H

NATIONAL JUNIOR COLLEGE, SINGAPORE
Senior High 2
Preliminary Examination
Higher 2

CANDIDATE NAME			
BIOLOGY CLASS	2bi2_____	REGISTRATION NUMBER	

Biology

9744/01

Paper 1 Multiple Choice

18 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, Biology class and registration number on all the work you hand in.

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.

Your five-digit OAS index number is made up of the **second** and **last four digits** of your registration number.

For example:

Registration no.	OAS Index no.
2**2**0**5123**	**25123**

This document consists of **20** printed pages.

1 The endosymbiotic theory states that eukaryotic mitochondria and chloroplasts originated from ancestral prokaryotes.

Which statements support this theory?

1 The smallest eukaryotic cells are the same size as many bacteria.

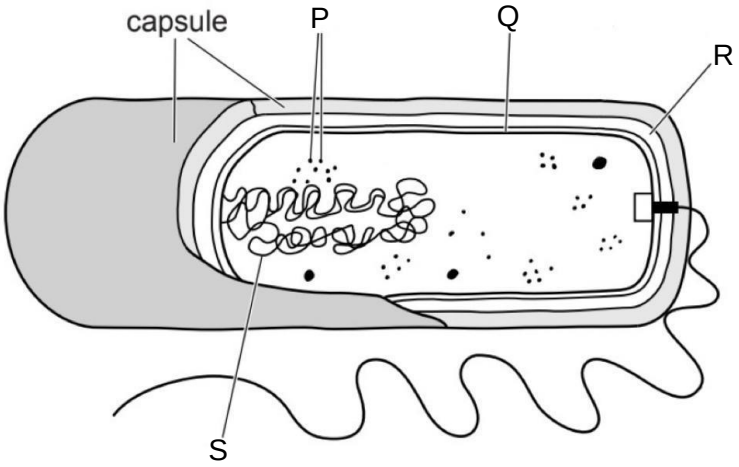
2 Eukaryotic cells and prokaryotic cells both have ribosomes free in the cytoplasm.

3 Human mitochondrial DNA is circular and contains no introns.

4 Chloroplasts divide by binary fission, independently of the plant cell.

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

2 The diagram shows the structure of a bacterium.



Which row correctly identifies the labelled structures?

	P	Q	R	S
A	70S ribosomes	plasma membrane	cellulose cell wall	single-stranded DNA
B	80S ribosomes	plasma membrane	cellulose cell wall	double-stranded DNA
C	70S ribosomes	plasma membrane	peptidoglycan cell wall	double-stranded DNA
D	80S ribosomes	tonoplast	peptidoglycan cell wall	double-stranded DNA

3 Raffinose is a trisaccharide that can be digested by enzymes.

The table shows the results of two different enzymatic incubations.

enzyme used	products
galactosidase	galactose and sucrose
sucrase	melibiose and fructose

Which statements are consistent with the results shown above?

1 Acid hydrolysis of raffinose would yield glucose.

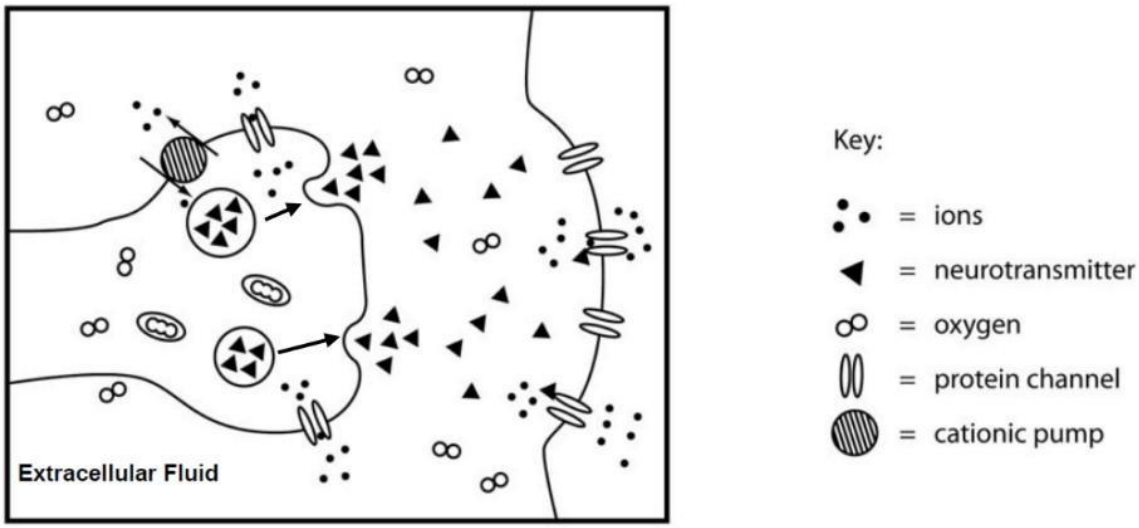
2 Melibiose is a disaccharide.

3 Raffinose is composed of three different monosaccharides.

4 The products of digestion by galactosidase and sucrase will yield a brick red precipitate when heated with Benedict's reagent.

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

4 The diagram shows how various substances are transported across the membranes of two nerve cells at a synapse.



Which statements correctly describe the transport of substances across the membranes?

