# RIVER VALLEY HIGH SCHOOL
# YEAR 6
# PRELIMINARY EXAMINATION

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | | | |
| CENTRE NUMBER | S | | | | | CLASS | | INDEX NUMBER | | | |

**H2 BIOLOGY** **9744/01**

Paper 1 Multiple Choice **19 Sep 2018**

**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, Centre number, index number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

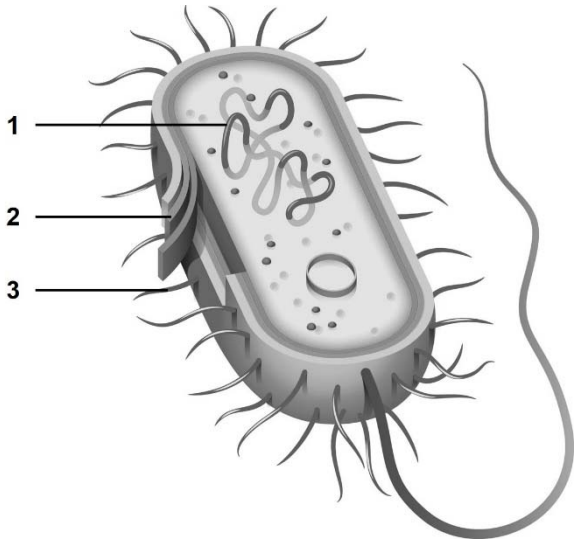
There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C**, and **D**.
Choose the one you consider correct and record your choice **in soft pencil** on the separate Answer Sheet.

**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.

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

**1** The diagram shows a typical unicellular prokaryote.




Which row correctly describes the labelled structures?

| | 1 | 2 | 3 |
|---|---|---|---|
| **A** | chromatin | cell surface membrane | pilus |
| **B** | chromosome | cell wall | flagellum |
| **C** | chromosome | cell wall | pilus |
| **D** | plasmid | cell surface membrane | flagellum |

**2** Which of the following correctly describes the process of exocytosis?

1 The secretory vesicle diffuses from the *trans* face of the Golgi apparatus towards the cell surface membrane.

2 Secretory vesicles tend to contain small molecules that cannot pass through the hydrophobic core of the membrane.

3 The membrane of the secretory vesicle fuses with the cell surface membrane, releasing the molecules into the extracellular fluid.

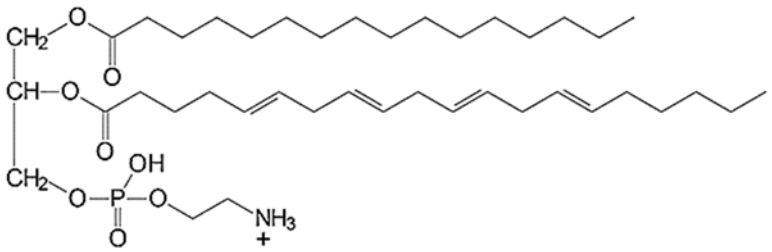
**A** 3 only

**B** 1 and 3 only

**C** 1 and 2 only

**D** All of the above

**3** The structure of phosphatidylcholine, a common membrane phospholipid, is shown.



Which combination correctly describes the synthesis, structure and property of one molecule of phosphatidylcholine?

| | number of water molecules eliminated during synthesis | number of ester bonds | property |
|---|---|---|---|
| **A** | 3 | 3 | amphipathic |
| **B** | 2 | 2 | amphipathic |
| **C** | 2 | 2 | amphoteric |
| **D** | 3 | 3 | amphoteric |

**4** The following statements describe the four levels of organisation of the structure of haemoglobin.

How many of the following statement(s) is true?

1 In primary structure, α and β subunits consist of any number of amino acids joined in a specific sequence by peptide bonds.

2 In secondary structure, the α-helices in each subunit are a result of hydrogen bonding between C=O and N-H groups of regions of the polypeptide backbone that are far apart.

3 In tertiary structure, R group interactions between amino acids allow hydrophilic amino acids to be clustered in the interior of the protein.

4 In quaternary structure, R group interactions between amino acids of different subunits allow for the molecule to exhibit cooperative binding.

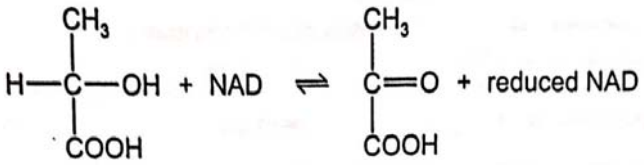
**A** 1

**B** 2

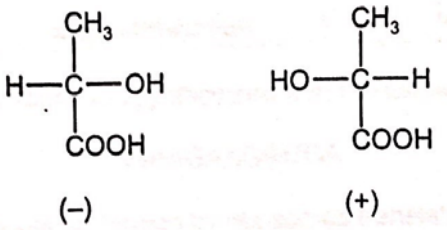
**C** 3

**D** 4

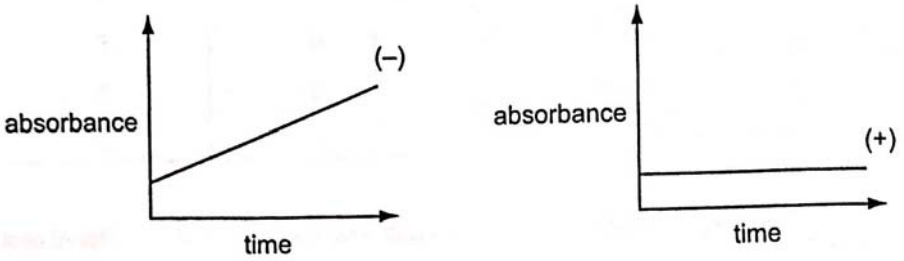
**5** Lactic dehydrogenase catalyses the conversion of lactic acid to pyruvic acid as shown in the following equation.




