RIVER VALLEY HIGH SCHOOL
YEAR 6
PRELIMINARY EXAMINATION II

H1 BIOLOGY 8875

PAPER 1
22 SEP 2017
1 HOUR

CANDIDATE NAME									
CENTRE NUMBER	S					INDEX NUMBER				

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Centre number and index number on the Answer Sheet in the spaces provided.
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There are **thirty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**.
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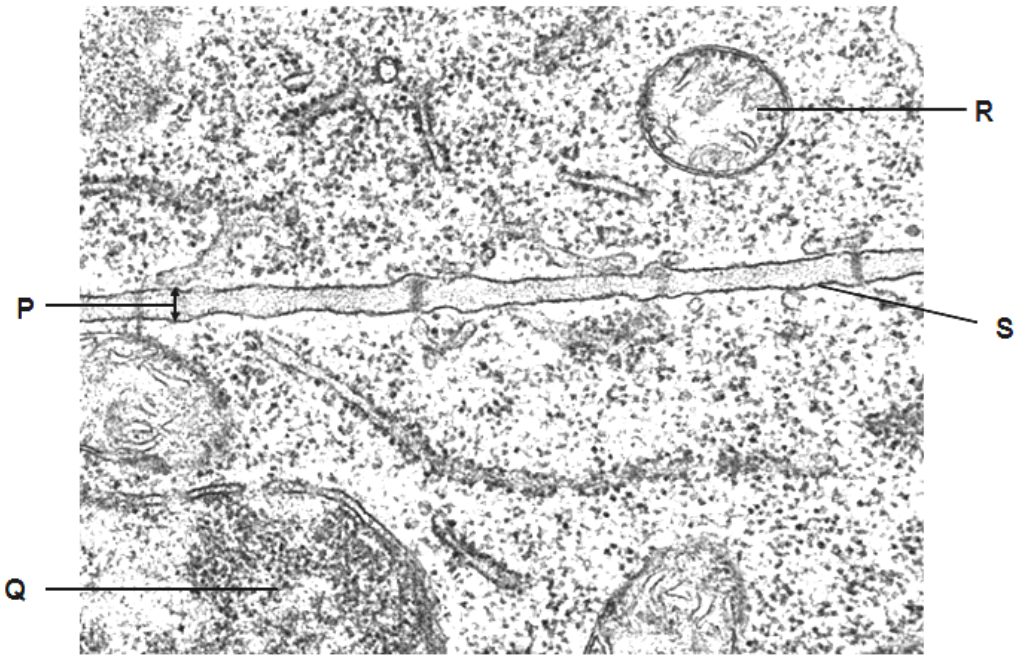
This Question Paper consists of **20** printed pages.

1 The figure below shows an electron micrograph with two plant cells.



Peter v. Sengbusch - b-online@botanik.uni-hamburg.de

Which of the following statements correctly describe the labelled structures?

1 **R** contains circular DNA and is found in both prokaryotic and eukaryotic cells.

2 **P** has a fluid mosaic structure and regulates the movement of substances between the two plant cells.

3 **S** acts as a selective permeable barrier.

4 **Q** contains enzymes which play an important role in cell specialisation.

A 1 and 3

B 3 and 4

C 1, 2 and 3

D All of the above

2 A student prepared three solutions of sugars, **X**, **Y** and **Z**, and diluted them to varying concentrations. A sample of each was heated with Benedict's reagent, with or without prior acid hydrolysis. The results are shown below.

	concentration of solution / moldm^{-3}					
	0.0001		0.001		0.01	
	no acid	with acid	no acid	with acid	no acid	with acid
X	blue solution	blue solution	green mixture	green mixture	orange mixture	orange mixture
Y	blue solution	green mixture	blue solution	green mixture	blue mixture	orange mixture
Z	blue solution	green mixture	green mixture	green mixture	orange mixture	orange mixture

Based on the results, which of the following conclusions are not correct?

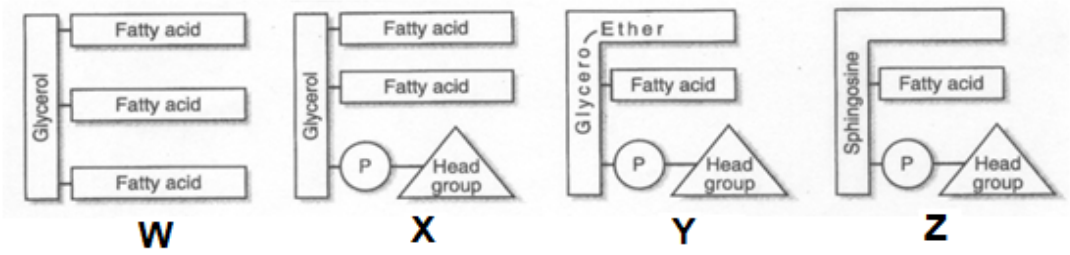
A Solution **Y** does not consist of monosaccharides.

B Solution **X** and solution **Y** consists of disaccharides only.

C Solution **X** consists of monosaccharides only.

D Solution **Z** contains disaccharides.

3 The diagram below shows the components of different types of lipids.



Which statement(s) correctly describes the four lipid molecules?

1 All molecules are made by condensation reactions.

2 The hydrocarbon chains of **W** are always from saturated fatty acids.

3 The hydrocarbon chains of molecules **W** and **Y** may be from saturated or unsaturated fatty acids.

4 The hydrocarbon chains of **X** are always of the same length.

A 1 only

B 1 and 4

C 1 and 3

D 2 and 4

4 The R groups of two amino acids are shown below.

amino acid	R group
serine	$-CH_2-OH$
alanine	$-CH_3$

When placed in aqueous medium, where in a globular protein will these amino acids be found?

A Both serine and alanine will be found in the interior of the globular protein.

B Both serine and alanine will be found on the exterior of the globular protein.

C Alanine will be found in the interior, and serine on the exterior of the globular protein.

D Alanine will be found on the exterior, and serine in the interior of the globular protein.

5 The pathways below show the relationship between an enzyme (**E**) and its substrate (**S**), product (**P**) and an inhibitor (**I**).

Pathway **A**: **E** + **S** → **E** + **P**

Pathway **B**: **E** + **S** + **I** → **E** + **S** + **I**

In the above reactions, assume that

- increasing the concentration of **S** increases the activity of the enzyme,
- at low substrate concentrations the presence of **I** reduces rate of reaction velocity, and
- the same maximum rate of reaction can be reached in the presence or absence of **I**.

Which mechanism is operating in pathway **B**?

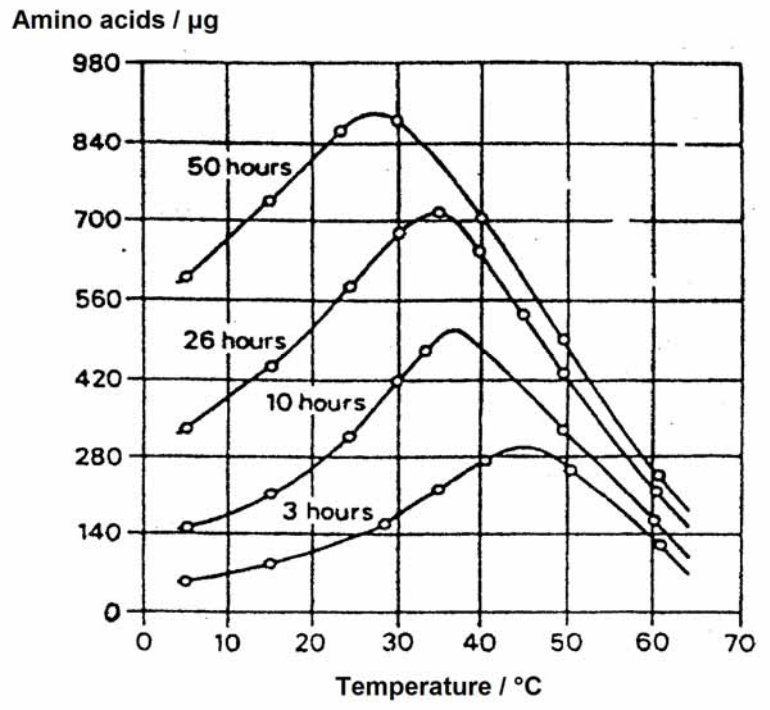
A Positive feedback

B Negative feedback

C Competitive inhibition

D Non-competitive inhibition

6 The graph below shows the effect of temperature on the activity of a proteolytic enzyme incubated at varying durations.



