



YISHUN INNOVA JUNIOR COLLEGE  
JC2 PRELIMINARY EXAMINATION  
**Higher 2**

CANDIDATE  
NAME

**ANSWERS**

CG

INDEX NO

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**BIOLOGY**

**9744/01**

Paper 1 Multiple Choice

**18 September 2023**

**1 hour**

Additional Materials: Multiple Choice Answer Sheet

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**READ THESE INSTRUCTIONS FIRST**

Do not use staples, paper clips, glue or correction fluid/tape.  
Write your name, index no. and CG on this cover page and OTAS provided unless this has been done for you.

There are **thirty** questions on 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.

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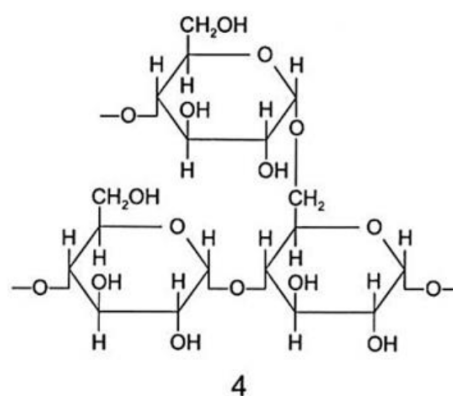
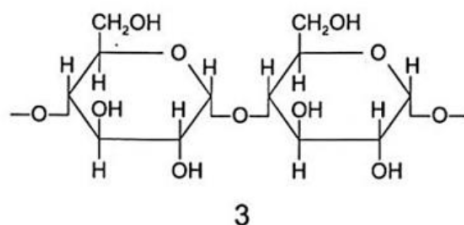
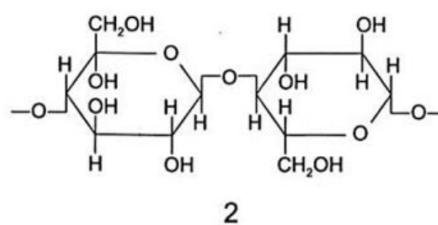
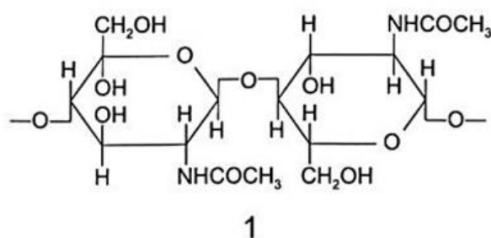
1 Different processes occur in different organelles in a plant cell.

- 1 transcription of circular DNA
- 2 assembly of ribosomal subunits
- 3 breaking of covalent bonds by hydrolysis
- 4 polymerisation of monomers containing nitrogen

Which processes occur in the following organelles?

	mitochondrion	chloroplast	nucleus
<b>A</b>	1	1	3, 4
<b>B</b>	1, 3	1, 2	2, 4
<b>C</b>	2, 3, 4	2, 4	1, 2, 4
<b>D</b>	1, 3, 4	1, 3, 4	2, 3, 4

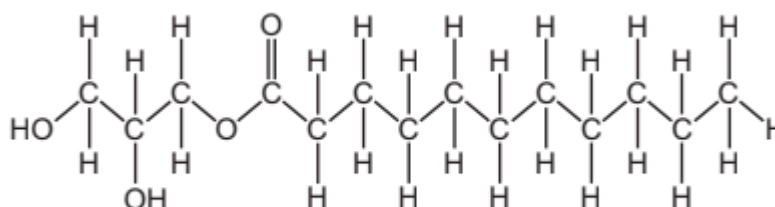
2 The diagrams show short sections of some common and modified polysaccharides.



Which statement is correct?

- A** 1 is found in cellulose as  $\beta$ -1,4-glycosidic bond is present.
- B** 2 is found in amylopectin, which is a helical molecule found in starch.
- C** 3 is found in cellulose, which is a linear unbranched chain of  $\beta$ -glucose monomers.
- D** 4 is found in glycogen, which is made of chains of  $\alpha$ -glucose linked by  $\alpha$ -1,4-glycosidic bonds and  $\alpha$ -1,6-glycosidic bonds at branch points.

- 3 Molecule X is a lipid.



molecule X

Which row is correct for molecule X and a triglyceride?

	molecule X contains	triglyceride contains
<b>A</b>	one unsaturated fatty acid	saturated fatty acids
<b>B</b>	no ester bonds	three ester bonds
<b>C</b>	one fatty acid	three fatty acids
<b>D</b>	two fatty acids	three fatty acids

- 4 Bread contains a mixture of polypeptides known as gluten.

Two of the polypeptides found in gluten are glutenin and gliadin.

Which statement describes the tertiary structure of a protein?

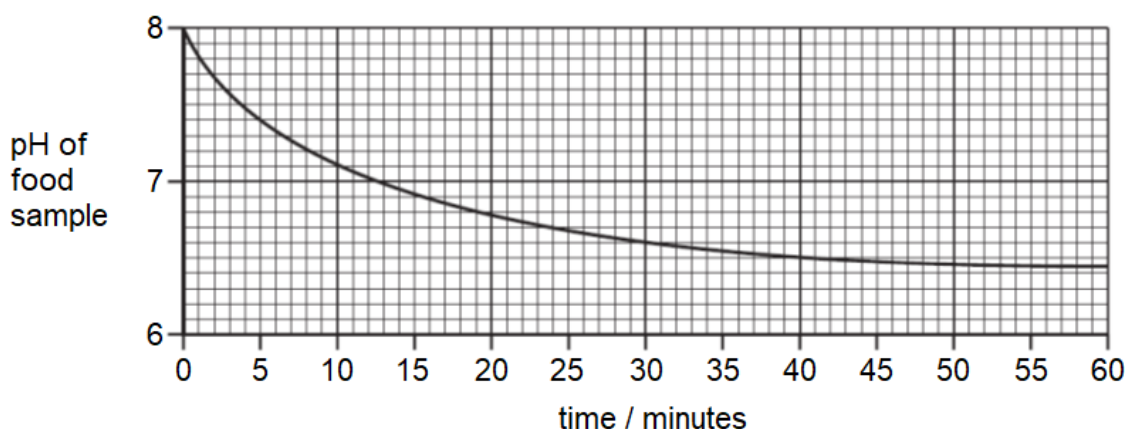
- A**  $\alpha$ -helical sections are found in glutenin and gliadin.
- B** A large proportion of the amino acids in gliadin are glutamine.
- C** Amino acids with hydrophobic R groups are found on the inside of glutenin.
- D** Disulfide bonds form between glutenin and gliadin.

