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TEMASEK JUNIOR COLLEGE

2024 JC2 PRELIMINARY EXAMINATION

Higher 2

TEMASEK JUNIOR COLLEGE

BIOLOGY **9744/01**

Paper 1 Multiple Choice **12 September 2024**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

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

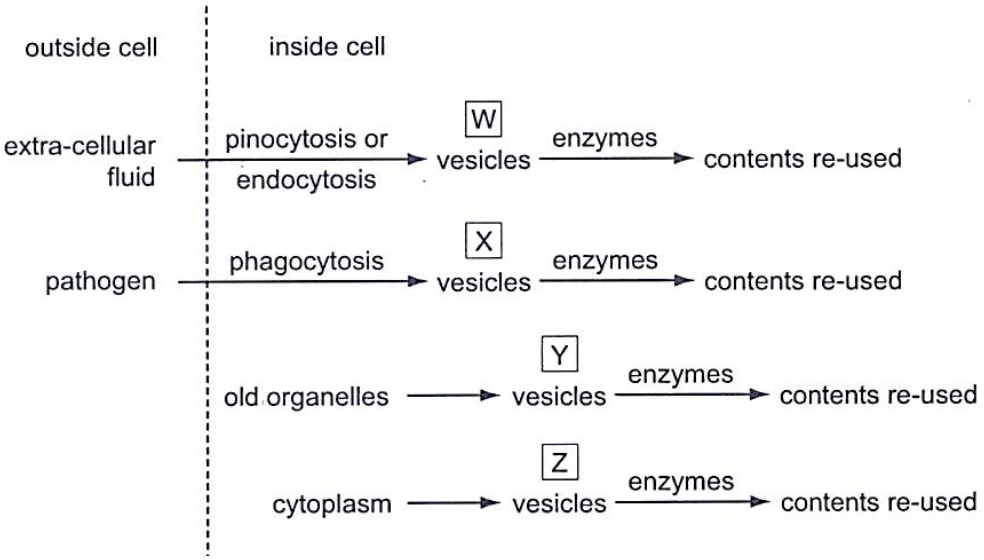
Do not open this booklet until you are told to do so.

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.

1 The flow chart show processes which take place inside animal cells.



Which processes require the activity of lysosomes

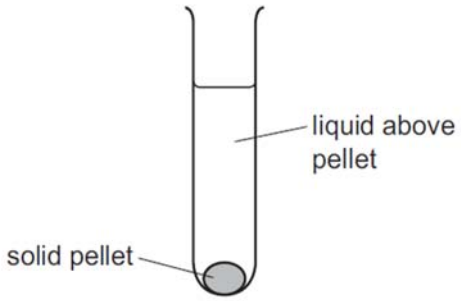
A W and X only

B X and Y only

C Y and Z only

D W, X, Y and Z

2 A scientist carried out an experiment to separate the organelles in an **animal cell** by mass. The scientist mixed the cells with a buffer solution which had the same water potential as the cells. The cells were broken open with a blender to release the organelles. The extracted mixture was filtered and then spun in a centrifuge at a high speed to separate the heaviest type of organelle. These sank to the bottom, forming solid pellet 1.



The liquid above pellet **1** was poured into a clean centrifuge tube and spun in the centrifuge at a higher speed to separate the next heaviest type of organelle. These organelles sank to the bottom, forming solid pellet **2**. This procedure was repeated twice more to obtain pellet **3** and pellet **4**, each containing a single organelle.

What is the main function of the type of organelle extracted in pellet **2**?

A digestion of old organelles

B production of ATP

C production of mRMA

D synthesis of protein

3 The three main factors that affect the rate of diffusion across a membrane can be expressed by the relationship shown.

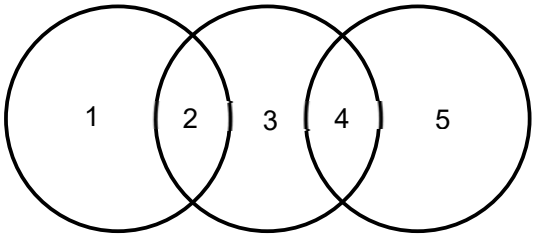
$$\text{rate of diffusion is proportional to } \frac{\text{surface area} \times \text{concentration difference}}{\text{thickness of membrane}}$$

Which changes in the factors would result in the rate of diffusion doubling?

1 surface area has doubled.
2 concentration difference has halved.
3 thickness of the membrane has doubled.
4 Thickness of the membrane has halved.