Which of the following can be deduced from the graph?

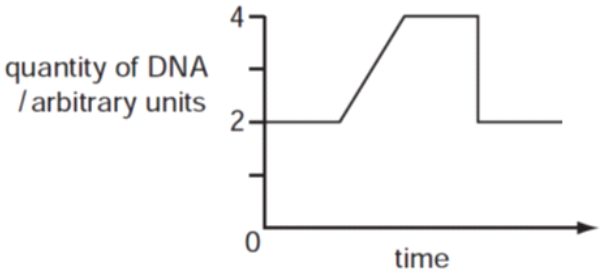
A The optimum temperature of the proteolytic enzyme is 27°C.

B The proteolytic enzyme undergoes denaturation at 27°C.

C The optimum temperature of the proteolytic enzyme decreases as the incubation time increases, due to time for breaking of covalent bonds.

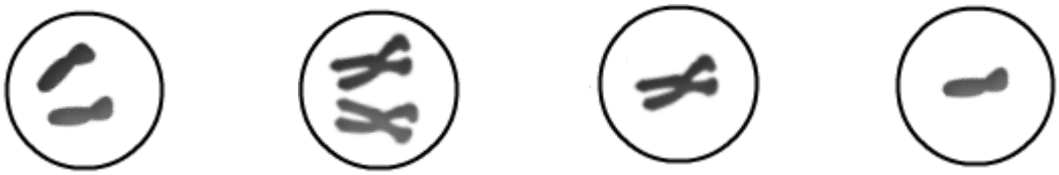
D The optimum temperature of the proteolytic enzyme increases with incubation time, causing the hydrolysis to last longer.

7 The graph shows the change in the quantity of DNA in a cell with one pair of chromosomes during a cell division.

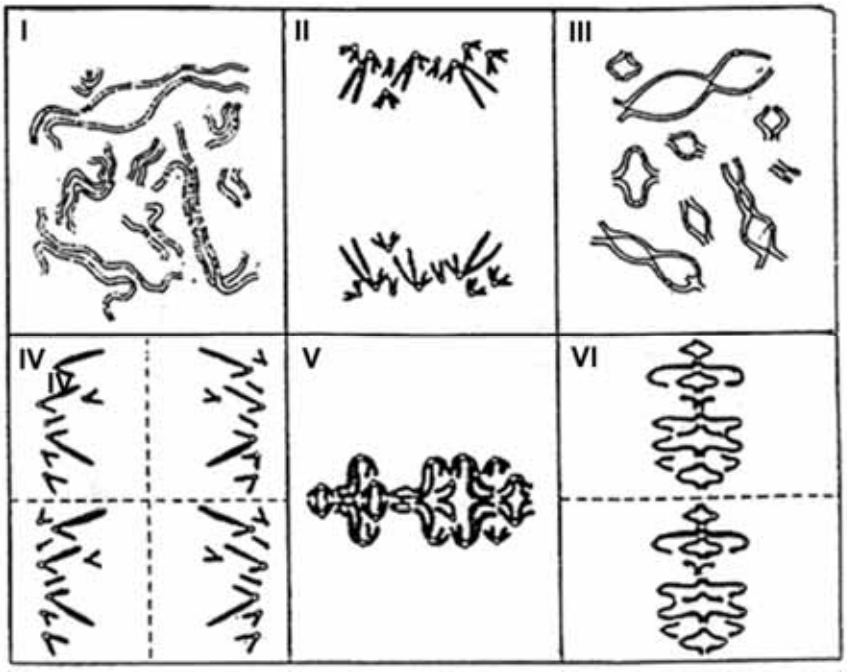


Which nucleus is formed as a result of this division?

A **B** **C** **D**



8 The diagram depicts the behaviour of chromosomes at various stages of meiosis of the same cell.



Which of the following shows the correct order of the stages?

A **III → V → II → VI → IV → I**

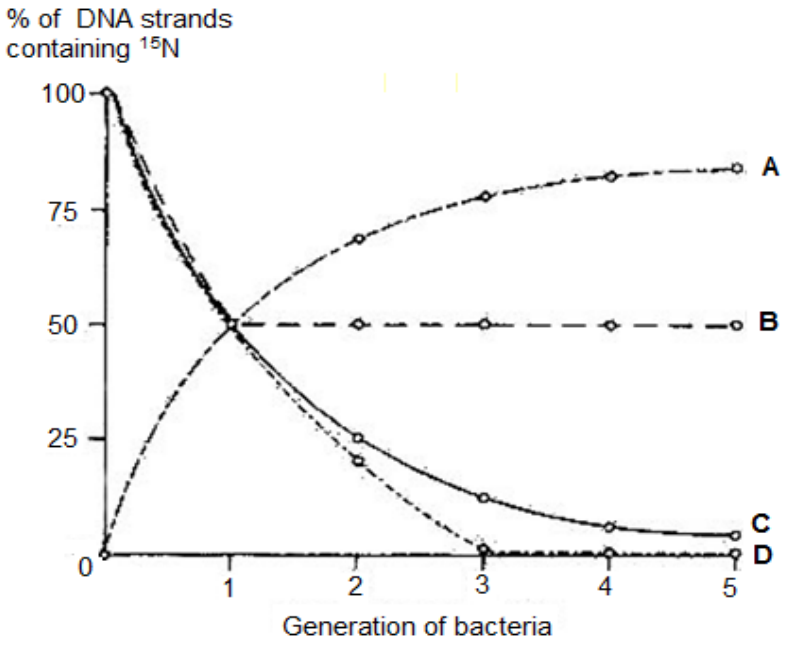
B **III → I → V → II → VI → IV**

C **II → III → I → V → VI → IV**

D **I → III → V → II → VI → IV**

9 Bacteria were cultured in a medium containing heavy nitrogen (^{15}N) until all their DNA were labelled. These bacteria were then grown in a medium containing only light nitrogen (^{14}N) for five generations. The percentage of DNA strands containing ^{15}N in each generation was estimated.

Which curve provides evidence that each daughter DNA molecule produced consists of a parental strand and a newly synthesised daughter strand?



10 A student obtained a sample of DNA from which mRNA was transcribed. He then separated the two strands of DNA by adding NaOH. While doing so, he accidentally contaminated the DNA-mRNA mixture with another DNA sample. The base composition of each DNA strand and that of the mRNA were analysed. The results of the analysis are shown in the table below.

	A	G	C	T	U
DNA strand 1	19.1	26.0	31.0	23.9	0.0
DNA strand 2	24.2	30.8	25.7	19.3	0.0
DNA strand 3	20.5	25.2	29.8	24.5	0.0
DNA strand 4	25.1	24.2	18.8	29.9	0.0
mRNA	19.0	25.9	30.8	0.0	24.3

Which strand of DNA was used as a template for the synthesis of mRNA?

A DNA strand 1

B DNA strand 2

C DNA strand 3

D DNA strand 4

11 Part of the amino acid sequence in β-globin chains of normal and mutant haemoglobin are shown.

normal haemoglobin	thr-pro-glu-glu
mutant haemoglobin	thr-pro-val-glu

Possible mRNA codons for these amino acids are shown below.

glutamine (glu)	GAA GAG
threonine (thr)	ACU ACC
proline (pro)	CCU CCC
valine (val)	GUA GUG

Which tRNA molecule is not involved in the formation of this part of amino acid sequence in mutant haemoglobin?

A

B

C

D

12 A black-haired female rabbit was crossed with a white-haired male rabbit. Eight offspring were born. Two were white-haired males, two were white-haired females and all the others were black-haired females.

Which statement is correct, from this evidence, about the inheritance of hair colour in rabbits?

A Hair colour is sex-linked in rabbits.