- 5 Equal sized potato pieces were placed into a test-tube and covered with a sucrose solution. The test-tube was left for 30 minutes. All other variables were standardised.

After 30 minutes, the potato pieces had not changed in size.

What can be concluded from this result?

- A The concentration of sucrose is the same in the potato and in the solution and there is no more movement of water into or out of the potato.
  - B The concentration of sucrose is the same in the potato and in the solution and there is no net movement of water into the potato.
  - C The water potential is the same in the potato and in the sucrose solution and there is no more movement of water into or out of the potato.
  - D The water potential is the same in the potato and in the sucrose solution and there is no net movement of water into or out of the potato.**
- 6 Lipase is an enzyme that catalyses the hydrolysis of lipids. An experiment was carried out to investigate changes in pH when lipase is added to a food sample containing a high proportion of lipids. The results are shown in the graph.



Which statements are possible explanations of the results of the experiment between 50 minutes and 60 minutes?

- 1 Enzyme concentration becomes the limiting factor.
  - 2 Substrate concentration becomes the limiting factor.
  - 3 All the enzyme active sites are occupied.
  - 4 Denaturation of the enzyme by the products takes place.
  - 5 There is end-product inhibition.
- A 1, 2 and 3
  - B 1, 4 and 5
  - C 2, 3 and 4
  - D 2, 4 and 5**

**7** Which statements about adult stem cells are correct?

- 1 They are multipotent cells that have yet to express the genes and produce proteins characteristic of their differentiated state but do so when needed for repair of tissues and organs.
- 2 They are multipotent cells found in the adult and can give rise to all the cell types in the body.
- 3 They are undifferentiated cells that divide asymmetrically, giving rise to one daughter cell that remains a stem cell and one daughter cell that will differentiate to replace damaged and worn-out cells in the adult tissue or organ.
- 4 They are undifferentiated cells that reside under the surface of epithelial tissue, in position to take over the function of the tissue when the overlying cells become damaged or worn out.

- A** 1 and 2 only
- B** 3 and 4 only
- C** 1, 3 and 4 only
- D** 2, 3, and 4 only

**8** Some of the events that occur when an influenza virus enters a host cell are listed.

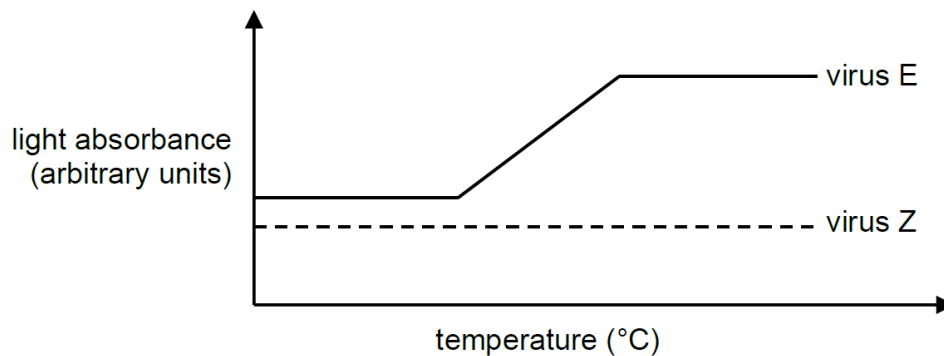
- 1 The virus becomes enclosed in an endosome.
- 2 Haemagglutinin undergoes a change in conformational rearrangement that change its binding specificity.
- 3 A low pH is produced in the endosome.
- 4 Haemagglutinin in the viral envelope binds to sialic acid.
- 5 The viral envelope fuses with the endosomal membrane.

Which sequence shows these events in the correct order?

- A** 2 → 5 → 1 → 3 → 4
- B** 4 → 1 → 2 → 3 → 5
- C** 4 → 2 → 1 → 3 → 5
- D** 2 → 5 → 1 → 4 → 3

- 9 Two new viruses E and Z, which infect eukaryotic cells, have been identified.

In one experiment, the nucleic acid from each virus is isolated and analysed over a range of temperatures. The light absorbance of nucleic acids increases when denaturation occurs. The behaviour of the nucleic acid from each virus is shown in the graph.



In a second experiment, it is found that treatment with reverse transcriptase inhibitors or with inhibitors of DNA synthesis blocks the ability of virus Z to infect cells. In contrast, reverse transcriptase inhibitors have no effect on the ability of virus E to infect cells but DNA synthesis inhibitors block infection by virus E.

Which of the following conclusions can be drawn from the results of both experiments?

- A** Virus E has double-stranded DNA as its genome while virus Z has single-stranded RNA.
- B** Virus E has single-stranded RNA as its genome while virus Z has double-stranded DNA.
- C** Virus E has double-stranded RNA as its genome while virus Z has single-stranded DNA.
- D** Virus E has double-stranded DNA as its genome while virus Z has double-stranded RNA.
- 10 A student made the following statements about how genetic variation arises in prokaryotes.
- 1 Prokaryotes may undergo antigenic drift to result in genetically different populations.
  - 2 Prokaryotes may accumulate mutations due to errors in DNA replication.
  - 3 Crossing over and independent assortment of chromosomes could give rise to daughter cells which are different from parent cells.
  - 4 Viruses may facilitate the transfer of bacterial genes between populations, leading to genetic variation.

