Civics Group	Index Number	Name (use BLOCK LETTERS)

H2

ST. ANDREW'S JUNIOR COLLEGE
2024 JC2 PRELIMINARY EXAMINATIONS

H2 BIOLOGY **9744/01**

Paper 1: Multiple Choice

Thursday 12th September 2024 1 hour

Additional Materials: Multiple Choice Answer Sheet (OTAS)

READ THESE INSTRUCTIONS FIRST

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

Write your name, civics group and index number on the multiple choice answer sheet in the spaces provided.

There are **30** questions in this paper. Answer all questions. For each question, there are four possible answers, A, B, C and D.

Choose the one you consider correct and record your choice in soft pencil on the separate multiple choice Optical answer sheet.

INFORMATION TO CANDIDATES

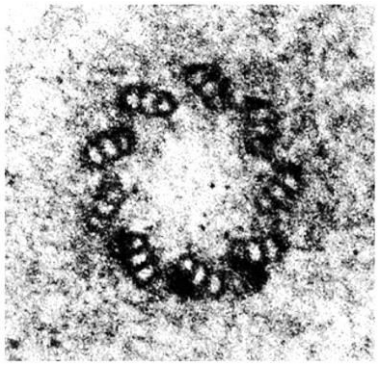
Each correct answer will score one mark. A mark will not be deducted for wrong answer. Any rough working should be done in this booklet.

At the end of the examination, submit both question paper and multiple choice answer sheet.

This document consists of **22** printed pages

[Turn over

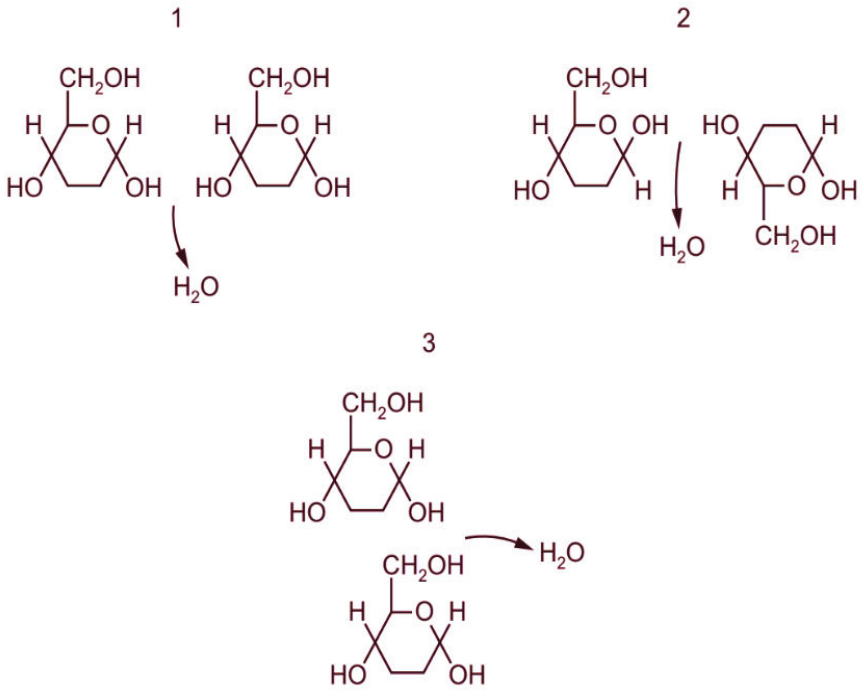
1 The electron micrograph shows a structure found in the cytoplasm of an animal cell.



Which biological molecule(s) are found in this structure?

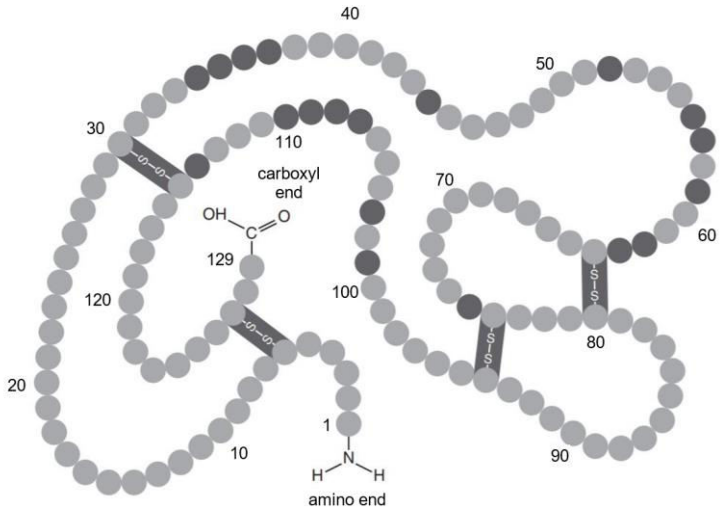
A Nucleic acids and proteins
B Proteins and phospholipids
C Nucleic acids only
D Proteins only

2 Which diagram(s) shows that a glycosidic bond can be formed?



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

3 The diagram shows the structure of a lysozyme molecule.



Which statement(s) about lysozyme are correct?

1 The primary structure of lysozyme is made up of 130 amino acids linked by peptide bonds.

2 Lysozyme has a secondary structure that has repeated patterns stabilised by hydrogen bonds between R groups.

3 Further folding of the polypeptide chain gives an overall specific 3D conformation due to R groups interactions.

4 Lysozyme is a quaternary globular protein held together by strong disulfide bonds.

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

4 The statements are comparisons of endocytosis and exocytosis.

- Both are mechanisms that involve vesicles and the transport of materials across the cell surface membrane.
- Both mechanisms occur to allow bulk transport across the cell surface membrane.
- Endocytosis involves taking materials into the cell, whereas exocytosis involves the release of materials from the cell.
- Some of the cell surface membrane is lost when endocytosis occurs and there is an increase in the cell surface membrane when exocytosis occurs.