Two isomers of lactic acid, (-) and (+), are shown below.




Reduced NAD absorbs ultraviolet light but NAD does not. The activity of bacterial lactic dehydrogenases on the two different isomers of lactic acid was compared. The absorbance of ultraviolet light was measured using an ultraviolet spectrophotometer. The graphs show the results.




What can be concluded about bacterial lactic acid dehydrogenases?

**A** The enzyme is specific to the (-) isomer.

**B** The enzyme is specific to the (+) isomer.

**C** Both isomers fit the active site.

**D** Neither isomer fit the active site.

**6** Both bacterium *Streptococcus salivarius* and fungus *Aspergillus niger* produce enzymes which digest complex sugars. The enzyme produced by *A. niger* has a higher molecular weight and is encoded by a different gene.

How can these enzymes digest the same complex sugars in the same way?

**A** Both enzymes have the same primary structures.

**B** Both enzymes have the same tertiary structures.

**C** The enzyme-substrate complexes formed by both enzymes are identical.

**D** The amino acids forming the active site are the same in both enzymes.

**7** Blood transfusion laboratories around the world are hoping to produce large numbers of red blood cells (RBCs) from 'spare' human embryos produced during *in vitro* fertilisation procedures.

Embryonic stem cells are removed from an embryo and cultured in a growth medium that stimulates their differentiation into RBCs.

Which statement correctly describes this differentiation?

**A** Multipotent embryonic stem cells differentiate into pluripotent blood stem cells and then into RBCs.

**B** Pluripotent embryonic stem cells differentiate into multipotent blood stem cells and then into RBCs.

**C** Totipotent embryonic stem cells differentiate into multipotent blood stem cells and then into RBCs.

**D** Totipotent embryonic stem cells differentiate into pluripotent blood stem cells and then into RBCs.

**8** An unknown organism has a linear double-stranded DNA genome like that in a eukaryote. When its DNA replication was examined, it was revealed that although the process is semi-conservative, no Okazaki fragments were observed in the multiple replication forks. In addition, the end-replication problem of shortened daughter strands was not observed.

Which statement correctly explains this phenomenon?

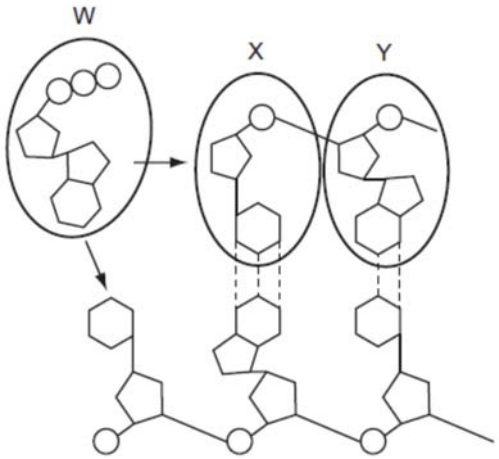
**A** The organism's DNA is antiparallel.

**B** DNA replication only starts at the 3' end of each template strand.

**C** DNA polymerases synthesise DNA in both 5' to 3' and 3' to 5' direction.

**D** DNA ligases are not involved in the DNA replication process.

**9** The diagram shows the synthesis of a polynucleotide. **W** is a nucleoside triphosphate and the arrows indicate the location where **W** form bonds with the polynucleotide.




Which statements are correct?

1 The base in **W** could be the purine, adenine.

2 The base in **Y** is the purine guanine.

3 The base in **X** is the pyrimidine, cytosine

4 The base in **X** could be the pyrimidine, uracil

**A** 1 and 3

**B** 2 and 3

**C** 2 and 4

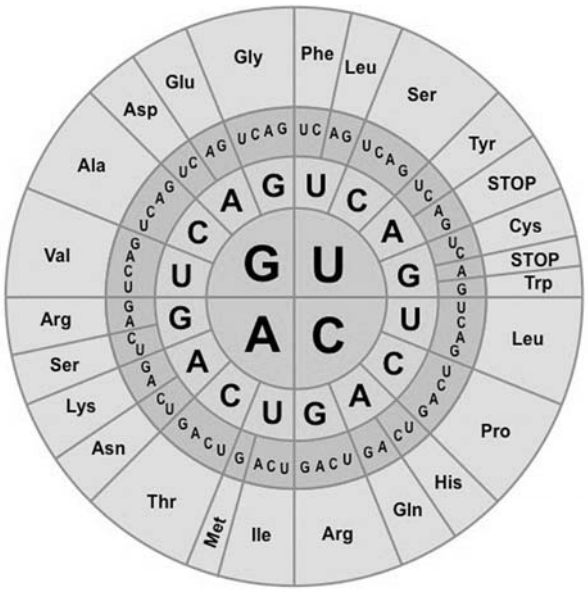
**D** All of the above

**10** A segment of a polypeptide chain, Arg – Gly – Leu – Phe – Val – Leu – Arg, is encoded by the following segment of DNA:

strand 1 3' G G C A T T C T G C T T A T C T G G G G A 5'

strand 2 5' C C G T A A G A C G A A T A G A C C C C T 3'

The genetic code (read from inside out) is given below.




