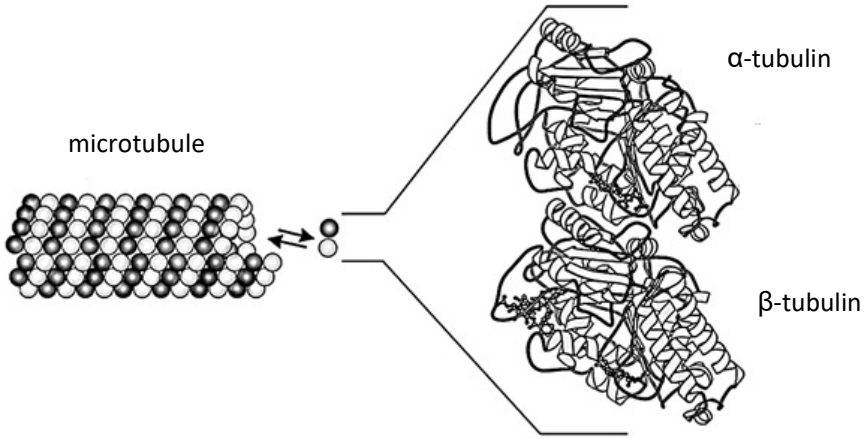
	cell	chloroplasts	nucleolus	nucleus
A	**F**	✗	✓	✗
	G	✓	✓	✓
B	**F**	✗	✓	✓
	G	✓	✗	✓
C	**F**	✓	✓	✗
	G	✓	✗	✓
D	**F**	✗	✗	✓
	G	✓	✓	✓

Key: ✓ = visible
✗ = not visible

2 The figure below shows an electron micrograph of a pair of barrel-shaped centrioles that play an important role in organising microtubules that serve as the cell's skeletal system. They help determine the locations of the nucleus and other organelles within the cell.



Microtubules are assembled from a heterodimeric protein called tubulin, as shown in the diagram below.



Which of the following explains why tubulin is considered a polymer as well as a monomer?

	why tubulin is a polymer	why tubulin is a monomer
A	It is a macromolecule.	It is a quaternary protein.
B	It is the building block of microtubule.	It is made up of many amino acids.
C	It is made up of many amino acids.	It is the building block of microtubule.
D	It has many α-helices and β-pleated sheets.	It is made up of two different subunits.

3 One way of representing fatty acid chains is **Cx : y**, where **Cx** is the number of carbon atoms and **y** is the number of double bonds.

The table shows the percentage mass of eight different fatty acid chains in four cell membranes, **1, 2, 3** and **4.**

Cell Membrane	percentage mass of each fatty acid chain							
	C10 : 0	**C12 : 0**	**C14 : 0**	**C16 : 0**	**C18 : 0**	**C18 : 1**	**C18 : 2**	**C18 : 3**
1	1	2	2	21	35	29	2	1
2			2	23	19	45	3	1
3		2	3	23	21	43	4	
4	1	2	4	22	2	52	11	1

Which of the following about the four cell membranes (**1, 2, 3** and **4**) is correct?

	Most fluid	Least fluid
A	**1**	**2**
B	**2**	**3**
C	**3**	**4**
D	**4**	**1**

4 Protein X is found in the common bean, *Phaseous vu/garis*. This protein decreases the activity of amylase in the gut of some insect pests.

Protein X also acts as a chitinase enzyme that breaks down chitin. Chitin is a polysaccharide found in the cell walls of fungi. Protein X has no other enzymatic activity.

Which conclusions are consistent with this information?

1 X has a complementary shape to starch allowing it to block the active site of amylase.

2 The active site of X is complementary in shape to chitin and also to amylase.

3 The presence of X can reduce the energy available to insects that feed on this plant.

4 X could protect this plant from attack by fungi.

A All of the above.