How many statement(s) is/are correct?

A 1
B 2
C 3
D 4

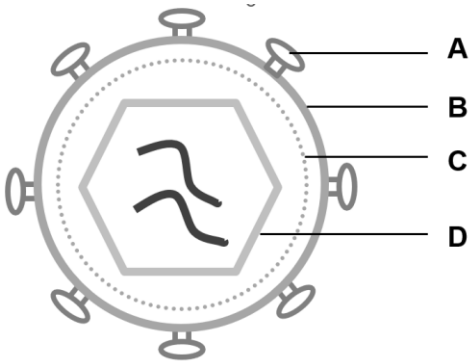
5 Influenza virus has an enzyme called neuraminidase which breaks down glycoproteins in the surface membrane of the cell that the virus will infect. The glycoprotein binds to the active site of neuraminidase by induced fit.

Which statements about the induced fit hypothesis of enzyme action are correct?

1 The active site must have the same shape as the substrate for them to bind together.
2 This enzyme is less likely to be affected by non-competitive inhibitors than an enzyme working by the lock-and-key mechanism.
3 The substrate is converted to product by specific R-groups in the active site just like the lock-and-key mechanism.

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

6 Which of the following components of the human immunodeficiency virus is not encoded by the viral genome?



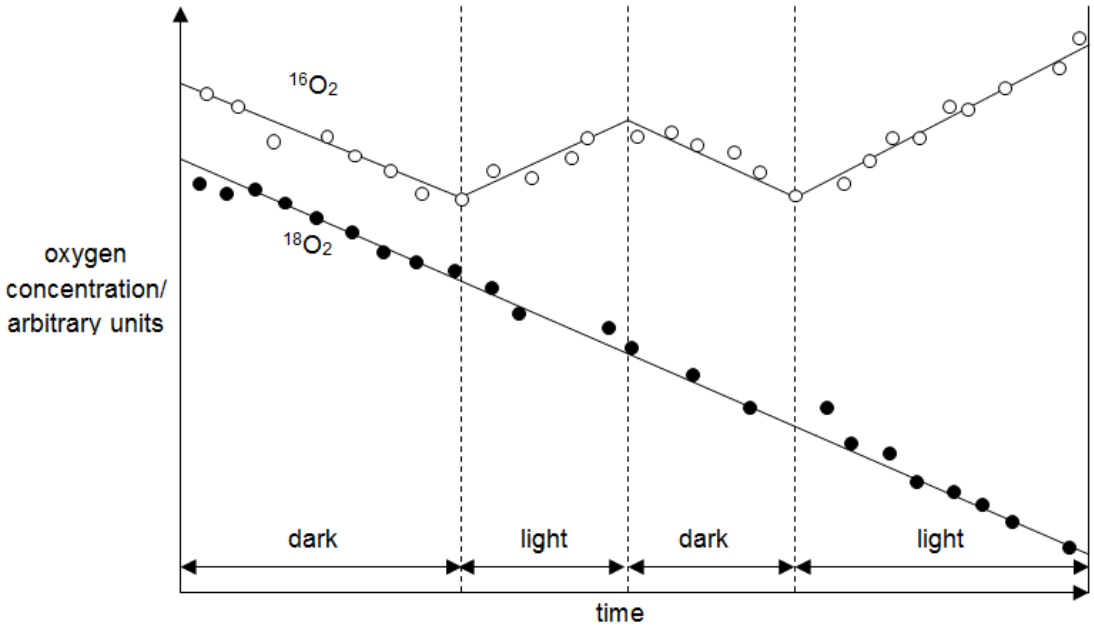
7 Which row correctly describes antigenic drift and antigenic shift?

	Antigenic drift	Antigenic shift
A	achieved by reassortment of gene segments	achieved by accumulation of mutations
B	new viral strain may infect hosts of the same species	new viral subtype may infect hosts in a different species
C	occurs less frequently	occurs more frequently
D	results in major antigenic change	results in minor antigenic change

8 Isotopes of oxygen can be used to distinguish between oxygen absorbed by plants and oxygen evolved.

A mixture of oxygen isotopes $^{16}O_2$ and $^{18}O_2$ was supplied to a suspension of the unicellular alga *Chlorella* which had previously been exposed to $^{16}O_2$ and immersed in $H_2{}^{16}O$ only. During the following hour, changes in concentration of these gases in the suspension were measured in light and dark conditions.

The graph shows the results.



What caused the concentration of $^{16}O_2$ to rise in light?