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

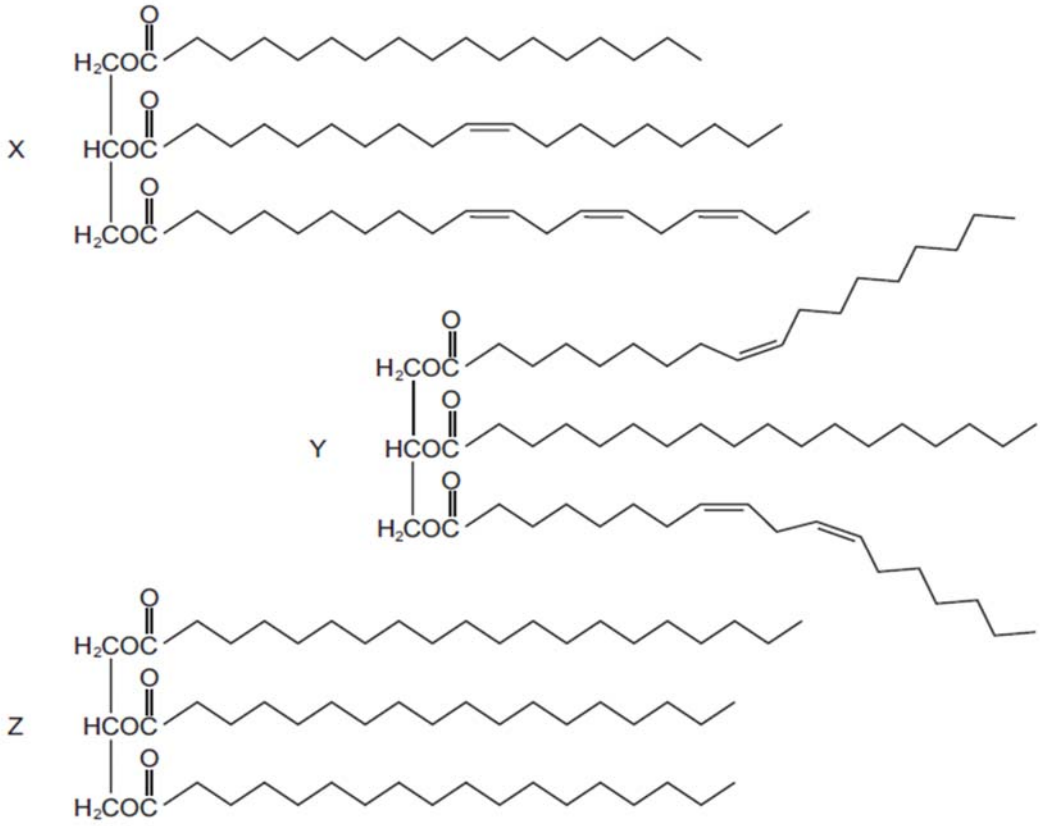
4 The diagram shows the relationship between different polysaccharides and glycosidic bonds formed between the monomers.



Which row is correct?

	1	2	3	4	5
A	Amylopectin	α 1,6	Cellulose	β 1,4	Glycogen
B	Amylose	α 1,4	Glycogen	β 1,4	Amylopectin
C	Cellulose	β 1,4	Amylose	α 1,4	Glycogen
D	Glycogen	α 1,6	Amylopectin	α 1,4	Amylose

5 The diagram shows three triglycerides, X, Y and Z.



Which row is correct for these triglycerides?

	contains saturated fatty acids	contains unsaturated fatty acids	contains more than two different fatty acids
A	X, Y and Z	X and Y	X and Y
B	X, Y and Z	Z	X and Y
C	X and Y	X, Y and Z	X, Y and Z
D	Z	X and Y	X, Y and Z

6 CYP3A4 is an important enzyme in the human digestive system where it is needed to break down a range of different toxins. The activity of CYP3A4 has been shown to be reduced by substances called furanocoumarins.

Furanocoumarins are found in some fruits and so dangerous concentrations of toxins may develop in the human digestive system when fruits containing furanocoumarins are eaten

From the information provided, what can be **concluded** about molecules of the enzyme **CYP3A4**?

A They lower the activation energy of the toxin breakdown reactions.

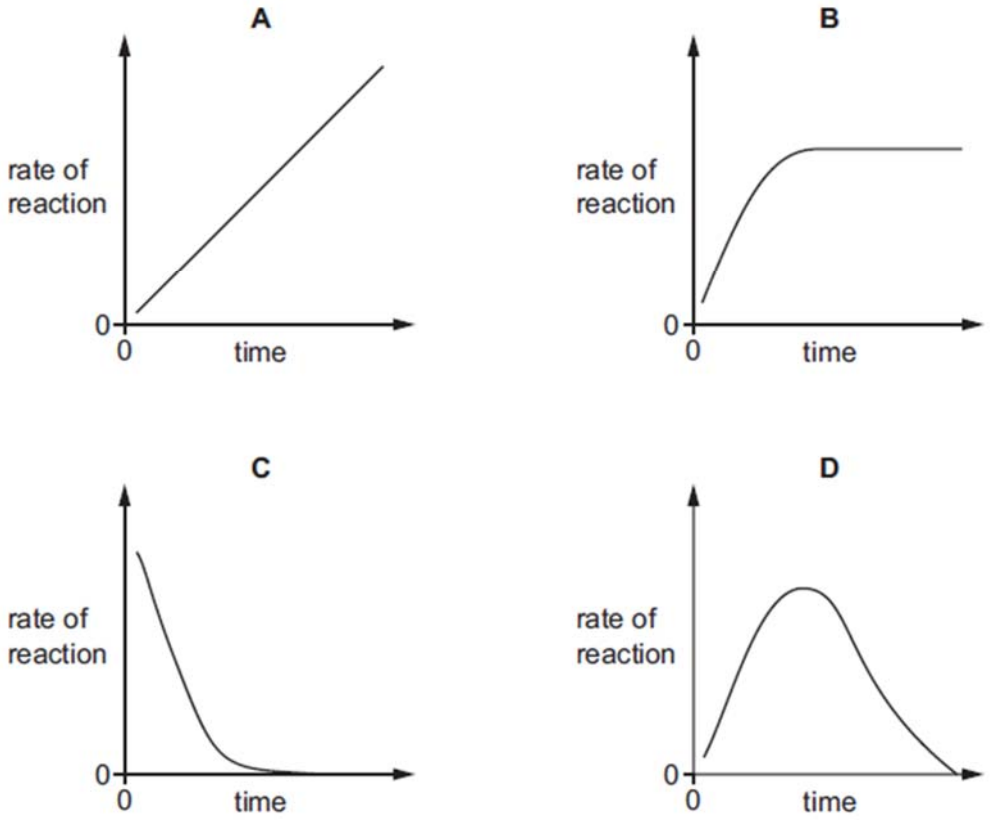
B They bind specifically through the active site to a substrate found in some fruits.