B 1, 3 and 4

C 1 and 2

D 3 and 4

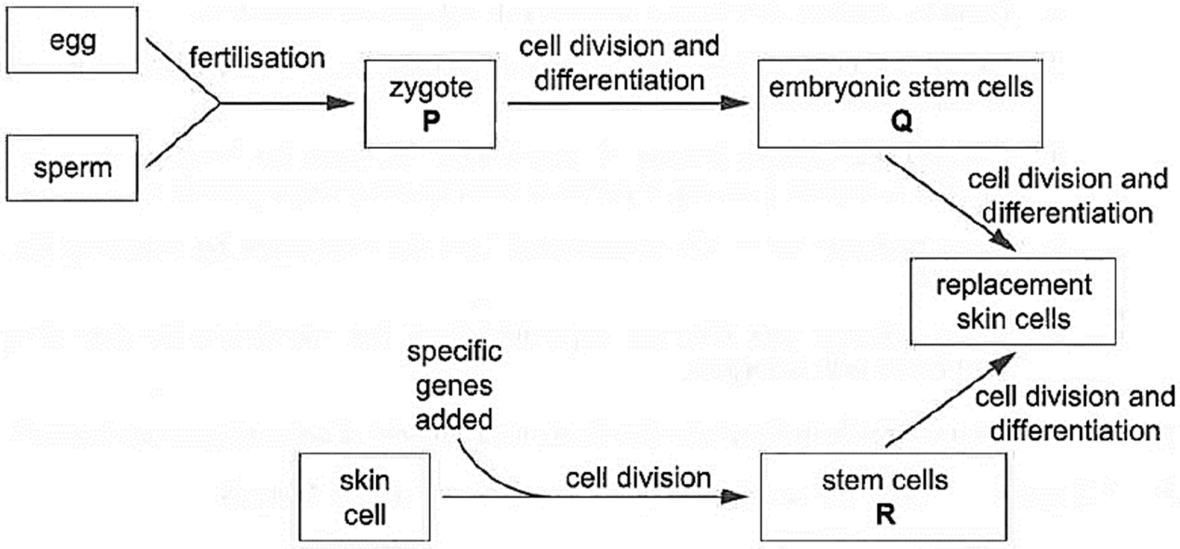
5 Molecules and ions can cross membranes by a number of different mechanisms.

Which row shows possible mechanisms by which each molecule or ion can cross the cell surface membrane?

	glycosylated enzyme	glucose	hydrogen ions	carbon dioxide
A	diffusion and exocytosis	facilitated diffusion	active transport and facilitated diffusion	diffusion
B	endocytosis	diffusion and facilitated diffusion	active transport and diffusion	diffusion and facilitated diffusion
C	exocytosis	active transport and facilitated diffusion	active transport and facilitated diffusion	diffusion
D	facilitated diffusion and endocytosis	facilitated diffusion	diffusion and facilitated diffusion	facilitated diffusion

6 Stem cells can be used to replace cells in damaged tissues, such as skin.

The diagram shows two ways in which replacement skin cells can be produced.



Which row correctly describes the stem cells P, Q and R?

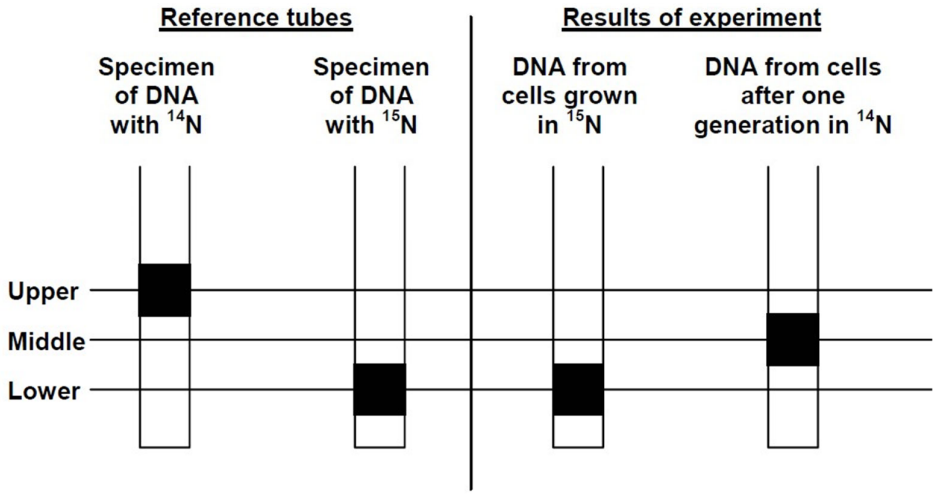
	P	Q	R
A	pluripotent	multipotent	totipotent
B	pluripotent	induced pluripotent	induced pluripotent
C	totipotent	pluripotent	induced pluripotent
D	totipotent	totipotent	totipotent

7 A research student wanted to replicate the Meselson and Stahl experiment.

He selected cells of the bacterium *E. coli* that have been grown for many generations on a medium containing only the heavy isotope of nitrogen (^{15}**N**) and transferred these cells to a medium containing only ^{14}**N** to grow.