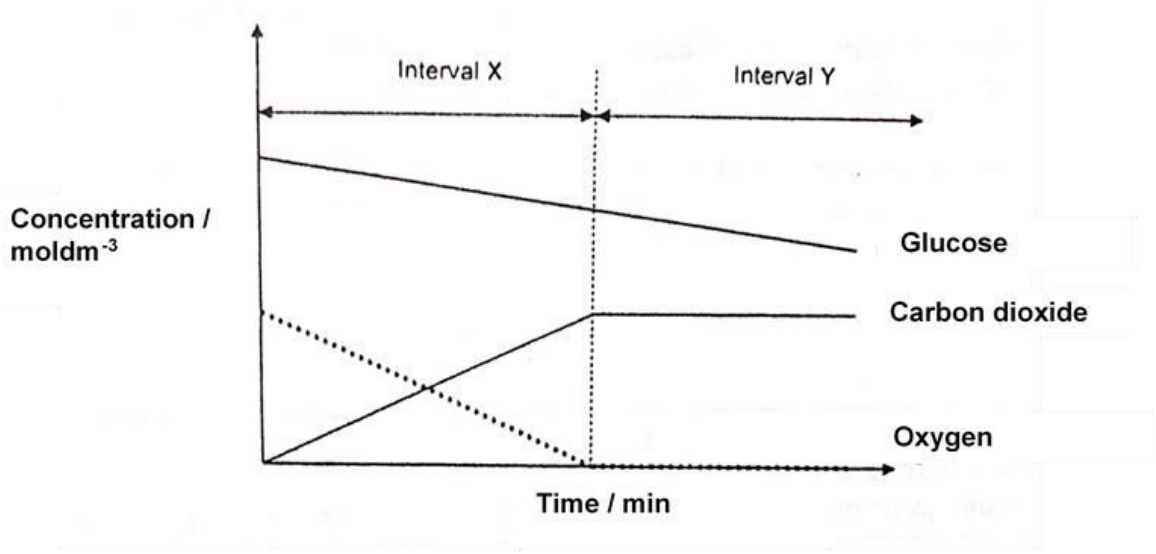
A $H_2{}^{18}O$ was being photolysed more rapidly than $H_2{}^{16}O$

B $^{16}O_2$ was being produced in photosynthesis faster than it was being absorbed in respiration.

C $^{16}O_2$ was being absorbed at different rates in light and dark.

D $^{16}O_2$ was being produced in photosynthesis but was not being absorbed in respiration.

9 In an experiment, metabolically active cells were introduced to a sealed container of nutrient solution. The graph of the levels of glucose, carbon dioxide and oxygen were then analyzed

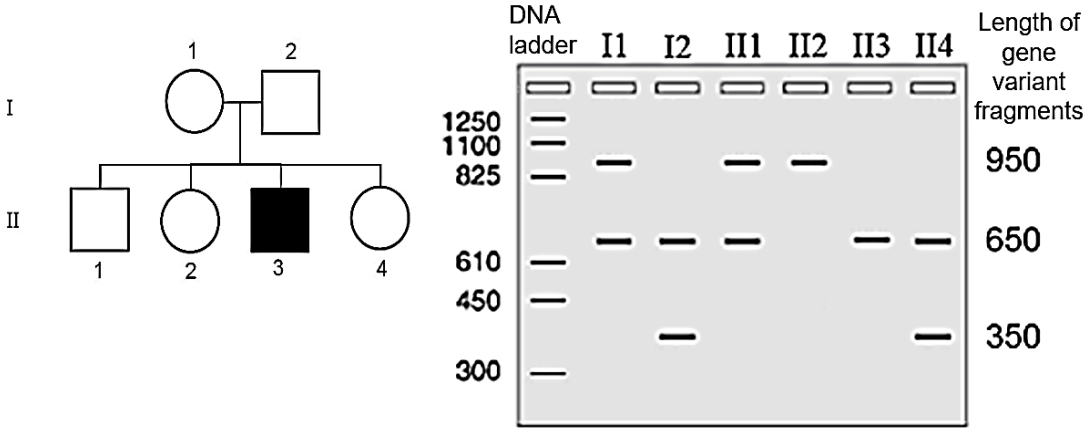


over time.

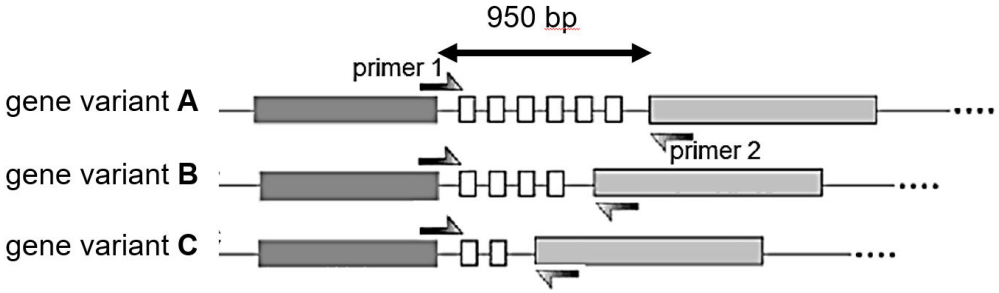
Which of the following can be concluded from the graph?

	Process happening at interval X	**Process happening at interval Y**
A	Aerobic respiration	Lactic acid fermentation
B	Aerobic respiration	Alcoholic fermentation
C	Lactic acid fermentation	Aerobic respiration
D	Alcoholic fermentation	Aerobic respiration

10 In a study of a genetic disorder involving one gene, the DNA from six members of a family was isolated, amplified by PCR and run on an agarose gel. The pedigree was constructed using information obtained from interviewing family members.



The results reveal that there are three forms of the gene. Each gene has a different number of repeats in one of its introns.



Given the above information, which of the statements are correct?

1 Gene variant B is associated with the disease phenotype.

2 It is possible, but rare, for individuals I1 and I2 to have an affected offspring with gene variant B and C due to crossing over event during meiosis in individual I1.