C They change permanently when acted upon by furanocoumarin molecules.

D They resume normal activity when concentrations of furanocoumarins decrease.

7 A **fixed volume** and **concentration** of **substrate** and **enzyme** were mixed. All other variables were kept constant. The enzyme-catalyzed reaction was allowed to proceed until it was completed.

Which graph shows how the rate of reaction changes with time? **C**



8 The table shows the percentages of nitrogenous bases in four samples of nucleic acids.

Which base is adenine?

Sample	Bases				
	A	**B**	**C**	**D**	**Uracil**
1	31	19	19	30	Nil
2	23	27	26	24	Nil
3	25	25	25	Nil	25
4	32	17	18	33	Nil

9 The active messenger RNAs (active mRNAs) in tissue cells can be isolated by passing the homogenized cell contents through a fractionating column. The column has short lengths of uracils nucleotides attached to a solid supporting material. Most molecules of mRNA that pass through the column quickly break up into small pieces and cannot be translated.

The active mRNAs that attach to the column can be separated again by appropriate treatment.

Which statements correctly describe active mRNA?

1 Active mRNAs can be held to the fractionating column by bonds between adenine and uracil bases.

2 Active mRNAs can be released from the fractionating column by breaking hydrogen bonds.

3 Only mRNAs with polyadenine tailing can be translated.

4 Polyadenine tailing stabilizes mRNA and prevents it from being broken up.

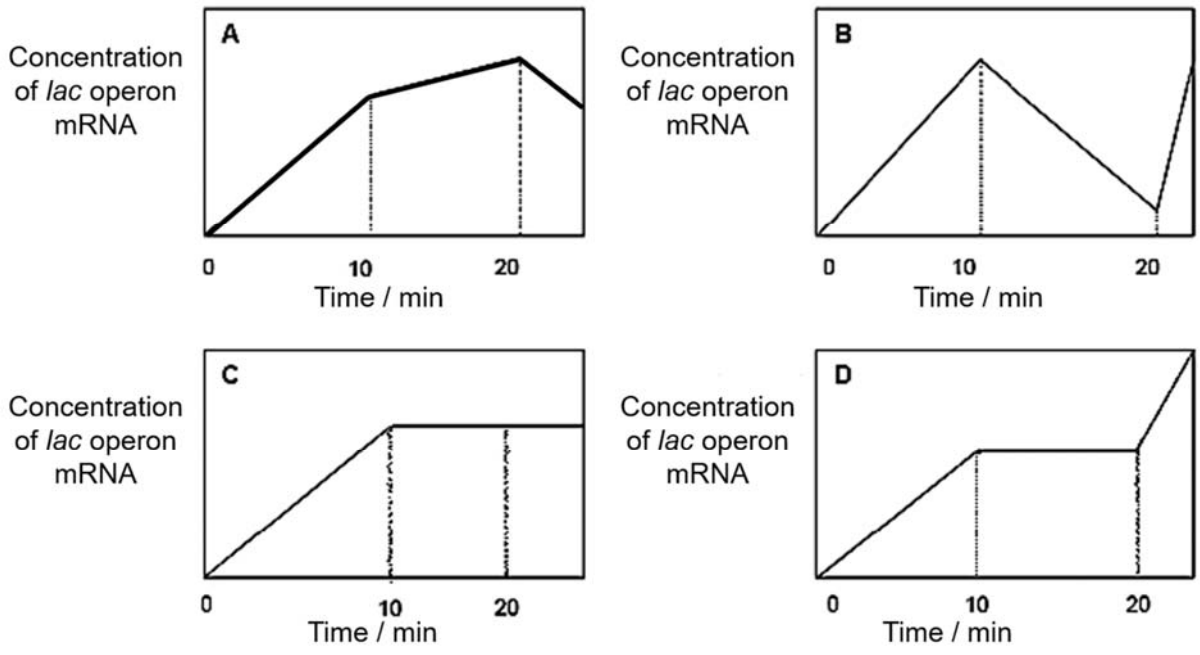
A 1 and 2 only **B** 1, 2 and 3 **C** 3 and 4 only **D** All of the above

10 IPTG in an analogue of lactose that binds to the *lac* repressor in the same fashion as allolactose. However, it cannot be metabolized by β-galactosidase.