Which of the following correctly identifies the template strand and mRNA codon?

| | template strand | mRNA codon coding for amino acid Leu |
|---|---|---|
| **A** | strand 1 | UUA |
| **B** | strand 1 | AUU |
| **C** | strand 2 | AUC |
| **D** | strand 2 | CUA |

**11** Which of the following are features of a eukaryotic genome?

1 multiple genes are under the control of the same regulatory sequence

2 many genes are interrupted by non-coding sequences

3 presence of multiple control elements for controlling gene expression

4 supercoiling in most regions to further compact the DNA molecule

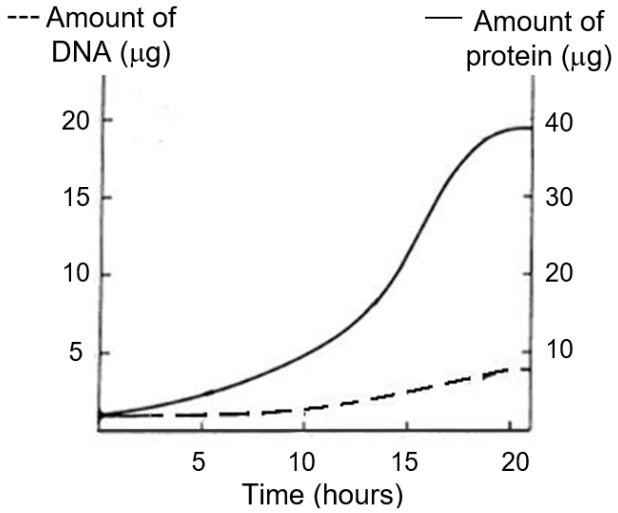
**A** 1 and 4

**B** 1 and 3

**C** 2 and 3

**D** 2 and 4

**12** The following graph shows the average amount of DNA and eggshell proteins present in germ cells of *Drosophila* flies that are actively producing eggs.




Which of the following could explain the graph?

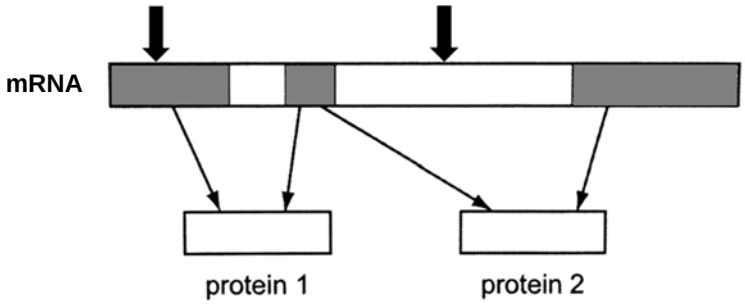
**A** The activity of eukaryotic initiation factor has increased, increasing the rate of transcription.

**B** Gene amplification has occurred, increasing the number of genes coding for eggshell proteins.

**C** DNA replication has occurred during meiosis, increasing the DNA templates available for transcription.

**D** Crossing over has occurred, translocating the genes coding for eggshell proteins to be under the control of an active promoter.

**13** The diagram shows alternative splicing, in which the same mRNA can be translated to give two different proteins.




If a base-pair addition occurred at the DNA corresponding to the two sites indicated by arrows, what is the likely result on proteins 1 and 2?

| | protein 1 | protein 2 |
|---|---|---|
| **A** | functional | functional |
| **B** | functional | non-functional |
| **C** | non-functional | functional |
| **D** | non-functional | non-functional |

**14** The following shows a target sequence of interest.

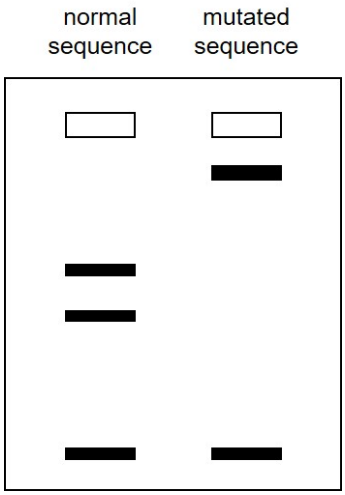
5’ CGA GCT TTT ATA GAT TAT AGG CCT AAC AGA CTA 3’

3’ GCT CGA AAA TAT CTA ATA TCC GGA TTG TCT GAT 5’

The sequence can be digested by two different restriction enzymes. The sequences recognised by the restriction enzymes and points of action (indicated by *) are shown.

| | |
|---|---|
| *Alu*I | 5’ … A G * C T … 3’ |
| | 3’ … T C * G A … 5’ |
| *Hae*III | 5’ … G G * C C … 3’ |
| | 3’ … C C * G G … 5’ |

A sample of the target sequence was digested with both restriction enzymes. The restriction fragments were then subject to gel electrophoresis. The same procedure was performed for a mutated target sequence.




Which of the following shows the mutation in the mutated target sequence?

| | restriction site | type of mutation |
|---|---|---|
| **A** | *Alu*I | base-pair substitution |
| **B** | *Alu*I | inversion of restriction sequence |
| **C** | *Hae*III | base-pair substitution |
| **D** | *Hae*III | inversion of restriction sequence |

**15** Yeast cells without a *cdc25* gene cannot divide. This gene is active throughout the cell cycle, steadily building up the concentration of a protein, p80cdc25. This protein activates a kinase which regulates other proteins involved in cell division, but does not seem to affect other cell processes. When the p80cdc25 protein reaches a critical concentration, mitosis starts.