Samples of the bacteria were removed from the culture after one generation and the DNA from the samples was extracted and centrifuged.

The results are illustrated in the diagram below:



The student then replated by transferring the remaining bacteria onto 2 new petri dishes of growth medium and allowed them to grow for 2 generations.

Samples were taken from each of the 2 petri dishes and DNA was extracted and centrifuged in 2 separate tubes, tube **X** and tube **Y** which showed different results.

The student suspected that there might have been a mixed up in the growth medium in the 2 petri dishes used for the replating. Instead of both containing ^{14}**N** only, the growth medium in one of the petri dishes might contain ^{15}**N** only.

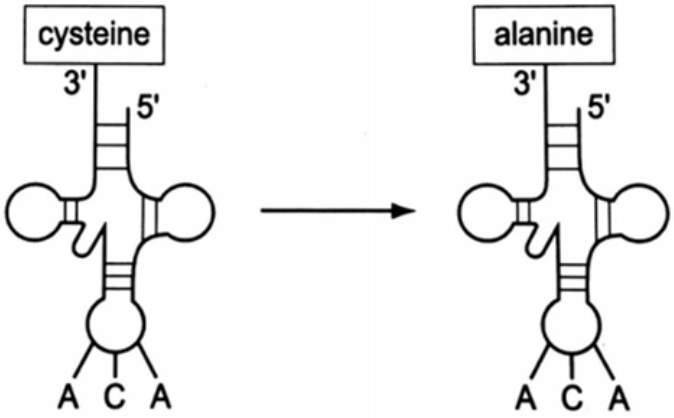
He analysed the results from tube **X** and tube **Y** and concluded that the DNA in tube **Y** came from bacteria cells that have been replated and grown on medium containing ^{15}**N.**

What are the positions and relative proportions of the bands in both tube **X** and tube **Y**?

	Tube **X**			Tube **Y**		
	Upper	Middle	Lower	Upper	Middle	Lower
A	0%	25%	75%	25%	75%	0%
B	50%	50%	0%	0%	50%	50%
C	50%	0%	50%	0%	75%	25%
D	75%	25%	0%	0%	25%	75%

8 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 statement is correct?

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

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

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

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

9 RNA interference (RNAi) is a natural cellular process that silences gene expression by promoting the degradation of mRNA. It plays an important role in gene regulation and innate defense against invading viruses.

Which statement about RNAi is correct?

A RNAi is an example of control of gene expression at translational level.

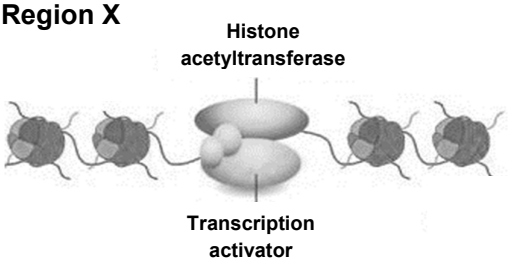
B RNAi decreases the rate of transcription.

C When RNAi occurs, chromatin structure becomes more condensed.

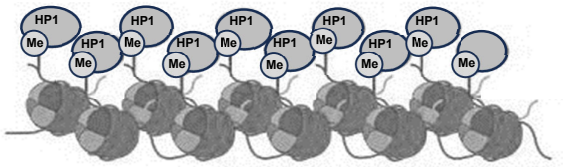
D RNAi interferes with post-translational modifications of primary RNA transcript.