Escherichia cells, which were grown in the absence of lactose and glucose, were initially supplemented with IPTG. After 10 minutes, glucose was added to the cells.

10 minutes after glucose was added, cAMP was added to the cells.

Which of the following **graphs best represents** how the **concentration** of the ***lac* operon mRNA** varied during the experiment? **B**



11 Which of the following pairs of statements is **not true** of generalized and specialized transduction?

	Generalized	**Specialized**
1	Transfers any bacterial DNA	Transfers a specific set of bacterial genes
2	Contains a hybrid chromosome in its capsid	Contains only bacterial chromosome in its capsid
3	Viral DNA is transcribed in the recipient cell	Viral DNA is **not** transcribed in the recipient cell
4	Viral DNA is integrated into the host chromosome	Viral DNA is not integrated into the host chromosome
5	Viral DNA is not replicated by binary fission of the recipient cell	Viral DNA is replicated by binary fission of the recipient cell

A 1, 4 and 5 **B** 2, 4 and 5 **C** 3, 4 and 5 **D** 2, 3 and 4

12 Which of the following statements about the reproductive cycle of the Human Immunodeficiency virus are false?

1 The HIV particles recognize the host cell through the sialic-acid containing proteins or lipids on the membrane of the host cell.

2 The genome of HIV consists of 2 copies of linear, single-stranded RNA enclosed in a nucleocapsid.

3 The viral DNA which enters the host cell's nucleus will be integrated into the genetic material of the host cell using the host cell's enzyme, integrase.

4 The viruses are released from the host cell by exocytosis.

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

13 Which of the following are properties of enhancers?

1 They are located away from the gene they control.

2 They are protein factors binding to regulatory regions of the DNA.

3 They increase the expression of the gene they control.

4 They are regulatory regions of the DNA which binds basal transcription factors to increase rate of gene expression.

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

14 Which processes require mitosis?

1 The cloning of T-lymphocytes

2 The repair of cell structures by protein synthesis.

3 The growth of multicellular organisms from a single cell

4 The reproduction of a unicellular eukaryote

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

15 What are the normal functions of stem cells in a living human?

	Functions		
A	Differentiating into **many kinds** of cells in a 3 – 5 cells stage of the human embryo	Producing insulin in pancreas damaged by type 1 diabetes	Cells that can differentiate into bone cells in the skeletons
B	Differentiating into many kinds of cells in a 3 – 5 cells stage of the human embryo	Producing red blood cells to replace worn out cells	Cells that can differentiate into cardiac muscle cells in the heart
C	Differentiating into only one kind of cells in a 3 – 5 cells stage of the human embryo	Producing dopamine in the brains of people with Parkinson's	Cells that can differentiate into cartilage cells in the joints
D	Differentiating into only one kind of cells in a 3 – 5 cells stage of the human embryo	Producing differentiated cells that can be used to screen new drugs	Cells that can differentiate into nerve cells in the brain

16 The table describes different kinds of mutations in DNA.

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

The diagram represents part of a DNA molecule.

Which diagram shows the DNA molecule with only transversion(s)?

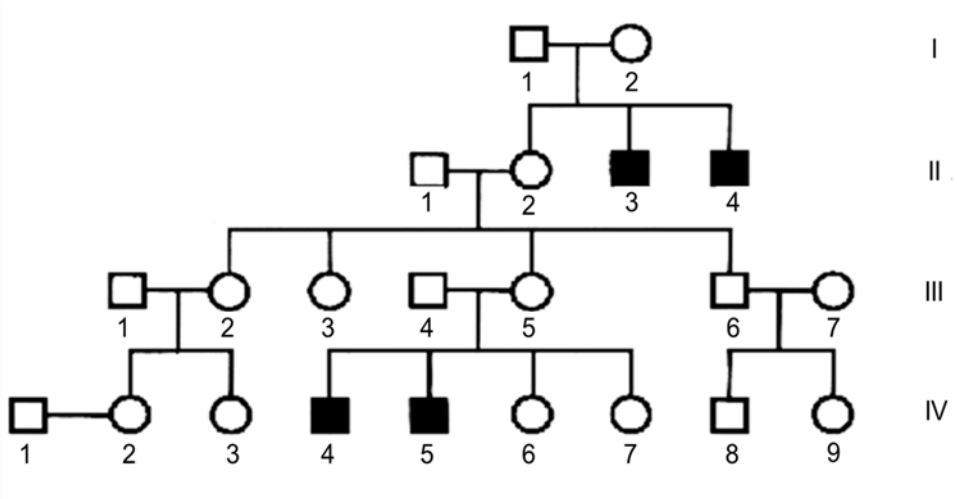
A

B

C

D

16 The pedigree below shows the inheritance of colour-blindness.



Which statement about this pedigree is false?