1 Ions move across the membrane through protein channels via facilitated diffusion.

2 Some ions are actively transported across the membranes by carrier proteins.

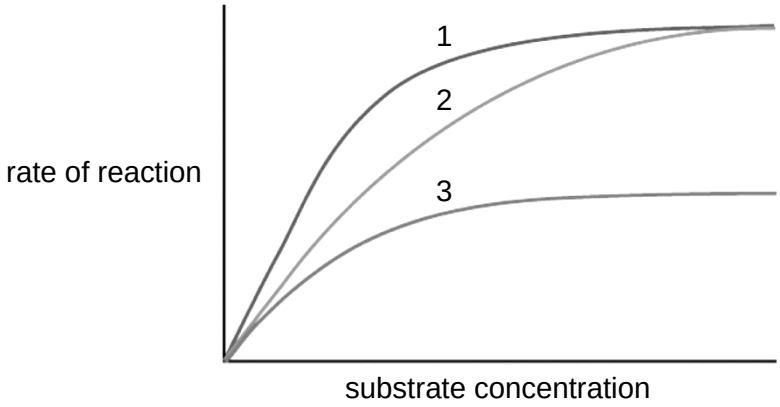
3 Some substances may diffuse readily across the membrane.

4 There are at least two transport mechanisms that require energy expenditure.

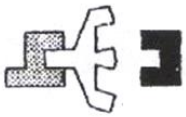
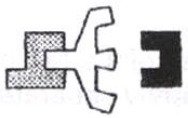
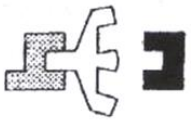
A 1, 2, 3 and 4 **B** 1, 2 and 3 only **C** 2, 3 and 4 only **D** 1 and 2 only

5 The diagram shows the action of an enzyme on a substrate.

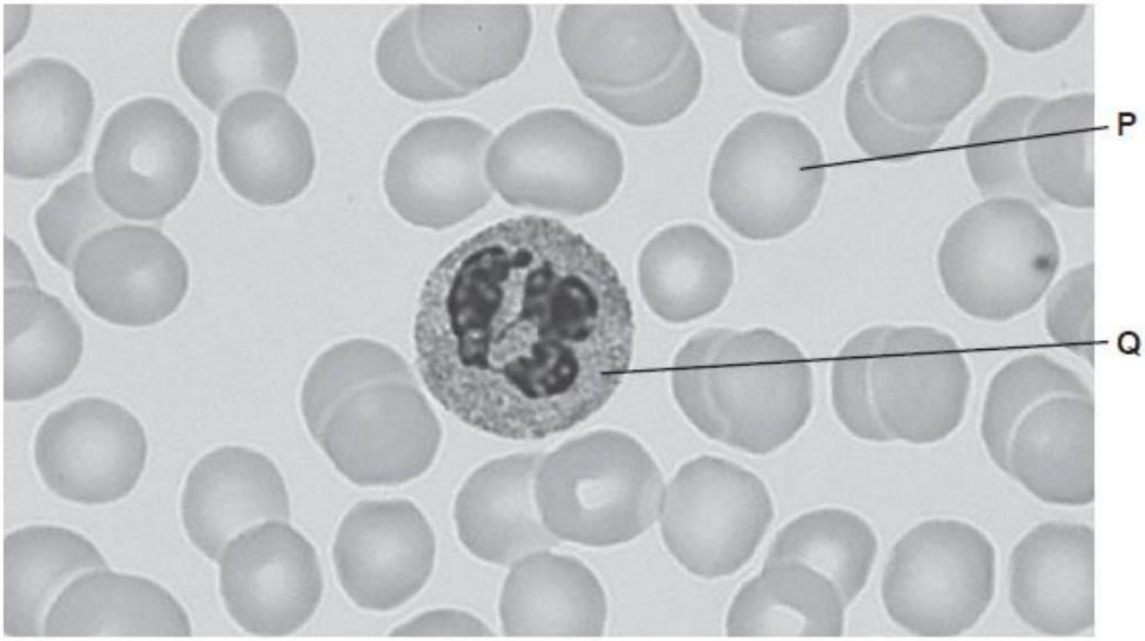
The rates of reaction of this enzyme were studied in the presence and absence of inhibitors. The curves obtained are shown below.



What do the curves show?

	curve 1	curve 2	curve 3
A			
B			
C			
D			

6 The image shows a micrograph of two different types of blood cell.



Both cell types P and Q develop from myeloid stem cells in the bone marrow.

Which statement correctly describes myeloid stem cells?

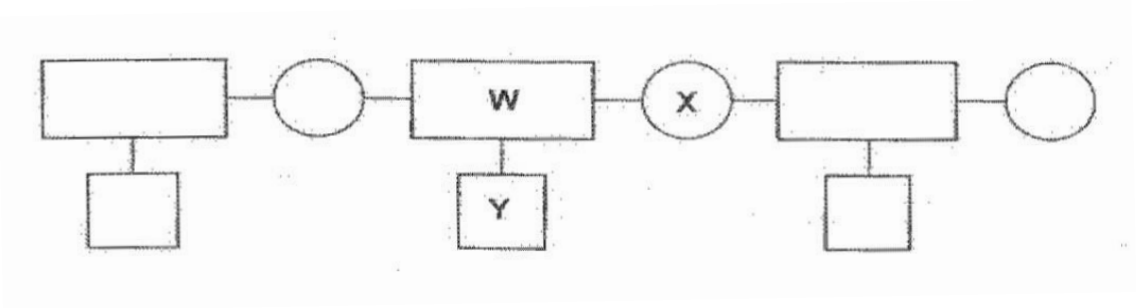
A They are both pluripotent and multipotent.

B They are multipotent but not pluripotent.

C They are neither pluripotent nor multipotent.

D They are pluripotent but not multipotent.

7 The diagram shows an anticodon.



Which row correctly identifies the labelled structures?