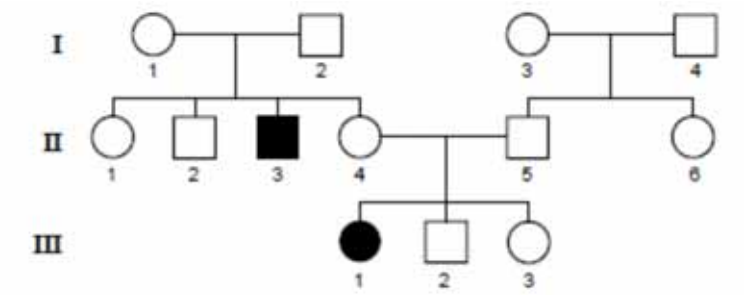
B The allele for black hair is dominant to the allele for white hair.

C The allele for white hair is dominant to the allele for black hair.

D The results of this cross are inconclusive.

13 Phenylketonuria (PKU) is a condition in which affected individuals fail to produce the enzyme phenylalanine hydroxylase. PKU is inherited as an autosomal recessive condition.

The following pedigree shows a family in which two members have PKU.



In the pedigree shown, individuals that must be heterozygous for PKU include

A I–2 **B** I–4 **C** II–1 **D** II–6

14 Tay-Sachs disease is characterised by abnormal accumulation of lipid-related compounds, which results in deterioration of cognitive and motor abilities.

It is caused by an autosomal recessive mutation in the allele coding for hexosaminidase A (HEXA), an enzyme that regulates the metabolism of phospholipids.

The base triplets in part of the coding DNA sequences for a normal HEXA allele and a mutant Tay-Sachs allele, as well as their corresponding amino acids are shown.

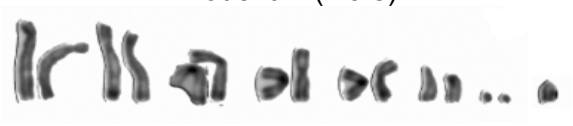
Normal HEXA allele	CGT Arg	ATA Ile	TCC Ser	TAT Tyr	GCC Gly	CCT Pro	GAC… Asp	
Tay-Sachs allele	CGT Arg	ATA Ile	TCT Ser	ATC Ile	CTA Leu	TGC Cys	CCC Pro	TGA… Thr

Which combination correctly describes the nature of mutation that results in the Tay-Sachs allele?

	changes to nucleotide sequences	**alteration of reading frame**	**length of polypeptide**
A	deletion of 2 bases	yes	shorter
B	insertion of 2 bases	yes	longer
C	substitution of 4 bases	no	unchanged
D	insertion of 4 bases	yes	longer

15 The figures below show the complete karyotypes of two rodents of the same species. In this species of rodent, males are the heterogametic sex, where they have two different sex chromosomes.

Rodent **A** (Male)



Rodent **B** (Female)

Which of the following observations is not true?

A A chromosomal aberration occurred in the ovary of the mother of rodent **B**

B Rodent **A** is diploid and 2n = 16.

C Rodent **B** has 1 missing chromosome.

D Non-disjunction of autosomes occurred in rodent **B**.

16 Which of the following statements are true about non-cyclic photophosphorylation?

1 $NADP^+$ is oxidized in non-cyclic phosphorylation.

2 P_{680} and P_{700} are reduced after the electrons are excited to higher energy levels.

3 ATP is synthesised in non-cyclic photophosphorylation.

4 The products of non-cyclic phosphorylation are $NADPH/H^+$, ATP and oxygen.

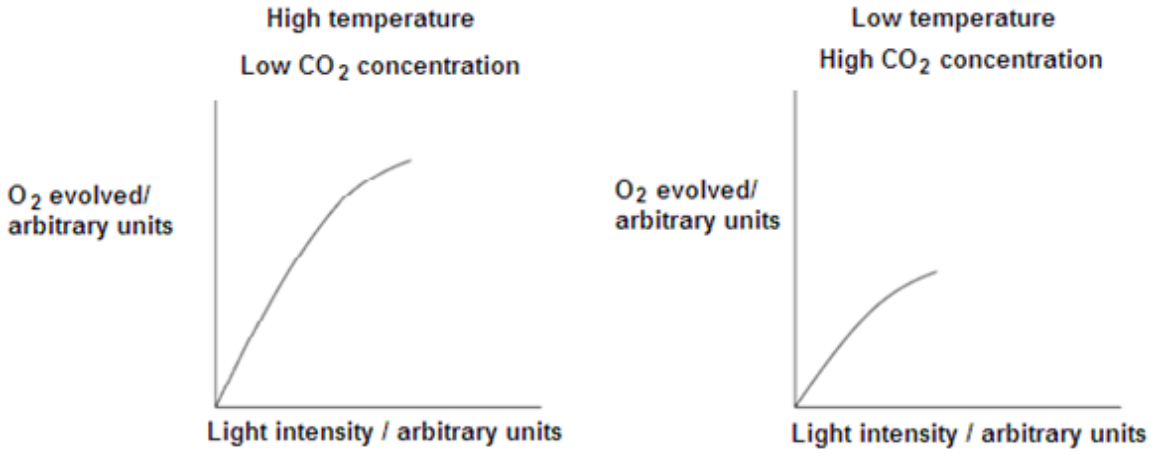
A 1 and 2

B 3 and 4

C 1, 2 and 3

D 2, 3 and 4

17 Students investigated the rate of photosynthesis by measuring the rate of oxygen evolved from an aquatic plant. The results of two experiments that they set up are shown below.



Which conclusion can be drawn from this data?

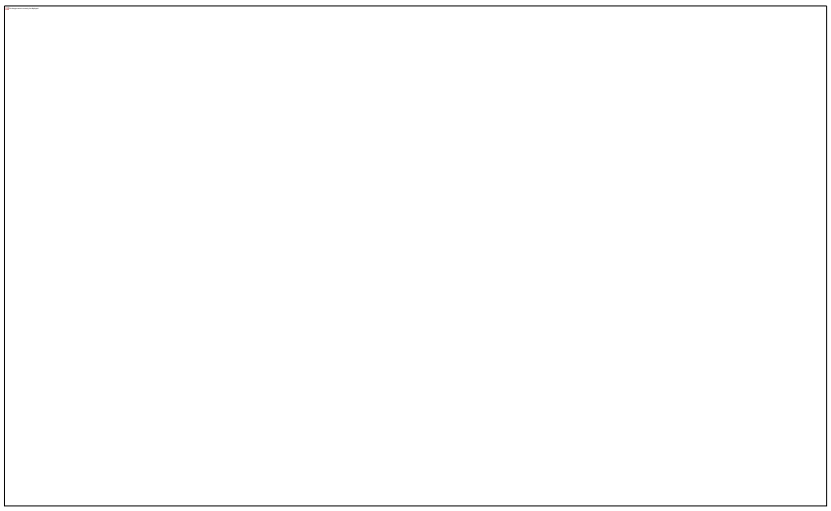
A Temperature does not affect the rate of photosynthesis.

B High concentrations of CO_2 reduce the rate of photosynthesis.

C Temperature and CO_2 concentration are both limiting factors.

D The greater the light intensity the greater the rate of photosynthesis.

18 The common isotope of oxygen is ^{16}O. Air containing $^{16}O_2$ and $^{18}O_2$ was bubbled through a suspension of algae for a limited period. After this, the concentration of these two isotopes of oxygen in the water was monitored for the next 50 minutes whilst the algae were subjected to periods of dark and light. The results are shown in the diagram.



What is the best explanation for these results?

A Both isotopes of oxygen are used by the algae in the dark in respiration, but in the light oxygen is produced from water in photorespiration.

B The algae can distinguish chemically between the two isotopes.

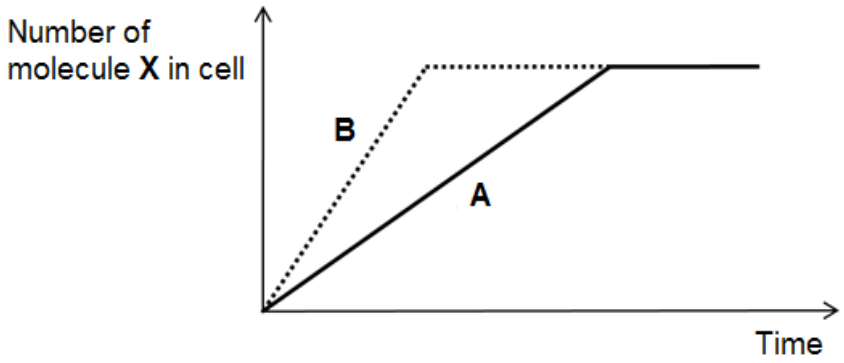
C The algae produce oxygen from the water which is used in photosynthesis, but only in the light.