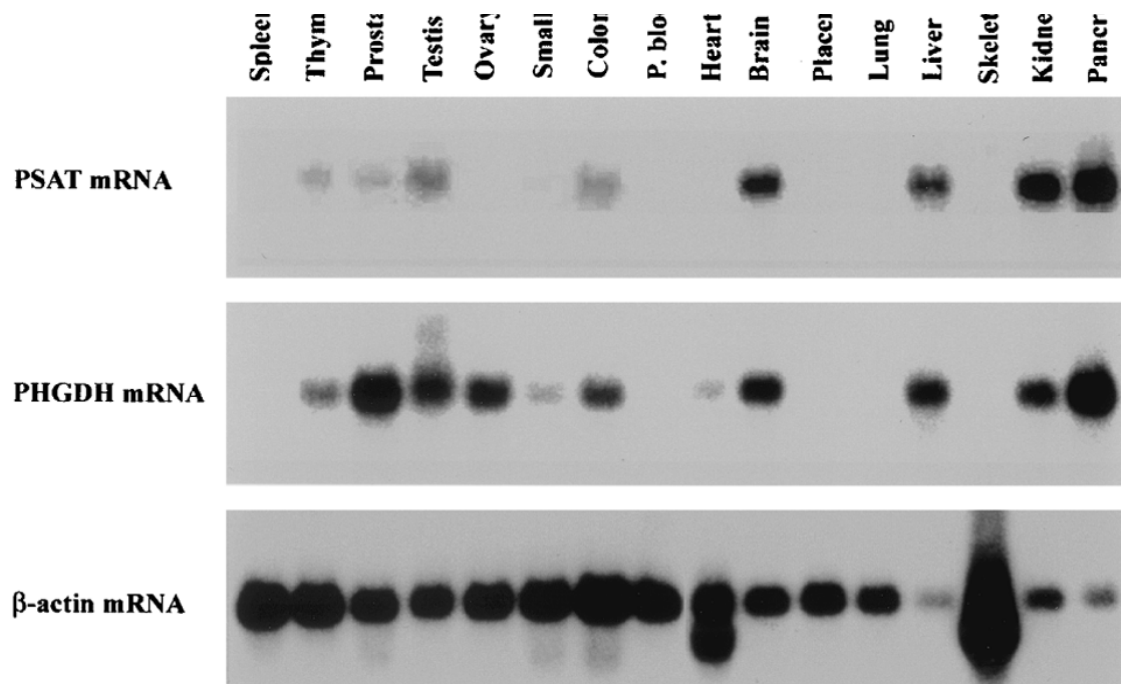
Which of statements are correct?

- A** 1 and 2 only
- B** 2 and 4 only
- C** 2, 3 and 4 only
- D** 1, 2 and 4 only

11 The end result of conjugation between two bacterial cells is

- A** two F<sup>+</sup> strains containing genes for pilus formation.
- B** two cells permanently linked by a cytoplasmic bridge.
- C** the transfer of the entire bacterial chromosome from donor to recipient cell.
- D** the integration of new genes into recipient bacterial chromosome.

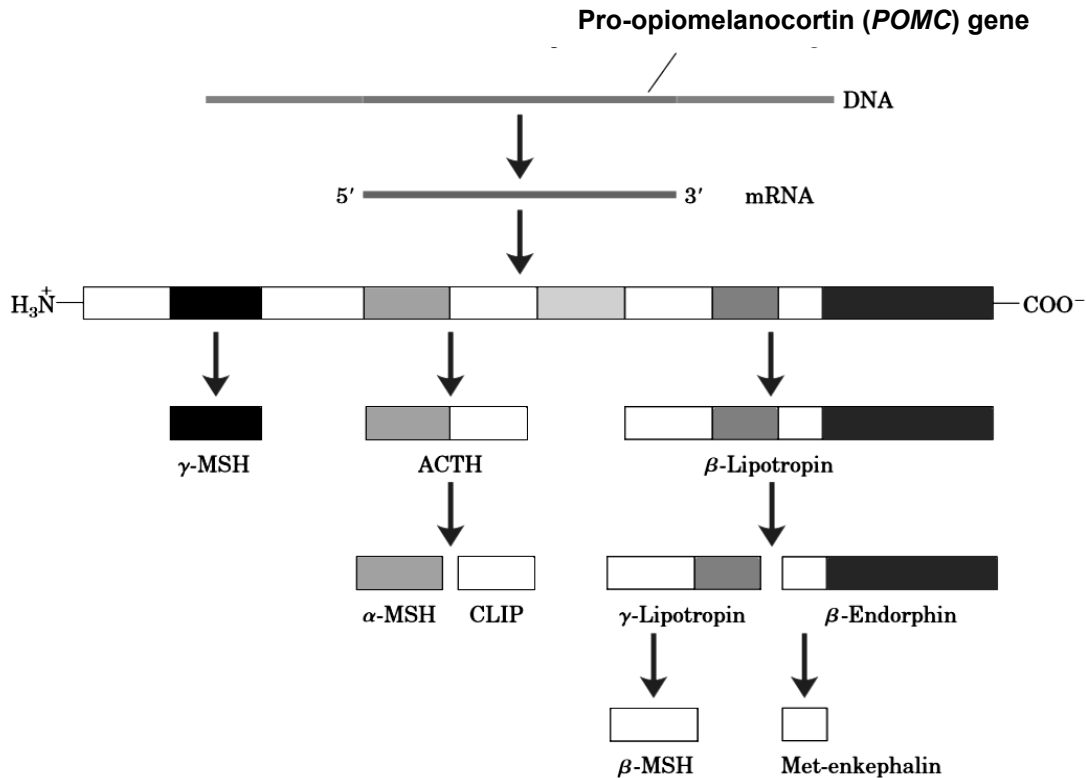
12 Both  $\beta$ -actin and D-3-phosphoglycerate dehydrogenase (PHGDH) are proteins that can be found in the human body. Multiple tissues from the same individual were taken, followed by the isolation of the respective mRNA from the same number of cells of each tissue type. The mRNA were then subjected to gel electrophoresis. The following autoradiograph shows the result of this study.