	W	X	Y
A	deoxyribose	base	phosphate
B	deoxyribose	phosphate	base
C	ribose	base	phosphate
D	ribose	phosphate	base

8 Edeine is an antibiotic that inhibits protein synthesis but has no effect on either DNA synthesis or RNA synthesis. When added to a translation mixture containing fully intact organelles, edeine stops haemoglobin synthesis after a short period of time.

Analysis of the edeine-inhibited mixture by centrifugation showed that all the mRNA accumulated, together with small ribosomal subunit and initiator tRNA.

What step in protein synthesis does edeine inhibit?

A It blocks the translocation of aminoacyl-tRNA from the A-site to the P-site of the ribosome.

B It inhibits the binding of aminoacyl-tRNA to the A-site in the ribosome.

C It interferes with chain termination and release of peptide.

D It prevents the formation of the translation initiation complex, which contains the initiator tRNA and both large and small ribosomal subunits.

9 A virus has a base ratio of (A + G) / (U + C) = 1.

What type of virus is this?

A a double-stranded DNA virus

B a single-stranded DNA virus

C a double-stranded RNA virus

D a single-stranded RNA virus

10 Human immunodeficiency virus (HIV) is a retrovirus. After infecting a host cell, viral DNA is produced and then incorporated into the DNA of the host cell. The modified host genome now codes for the production of new HIV particles.

Which inhibitor(s) could be used as a potential treatment to slow down the spread of HIV?

1 inhibitor of integrase

2 inhibitor of neuraminidase

3 inhibitor of RNA-dependent DNA polymerase

4 inhibitor of RNA-dependent RNA polymerase

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

11 Which row incorrectly describes a difference between generalised and specialised transduction?

	generalised transduction	specialised transduction
A	Donor DNA is hydrolysed into pieces upon entry of phage genome.	Donor DNA is not hydrolysed immediately into pieces upon entry of phage genome.
B	Phage DNA is not integrated into the host chromosome.	Phage DNA is integrated into the host chromosome.
C	Random donor DNA is transferred.	Specific donor DNA is transferred.
D	Transducing phage contains phage DNA.	Transducing phage does not contain phage DNA.

12 Mutant *Escherichia coli* were grown in a medium without glucose and lactose. It was observed that the *lac* structural genes were expressed efficiently.

Which mutation(s) is/are present in the mutant *E. coli*?

1 a mutation in the *lacI* gene

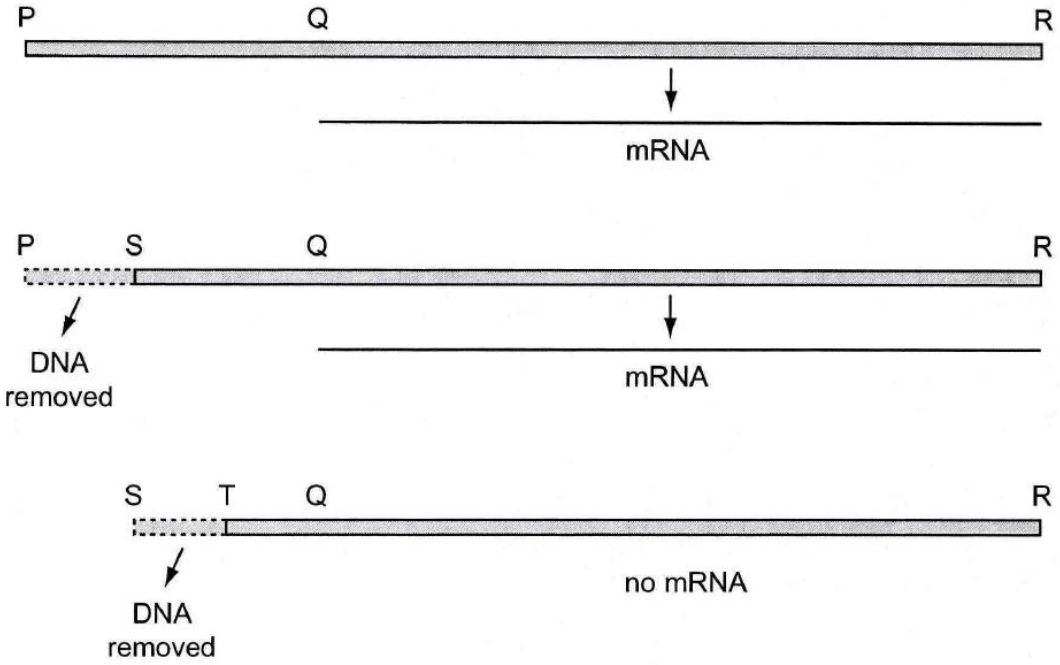
2 a mutation in the *lac* operator

3 a mutation in the *lac* promoter

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

13 A length of DNA contains a non-coding region, PQ and a coding region, QR. The effect of removing parts of the non-coding region on the coding region was investigated.

The diagram shows the results of removing PS and then ST.



Which conclusion may be deduced from these results?

A The removal of any DNA from the non-coding region affects transcription.

B The beginning of the promoter region is between P and S.

C The beginning of the promoter region is between S and T.

D The non-coding region has no role in transcription.

14 Mature mRNA and DNA are extracted from the same cells and mixed in conditions that favour the mRNA and complementary parts of the DNA becoming linked. Some parts of the DNA remain as double stranded DNA. Other parts of the DNA form equal numbers of single stranded DNA loops and double stranded DNA–mRNA loops.

What describes these loops?