D The two isotopes have different rates of diffusion.

19 After vigorous exercise, changes occur in the muscle tissue. Compared with 'at rest' conditions what will be changes be?

	ATP	lactate	pH
A	decreased	increased	decreased
B	increased	increased	increased
C	decreased	decreased	increased
D	increased	decreased	decreased

20 Graph **A** shows the transport of molecule **X**, with the help of carrier proteins, into a cell over time.

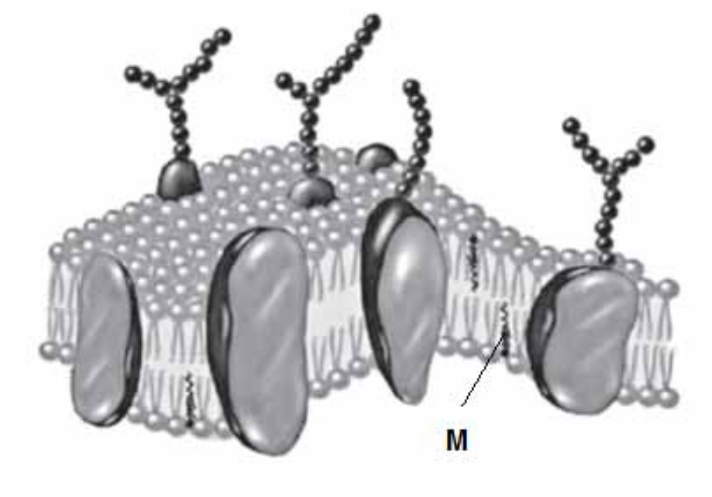


A student predicted that the alteration of one variable would result in graph **B**.

Which row shows the correct transport process and the alteration in variable that would result in graph **B**?

	transport process	alteration resulting in graph **B**
A	facilitated diffusion	increase in environmental temperature to 90 °C
B	active transport	increase in concentration of **X** in cell
C	facilitated diffusion	increase in number of carrier proteins
D	active transport	increase in availability of ATP

21 The diagram below shows a plasma membrane.



Which of the following correctly describes the function of molecule **M**?

1 limits membrane fluidity

2 enhances membrane fluidity

3 limits membrane permeability

4 enhances membrane permeability

5 allows for cell-cell adhesion

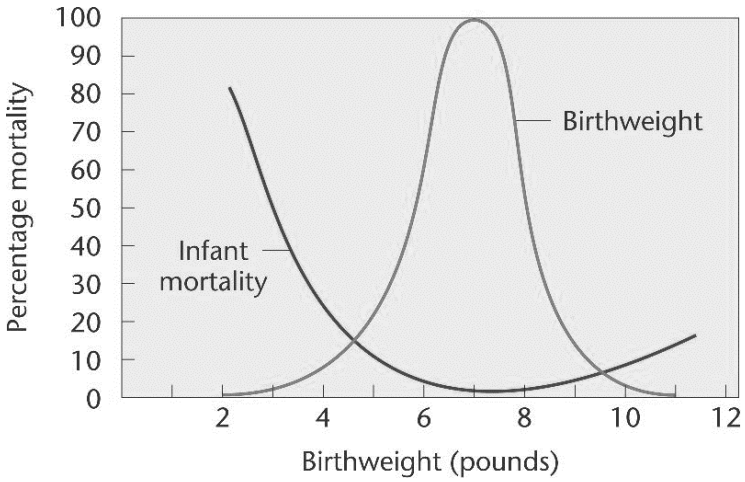
A 1 and 2 only

B 1, 2 and 3 only

C 1, 2, 3 and 4 only

D All of the above

22 The graph below shows the relationship between birthweight and infant mortality in humans.



What type of selection is demonstrated above?

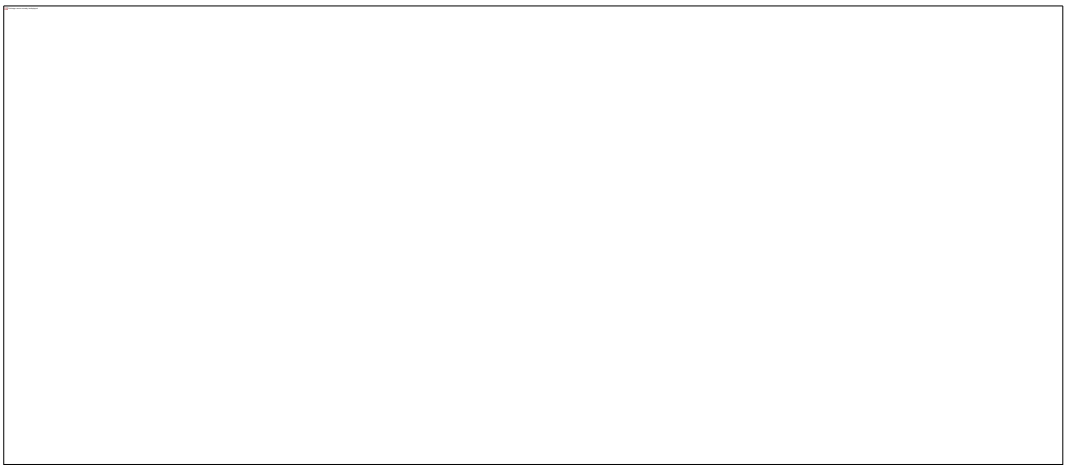
A Directional selection

B Disruptive selection

C Stabilising selection

D Artificial selection

23 The formation of the Isthmus of Panama around 3 *Mya* led to the separation of the Pacific and Atlantic oceans. Pistol shrimps of the *Alpheus* genus can be found in both oceans, surrounding the Isthmus. *Alpheus nuttingi* resides in the Atlantic ocean and *Alpheus millsae* resides in the Pacific ocean.



Despite being physically separated, *A. nuttingi* and *A. millsae* are morphologically and genetically very similar. The two species have also been shown to be capable of interbreeding in captivity. Which of the following statements are likely to be true?

1 *A. nuttingi* and *A. millsae* are derived from a common ancestral species.

2 The formation of the Isthmus resulted in geographical isolation of the two species 3 *Mya*.

3 *A. nuttingi* and *A. millsae* are two separate species because they are geographically isolated.

4 Similar environmental conditions around the Isthmus exerted similar selection pressures, leading to convergent evolution between *A. nuttingi* and *A. millsae*.

A 1 only

B 1 and 3

C 2 and 3

D 3 and 4

24 Myxomatosis is a viral disease of rabbits. It spreads rapidly and most rabbits die within 14 days of being infected. Myxomatosis has been deliberately used to reduce the number of rabbits in countries where they are a significant crop pest.

The initial release of the virus caused populations to fall by over 90%. Resistance to myxomatosis increased in the 70 years following initial release, so at the present time up to 50% of infected rabbits are able to survive.

Which of the following statements could explain the increasing frequency of resistance to myxomatosis in the years following release of the virus?

1 In populations with high incidences of myxomatosis, mutations leading to resistance are more likely to occur.

2 Infected rabbits die quickly, hence the alleles that code for myxomatosis are eliminated from the population.

3 The initial release of the virus led to death of large number of rabbits, greatly altering the frequency of alleles in rabbit populations.

4 During disease outbreaks there is greater food availability for the surviving rabbits, increasing the probability that they survive.