10 The diagram shows two different **regions X** and **Y** of a eukaryotic chromosome.

Region X



Region Y



Me Methylation

HP1 Heterochromatin Protein 1

	Region X	Region Y
1	Less condensed	Highly condensed
2	Contains unique sequence	Contains repetitive sequences
3	Gene-rich	Gene-poor
4	Replicated during cell cycle	Not replicated during cell cycle
5	Recombination during meiosis	No recombination during meiosis

Which of the above comparisons are correct?

A 1 and 3

B 2 and 5

C 1, 2, 3 and 5

D All of the above

11 Which of the following could lead to chromosomal translocation?

1 end to end fusion of chromosomes.

2 meiosis.

3 viral infection.

4 unequal crossing over.

A 1 and 2

B 3 and 4

C 1, 2 and 4

D All of the above

12 A cell contains 40 chromosomes at anaphase II of meiosis.

How many chromosomes would be present in the anaphase I of meiosis?

A 80

B 40

C 20

D 10

13 Cancer research has found that gene amplification is involved in the development of cancer. This research has identified one type of sequence that causes a break in DNA before gene amplification.

How might the findings of this research be used?

A to identify people at risk of developing cancer.

B to prevent cancer from developing in 'at risk' people.

C to repair DNA breaks before amplification occurs.

D to use modern technology to remove DNA.

14 Cancer has been known to develop in later stages of life. What is the possible explanation for this observation?

A Errors occur during DNA replication at a basal rate of 1 in 100 million base pairs.

B A single mutation in a tumour suppressor gene will lead to cancer.

C Only a single copy of oncogene is required for uncontrolled division.

D Reactivation of telomerase gene only.

15 Variation in the length of mature leaves within a population of pineapple leaves was investigated.

Length / cm	Frequency
1 to < 3	0
3 to < 5	2
5 to < 7	5
7 to < 10	22
10 to < 12	7
12 and above	1

Which of the following statements could explain the variation in leaf length in this population?

A The difference in the leaf length is only due to differences in their growth environment.

B The leaf length is controlled by a single gene with three alleles.

C The variation in the leaf length is due to epistasis.

D The additive effect of several genes.

16 Two genes involved in the appearance of hair on goats are found on different chromosomes.

Crossing a pure-bred goat with black, wavy hair with a pure-bred goat with white, straight hair resulted in offspring that all had grey and wavy hair.

Which of the following is correct about the two genes?

	gene for hair colour	gene for wavy/straight hair
A	3 alleles: 1 for black, 1 for grey and 1 for white.	2 alleles: allele for wavy hair is dominant and allele for straight hair is recessive.
B	2 alleles: allele for black hair and allele for white hair show incomplete dominance.	2 alleles: allele for wavy hair shows complete dominance over allele for straight hair.
C	3 alleles: 1 for black, 1 for grey and 1 for white.	2 alleles: allele for straight hair is dominant and allele for wavy hair is recessive.
D	2 alleles: allele for black hair, and allele for white hair show codominance.	2 alleles: allele for wavy hair is transcribed but allele for straight hair is not transcribed.

17 Some features of the life cycle of a virus are listed below:

1 Membrane fusion

2 Transcription of RNA genome

3 Receptor mediated endocytosis

4 Translation of viral proteins

5 Assembly of new viral particles

Which virus has all these features in its reproductive cycle?

A HIV

B Influenza virus

C Lambda phage

D T4 phage

18 A virus has a base ratio of (A + U) / (C + G) = 1. What type of virus is this?

A A single-stranded RNA virus

B A double-stranded RNA virus

C A single-stranded DNA virus

D A double-stranded DNA virus

19 Two mutant strains of *Escherichia coli*, one having the F plasmid and the other without the F plasmid were mixed in suspension. One was unable to synthesise biotin and the amino acid threonine, the other was unable to manufacture the two amino acids leucine and lysine. The genes coding for the synthesis of these essential metabolites are widely separated on the bacterial chromosome.

After sixty minutes the bacteria were plated onto a growth medium deficient in all four metabolites. Four hundred colonies grew.

Which process would result in bacteria that are able to grow on a growth medium deficient in these essential metabolites?

A Conjugation

B Transduction

C Transformation

D Translocation

20 A single mutation has occurred in an *Escherichia coli.* Glucose and lactose are both absent in the culture medium where the mutant *E. coli* is grown in. An analysis of proteins synthesised by mutant *E. coli* found substantial amount of β-galactosidase, transacetylase and permease.