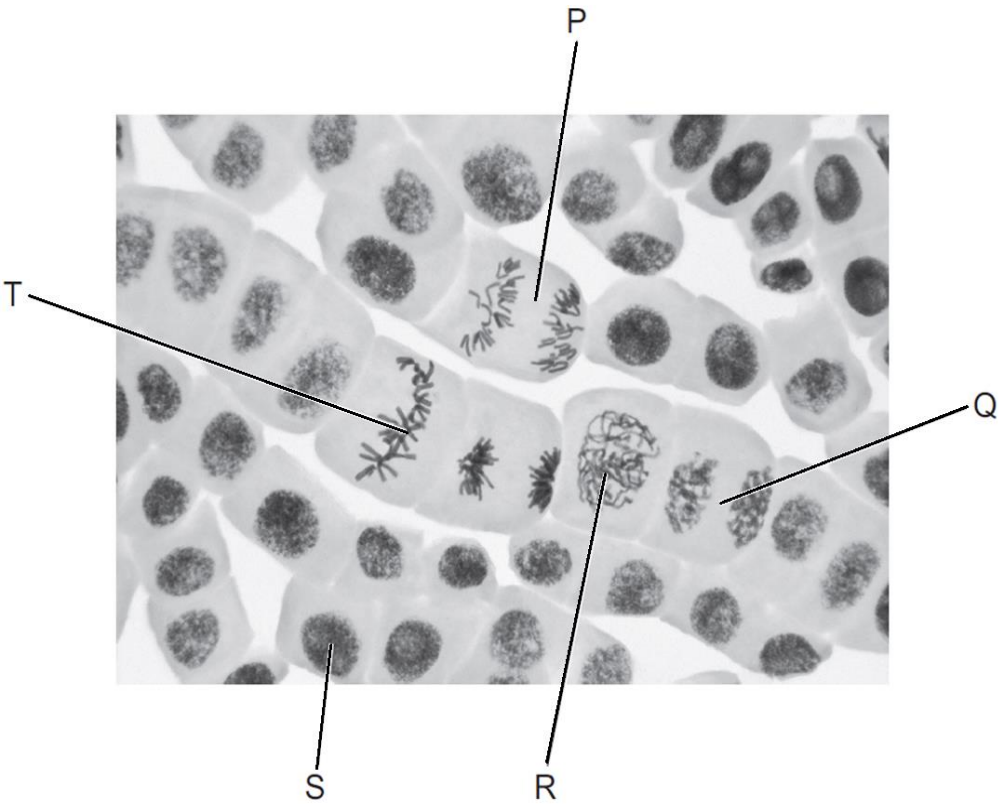
A exons form single stranded loops, introns form double stranded loops

B exons form double stranded loops, introns form single stranded loops

C template exons form double stranded loops, non-template exons form single stranded loops

D template introns form double stranded loops, non-template introns form single stranded loops

15 The photomicrograph shows cells in different stages of mitotic cell cycle.



Which statements are correct?

1 A cell in stage P and a cell in stage T have the same amount of DNA.

2 DNA replication is occurring during stage R.

3 Stage T shows metaphase.

4 The correct order for the stages of mitotic cell cycle is S → R → T → P → Q.

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

16 Klinefelter syndrome is a genetic condition in humans where a male has an extra X chromosome.

It usually happens when non-disjunction occurs during meiosis, forming an abnormal gamete.

At which stages of meiosis in a female or male could non-disjunction occur so that fertilisation of an abnormal gamete with a normal gamete would result in a child that has Klinefelter syndrome?

	female		male	
	meiosis I	meiosis II	meiosis I	meiosis II
A	✓	✓	✓	✗
B	✓	✓	✗	✓
C	✓	✗	✓	✗
D	✗	✓	✗	✓

key

✓ = non-disjunction could occur

✗ = non-disjunction could not occur

17 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.

A–T
A–T
C–G
C–G

Which diagram shows the DNA molecule after a transition has occurred?

A

T–A

B

A–T

C

A–T

D

A–T

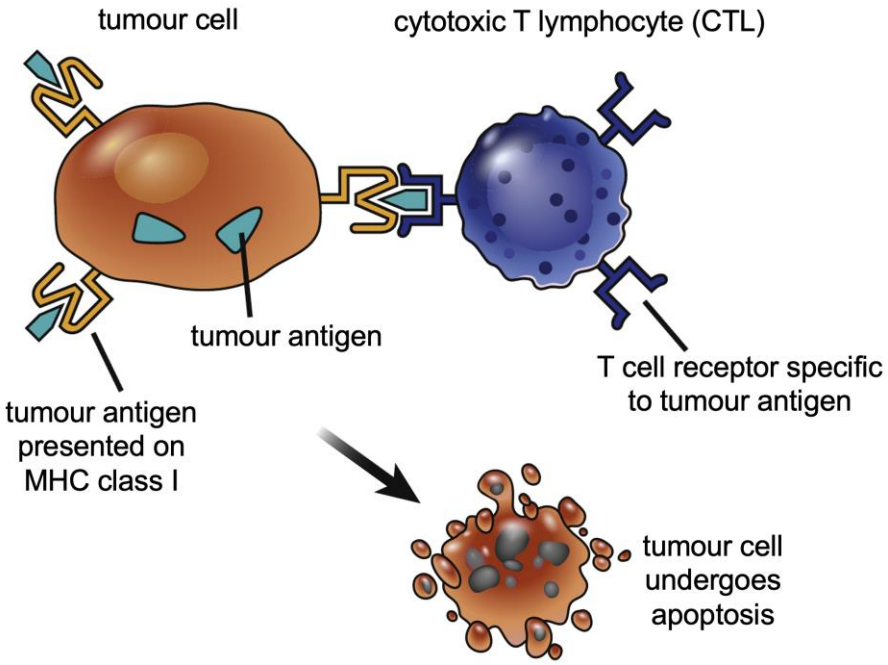
A–T C–G C–G	A–T C–G G–C	A–T T–A C–G	A–T A–T C–G

18 Cytotoxic T lymphocytes (CTLs) play an important role against cancer.

Tumour antigens are proteins that are differentially expressed by tumours but not by normal tissues.