Which changes will be seen if p80cdc25 is produced at a faster rate than usual?

1 faster cell cycle

2 slower cell cycle

3 smaller cells

4 larger cells

**A** 1 and 3

**B** 1 and 4

**C** 2 and 3

**D** 2 and 4

**16** In 2009, the H1N1 influenza outbreak caused nearly 15 000 deaths worldwide. The highly virulent virus was formed by antigenic shift.

Which of the following is most likely to have resulted in antigenic shift?

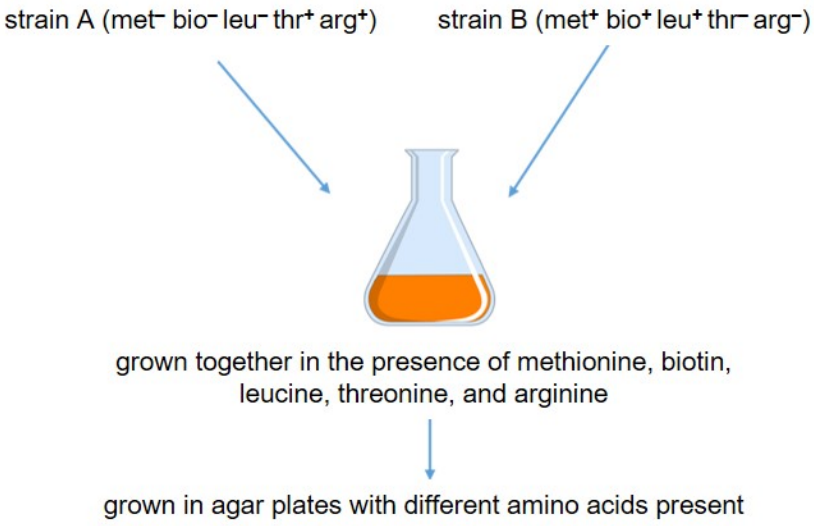
**A** Chance mutations occurring in a strain of influenza, giving rise to novel haemagglutinin proteins.

**B** Recombination of viral genes within a host cell during infection.

**C** Simultaneous infection of a cell by two or more strains of influenza.

**D** High error rate in influenza RNA-dependent RNA polymerase resulting in new strains upon viral reproduction.

**17** In order for bacteria to survive and replicate, they need essential amino acids including methionine (met), biotin (bio), leucine (leu), threonine (thr) and arginine (arg). Bacteria either have the genes required for the synthesis of the amino acid (indicated by "+") or do not have the genes (indicated by "–"), thus have to take up the amino acids from the culture medium. The figure below shows an investigation to study gene transfer between two strains of bacteria.




The results of the investigation are summarised in the table below.

| amino acid present in agar plate | | | | | presence of bacteria colonies |
|---|---|---|---|---|---|
| methionine | biotin | leucine | threonine | arginine | |
| X | ✓ | ✓ | ✓ | ✓ | yes |
| X | X | ✓ | ✓ | ✓ | yes |
| X | ✓ | X | X | ✓ | yes |
| X | X | X | ✓ | ✓ | yes |
| X | ✓ | ✓ | ✓ | X | yes |
| X | X | X | X | X | yes |

Which of the following process(es) could explain the above results?

1 Conjugation

2 Transduction

3 Transformation

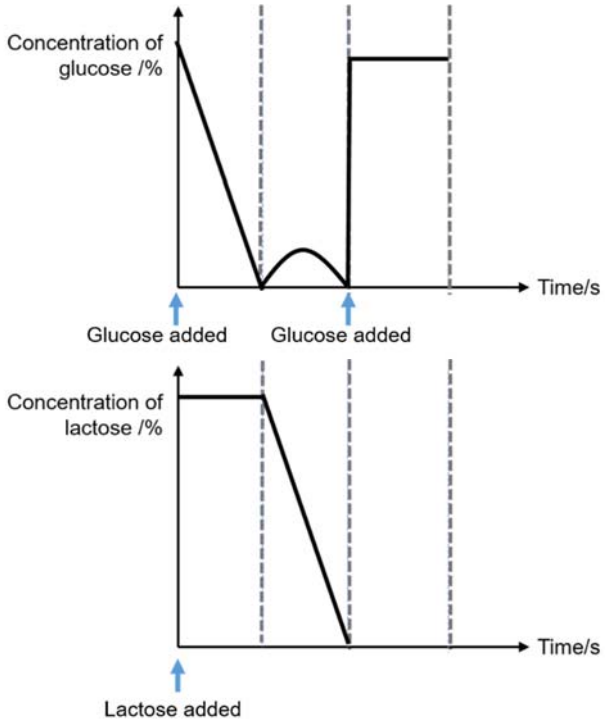
**A** 3 only

**B** 1 and 2

**C** 1 and 3

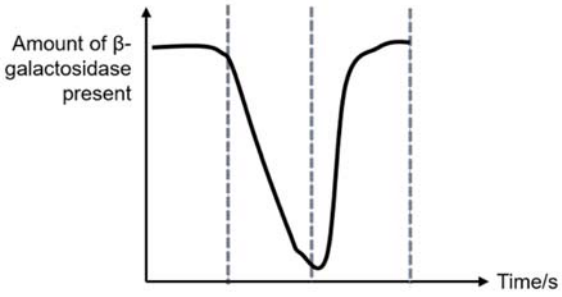
**D** 1, 2 and 3

**18** *Escherichia coli* are able to metabolise both glucose and lactose for their energy requirement. In an experiment, researchers added glucose and lactose into the *E. coli* culture at different time points and measured the β-galactosidase, glucose and lactose levels at regular time intervals. The arrows in the diagram indicate the addition of the respective metabolite into the culture.