3 Individual I2 is not the biological father of individual II2.

4 The primers that flank the section of the gene variants are complementary to each other.

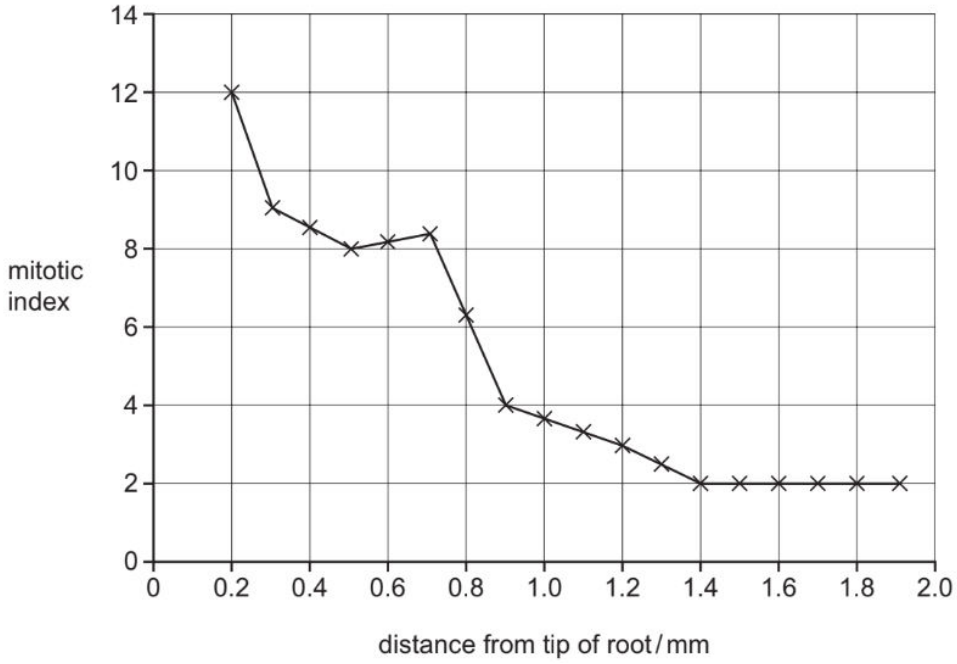
A 1 and 3 only
B 1 and 2 only
C 1, 2 and 4 only
D 2, 3 and 4 only

11 The mitotic index is a measure of the proportion of cells that are undergoing mitosis in an area

of tissue. It is calculated using the formula shown.

mitotic index = (number of cells undergoing mitosis ÷ total number of cells) × 100

A scientist calculated the mitotic index of areas of onion root at different distances from the tip of the root. The results are shown below.



Which statement is correct?

A No cell division occurs further than 1.4 mm from the tip of the root.
B The rate of cell division decreases as the distance from the root tip decreases.
C Most of the cells undergoing cell division are closer to the tip of the root.
D For a sample of 200 cells, 0.2 mm from the tip of the root, 6 would be undergoing mitosis.

12 A scientist has two cultures of cells. Culture A consists of normal cells while culture B consists

of cancerous cells that divide uncontrollably. In order to determine if the uncontrolled growth in culture B was the result of an oncogene or a mutated tumour suppressor gene, he fused the cells from the two cultures to form a hybrid cell line.
He listed all the possible combinations in terms of the type of gene mutated in the cancerous cells and the expected growth of hybrid cells as shown in the table below.

combination	type of gene mutated in the cancerous cells	expected growth of hybrid cells
1	oncogene	grow normally
2	oncogene	grow uncontrollably
3	mutated tumour suppressor gene	grow normally
4	mutated tumour suppressor gene	grow uncontrollably

Which two combinations are correct?
A 1 and 3 only
B 1 and 4 only
C 2 and 3 only
D 2 and 4 only

13 Myocardial infarction, the most common cause of heart failure, results in the death of up to 1 billion highly specialized heart cells. In recent years, researcher have used pluripotent stem cells to differentiate into heart cells and engrafting these heart cells into patients that suffered from myocardial infarction.

Only 10% of injected heart cells survive after delivery into the heart. In these surviving cells, they had higher proliferative capacity. In addition, the researchers also discovered that injected heart cells survived better when they are co-transplanted with micro-blood vessels made from fats.
Based on the information above, which of these statements are true?

1 Both embryonic stem cells and induced pluripotent stem cells can be used for this process.
2 The injected heart cells may have died in the patient due to insufficient oxygen and nutrients supplied to it.
3 Injected heart cells that survived had lower expression of proto-oncogenes.

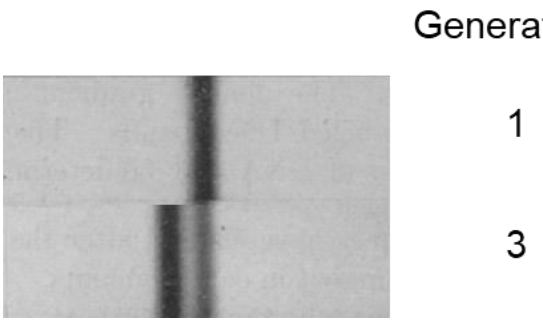
A 1, 2 and 3
B 1 and 2 only
C 2 and 3 only
D 1 and 3 only

14 Which feature(s) can be found in both a typical leaf cell and a photosynthetic bacteria?

1 Chloroplast
2 70S ribosomes
3 Lysosomes
4 Centrosome

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

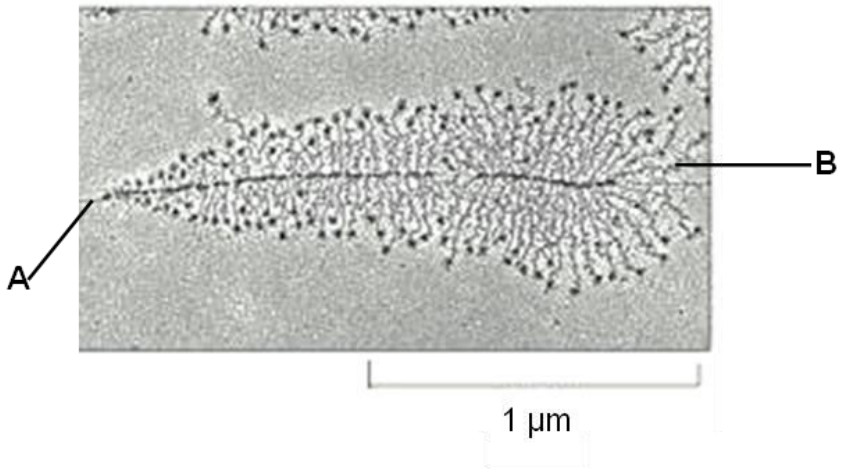
15 Messelson and Stahl investigated the mechanism of DNA replication in 1958. In the experiment, *E.coli* grown in a growth medium containing ^{15}N (generation 0) was transferred to a growth medium containing only ^{14}N. The DNA was extracted and centrifuged at high speed in a salt density gradient. DNA molecules of the same density appear as a band in a UV absorption photographs. The image below shows the DNA bands at generation 1 and 3.