With reference to the diagram above, which of the following statements is **not** true?

- A** Activators are bound to enhancers of the gene coding for  $\beta$ -actin in skeletal muscle cells.
- B** Repressors are bound to silencers of the gene coding for PHGDH in lung cells.
- C** The gene coding for  $\beta$ -actin is located in euchromatin.
- D** The gene coding for PHGDH cannot be found in all types of cells.

- 13 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.

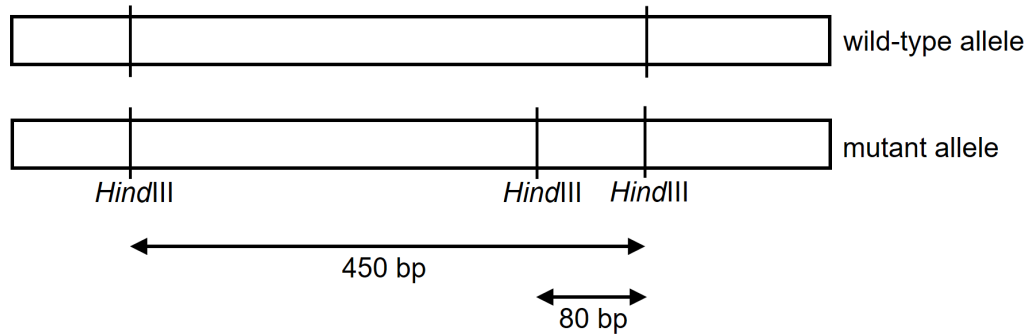
Which of the following statements is correct?

- A** Parts of the amino acid sequence of POMC polypeptide can undergo rearrangement to form peptide hormones of varying length.
- B** Specific chemical signals are required for the formation of unique peptide hormones in different tissues.
- C** The types of hormones formed in a specific tissue depend on the control of gene expression at the translational level.
- D** The different hormones are formed by alternative splicing.



- 14 A patient is suspected to be heterozygous for a gene (650bp) associated with mild neurological disorder. The mutated form of the gene arises because of a single nucleotide substitution that generates an extra *Hind*III restriction site.

The *Hind*III restriction sites on the wild-type (normal) allele and mutant allele are shown in the diagram.



You collected a blood sample from the patient and extracted the **total genome** from the white blood cells.

Which molecular techniques should be used to confirm the genotype of this patient?

	polymerase chain reaction	restriction digestion with <i>Hind</i> III enzyme	nucleic acid gel electrophoresis	Southern blotting	nucleic acid hybridization
<b>A</b>	x	✓	✓	✓	✓
<b>B</b>	✓	x	✓	x	x
<b>C</b>	x	✓	✓	x	x
<b>D</b>	✓	✓	x	✓	✓

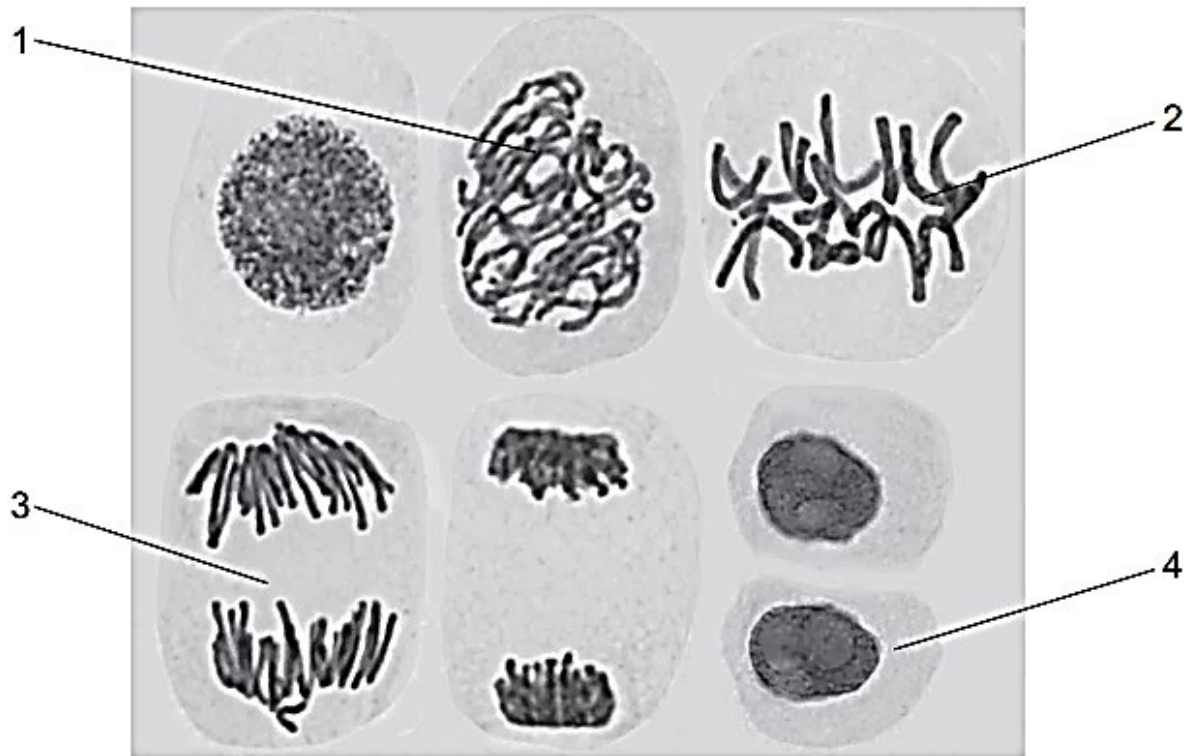
key

✓ = used

x = not used

- 15** A drug has been developed to treat certain types of cancer. It prevents mitosis by binding to the spindle. This prevents sister chromatids from being separated and moving to opposite poles of the cell.