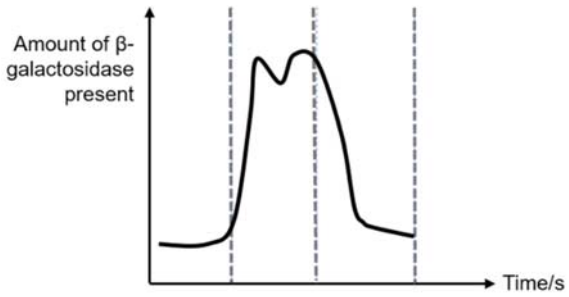



Which graph correctly shows the corresponding amount of β-galactosidase present in the culture?

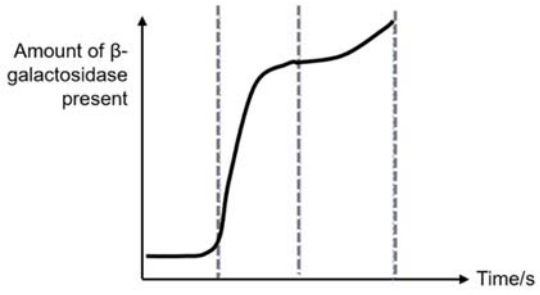
**A**



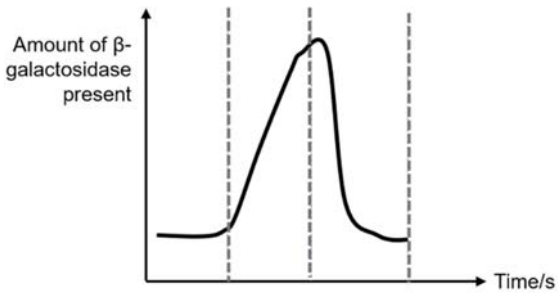

**B**




**C**



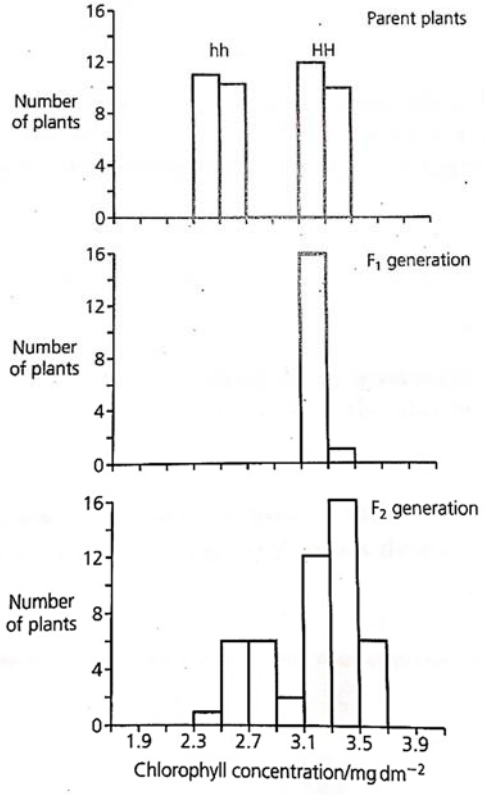

**D**



**19** In wheat, the flag-leaf is the last leaf to be produced. The concentration of chlorophyll in the flag-leaf is controlled by a single gene. The allele for high chlorophyll concentration, **H**, is dominant to that for low chlorophyll concentration, **h**.

Pure breeding wheat with genotypes **HH** and **hh** were crossed to produce an F1 generation. The plants were then interbred to produce an F2 generation.

The chlorophyll concentration of flag-leaves in each generation were analysed and the results are shown below.




A student made four deductions based on information presented above.

1 Chlorophyll concentration in plants exhibits discontinuous variation as it is controlled by a single pair of alleles.

2 The large number of plants with high chlorophyll concentration in the F1 generation shows that the allele **H** is the dominant allele.

3 The genotype for the 16 F1 plants is all **HH** as they have the same chlorophyll concentration as parent plants with **HH** genotype.

4 The chlorophyll concentration in plants is affected by sunlight availability.

How many of the above statements are supported by the results?

**A** 0

**B** 1

**C** 2

**D** 3

**20** Length of legs, stripes on body, eye colour and roughness of body of *Drosophila* were investigated to determine the linkage of genes controlling these characteristics.

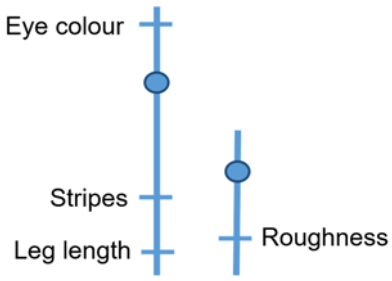
Pure-breeding parents were crossed to produce heterozygous F1. Subsequently, a test cross was conducted on the F1 *Drosophila* to determine the relative distance between different pairs of genes.

The results of the test crosses are summarised in the table below.