Tumour antigens are presented on MHC class I molecules on tumour cells. CTLs recognise and bind to presented tumour antigens and stimulate tumour cells to undergo apoptosis.

The diagram shows how a CTL kills a tumour cell.



The accumulation of mutations in tumour cells can enable tumour cells to evade immune responses, causing the development of cancer.

Which process(es) can enable tumour cells to evade immune responses?

1 Tumour cells fail to produce tumour antigens.

2 Gain-of-function mutation in MHC class I gene, resulting in tumour cells producing more MHC class I molecules.

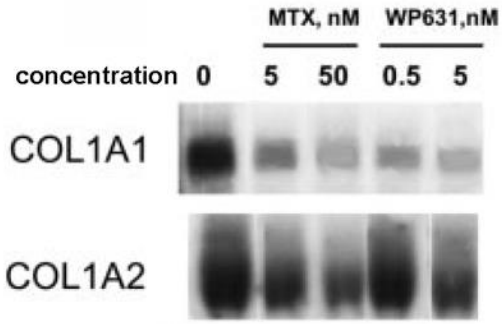
3 Loss-of-function mutation in MHC class I gene, resulting in tumour cells producing no MHC class I molecules.

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

19 Mitoxantrone (MTX) and WP631 are drugs that interact with DNA. In a study, human dermal fibroblasts were treated with different concentrations of these drugs to assess their effects on collagen biosynthesis.

COL1A1 and *COL1A2* genes code for polypeptides that make up type 1 collagen molecules.

The diagram shows the results of gel electrophoretic analysis of *COL1A1* and *COL1A2* mRNA levels at different concentrations of the drugs, compared with 18S ribosomal mRNA gene which is a housekeeping gene.



Which conclusion can be drawn from the data?

A Both MTX and WP631 reduce COL1A1 mRNA levels, but have no effect on COL1A2 mRNA levels.

B Both MTX and WP631 reduce both COL1A1 and COL1A2 mRNA levels to a similar extent.

C WP631 reduces COL1A1 mRNA levels more effectively than MTX.

D WP631 reduces COL1A2 mRNA levels more effectively than MTX.

20 Two genes, Q and R, affect the size and pigmentation of the petals of a flower, respectively.

Gene Q has two alleles, Q^L and Q^A. The genotype Q^L Q^L produces large petals, Q^L Q^A produces small petals and in Q^A Q^A, petals are absent.

Gene R has two alleles. R produces a red pigment and is dominant over the allele r that produces no pigment.

Two plants, both heterozygous for both genes, are crossed.

How many phenotypes are expected in the next generation?

A 4 **B** 5 **C** 6 **D** 9

21 Both the Dexter and Kerry cattle breeds originated in Ireland. The cattle may be polled (hornless) or horned. The Dexter cattle have short legs, whereas the Kerry cattle have long legs. When many offspring were obtained from matings between polled Kerrys and horned Dexters, half were found to be polled Dexters and half polled Kerrys. When these two types of F1 cattle were mated to one another, the following F2 phenotypic ratio was obtained:

- 3/8 polled Dexters
- 3/8 polled Kerrys
- 1/8 horned Dexters
- 1/8 horned Kerrys

A geneticist was puzzled by these data and interviewed farmers who had bred these cattle for decades. She learned that Kerrys were true breeding.

Which statement best explains the genetic basis of these traits?

A Both traits are controlled by a single gene with incomplete dominance.

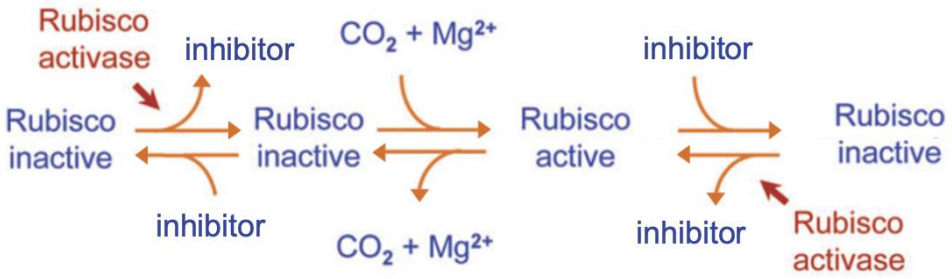
B The polled trait is dominant, and the short-leg trait is caused by a recessive allele.

C The polled trait is dominant, and the short-leg trait is caused by a dominant allele.

D The polled trait and short-leg trait are both controlled by recessive alleles.

22 RuBP carboxylase (Rubisco) is a key enzyme in the Calvin cycle.

The diagram shows the mechanisms involved in the regulation of Rubisco activity.



Which statement incorrectly describes the regulation of Rubisco activity?