Which of the following mutations could have taken place in the *E. coli* cell?

1 Mutation in the promoter of the *lac* structural genes

2 Mutation in the *lac I* gene

3 Mutation in the operator of the *lac* operon

A 1 only

B 2 only

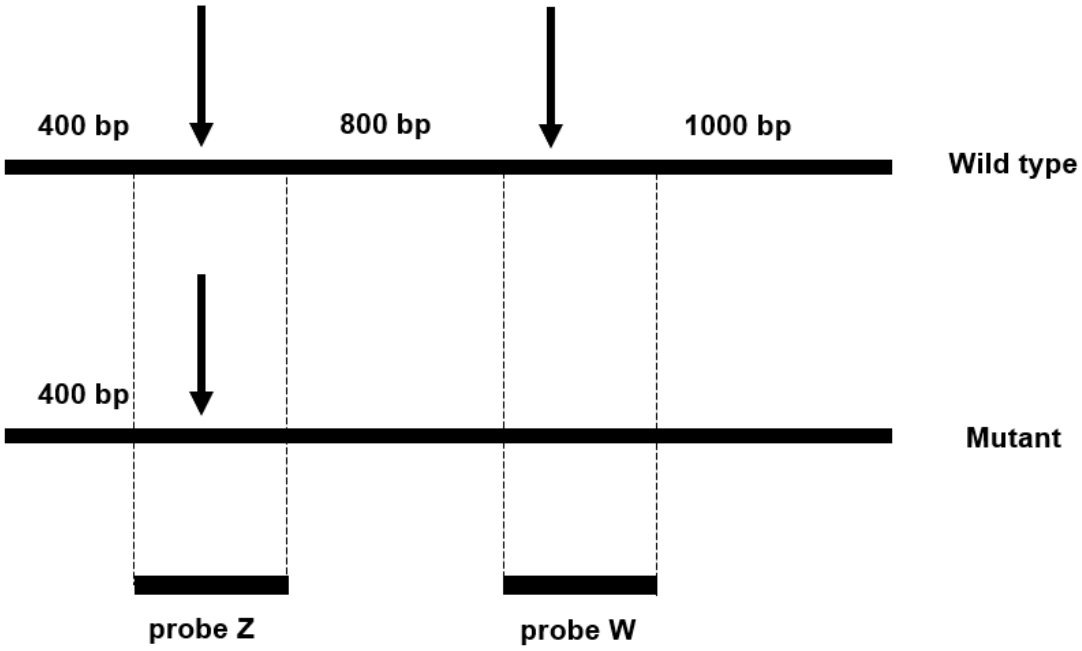
C 1 and 2

D 2 and 3

21 A recessive genetic disease known as disease **X** is caused a mutation in a gene.

Figure below shows the ***BamHI*** restriction sites present in wild type and mutant of the gene. Additionally, the probes that can be used to detect the presence of the mutation are also shown in the figure below.

The restriction sites are indicated as arrows and the regions where the probes bind are indicated by the dotted lines.



How many band(s) would be observed if the DNA sample of a carrier of disease **X** is subjected to Southern Blotting using probe **W**?