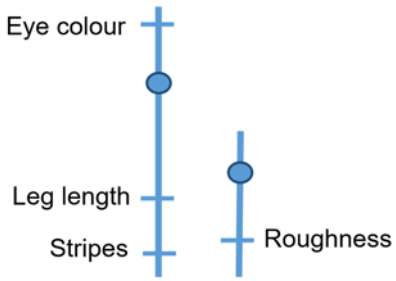
| parent | | offspring | | | |
|---|---|---|---|---|---|
| F1 individual | test cross individual | | | | |
| long legs, striped body | short leg, plain body | 130 long legs, striped body | 122 short legs, plain body | 24 short legs, striped body | 24 long legs, plain body |
| long legs, red eye | short legs, white eye | 79 long legs, red eye | 82 short legs, white eye | 55 long legs, white eye | 50 short legs, red eye |
| striped, rough body | plain, smooth body | 77 striped, rough body | 71 plain, smooth body | 75 striped, smooth body | 71 plain, rough body |
| striped body, red eye | plain body, white eye | 113 plain body, white eye | 112 striped body, red eye | 31 striped body, white eye | 36 plain body, red eye |

Which of the following correctly shows the relative position of the four genes controlling the investigated characteristics?

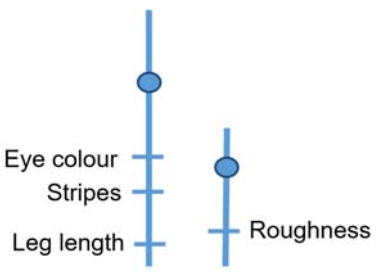
**A**




**B**




**C**




**D**

**21** In a species of mammal, the inheritance of skin colour is controlled by three pairs of alleles, **A**/**a**, **B**/**b** and **C**/**c**, which are inherited independently.

Alleles **A**, **B** and **C** code for the production of roughly the same degree of pigmentation. If skin colour is proportional to the sum of the dominant alleles present, how many classes of skin colour would be expected from a mating between two individuals that are heterozygous at all three loci?

**A** 3

**B** 6

**C** 7

**D** 9

**22** A yellow seed, green-stemmed plant with the genotype **YYrr** was crossed with a white seed, red-stemmed plant with the genotype **yyRR**. The F1 plants were allowed to self-fertilise. A chi-squared test was carried out on the results obtained for the F2 generation.

Part of the table of chi-squared values is shown.

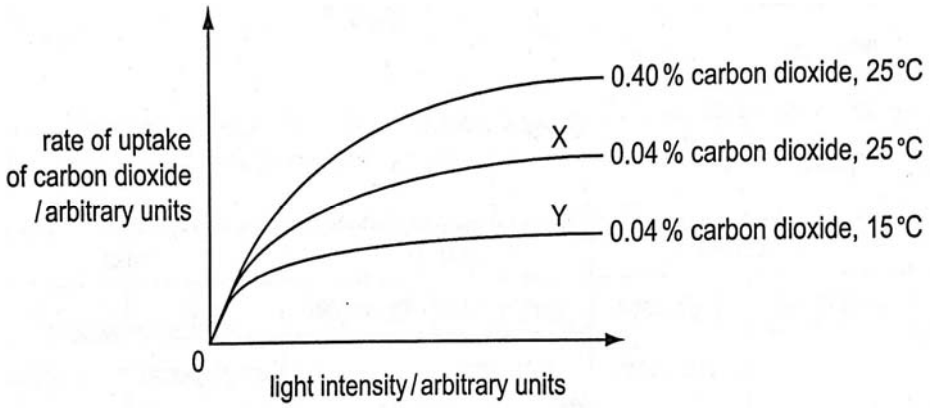
| degrees of freedom | p = 0.5 | p = 0.1 | p = 0.05 | p = 0.01 | p = 0.001 |
|---|---|---|---|---|---|
| 1 | 0.46 | 2.71 | 3.84 | 6.64 | 10.83 |
| 2 | 1.39 | 4.6 | 5.99 | 9.21 | 13.82 |
| 3 | 2.37 | 6.25 | 7.82 | 11.34 | 16.27 |
| 4 | 3.37 | 7.78 | 9.49 | 13.28 | 18.46 |
| 5 | 4.35 | 9.24 | 11.07 | 15.09 | 20.52 |

The chi-squared value in this investigation is 10.6.

What is the p-value and does the results fit the expected ratio?

| | p-value | results fit expected ratio |
|---|---|---|
| **A** | between 0.01 and 0.05 | no |
| **B** | between 0.01 and 0.05 | yes |
| **C** | between 0.05 and 0.1 | yes |
| **D** | between 0.1 and 0.5 | no |

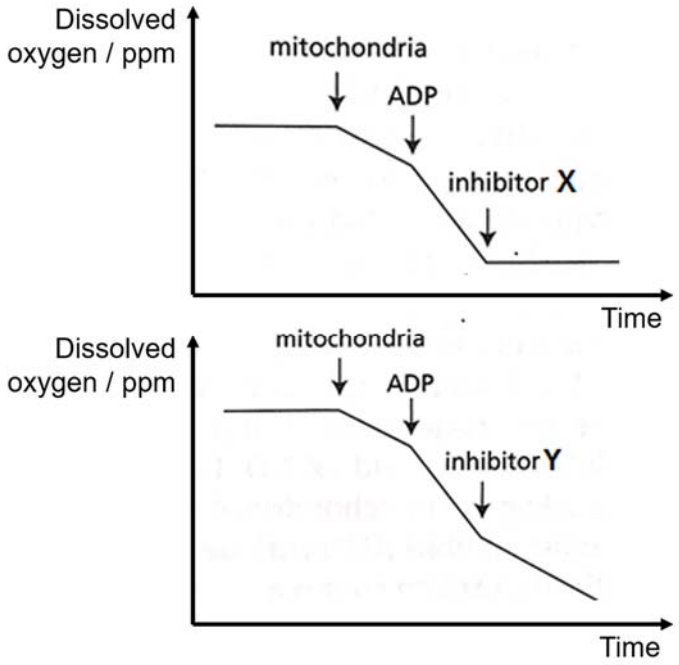
**23** The graph shows the rate of uptake of carbon dioxide by a photosynthetic plant in different conditions.