The photomicrograph shows cells in different phases of mitosis.



Which stages of mitosis will be able to occur in a cell which is entering prophase when treated with this drug?

- A** 1 and 2 only
- B** 2 and 3 only
- C** 3 and 4 only
- D** 2 only

- 16** Melanoma is a form of skin cancer that begins in cells called melanocytes that control pigment production in the skin.

Which of the following correctly compares a normal melanocyte with a cancerous one?

	similarity	difference
<b>A</b>	active telomerase is present in both cells	more gene mutations have been accumulated in cancerous melanocytes
<b>B</b>	both cells contain well-defined nuclei	cancerous melanocytes are always in the M phase of the cell cycle
<b>C</b>	both cells arise from pre-existing cells	the cell cycle of cancerous melanocytes is arrested at either the S or M phase
<b>D</b>	some genes are switched off in both cells	cancerous melanocytes continue to divide even when they are tightly packed

- 17** Which statement uses genetic terms correctly?

- A** For a gene with multiple alleles, whether each allele is dominant or recessive is independent of the other alleles.
- B** For a gene with two alleles showing incomplete dominance, the genotypic ratio in a cross involving two heterozygotes is always the same as the phenotypic ratio.
- C** Homologous chromosomes have the same alleles at the same loci.
- D** X-linked recessive diseases only occur in males since females can only be carriers.

- 18** In humans, a certain disease is caused by inheriting two recessive alleles of gene Q/q. Identical twins occur once in approximately 300 births.

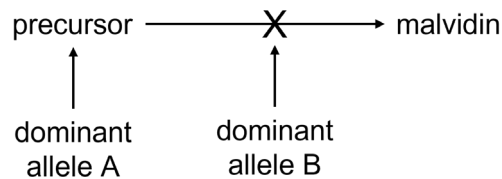
A woman who is heterozygous for gene Q/q is about to give birth. Her husband is also heterozygous for this gene.

What is the probability that the woman will give birth to identical twins that do **not** have the disease?

- A** Approximately 1 in 300
- B** Approximately 1 in 400
- C** Approximately 1 in 800
- D** Approximately 1 in 1200

- 19 In the *Primula* plant, production of the pigment malvidin creates blue flowers. Synthesis of malvidin is controlled by a dominant allele A at the A/a gene locus which codes for a colourless precursor substance.

However, the conversion of the precursor substance to malvidin can be suppressed by another dominant allele B at the gene locus B/b as shown in the biochemical pathway below. Flowers with absence of malvidin appear white.

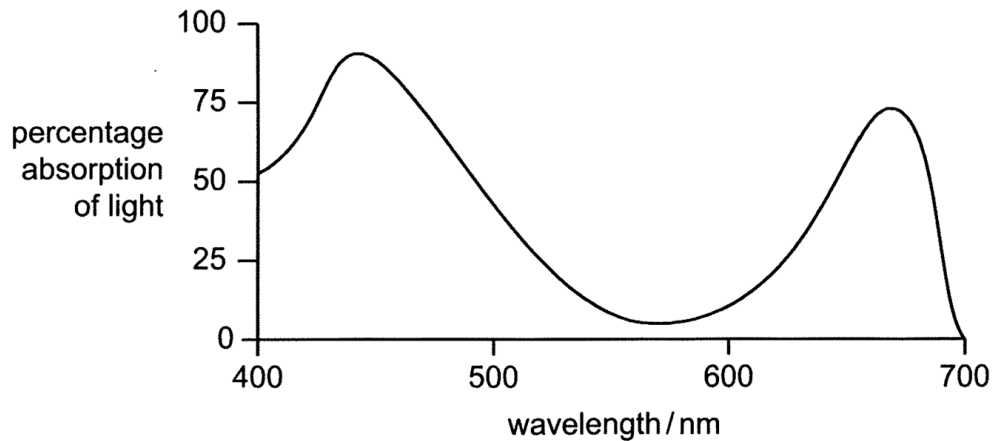


When two plants with white flowers are crossed, the offspring generation has 54 plants with white flowers and 11 plants with blue flowers.

Which of the following statements is **not** true?

- A The parent plants are heterozygous for the A/a and B/b gene loci.
- B The genotypes AABB, aaBB and aabb produce the same phenotype.
- C The probability of obtaining a pure-breeding offspring at both loci with white flowers is 1/8.
- D The deviation from the expected Mendelian ratio is due to gene interaction in which the expression of gene B masks the phenotypic expression of gene A.

- 20** The graph shows the absorption of light at different wavelengths by intact chloroplasts from a pond weed.



A sample of the same pond weed was exposed to four different wavelengths of light of the same intensity for the same time. The table shows the number of bubbles produced by the pond weed at each wavelength of light.

experiment	number of bubbles			mean number of bubbles
1	15	14	16	15
2	12	11	13	12
3	3	4	2	3
4	1	2	0	1

Which row shows the number of bubbles produced by the different wavelengths of light investigated?

	mean number of bubbles			
	440nm	520nm	560nm	670nm
<b>A</b>	1	12	15	3
<b>B</b>	3	1	12	15
<b>C</b>	12	15	3	1
<b>D</b>	15	3	1	12

- 21** Isolated chloroplasts, suspended in buffer solution, are often used to study the light-dependent stage of photosynthesis.

During this stage, electrons are transferred by carriers and provide energy so that a proton gradient can be formed. Protons diffuse through membrane proteins that are linked to synthase enzymes.