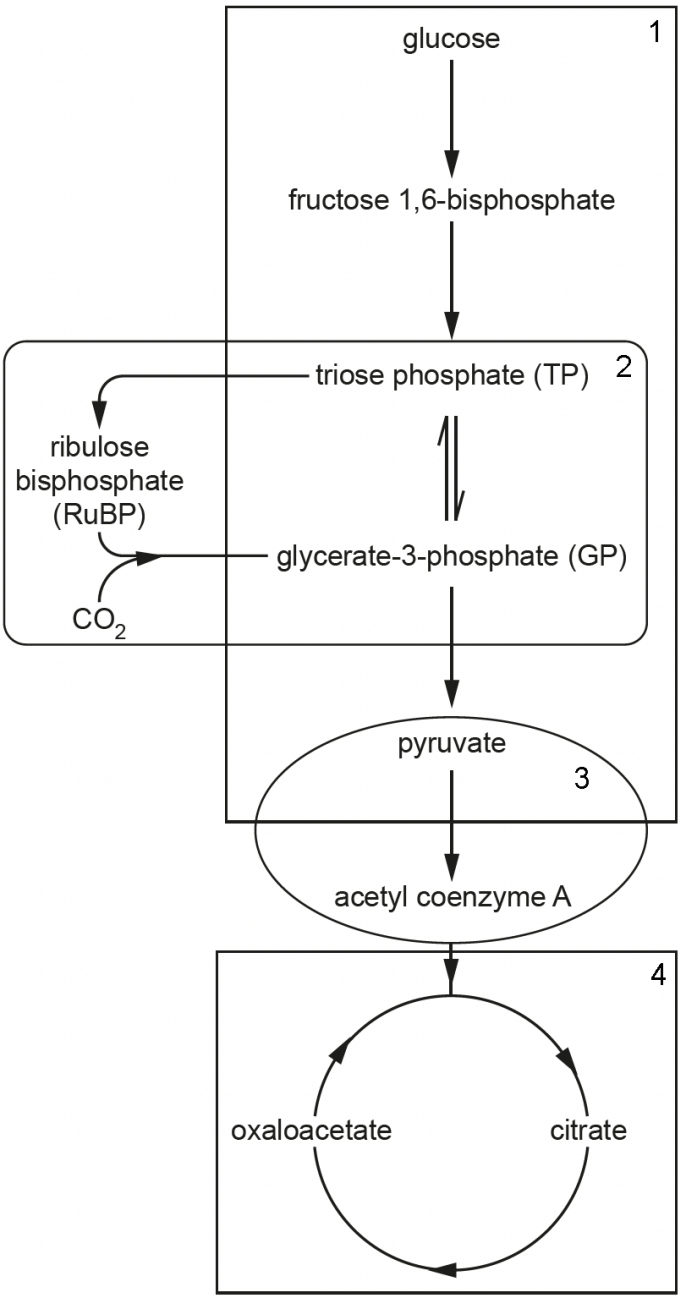
A The binding of inhibitor to Rubisco is reversible.

B The inhibitor can bind to either Rubisco or Rubisco-CO_2-Mg^{2+} complex.

C The rate of carbon fixation decreases when Mg^{2+} dissociates from active Rubisco.

D Rubisco activase is always needed for the activation of Rubisco.

23 The diagram shows some metabolic processes in a plant cell.

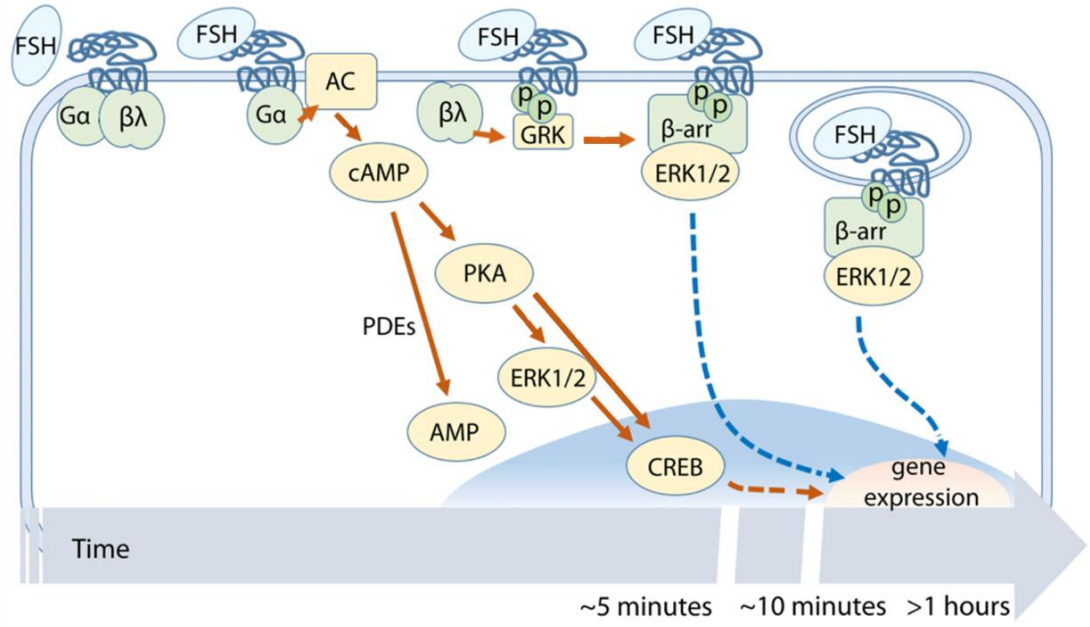


Which row is correct?

	involvement of decarboxylation	production of ATP	involvement of net use of ATP
A	1, 2 and 3	1	1 and 2
B	1, 3 and 4	1 and 4	1 and 2
C	3 and 4	1 and 4	2
D	4	1, 3 and 4	2

24 Follicle-stimulating hormone (FSH) mediates spermatogenesis in males.

The diagram shows the succession of events following the binding of FSH to its receptor. The dotted arrows result in gene expression.