A 4 only

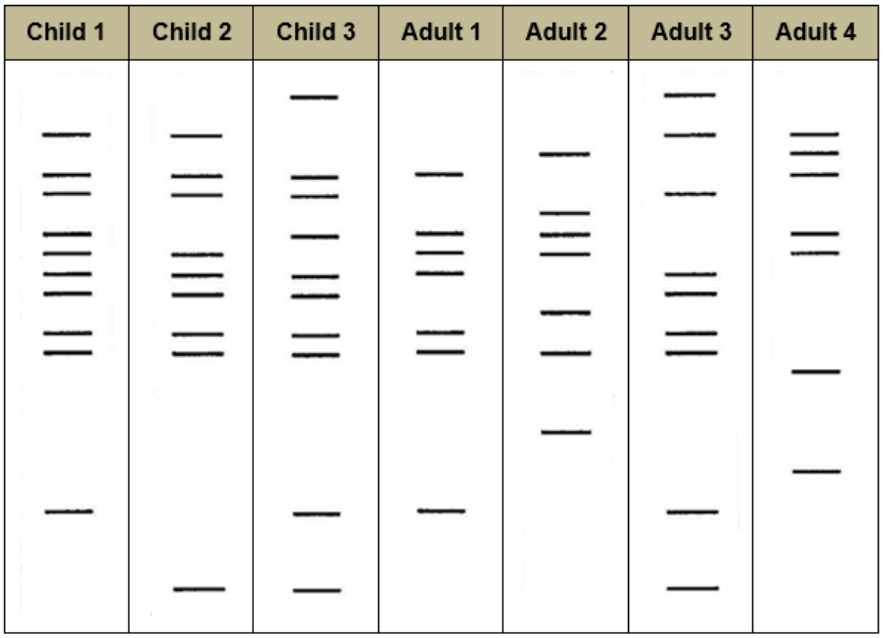
B 1 and 2 only

C 2 and 4 only

D 2, 3 and 4 only

25 Seven skeletons were found in an unidentified grave. To establish the relationship between these seven individuals, DNA were isolated from these skeletons and then analysed using gel electrophoresis.

The results obtained from the skeletons, three children and four adults, are shown below.



Other analysis showed that all three children have the same parents. Which two adults may be the parents of these children?

A Adults 1 and 2

B Adults 1 and 3

C Adults 2 and 3

D Adults 2 and 4

26 Which of the following statements about polymerase chain reaction are true?

1 Copy fragments of DNA
2 Amplify fragments of DNA
3 Translate fragments of DNA
4 Requires an excess of RNA primers
5 Requires DNA-dependent DNA polymerase

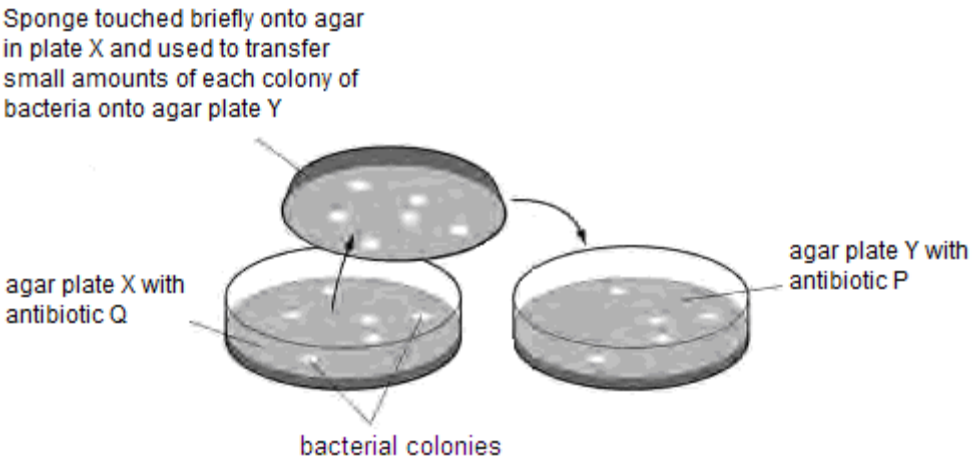
A 1 and 2

B 2 and 5

C 1, 2 and 4

D 1, 2 and 5

27 The diagram shows a method used to detect bacteria colonies which are successfully transformed during genetic engineering.



Which explains why other methods for detecting successful transformation are now preferred?

1 Incorporating heavy-metal resistance genes along with the desired genes means that you can easily kill cells that have not been transformed.

2 Presence or absence of non-toxic fluorescent markers is easy to detect using ultra-violet light.

3 The antibiotic resistance genes previously used as markers might have escaped into the environment.

4 The antibiotic resistance genes previously used as markers killed the transformed cells so they were difficult to use.

A 1 and 3

B 2 and 4

C 1, 2 and 3

D 1, 2, 3 and 4

28 Which of the following best explains why a genome project is not finished when the sequence has been completed?

A Genomes change too fast and must constantly be updated.

B Without knowing the number, the function, and the location of genes within a genome, the sequence is not very useful.

C Individuals within a species are so unique that having a single sequence is insufficient to characterise a species' genome.

D Many sections of a genome are too difficult to sequence and have not actually been included in 'complete' genomes.

29 Which of the following statements regarding stem cells are **not** correct?

1 Stem cells are present within various organs of the adult body.

2 Stem cells can develop into a whole organism when implanted into the womb.

3 Stem cells can be grown indefinitely in culture under appropriate culture conditions.

4 Stems cells isolated from a 3-5 day old human embryo can differentiate into only one kind of cells.

A 1 and 3 only

B 2 and 4 only

C 1, 2 and 3

D 2, 3 and 4

30 Maize varieties with leaves that produce protein toxic to insects are being developed. The DNA coding for these toxic proteins was inserted into a maize chromosome via a bacterial plasmid. Many people oppose to this process.

Which objection is **not** biologically valid?

A Beneficial insects may be killed if they eat genetically modified maize.

B Genes for antibiotic resistance are present in plasmids and these genes may be passed to harmful bacteria.

C Hybridisation may transfer the bacterial genes from maize to weeds, giving the weed species new and harmful characteristics.

D Mutations may be caused in cattle or humans that eat the genetically modified maize.

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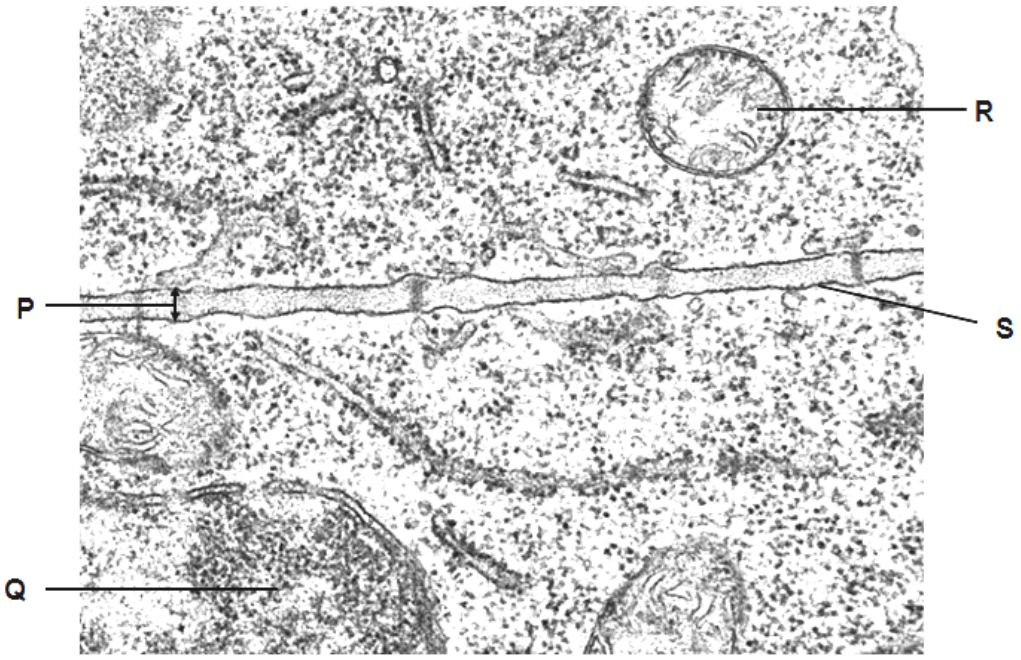

Peter v. Sengbusch - b-online@botanik.uni-hamburg.de

Which of the following statements correctly describe the labelled structures?

1 **R** contains circular DNA and is found in both prokaryotic and eukaryotic cells.