The density of the DNA band at generation 0 is 1.724 and the density of the darker band of DNA at generation 3 is 1.710. What is the estimated density of the DNA band at generation 1?

A 0.855
B 0.862
C 1.717
D 1.723

16 The image below shows the transcription of a gene in amphibian oocytes.



Which of the following can be deduced from the information provided?

1 Simultaneous transcription and translation occur
2 The image is magnified 43000x
3 A shows the 3' end of DNA
4 B shows the polypeptide chain formed

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

17 The first five codons of an mRNA molecule and the first five amino acids of the encoded polypeptide is shown.

AUG --	AAG --	UGU --	UAU --	UUA --	AUG
methionine	lysine	cysteine	tyrosine	leucine	methionine

As a result of mutation, a tripeptide was produced instead of the normal polypeptide.

Which statement explains the production of a tripeptide?

A The DNA triplet coding of methionine is changed from TAC to ATC.
B The DNA triplet coding of cysteine is changed from ACA to ATG.
C The DNA triplet coding of tyrosine is changed from ATA to ATC.
D The DNA triplet coding of leucine is changed from AAT to ATT.

18 A study was conducted to look at the short-term effects of a change in diet on the risk of type 2 diabetes in young adults.

Control of blood glucose concentration was investigated using an oral glucose tolerance test. For this test, the person was given a concentrated glucose drink (at time zero) and then blood samples were taken every 15 minutes to determine the plasma insulin level. This test was done before the study diet and after two weeks on the study diet. Mean results are shown in the graph, including the standard deviation.

Which of the following is a most valid conclusion based on the data?

A The study diet decreases the risk of type 2 diabetes.
B The study diet does not change the risk of type 2 diabetes.
C The blood glucose concentration reduces faster after the study diet.
D Insulin secreted by the muscle cells reduces the blood glucose concentration slower after the study diet.

19 Which statements about the process of transcription in eukaryotes are incorrect?

1 Some transcription factors bind to activators to activate a transcription initiation site.
2 Some transcription factors bind to promoters, causing RNA polymerase to form a complex at a transcription initiation site.
3 Transcription of the template strand of a DNA molecule occurs by RNA polymerase adding nucleotides to the 5' end of a growing DNA molecule.
4 Pre-mRNA processing to remove all introns occurs in the nucleus and may occur alongside transcription.

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

20 The table compares the structure and function of some elements of the *trp* operon.

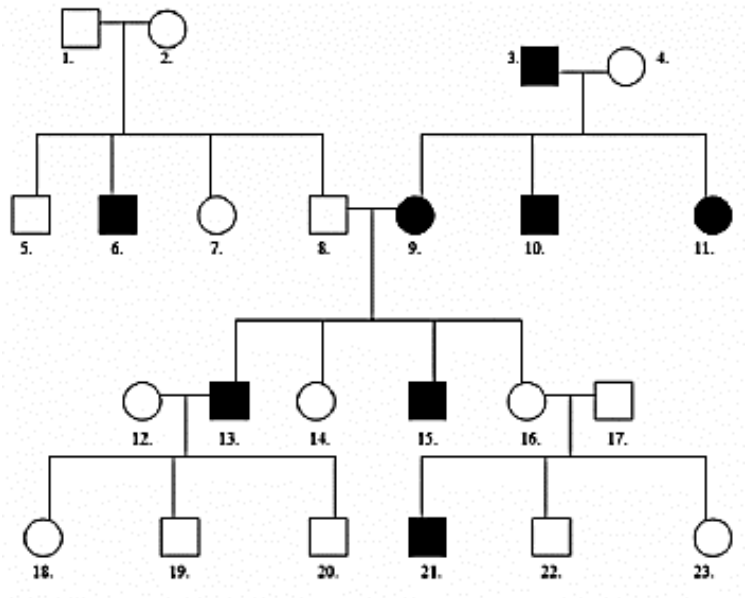
	Made of protein	Interacts with protein	Codes for protein
trp repressor	1	5	9
trp promoter	2	6	10
trp operator	3	7	11
trpE	4	8	12

Which combination of numbers link the four elements of the trp operon listed to their correct structures and functions?

A 1, 2, 4, 5 and 6
B 1, 3, 8, 9 and 10
C 1, 6, 7, 8 and 12
D 1, 7, 9, 10 and 12

21 The diagram below shows the pedigree of a family with a genetic condition Z controlled by a

single gene.



What is true about the inheritance of Z ?

	the allele coding for Z is dominant	the allele coding for Z is autosomal	offspring 9 is homozygous	offspring of parents with condition Z will all have condition Z
A	true	true	false	true
B	true	false	true	false
C	false	false	true	false
D	false	true	true	true

22 Retinitis pigmentosa is a rare degenerative disease of the retina that leads to blindness. There are two forms of the disease:

- Usher syndrome, caused by an autosomal recessive allele, *USH2A,* of a gene on chromosome 1
- A form of the disease affecting rhodopsin, caused by an autosomal dominant allele of the *RHO* gene on chromosome 3

A man who does not carry *USH2A* has a single copy of the *RHO* mutation. A woman has Usher syndrome and homozygous recessive for the *RHO* gene.