A Individuals I-2, II-2 and III-5 are heterozygous for the gene associated with colour-blindness.

B Colour-blind males inherited the allele for colour-blindness from their mothers.

C Individual II-2 does not have the allele for colour-blindness since all her children do not have colour-blindness.

D The gene associated with colour-blindness is found on the X chromosome.

18 A student investigated the effect of salt concentration on the growth of one species of brine shrimp.

The student placed 100 shrimp eggs in a beaker containing 3% salt solution. Seven days after the eggs hatched, 10 shrimps were collected and their lengths measured. The procedure was repeated using a 5% salt solution, 10 shrimps were also collected and their lengths measured. All over variables were kept constant.

The student carried out a ***t*-test** to see if there was a significant difference between the mean lengths of brine shrimps in these two salt solutions. The calculated **t value** was found to be **4.55**.

Part of the table of t values is shown.

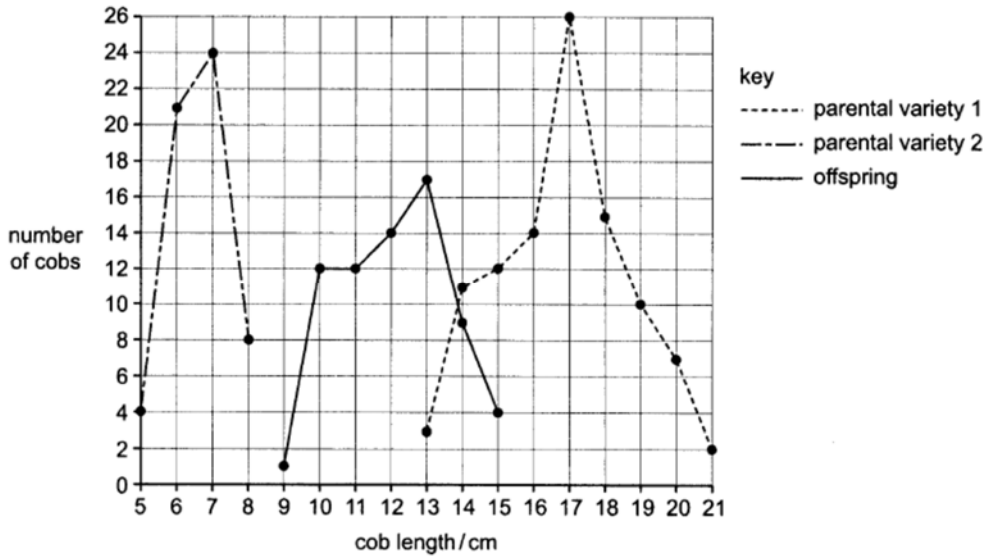
degrees of freedom	probability				
one-tailed t-test	*0.10*	*0.05*	*0.025*	*0.01*	*0.005*
two-tailed t-test	*0.20*	*0.10*	*0.05*	*0.02*	*0.01*
8	1.397	1.860	2.306	2.896	3.355
10	1.372	1.812	2.228	2.764	3.169
18	1.330	1.734	2.101	2.552	2.878
20	1.325	1.725	2.086	2.528	2.845

Which of the following gives the corresponding t critical value and p value, as well as the correct conclusion made from the t-test?

	t critical value	*p* value	conclusion
A	1.860	$p < 0.05$	The difference between the mean lengths of brine shrimps in 3% and 5% salt solutions is significant. Salt concentration has an effect on the growth of brine shrimp.
B	1.812	$p > 0.05$	The difference between the mean lengths of brine shrimps in 3% and 5% salt solutions is not significant. Salt concentration does not have an effect on the growth of brine shrimp.
C	2.101	$p < 0.05$	The difference between the mean lengths of brine shrimps in 3% and 5% salt solutions is significant. Salt concentration has an effect on the growth of brine shrimp.
D	2.086	$p > 0.05$	The difference between the mean lengths of brine shrimps in 3% and 5% salt solutions is not significant. Salt concentration does not have an effect on the growth of brine shrimp.

19 Two pure-bred lines of two varieties of maize which differed markedly in cob length were crossed. The length of the cobs produced by the two parental varieties and their offspring were measured to the nearest centimetre. The number of cobs in each length category was counted.

The graph shows the results.



What is the cause if the phenotypic variation shown in cob length within the two parental varieties and their offspring?