2 **P** has a fluid mosaic structure and regulates the movement of substances between the two plant cells.

3 **S** acts as a selective permeable barrier.

4 **Q** contains enzymes which play an important role in cell specialisation.

A 1 and 3

B 3 and 4

C 1, 2 and 3

D All of the above

2 A student prepared three solutions of sugars, **X**, **Y** and **Z**, and diluted them to varying concentrations. A sample of each was heated with Benedict's reagent, with or without prior acid hydrolysis. The results are shown below.

	concentration of solution / moldm^{-3}					
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Y	blue solution	green mixture	blue solution	green mixture	blue mixture	orange mixture
Z	blue solution	green mixture	green mixture	green mixture	orange mixture	orange mixture

Based on the results, which of the following conclusions are not correct?

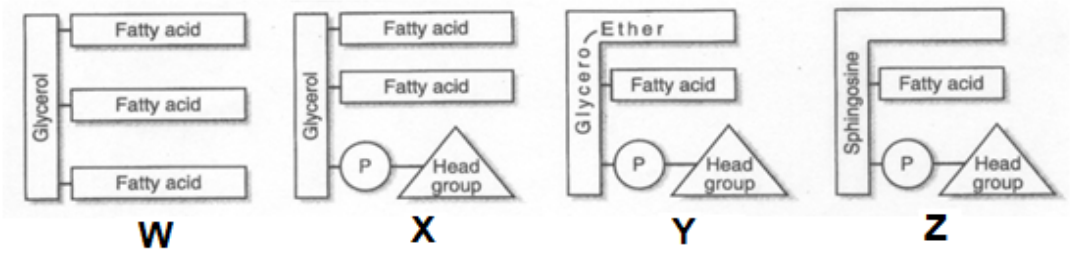
A Solution **Y** does not consist of monosaccharides.

B Solution **X** and solution **Y** consists of disaccharides only.

C Solution **X** consists of monosaccharides only.

D Solution **Z** contains disaccharides.

3 The diagram below shows the components of different types of lipids.



Which statement(s) correctly describes the four lipid molecules?

1 All molecules are made by condensation reactions.

2 The hydrocarbon chains of **W** are always from saturated fatty acids.

3 The hydrocarbon chains of molecules **W** and **Y** may be from saturated or unsaturated fatty acids.

4 The hydrocarbon chains of **X** are always of the same length.

A 1 only

B 1 and 4

C 1 and 3

D 2 and 4

4 The R groups of two amino acids are shown below.

amino acid	R group
serine	$-CH_2-OH$
alanine	$-CH_3$

When placed in aqueous medium, where in a globular protein will these amino acids be found?

A Both serine and alanine will be found in the interior of the globular protein.

B Both serine and alanine will be found on the exterior of the globular protein.

C Alanine will be found in the interior, and serine on the exterior of the globular protein.

D Alanine will be found on the exterior, and serine in the interior of the globular protein.

5 The pathways below show the relationship between an enzyme (**E**) and its substrate (**S**), product (**P**) and an inhibitor (**I**).

Pathway **A**: **E** + **S** → **E** + **P**

Pathway **B**: **E** + **S** + **I** → **E** + **S** + **I**

In the above reactions, assume that

- increasing the concentration of **S** increases the activity of the enzyme,
- at low substrate concentrations the presence of **I** reduces rate of reaction velocity, and
- the same maximum rate of reaction can be reached in the presence or absence of **I**.

Which mechanism is operating in pathway **B**?

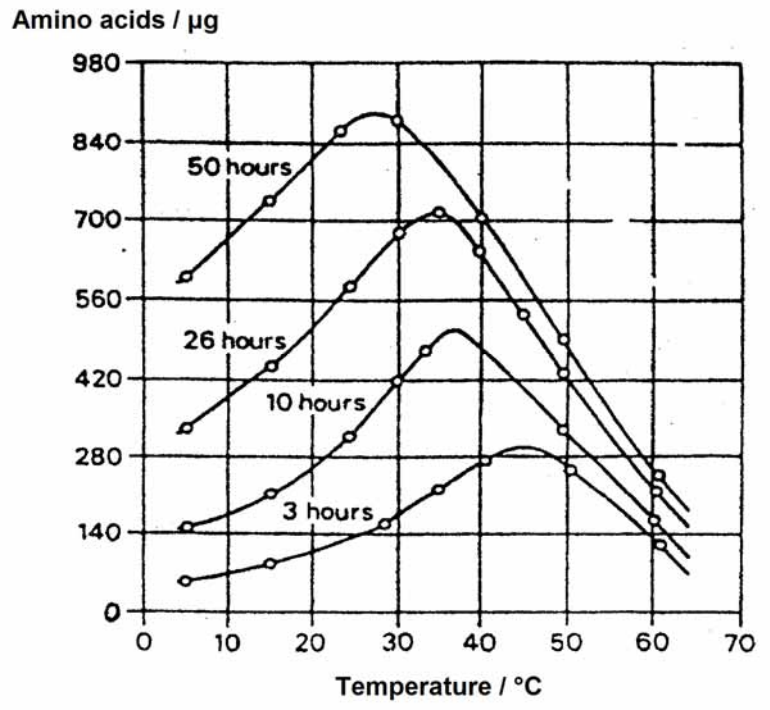
A Positive feedback

B Negative feedback

C Competitive inhibition

D Non-competitive inhibition

6 The graph below shows the effect of temperature on the activity of a proteolytic enzyme incubated at varying durations.



Which of the following can be deduced from the graph?

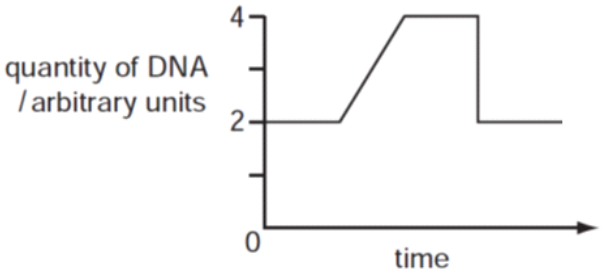
A The optimum temperature of the proteolytic enzyme is 27°C.

B The proteolytic enzyme undergoes denaturation at 27°C.

C The optimum temperature of the proteolytic enzyme decreases as the incubation time increases, due to time for breaking of covalent bonds.

D The optimum temperature of the proteolytic enzyme increases with incubation time, causing the hydrolysis to last longer.

7 The graph shows the change in the quantity of DNA in a cell with one pair of chromosomes during a cell division.



Which nucleus is formed as a result of this division?

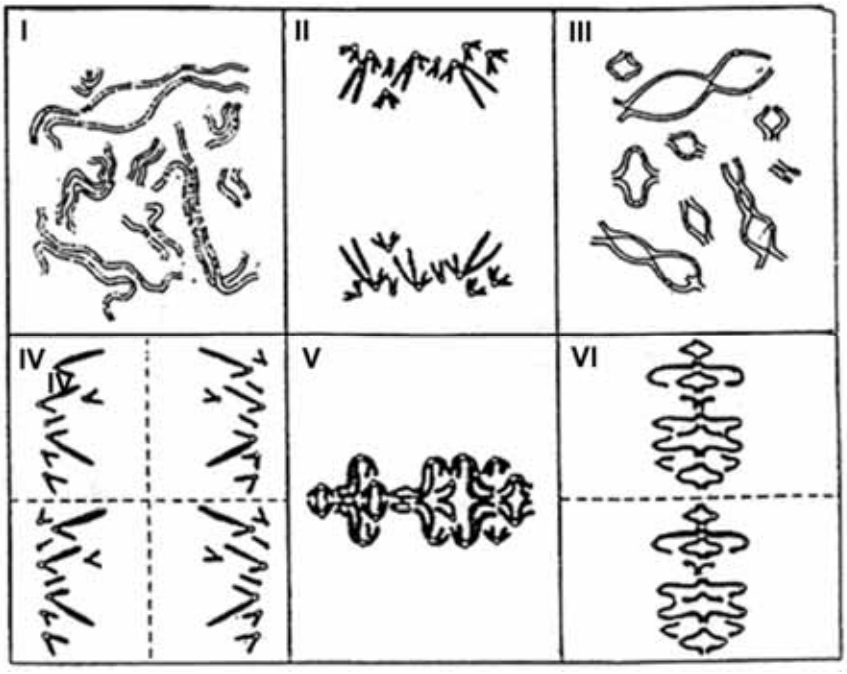
A

B

C

D

8 The diagram depicts the behaviour of chromosomes at various stages of meiosis of the same cell.



Which of the following shows the correct order of the stages?