What is the likelihood of their first two children having retinitis pigmentosa?

A 1/4
B 3/16
C 1/2
D 9/16

23 Homozygous wild type flies (tanned body and normal wings) were crossed with homozygous

flies with brown body and vestigial wings. All the offspring flies had tanned body and normal wings. These flies were allowed to breed to and produced the following results:

wild type (tanned body, normal wings)	brown body and normal wings	tanned body, vestigial wings	brown body, vestigial wings
1627	569	581	223

A chi-squared value was calculated to test the null hypothesis that there is no significant difference between the observed and expected values. Any difference is due to chance.

The ratio of phenotypes expected for such a dihybrid cross is 9:3:3:1.

Formula for χ^2 calculation:

$$\chi^2 = \Sigma \frac{(O-E)^2}{E} \qquad v = c - 1$$

where Σ = 'sum of…' O = observed 'value'
v = degrees of freedom E = expected 'value'
c = number of classes

A table of chi-squared value is provided.

Degrees of freedom	p = 0.05	p = 0.01	p = 0.001
1	3.84	6.64	10.83
2	5.99	9.21	13.82
3	7.82	11.35	18.47

What can be concluded about the determination of body colour and wing shape in fruit flies?

A Do not reject null hypothesis at p=0.01. Deviation from the expected 9:3:3:1 is not significant.

B Deviation from the 9:3:3:1 ratio is due to chance and there was no independent assortment of genes for body colour and wing shape.

C Reject the null hypothesis at p = 0.05 and any difference between observed and expected results is not due to chance.

D Do not reject null hypothesis because the sample sizes are large.

24 Red light can only penetrate about 10 m through water, but blue and green wavelengths can penetrate more than twice the distance.

Pigments which can absorb light of one colour and use the energy to emit light of another colour are called ‘fluorescent’. Many reef corals living at depths 10 to 20 m fluoresce red.

Some fish living between 10 and 20 m also have pigments which fluoresce red. These pigments often surround the eyes and form patches on the body and fins, in patterns unique to each species.

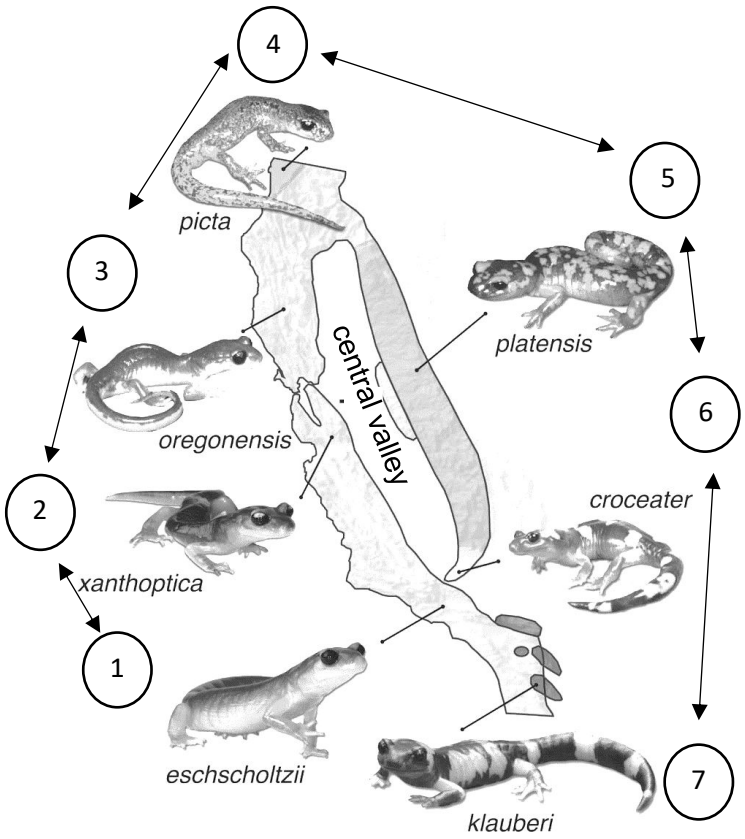
Which of these suggested reasons could explain the selective advantage of fluorescence for these fish?

1 Fluorescent patches provide camouflage.
2 Recognition of their own species avoids interbreeding with other species.
3 The fluorescent patches do not attract predators more than 10 m away.

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

25 *Ensatina eschscholtzff* is a species of salamander that live in the mountains around the Central Valley in California. There are seven different types of ensatina salamander which differ in

colour. The distribution of the types (1 to 7) is shown in the diagram. Arrows show which types interbreed where their ranges overlap.



Which statements could not apply to these salamanders?