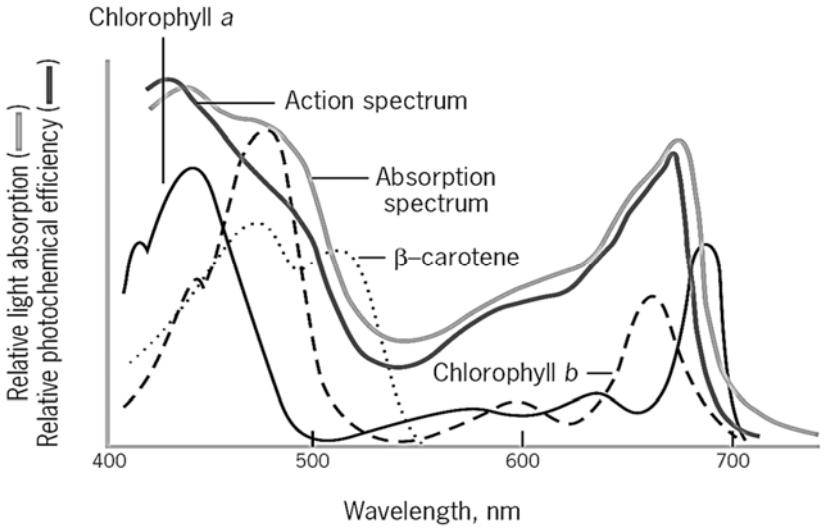
A additive effect of different genes

B linkage and crossing-over at meiosis

C segregation and independent assortment of alleles

D various environment factors

20 The figure below shows the absorption spectrum of the photosynthetic pigments of a flowering plant and its action spectrum.



What can be concluded from the graph above?

1 The relative light absorption will be higher at higher temperatures, as temperature is a limiting factor.

2 The green leaves reflect light of wavelength 550nm, hence the photochemical efficiency is low.

3 The compensation point of β-carotene, whereby the rate of photosynthesis equals the rate of respiration, occurs at 550nm.

4 The accessory pigments chlorophyll b and β-carotene absorb light energy mostly at 480nm.

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

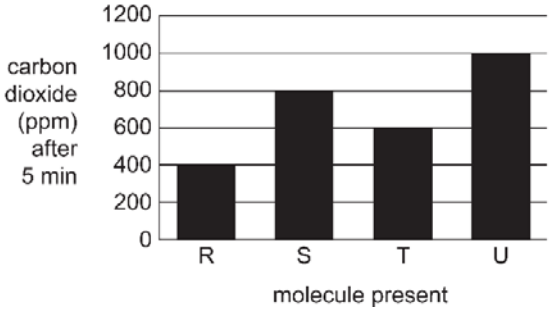
21 A student investigated the effect of the presence of four different molecules, R, S, T and U, on the rate of cellular respiration in human liver cells. The production of carbon dioxide by the cells was recorded over a five-minute interval. The final concentration of carbon dioxide was recorded. The data collected is shown below.

Molecule present	Concentration of carbon dioxide (ppm) after five minutes
R	400
S	800
T	600
U	1000

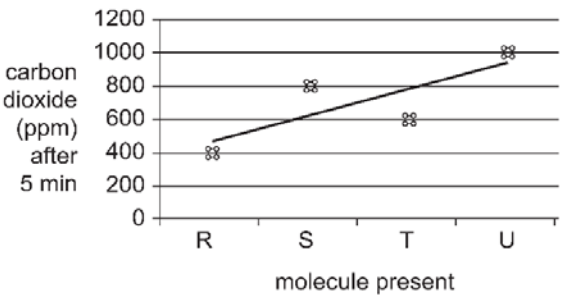
The student presented the results as a graph.

Which one of the following graphs is the best representation of the results?