A **III → V → II → VI → IV → I**

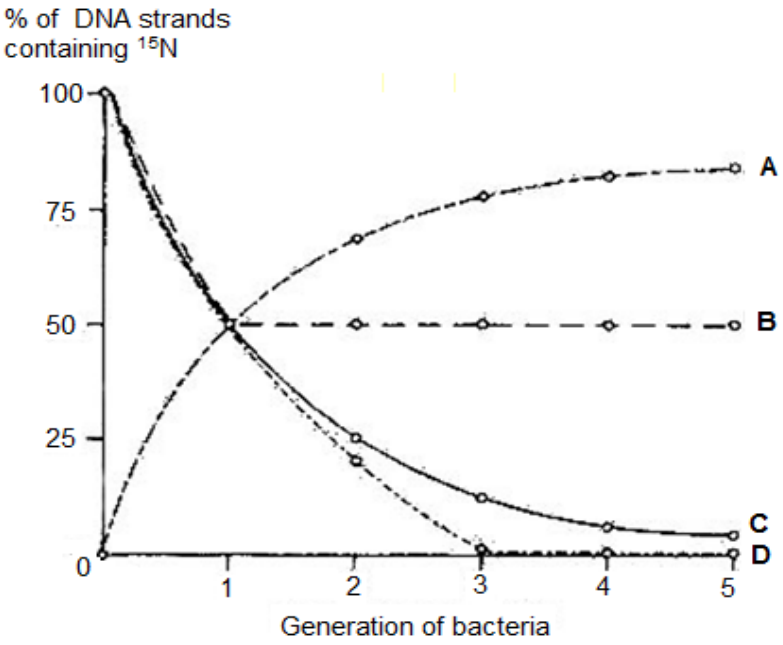
B **III → I → V → II → VI → IV**

C **II → III → I → V → VI → IV**

D **I → III → V → II → VI → IV**

9 Bacteria were cultured in a medium containing heavy nitrogen (^{15}N) until all their DNA were labelled. These bacteria were then grown in a medium containing only light nitrogen (^{14}N) for five generations. The percentage of DNA strands containing ^{15}N in each generation was estimated.

Which curve provides evidence that each daughter DNA molecule produced consists of a parental strand and a newly synthesised daughter strand? Answer: C



10 A student obtained a sample of DNA from which mRNA was transcribed. He then separated the two strands of DNA by adding NaOH. While doing so, he accidentally contaminated the DNA-mRNA mixture with another DNA sample. The base composition of each DNA strand and that of the mRNA were analysed. The results of the analysis are shown in the table below.

	A	G	C	T	U
DNA strand 1	19.1	26.0	31.0	23.9	0.0
DNA strand 2	24.2	30.8	25.7	19.3	0.0
DNA strand 3	20.5	25.2	29.8	24.5	0.0
DNA strand 4	25.1	24.2	18.8	29.9	0.0
mRNA	19.0	25.9	30.8	0.0	24.3

Which strand of DNA was used as a template for the synthesis of mRNA?

A DNA strand 1

B DNA strand 2

C DNA strand 3

D DNA strand 4

11 Part of the amino acid sequence in β-globin chains of normal and mutant haemoglobin are shown.

normal haemoglobin	thr-pro-glu-glu
mutant haemoglobin	thr-pro-val-glu

Possible mRNA codons for these amino acids are shown below.

glutamine (glu)	GAA GAG
threonine (thr)	ACU ACC
proline (pro)	CCU CCC
valine (val)	GUA GUG

Which tRNA molecule is not involved in the formation of this part of amino acid sequence in mutant haemoglobin?

A

B

C

D

12 A black-haired female rabbit was crossed with a white-haired male rabbit. Eight offspring were born. Two were white-haired males, two were white-haired females and all the others were black-haired females.

Which statement is correct, from this evidence, about the inheritance of hair colour in rabbits?

A Hair colour is sex-linked in rabbits.

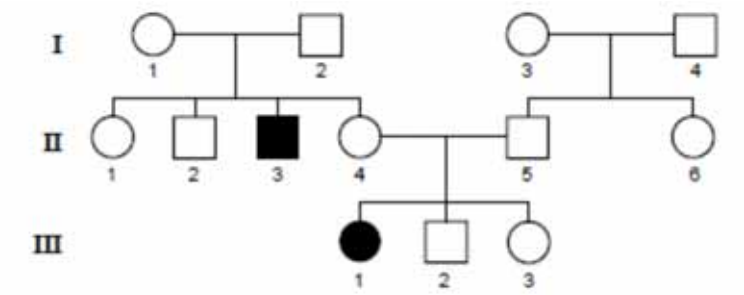
B The allele for black hair is dominant to the allele for white hair.

C The allele for white hair is dominant to the allele for black hair.

D The results of this cross are inconclusive.

13 Phenylketonuria (PKU) is a condition in which affected individuals fail to produce the enzyme phenylalanine hydroxylase. PKU is inherited as an autosomal recessive condition.

The following pedigree shows a family in which two members have PKU.



In the pedigree shown, individuals that must be heterozygous for PKU include

A I–2 **B** I–4 **C** II–1 **D** II–6

14 Tay-Sachs disease is characterised by abnormal accumulation of lipid-related compounds, which results in deterioration of cognitive and motor abilities.

It is caused by an autosomal recessive mutation in the allele coding for hexosaminidase A (HEXA), an enzyme that regulates the metabolism of phospholipids.

The base triplets in part of the coding DNA sequences for a normal HEXA allele and a mutant Tay-Sachs allele, as well as their corresponding amino acids are shown.

Normal HEXA allele	CGT Arg	ATA Ile	TCC Ser	TAT Tyr	GCC Gly	CCT Pro	GAC… Asp	
Tay-Sachs allele	CGT Arg	ATA Ile	TCT Ser	ATC Ile	CTA Leu	TGC Cys	CCC Pro	TGA… Thr

Which combination correctly describes the nature of mutation that results in the Tay-Sachs allele?

	changes to nucleotide sequences	**alteration of reading frame**	**length of polypeptide**
A	deletion of 2 bases	yes	shorter
B	insertion of 2 bases	yes	longer
C	substitution of 4 bases	no	unchanged
D	insertion of 4 bases	yes	longer

15 The figures below show the complete karyotypes of two rodents of the same species. In this species of rodent, males are the heterogametic sex, where they have two different sex chromosomes.

Rodent **A** (Male)

Rodent **B** (Female)

Which of the following observations is not true?

A A chromosomal aberration occurred in the ovary of the mother of rodent **B**

B Rodent **A** is diploid and 2n = 16.

C Rodent **B** has 1 missing chromosome.

D Non-disjunction of autosomes occurred in rodent **B**.

16 Which of the following statements are true about non-cyclic photophosphorylation?

1 $NADP^+$ is oxidized in non-cyclic phosphorylation.