Legend:

AC = adenylyl cyclase	PKA = protein kinase A
AMP = adenosine monophosphate	ERK1/2 = a type of kinase
cAMP = cyclic AMP	GRK = a type of kinase
PDE = phosphodiesterase	CREB = a type of transcription factor
p = phosphate group	β-arr = β-arrestin

Which statement is supported by the information?

A ERK1/2 activation by β-arrestin occurs after FSH binding and leads to the internalisation of FSH receptor complex within 5 minutes.

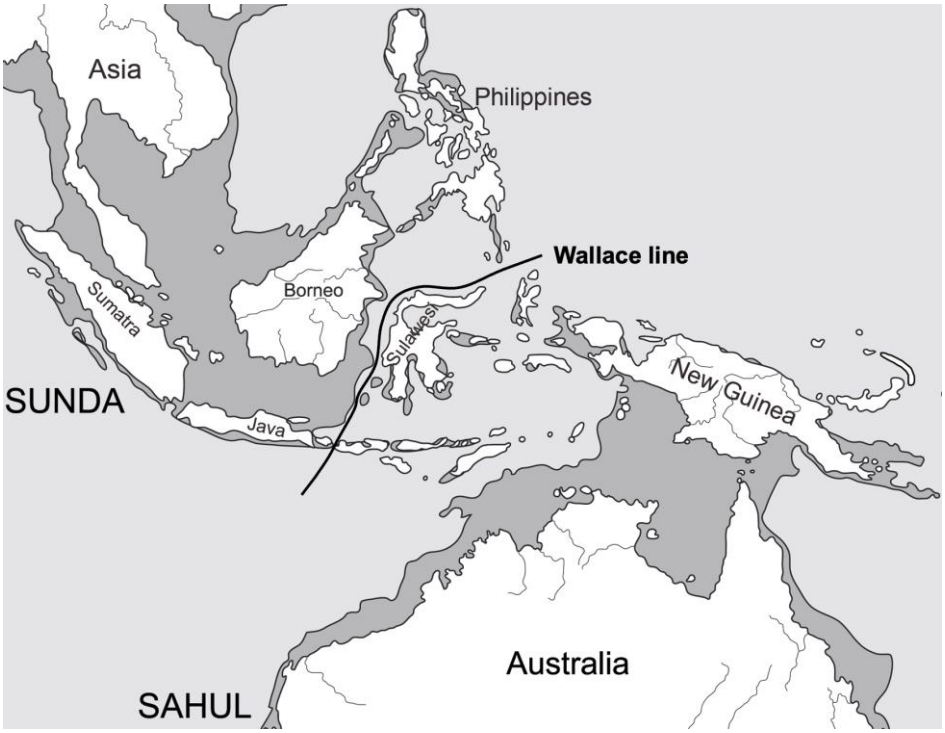
B GRK activation enhances the production of cAMP, which leads to sustained phosphorylation of ERK1/2 and activation of gene expression.

C Increased activity of PDEs can lead to downregulation of cAMP-dependent phosphorylation cascade and decreased gene expression.

D The internalisation of the FSH receptor is the first event after FSH binding, leading to rapid termination of signal transduction.

25 While travelling around the Malay Archipelago, a group of islands between mainland Asia and Australia, Alfred Russel Wallace observed a distinct distribution of fauna and proposed the Wallace line. West of the Wallace line, the fauna is dominated by placental mammals, such as tigers and elephants. In contrast, east of the Wallace line, marsupials like kangaroos and koalas dominate.

The map shows the Malay Archipelago with the Wallace line cutting between Borneo and Sulawesi.



The Malay Archipelago was formed when the Sahul landmass separated from Antarctica about 45 million years ago and moved closer to the Sunda landmass. During the last Ice Age, lowered sea levels caused many islands to become connected, forming larger landmasses. The Sunda landmass linked modern-day mainland Asia with parts of Indonesia west of the Wallace line, while the Sahul landmass connected modern-day Australia and New Guinea, as indicated by the dark grey regions.

Which statement best explains how the Wallace line supports the theory of evolution?

A The Wallace line shows that differences in climate and vegetation resulted in different selection pressures, giving rise to different species with different traits in different regions.

B The Wallace line shows how geographical isolation led to the divergence of ancestral populations into separate evolutionary lineages, resulting in distinct faunas on the two sides of the line, despite the proximity of the islands caused by continental drift.

C The Wallace line shows the evolution of marsupials into placental mammals, which are better adapted to their environments due to their more advanced reproductive strategies, including more developed fetuses and reduced need for parental care after birth.

D The Wallace line does not support the theory of evolution because no transitional mammalian fossils with shared traits between placental mammals and marsupials have been found to bridge the gap between species on either side.

26 What is the most likely explanation for the absence of speciation in modern man?

A Travelling prevents establishment of completely isolated populations.

B Absence of genetic mutations results in the lack of genetic variation in populations.

C Rapid environmental changes result in different selection pressures experienced by isolated populations.

D Distinctly different behavioural and cultural patterns severely limit gene flow between racial groups.