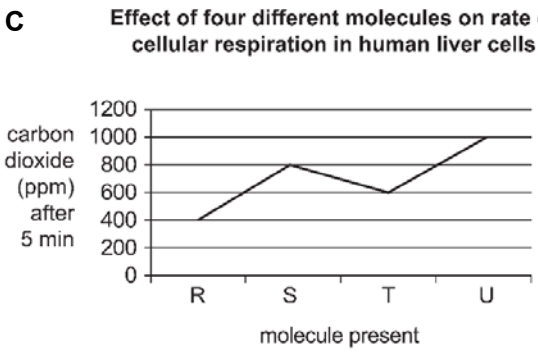
A



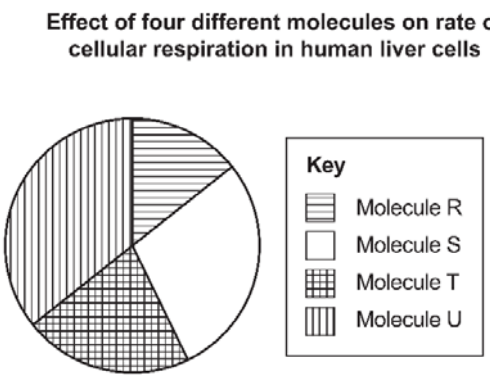
B



C

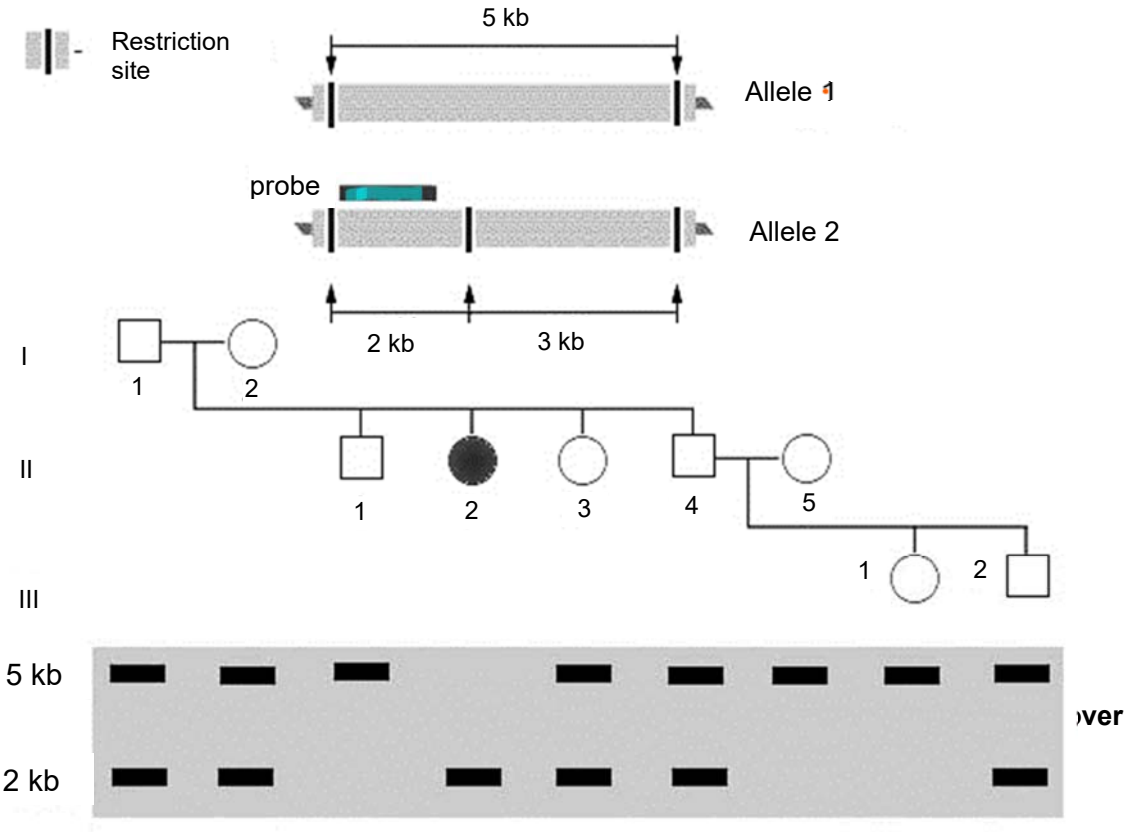


D



22 DNA analysis techniques were used to analyze the inheritance of a rare mutations that caused the pre-mature degeneration of the nervous system.

Genomic DNA was digested with a restriction enzyme *Bam*HI and the results of the gel electrophoresis and nucleic acid hybridization are shown in the diagram below.



What of the following observations cannot be concluded from the information provided?

A The mutation that causes the disease is probably recessive.

B The mutation that causes the disease is likely to be located in a coding region of the genome.

C There can only be a maximum of three *Bam*HI restriction sites on **Chromosome 5** in the affected individual.

D The children of II-1 are unlikely to inherit the disease.

23 Paleontologists believe that the Victorian ornithopods, a group of herbivorous dinosaurs in Australia, shared a close common ancestor with several ornithopod fossils found in Antarctica, South America and Africa.

Which one of the following is the most likely explanation for the distribution of these fossils?

A Antarctica, South America and Africa were joined to Australia in the distant past.

B The strong tails of the ornithopods enabled them to swim for sustained periods of time to other continents.

C The small forelimbs of the ornithopods suggest that they were evolving wings for flight.

D Seagoing, scavenger birds carried the fossil bones of the ornithopods to other continents.

24 Early in 2012, biologists announced the discovery of a new lizard species.

To claim that the lizards belong to a new species, the biologist must show that the lizards

1 look different from known species.

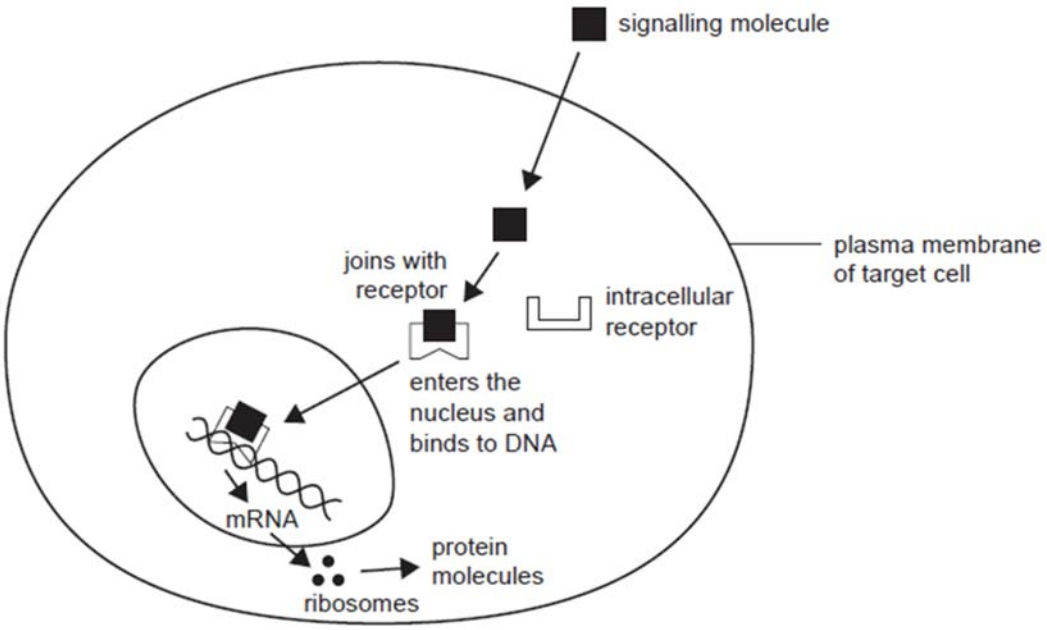
2 have similar genetic sequences to known species.