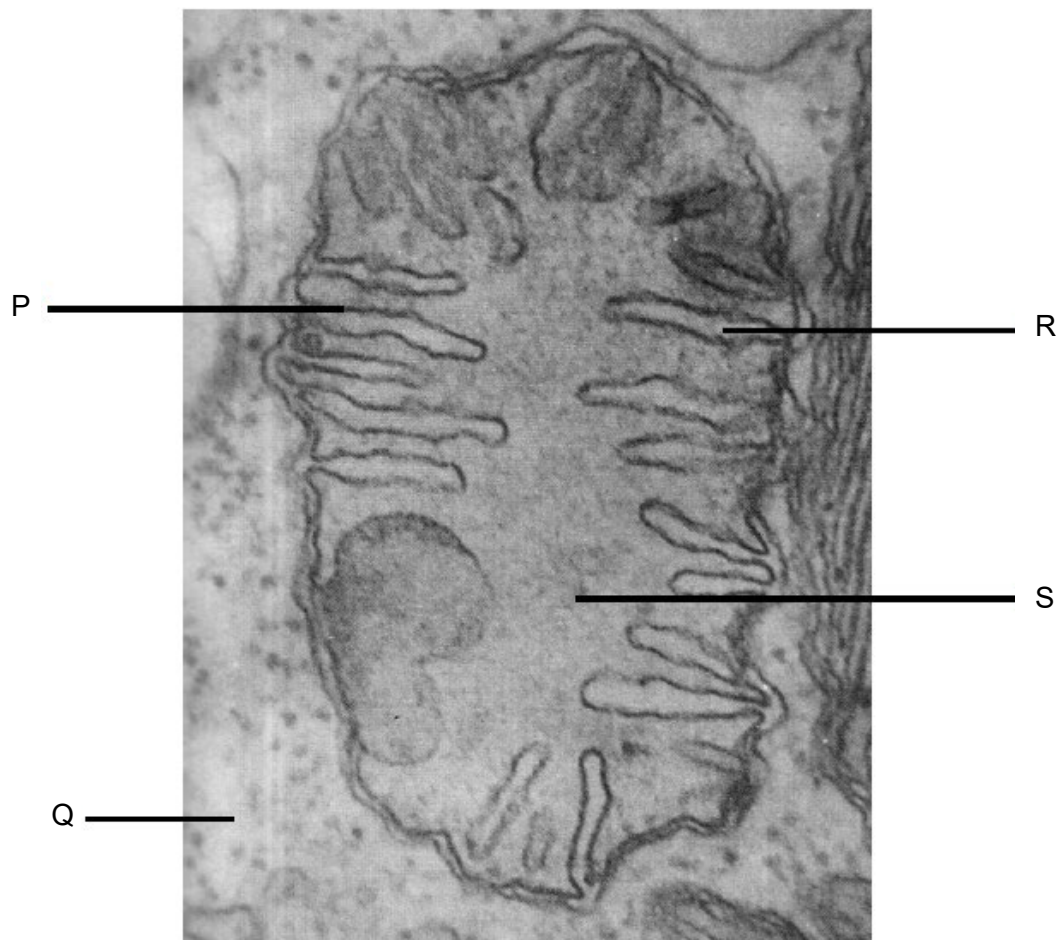
Three compounds that can be added to isolated chloroplasts are:

- 1 DCMU, which inactivates a carrier that accepts electrons from photosystem II
- 2 DCPIP, which can act as a final electron acceptor
- 3 Ammonium hydroxide solution, which absorbs protons

Which compounds, when added separately to isolated chloroplasts, would allow the light dependent stage of photosynthesis to occur and which would inhibit it?

	allow	inhibit
<b>A</b>	1	2 and 3
<b>B</b>	1 and 3	2
<b>C</b>	2	1 and 3
<b>D</b>	2 and 3	1

22 The figure below shows an electron micrograph of an organelle.

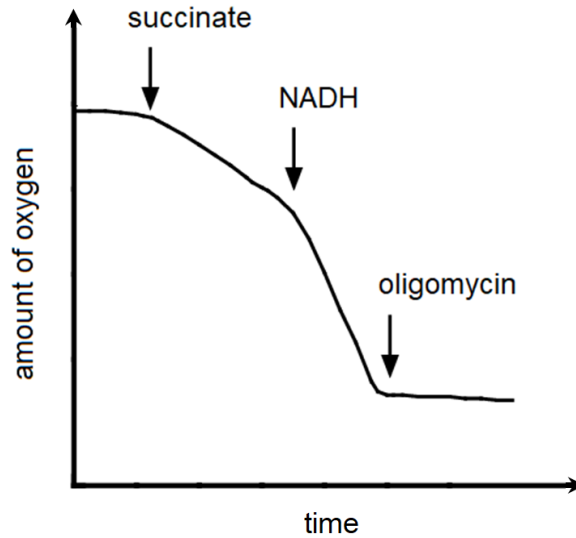


Match the following processes with the structures labelled P to S above.

	breakdown of fructose-6-phosphate	oxidative phosphorylation only	temporary lowering of pH	formation of water
<b>A</b>	<b>Q</b>	<b>P</b>	<b>R</b>	<b>S</b>
<b>B</b>	Q	R	S	P
<b>C</b>	R	S	P	Q
<b>D</b>	S	P	Q	R

- 23** A suspension of mitochondria was prepared in a buffer containing ADP and inorganic phosphate (Pi). The oxygen concentration in the buffer was monitored carefully and recorded as shown below.

At the times indicated, a specific reagent was added to the buffer. Throughout the experiment, the concentrations of ADP and Pi were in excess.