Based on the graph, which processes limit the rate of uptake of carbon dioxide?

| | X | Y |
|---|---|---|
| **A** | light dependent reaction | light dependent reaction |
| **B** | light dependent reaction | light independent reaction |
| **C** | light independent reaction | light dependent reaction |
| **D** | light independent reaction | light independent reaction |

**24** In an investigation analysing mitochondria function, different inhibitors were introduced and the change in dissolved oxygen levels were recorded. In all the experiments, mitochondria was added to a buffer solution containing respiratory substrates. After a short interval, ADP was added, followed by inhibitor **X** or **Y**.

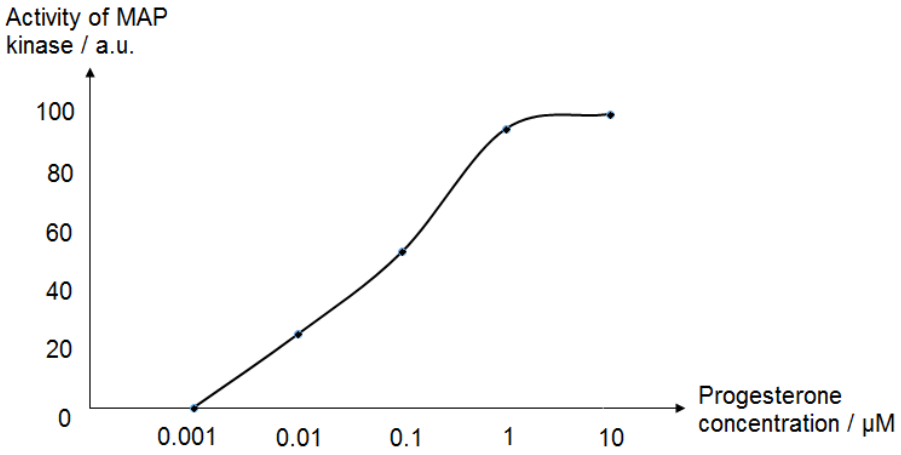



Which of the following correctly explains how the addition of ADP, inhibitor **X** and inhibitor **Y** affect the levels of dissolved oxygen?

| | ADP | inhibitor **X** | inhibitor **Y** |
|---|---|---|---|
| **A** | Increase substrate concentration of ATP synthase | Increase inner mitochondria membrane permeability | End product inhibition of ATP synthase |
| **B** | Increase substrate concentration of ATP synthase | Increase inner mitochondria membrane permeability | Inhibits cytochrome complex of electron transport chain |
| **C** | Increase substrate concentration of ATP synthase | Inhibits cytochrome complex of electron transport chain | Inhibits ATP synthase |
| **D** | End product inhibition of ATP synthase | Inhibits ATP synthase | Inhibits cytochrome complex of electron transport chain |

**25** Maturation of frog oocytes (fertilised eggs) results from a series of cell signalling events triggered by the hormone progesterone. Progesterone directly stimulates the translation of mRNA encoding Mos, a protein that sets off a downstream signalling cascade. This cascade leads to the activation of an enzyme called MAP kinase. MAP kinase directly stimulates oocyte maturation.

In an investigation, 16 frog oocytes were treated with six different concentrations of progesterone. The activity of MAP kinase was measured by the proportion of oocytes that have matured. The results are shown in the graph.




Which of the following cannot be concluded from the information above?

1 Progesterone is a lipid-soluble hormone.

2 55 oocytes would have matured in the set-up with 0.1 μM progesterone.