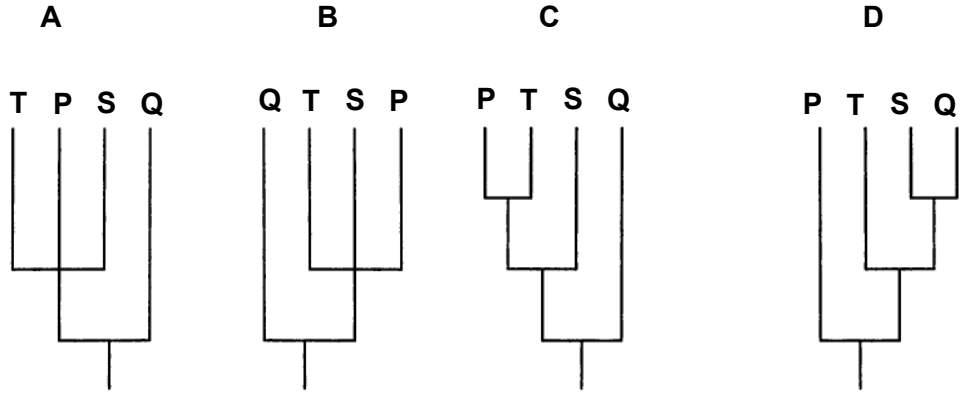
1 The seven different types of the salamander had each adapted to different environmental conditions
2 The different types of salamanders are one biological species as the types can interbreed allowing alleles to pass from type 1 through the other types to type 7.
3 The mountains served as a geographical barrier to reproductively isolate type 1 and type 7 from being able to interbreed.
4 Genetic drift occurred for type 7 causing it to be morphologically different and behave as a distinct species compared to type 1.

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

26 In a study, multiple sequence alignment of an intron of a gene was used to construct the phylogeny for four different species of mammals. Species **P**, **S** and **T** are known to share a common ancestor that is not a common ancestor of **Q**.

Species	Nucleotide base sequences
Species **P**	ACACAGCTCGATGCTACCTATATTATTGTCTGATCGATGGAACTAGATCCAGATCG
Species **Q**	ACACTGCTAGATGCTAGCTATATTTTTGTCTGATGGATGGAACTAGATCGAGATCG
Species **S**	ACACTGCTCGATGCTAGCTATATTATTGTCTGATGGATGGAACTAGATCGAGATCG
Species **T**	ACACAGCTCGATGCTAGCTATATTATTGTCTGATCGATGGAACTAGATCCAGATGG

Which phylogeny of these four organisms is most closely supported by this multiple sequence alignment?



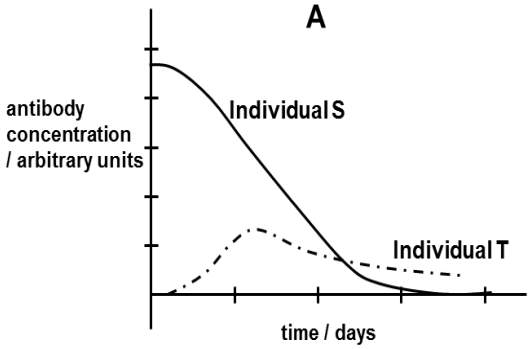
27 Penicillin is an antibiotic used to treat infections caused by bacteria.
Which events explain how bacteria become resistant to penicillin?

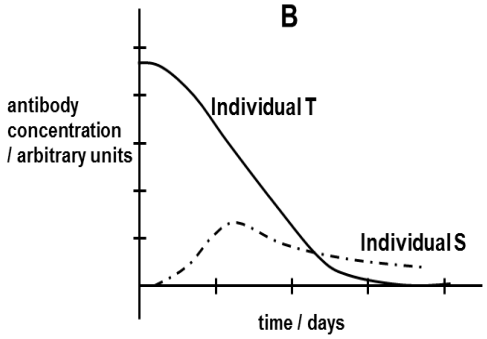
1 The number of bacteria with the allele for resistance to penicillin increases.
2 Resistance to penicillin is the result of a mutation in a bacterium.
3 Bacteria with the allele for resistance to penicillin pass the allele to their daughter cells.
4 The mutation for resistance to penicillin is always caused by the presence of penicillin.

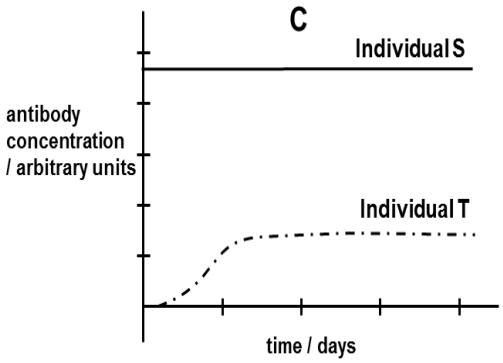
A 1, 2, 3 and 4
B 1, 2 and 3 only
C 1 and 4 only
D 2 and 3 only

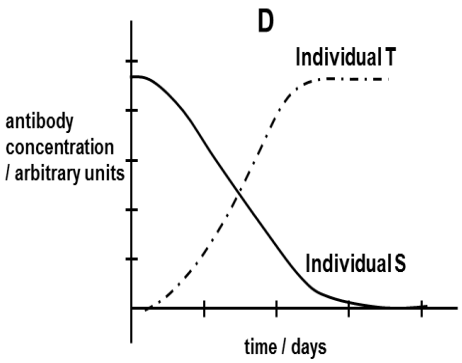
28 Two individuals took part in a study to investigate the effectiveness of two different types of immunisation. Individual S received an injection of antibodies against tetanus and Individual T received a tetanus vaccination.

Which of the options below shows correctly the changes to the antibody concentration in the blood of S and T?