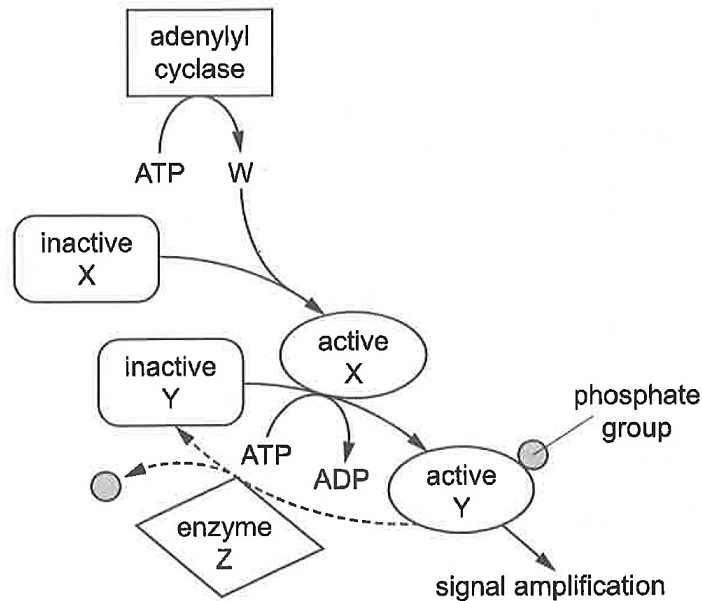
Which one of the following shows correctly from the highest to the lowest, the rate of ATP production after the addition of the three chemicals?

	highest rate	lowest rate
<b>A</b>	NADH	succinate
<b>B</b>	succinate	NADH
<b>C</b>	succinate	oligomycin
<b>D</b>	oligomycin	NADH



- 24** Glucagon triggers the conversion of glycogen to glucose in liver cells. This cellular response is the result of a cell signalling mechanism initiated by binding of glucagon to a receptor in the cell surface membrane. This leads to the activation of the enzyme adenylyl cyclase.

Part of the cell signalling mechanism that follows activation of adenylyl cyclase is shown in the diagram.



Which row correctly identifies the molecules in the diagram labelled W, X, Y and Z?

	W	X and Y	Z
<b>A</b>	cAMP	phosphatases	kinases
<b>B</b>	cAMP	kinases	phosphatases
<b>C</b>	ADP + Pi	phosphatase	kinases
<b>D</b>	ADP + Pi	kinases	phosphatases

- 25** In which of the following situations would evolution be slowest for an interbreeding population?

	Migration	Selection Pressure	Variation due to mutation
<b>A</b>	Absent	Low	Low
<b>B</b>	Absent	High	High
<b>C</b>	High	Low	High
<b>D</b>	High	High	Low

- 26** Zebras with some horizontal stripes are bitten less frequently by tsetse flies than those with only vertical stripes. These flies carry diseases that infect zebras.

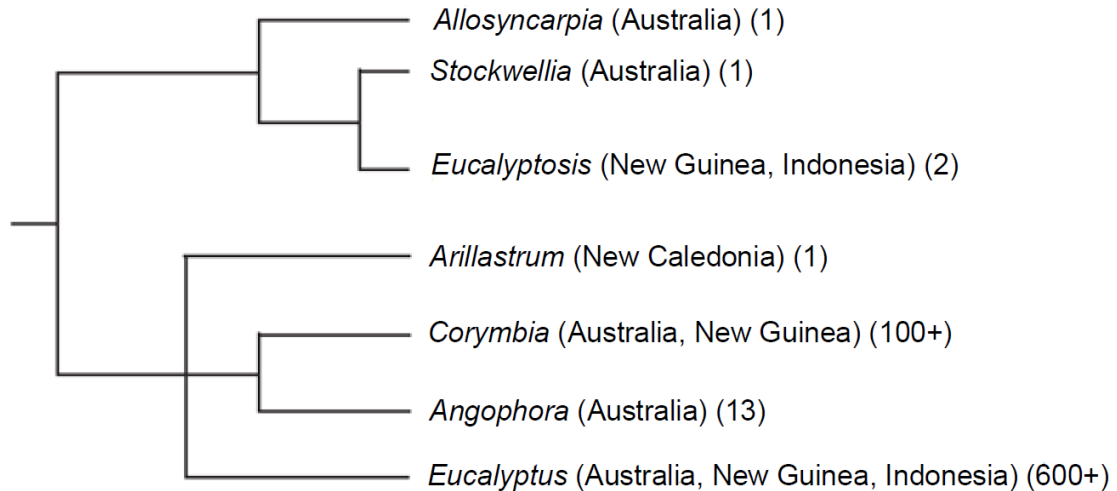
Which combination of statements could explain an increase in the proportion of individuals with horizontal stripes in a population of zebras over several generations?

- 1 Tsetse flies are a selection pressure.
- 2 Compared with other zebras, zebras with some horizontal stripes are likely to get fewer diseases from tsetse flies.
- 3 Zebras with some horizontal stripes pass the allele responsible for these stripes to their offspring.
- 4 On average, zebras with some horizontal stripes live longer as they have resistance against disease.

- A** 1, 2, 3 and 4
- B** 1, 2 and 3 only
- C** 1, 2 and 4 only
- D** 2 and 3 only

- 27** Eucalypts are commonly known as gum trees and they originate from Australia. They have been recently classified into seven different genera based on the basis of nuclear and chloroplast DNA sequencing.

A proposed phylogeny for the seven genera is shown in the diagram, along with the countries in which they are found and the number of species in the genus.



Which statement(s) regarding the Eucalypts can be concluded from the diagram?

- 1 *Allosyncarpia* is more closely related to *Eucalyptosis* than *Arillastrum*
- 2 *Corymbia* shares greater DNA homology with *Arillastrum* than *Angophora* with *Arillastrum*
- 3 *Eucalyptus* is the fittest amongst all the genera of Eucalypts in Australia
- 4 Sympatric speciation resulted in the different genera in New Guinea