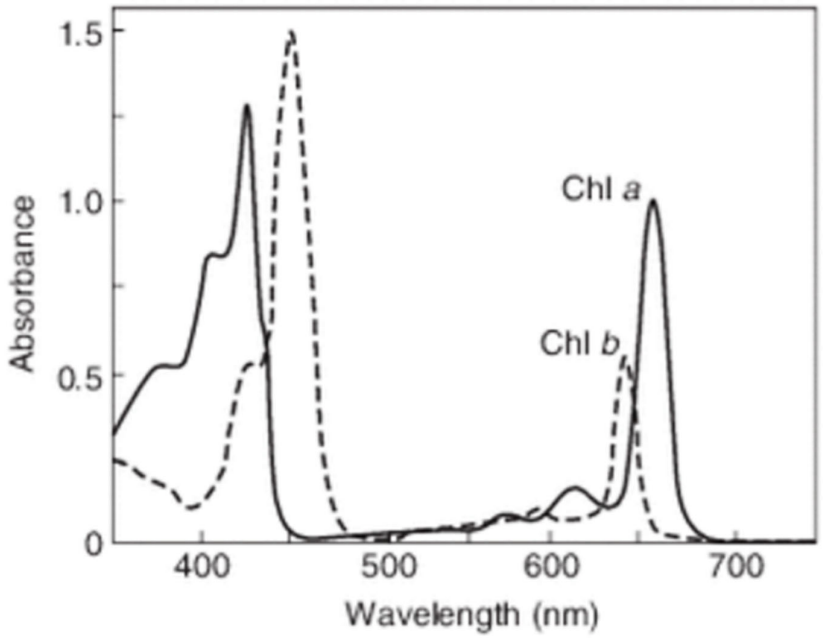
A 4

B 3

C 2

D 1

22 The graph below shows the absorption spectrum of chlorophyll *a* and *b*.



A plant that contains only chlorophyll *a* will:

A have the highest rate of photosynthesis if grown under light with wavelength of 470nm.

B have the highest rate of photosynthesis if grown under light with wavelength of 660nm.

C have the highest rate of photosynthesis if grown under light with wavelength of 420nm.

D have the same rate of photosynthesis regardless of the wavelength of light it is subjected to.

23 Which of the following is true for both lactate and ethanol fermentation?

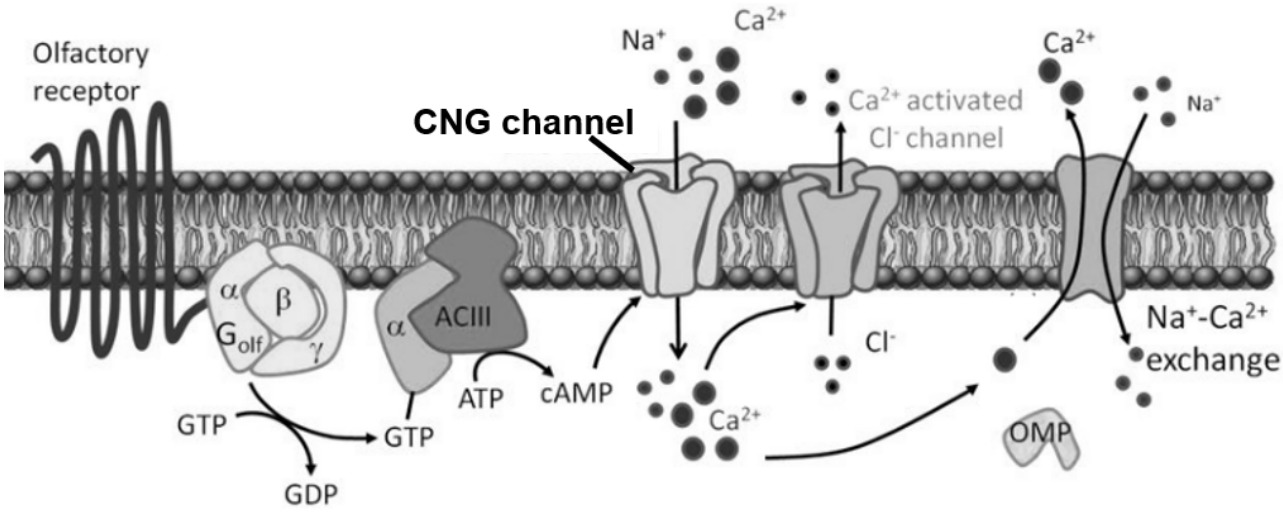
A Both processes involve the production of NADH.

B 2 net ATP is produced during the process.

C Carbon dioxide gas is released during the process.

D ATP is not produced during the process.

24 Cell signalling in the olfactory system allows human to sense smell.



Which of the following statements is incorrect?

A When Na^+ binds to the CNG channel, conformational change occurs which leads to the opening of the CNG channel.