27 Which statement correctly explains the cause of coral bleaching?

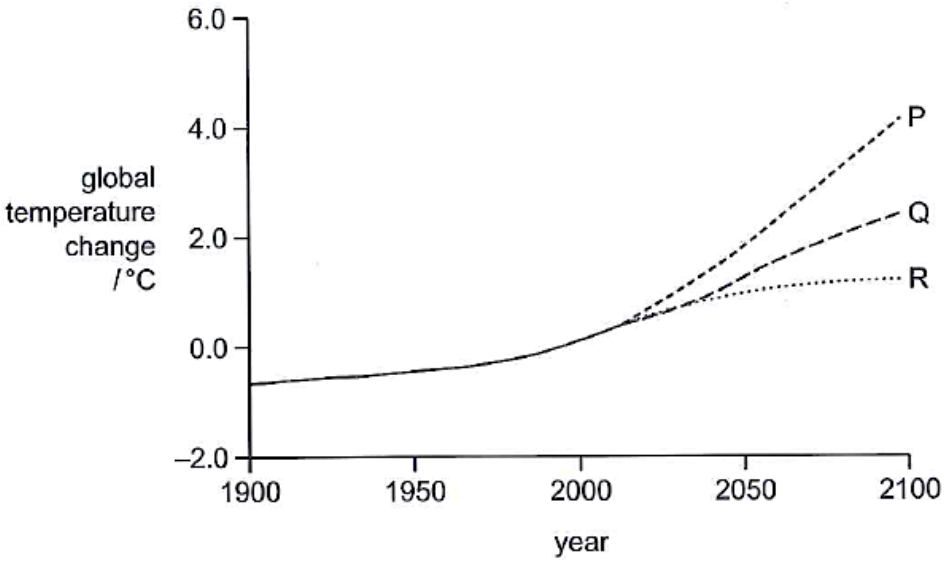
A Expulsion of zooxanthellae due to increased water temperatures results in coral bleaching.

B Exposure to too much physical disturbance, such as strong currents or wave action, results in coral bleaching.

C Ocean acidification reduces calcium carbonate available for corals to build their skeletons, resulting in coral bleaching.

D Insufficient sunlight for photosynthesis in corals results in coral bleaching.

28 The graph shows the global temperature change based on three different climate models, P, Q and R. Model Q predicts global temperature change by assuming that no new factors act to influence the rate of climate change. Models P and R predict global temperature change by assuming different factors act to influence the rate of climate change.



The following statements describe factors used in the construction of models P and R.

1 An increased global temperature and reduced rainfall will lead to an increase in forest fires.

2 Permanently frozen soil and sediment in the Arctic will begin to thaw as global temperatures increase.

3 Rising sea temperatures will cause increased growth of photosynthetic algae.

4 Rising sea temperatures will reduce the solubility of greenhouse gases in the oceans.

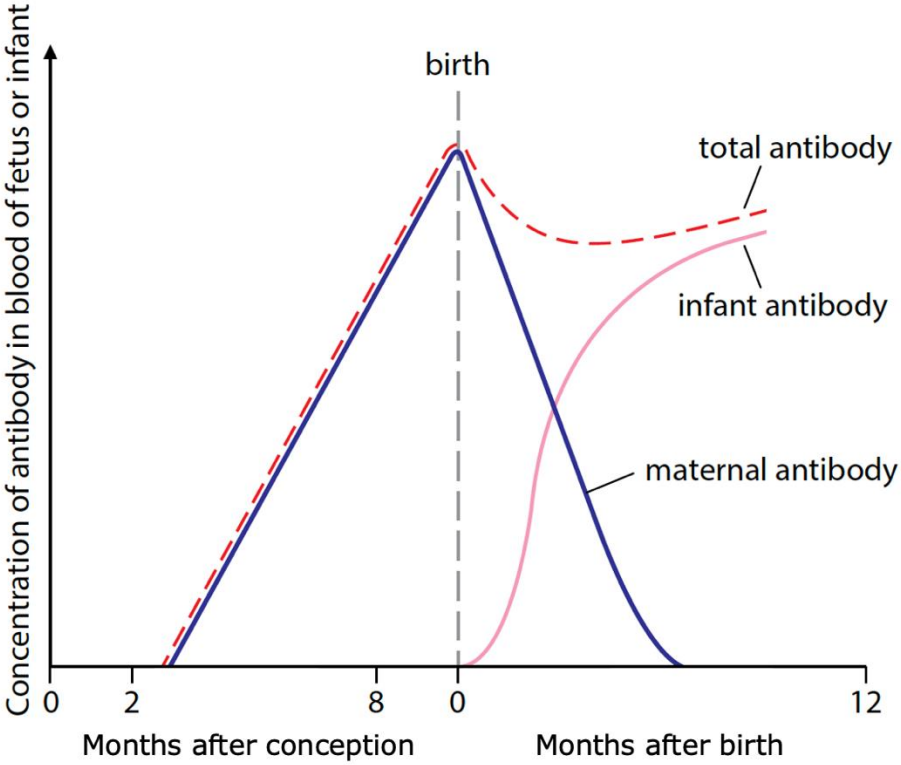
Which of these statements account(s) for models P and R?

	model P	model R
A	1, 2 and 4	3
B	1 and 3	2 and 4
C	2	1, 3 and 4
D	3 and 4	2 and 4

29 Which row correctly shows the roles of cells in the immune system?

	neutrophils	dendritic cells	T lymphocytes	B lymphocytes
A	production of histamines	phagocytosis	production of cytokines	production of antibodies
B	production of cytokines	antigen presentation	production of antibodies	phagocytosis
C	production of cytokines	phagocytosis	production of granzymes	antigen presentation
D	antigen presentation	production of granzymes	production of cytokines	phagocytosis

30 The graph shows the changes in the concentration of different types of antibodies in blood of fetus or infant from after conception to a few months after birth.



Measles vaccine is typically given to infants who are about 12 months old.

Based on the graph, which statement explains why the measles vaccine is typically not administered during the first few months of a child's life?

A The infant's immune system is unable to produce any antibodies in response to the vaccine.

B The infant's blood contains high levels of maternal antibodies specific to measles virus, hence the vaccine can be neutralised, reducing its effectiveness.

C The measles virus is not harmful to infants under six months old.

D Early vaccination can overstimulate the infant's immune system, leading to autoimmune diseases.