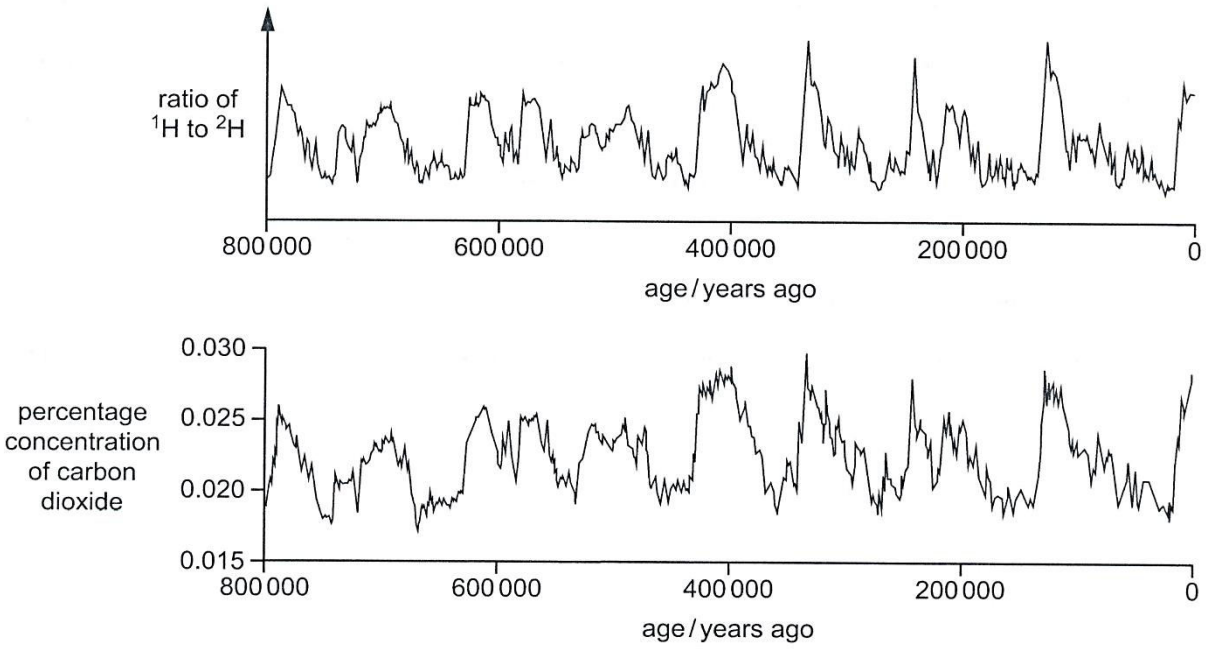






29 Ice samples from deep in the ice sheets in Antarctica were formed hundreds of thousands of

years ago. As ice forms, small bubbles of air were trapped in the ice. The air bubbles can be analysed to determine the concentration of carbon dioxide present. The figure below shows the ratio of ^{1}H to ^{2}H in ice samples formed over the last 800 000 years and the corresponding atmospheric carbon dioxide concentrations.



Past temperatures can be estimated by analysing the ratio of the hydrogen isotope ^{1}H to the hydrogen isotope ^{2}H in ice samples. The ratio of ^{1}H to ^{2}H increases as the temperature increases.

Which of the following can be deduced from the information above?

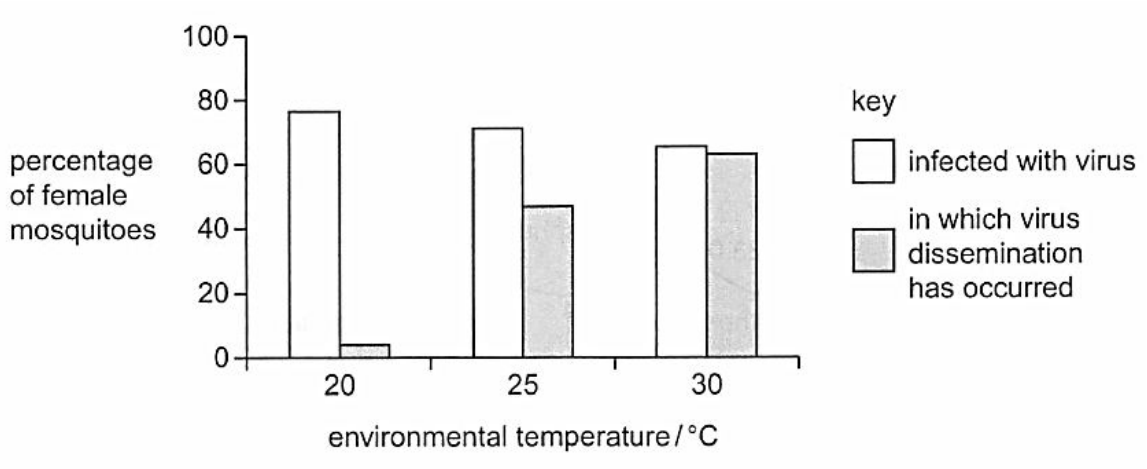
1 An increase in the concentration of greenhouse gases caused an increase in the ratio of ^{1}H to ^{2}H.
2 An increase in temperature corresponds to increase in the percentage of carbon dioxide concentrations respectively.
3 A decrease in the ratio of ^{1}H to ^{2}H corresponds to a decrease in temperature as more ice sheets reflect sunlight back into space.
4 A decrease in temperature corresponds to a decrease in carbon dioxide as less heat is trapped and re-emitted into the atmosphere.

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

30 Dissemination is defined as the movement of the dengue virus out of the intestines into the salivary glands of infected female mosquitoes. The mosquito is infectious and capable of

transmitting the virus to a human host during its one-month lifespan.

The bar chart below shows the effect of environmental temperature on infection of female mosquitoes and dissemination.



Which of the following is an **incorrect** conclusion from these results on the effect of environmental temperature on dissemination of the dengue virus in female mosquitoes ?

A At an environmental temperature of 20 °C, dissemination in percentage of female mosquitoes was at its lowest.

B At an environmental temperature of 25 °C, the percentage of non-disseminated infected female mosquitoes was around 50%.

C At an environmental temperature of 30 °C, nearly all the infected mosquitoes disseminated the virus.

D As temperature increased from 20 to 30 °C, dissemination increased resulting in higher percentage of infectious female mosquitoes.

-End of Paper-