**A** 1 only

**B** 1 and 2 only

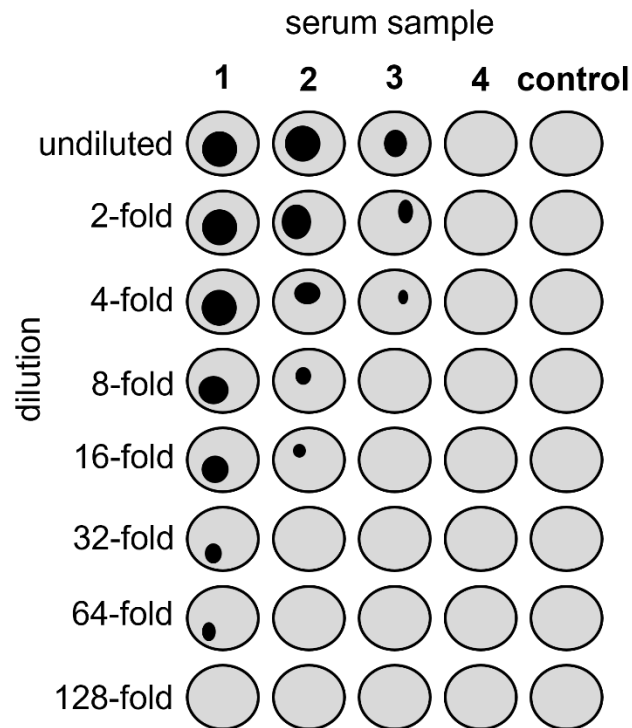
**C** 3 and 4 only

**D** 1, 2 and 4

- 28** The effectiveness of a vaccine is measured by the concentration of antibodies produced that can bind to specific antigens in the vaccine.

Blood from an individual is taken at different times after vaccination and the blood serum containing antibodies is extracted. The serum is then subjected to a serial dilution where the concentration is halved with each successive dilution. Each diluted blood serum is added to a well containing a fixed concentration of antigens. At a sufficiently high antibody concentration, a visible dark spot is formed due to a high level of antigen-antibody agglutination.

The diagram shows the results of an investigation on the effectiveness of the first dose of the vaccine and the second dose given after six months. Four serum samples were taken at different time points.



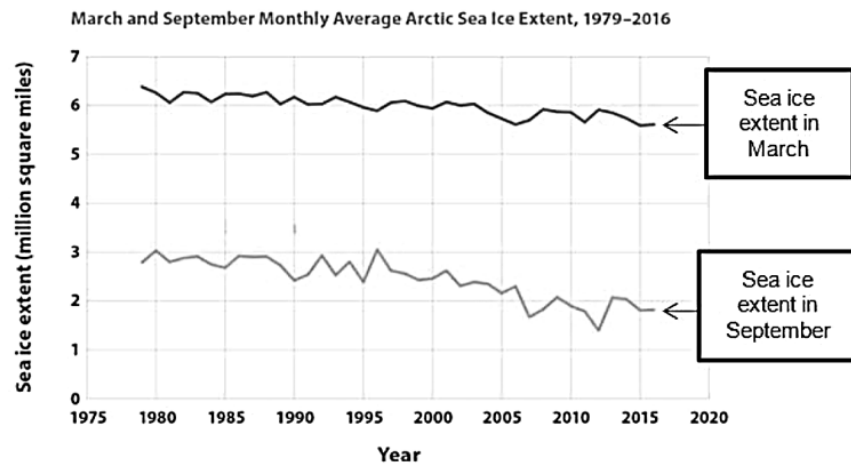
Which serum samples correspond to the different time points after the first dose and the second dose were given?

	two days after first dose is given	immediately before second dose is given	two days after second dose is given	six months after second dose is given
<b>A</b>	1	2	4	3
<b>B</b>	1	4	2	3
<b>C</b>	4	2	3	1
<b>D</b>	4	3	1	2

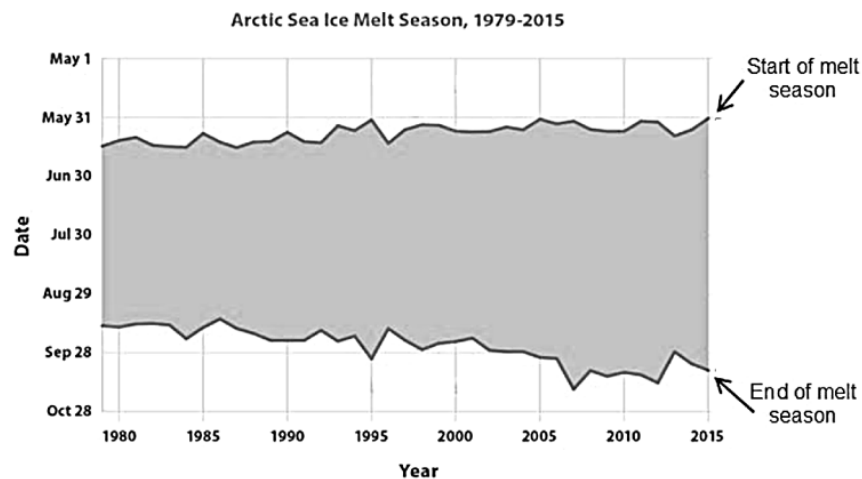
**29** Sea ice is an integral part of the Arctic Ocean.

Fig. A shows how the extent of area covered by Arctic sea ice has been changing over the years. Fig. B shows how the start and end of melt seasons have been changing over the same period.

**Fig. A**



**Fig. B**



Which of the following statements are valid inferences from the information above?

- 1 Sea ice extent in March is greater than that in September because March is during winter when more sea ice forms.
- 2 Sea ice extent in both March and September have likely been decreasing due to increased global warming.
- 3 The duration of sea ice melt season has increased by about a month from 1979 to 2015.
- 4 From 1979 to 2015, the winter season has been arriving earlier while the summer season has been arriving later.

- A** 1 and 2 only
- B** 2 and 4 only
- C** 1, 2 and 3 only
- D** 1, 2, 3 and 4

- 30** Malaria, Zika and dengue are infectious diseases which are transmitted with the help of the mosquitoes.

Which factor most likely explains the increase in number of people infected by these mosquito-borne diseases in recent years?

- A** Changing weather patterns promote the growth and migration of mosquito populations.
- B** Globalisation has facilitated the movement of people around the world.
- C** Global warming has resulted in increased availability of water bodies for mosquito breeding.
- D** Inability to develop an effective vaccine against the diseases.

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