3 do not reproduce fertile offspring with members of known species.

Which statement(s) correctly support the claim?

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

25 Consider the diagram below of a signaling molecule interacting within a target cell.



Which of the following statement correctly for describes the interaction between the signaling molecule and the target cell?

A The signaling molecule must be hydrophilic.

B The original signal is amplified during signal transduction.

C The response of the target cell is increased gene expression.

D Second messengers are produced during signal transduction.

26 An example of an innate response by the human immune system is

A cytotoxic T cells releasing chemicals into infected cells.

B the production of plasma cells that produce antibodies.

C phagocytes engulfing non-self material.

D the production of memory B cells.

27 A patient with kidney failure can be given a kidney transplant. In a kidney transplant, a healthy kidney is taken from another person and put into the patient's body.

Sometimes the donated kidney cells are targeted by the patient's immune system.

The statements below describe the stages of the primary immune response.

Activated T-helper cells secretes cytokines.

1 B-lymphocytes differentiate into plasma cells and make antibodies.

2 T-killer cells bind to antigens on donor kidney cells.

3 T-killer cells release toxins that destroy the donor kidney cells.

4 T-lymphocytes multiply by mitosis and differentiate into T-killer cells.

Which order correctly explains how donor kidney cells are killed?

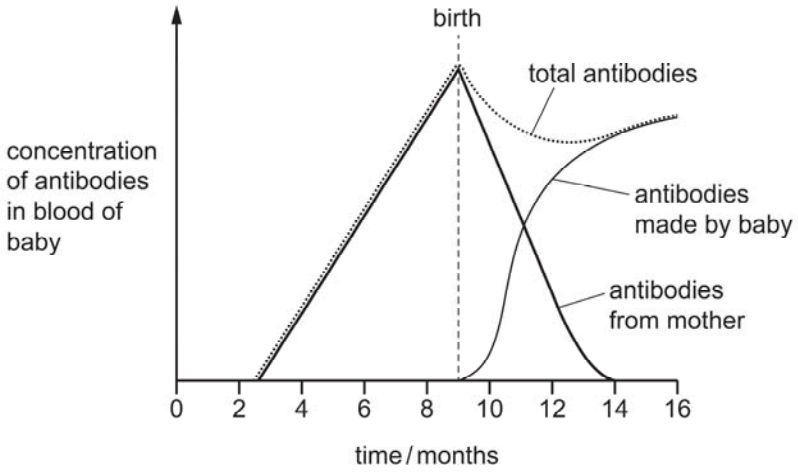
A 1 5 2 3

B 1 5 3 4

C 3 1 5 2

D 3 5 4 1

28 The graph shows the changes that occur in the concentration of antibodies in the blood of a baby before birth and during the first few months after birth.



Which description about the changes in immunity during the first few months after birth is correct?

A Active artificial immunity decreases, active natural immunity increases.

B Active natural immunity decreases, active artificial immunity increases.

C Passive artificial immunity decreases, active natural immunity increases.

D Passive natural immunity decreases, active natural immunity increases.

29 The spider-orchid only flowers for a relatively brief time. Its flower resembles a spider and emits a scent that mimics that of a female bee, tricking male bees into attempting to mate with the flowers, thereby allowing the plant's pollination.

The bees emerge in spring after hibernation and take flight, with the males flying earlier than the females.

Global warming has resulted in temperatures in the spring months to be higher than before, affecting the interaction between the spider-orchid and the male bees.

1 Female bees are emerging from hibernation earlier than usual, competing with the orchid flower and preventing it from being pollinated by the male bees.

2 The spider-orchid flowers earlier, resulting in desynchronisation between the pollination process and the hatching of the bee larvae.

3 The hatching process of the bee larvae is slower as some of the enzymes involved are inactivated at higher temperatures, resulting in the later emergence of the bees.

Which statements are possible concerns of higher temperatures in spring?

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

30 Which of the following correctly shows the effect of climate change on coral reefs and associated ecosystem?

	Average number of zooxanthellae in each polyp	Mass of basal plate of hard corals	Diversity of catch from nearby fisheries
A	Increased	Unaffected	Increased
B	Decreased	Unaffected	Increased
C	Increased	Decreased	Decreased
D	Decreased	Decreased	Decreased