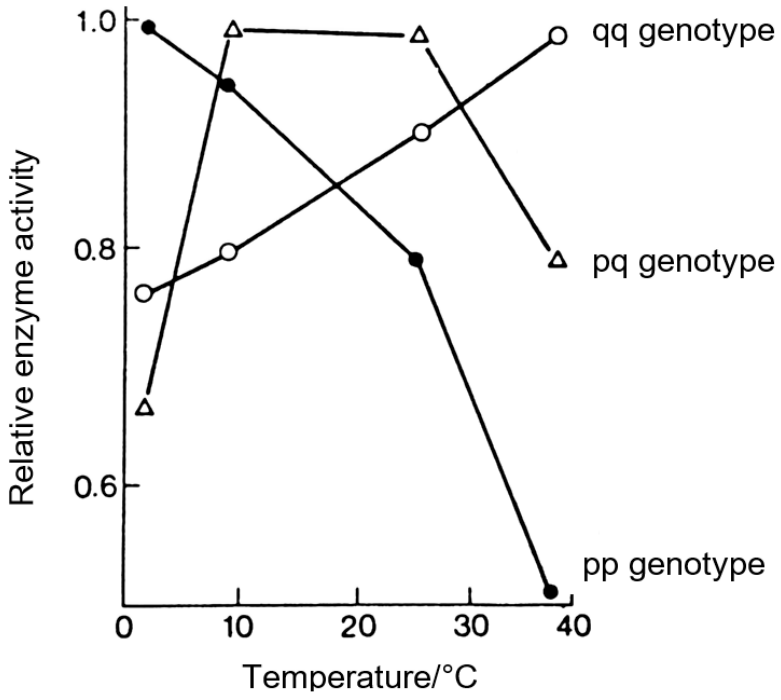
B The olfactory receptor is a type of G-protein linked receptor.

C The formation of second messenger by ACIII is a step that involves signal amplification.

D The activation of the CNG channel leads to a decrease in intracellular chloride ions (Cl^-).

25 In the North American catfish Catostomus clarki, two alleles, represented by **p** and **q**, control the synthesis of a vital enzyme.

The three possible genotypes (**pp**, **pq**, **qq**) lead to the synthesis of variations of the same enzyme with different optimal temperature as shown in the graph below.



When the mean annual temperature is 5 °C, which of the following statements is correct?

A Frequency of allele **p** in the gene pool will increase.

B Frequency of allele **q** in the gene pool will increase.

C Allele **p** will become dominant and allele **q** will become recessive.

D The heterozygotes will have an advantage over the homozygotes.

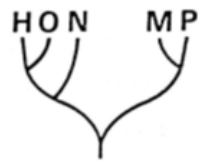
26 Human blood, when mixed with antibodies to human blood, will give maximum precipitation.

When other animals' blood was mixed with antibodies to human blood, the following experimental results were obtained.

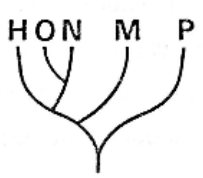
Species	Human	M	N	O	P
Percentage of precipitation / %	100	37	75	79	17

If the human species is denoted by the symbol **H**, which of the following phylogenetic trees would reflect the above results?