3 The maturation of frog oocytes is activated by phosphorylation.

4 The rate of oocyte maturation is highest at 0.5 μM progesterone.

5 Mos is a second messenger.

6 Signal transduction for maturation of frog oocyte is multistep.

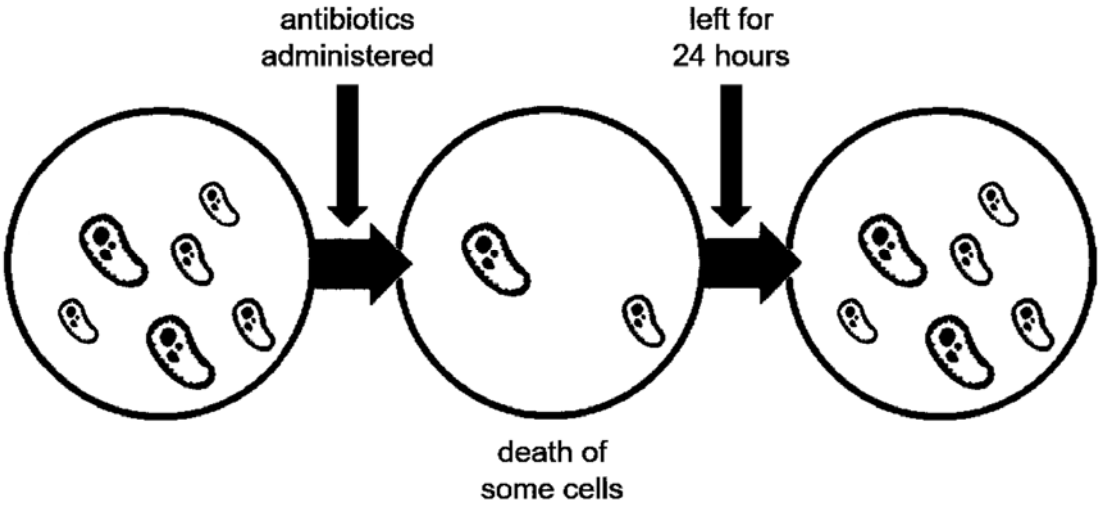
**A** 2 and 4 only

**B** 1, 3 and 6 only

**C** 2, 4 and 5 only

**D** 3, 5 and 6 only

**26** The diagram shows the administration of antibiotics to a culture of different bacteria strains.




Which of the following can be observed?

1 sympatric speciation

2 antibiotics resulting in a bottleneck event

3 convergent evolution as the strain develops antibiotic resistance

4 variation as the raw material for natural selection

**A** 1 only

**B** 2 only

**C** 1 and 3 only

**D** 2 and 4 only

**27** Recent DNA studies have examined the skeletal remains of Europeans buried during the plagues of the Roman Empire, the Middle Ages, the seventeenth and eighteenth centuries and in modern times. These plague outbreaks varied in their symptoms and severity. Despite these differences, the studies suggest that these plagues were all caused by the bacterium *Yersina pestis*.

Which statement does **not** describe a feature that could contribute to the evolution of *Y. pestis* through natural selection?

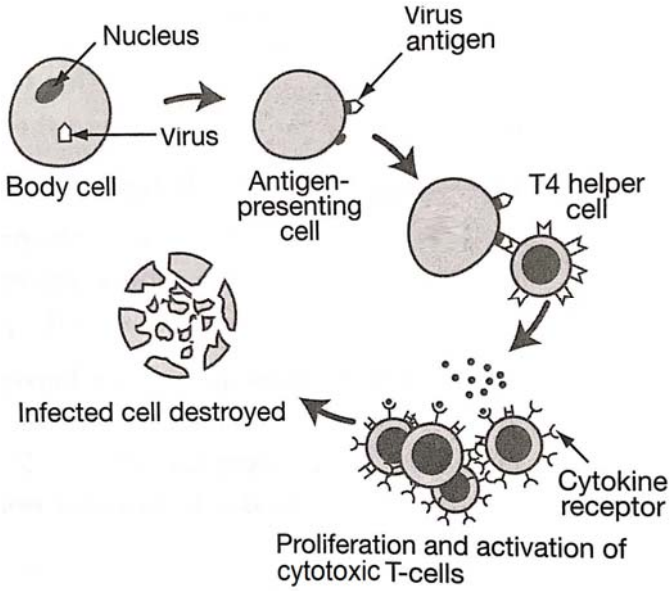
**A** Bacteria from the various strains of *Y. pestis* have different genotypes which could account for the changes in the symptoms and severity of the disease over the centuries.

**B** Bacteria within each strain of *Y.* pestis have the same DNA sequence but, depending on their interaction with the human host, can cause different symptoms with a variety of consequences.

**C** Changes in the genome of *Y. pestis* over the centuries may be associated with changes in its environment, including the changing genetic characteristics of human hosts.

**D** Two DNA sequences that significantly increase the severity of the disease have been found in plasmids that replicate independently of the rest of the bacterial DNA.

**28** The following diagram shows cell-mediated immunity.




Which of the following correctly describes the events in this cell-mediated immunity?

1 Foreign antigen is displayed on the surface of the body cell via major histocompatibility complex II.

2 Displayed virus antigens are targets for cytotoxic T cells.

3 T4 helper cells have a receptor to identify presented antigen.

4 The antigen stimulates the cytotoxic T cells to produce antibodies.

**A** 1 and 2 only

**B** 2 and 3 only

**C** 1, 2 and 3 only

**D** All of the above

**29** The first step in producing anti-venoms for snake bites is to inject a horse with a small amount of the particular snake venom. The anti-venom is then isolated from the blood of the horse.

Why are anti-venoms effective against snake poison?

**A** They contain molecules that will bind with the poison.

**B** They cause specific T cells to bind with infected cells.

**C** They cause specific B cells to bind with infected cells.

**D** They give immunological memory so that there will be faster future response.

**30** In the Indian state of Odisha, the incidence of dengue in the first half of 2018 has tripled compared to the whole of 2017. Officials have attributed the severe spike in cases to the prolonged monsoon season leading to intermittent heavy rainfall in the first half of the year. The dengue virus is transmitted by the *Aedes aegypti* mosquito.

Which of the following are possible explanations for the spike in dengue cases?

1 Persistent rainfall resulted in increased number of breeding habitats for the mosquito.

2 Persistent rainfall led to dried out mosquito eggs being rehydrated and hatching.

3 Decrease in temperature in Odisha results in shorter life cycle of mosquitoes.

4 Insufficient proportion of citizens are vaccinated against the dengue virus, resulting in a lack of herd immunity.

**A** 1 and 2 only

**B** 3 and 4 only

**C** 1, 2 and 3 only

**D** All of the above

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