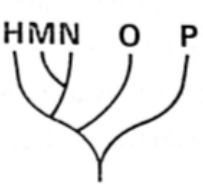
A



B

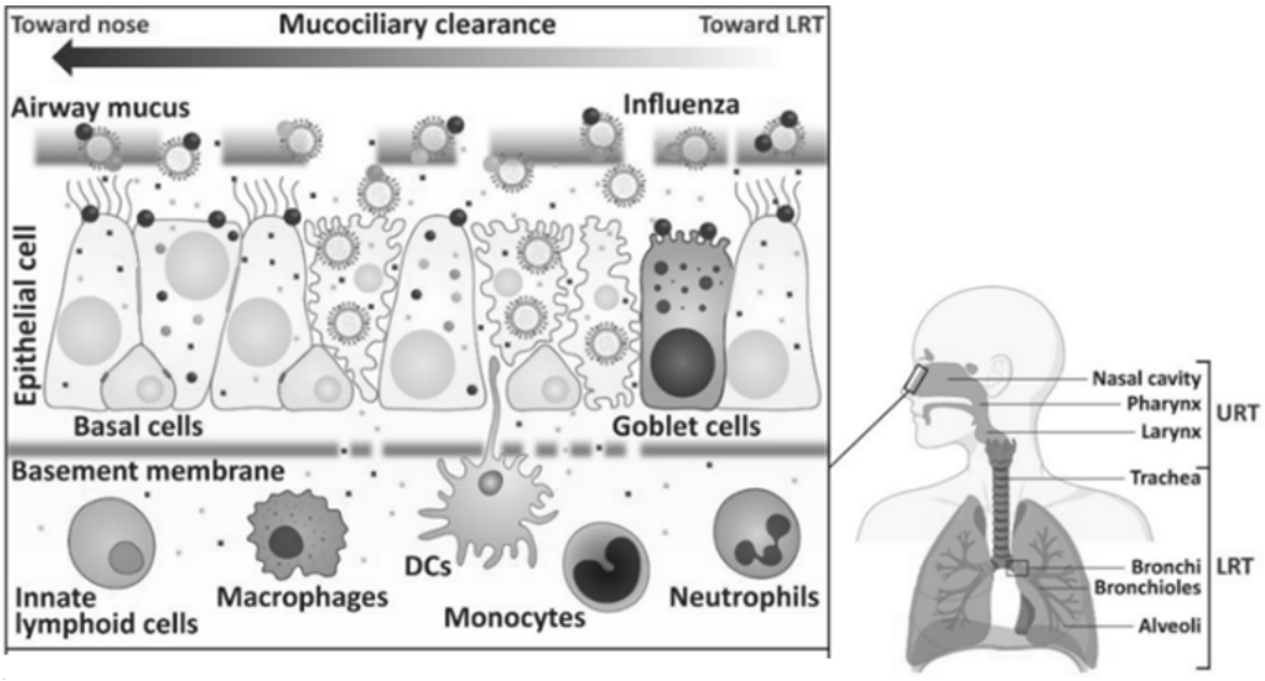


C



D

27 The figure below illustrates an infection by influenza virus.



Which one of the following statements is correct?

A The presence of mucus facilitates the movement of influenza virus into the lung.

B Macrophages are examples of cells that express both MHC Class I and Class II.

C Dendritic cells (DCs) are part of the adaptive immunity and are responsible for secreting immunoglobulin.

D The epithelial cells lining the upper respiratory tract (URT) are not part of the immune system.

28 IgG is a class of antibody that is found in high concentration during a secondary immune response.

Which of the following is **not** a function of IgG?

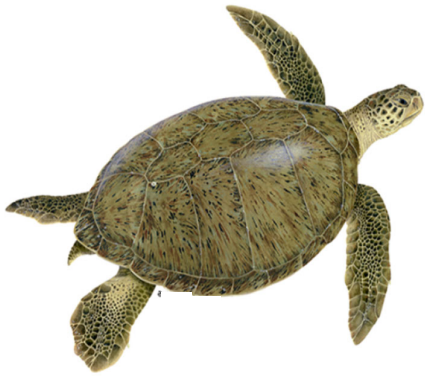
A Opsonisation

B Neutralisation

C Class switching

D Agglutination

29 The habitat of sea turtles is shallow coastal water in warm and temperate seas.



Sea turtles migrate to breeding areas to lay their eggs on sandy beaches. The nest temperature has a strong influence on the sex of the offspring. Colder temperatures result in a higher proportion of males and warmer temperatures result in a higher proportion of females.

Which effects of climate change could contribute to a decline in populations of sea turtles?

1 Increased melting of glaciers causing a rise in sea level.

2 Increased air temperature causing more heating of the Earth's surface.

3 Changes in ocean currents modifying migration pathways.

4 Heavy rainfall causing flooding of land and coastal erosion.

A All of the above

B 1, 2 and 3

C 1 and 2

D 2 and 4

30 Several factors can help to predict the risk of an outbreak of viral dengue disease in a human population. Four of these factors are listed.

	factor
P	Frequency of rainfall
Q	Incidence of viral dengue disease in the human population
R	Size of the mosquito population
S	Temperature

Ways in which these factors could affect this risk are also listed.

	what the factor could affect
1	Proportion of mosquitoes that are carriers of the dengue virus
2	Generation time of vector
3	Ability of vector to breed
4	Rate of new infections in the human population

Which row links each factor to one way it could affect the risk of an outbreak of dengue disease?

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

END OF PAPER

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