2 P_{680} and P_{700} are reduced after the electrons are excited to higher energy levels.

3 ATP is synthesised in non-cyclic photophosphorylation.

4 The products of non-cyclic phosphorylation are $NADPH/H^+$, ATP and oxygen.

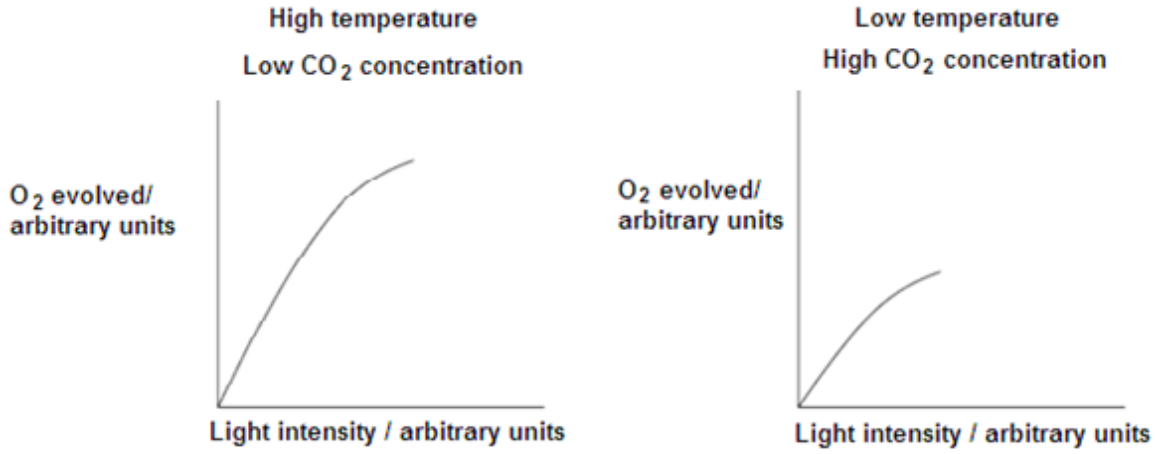
A 1 and 2

B 3 and 4

C 1, 2 and 3

D 2, 3 and 4

17 Students investigated the rate of photosynthesis by measuring the rate of oxygen evolved from an aquatic plant. The results of two experiments that they set up are shown below.



Which conclusion can be drawn from this data?

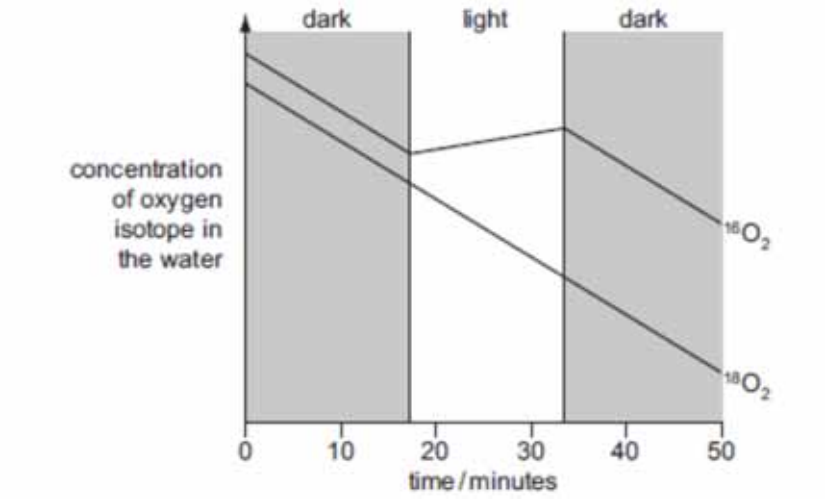
A Temperature does not affect the rate of photosynthesis.

B High concentrations of CO_2 reduce the rate of photosynthesis.

C Temperature and CO_2 concentration are both limiting factors.

D The greater the light intensity the greater the rate of photosynthesis.

18 The common isotope of oxygen is ^{16}O. Air containing $^{16}O_2$ and $^{18}O_2$ was bubbled through a suspension of algae for a limited period. After this, the concentration of these two isotopes of oxygen in the water was monitored for the next 50 minutes whilst the algae were subjected to periods of dark and light. The results are shown in the diagram.



What is the best explanation for these results?

A Both isotopes of oxygen are used by the algae in the dark in respiration, but in the light oxygen is produced from water in photorespiration.

B The algae can distinguish chemically between the two isotopes.

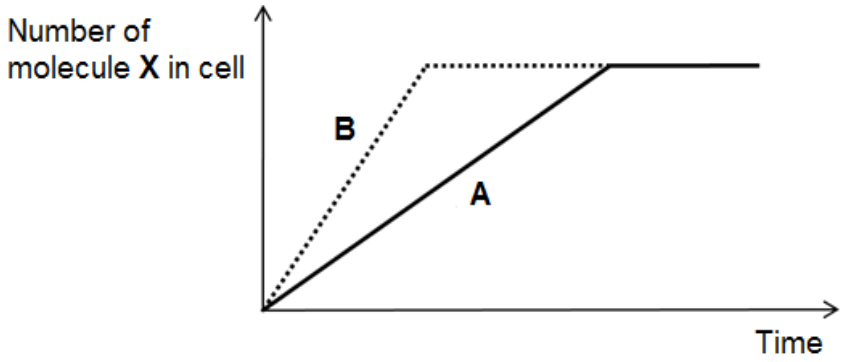
C The algae produce oxygen from the water which is used in photosynthesis, but only in the light.

D The two isotopes have different rates of diffusion.

19 After vigorous exercise, changes occur in the muscle tissue. Compared with 'at rest' conditions what will be changes be?

	ATP	lactate	pH
A	decreased	increased	decreased
B	increased	increased	increased
C	decreased	decreased	increased
D	increased	decreased	decreased

20 Graph **A** shows the transport of molecule **X**, with the help of carrier proteins, into a cell over time.

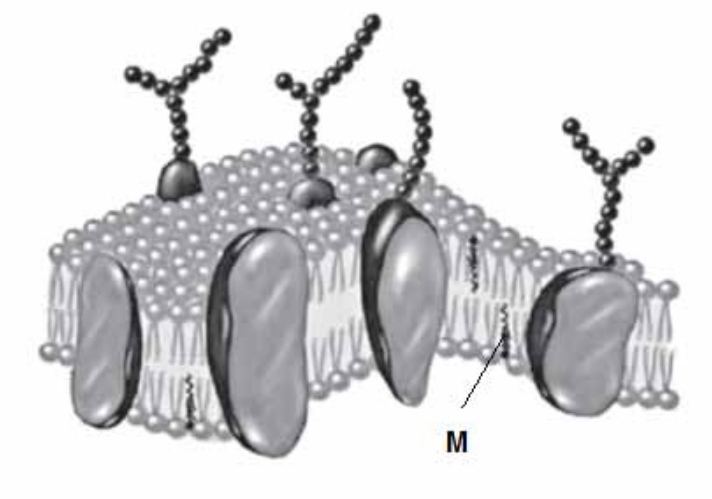


A student predicted that the alteration of one variable would result in graph **B**.

Which row shows the correct transport process and the alteration in variable that would result in graph **B**?

	transport process	alteration resulting in graph **B**
A	facilitated diffusion	increase in environmental temperature to 90 °C
B	active transport	increase in concentration of **X** in cell
C	facilitated diffusion	increase in number of carrier proteins
D	active transport	increase in availability of ATP

21 The diagram below shows a plasma membrane.



Which of the following correctly describes the function of molecule **M**?

1 limits membrane fluidity

2 enhances membrane fluidity

3 limits membrane permeability

4 enhances membrane permeability

5 allows for cell-cell adhesion

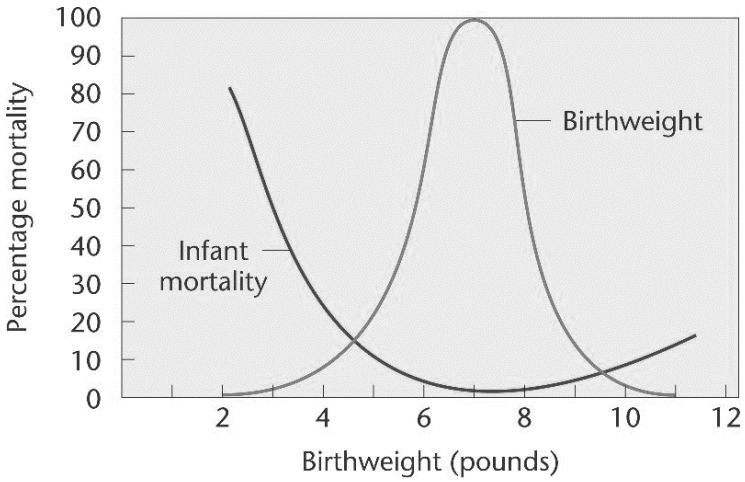
A 1 and 2 only

B 1, 2 and 3 only

C 1, 2, 3 and 4 only

D All of the above

22 The graph below shows the relationship between birthweight and infant mortality in humans.



What type of selection is demonstrated above?

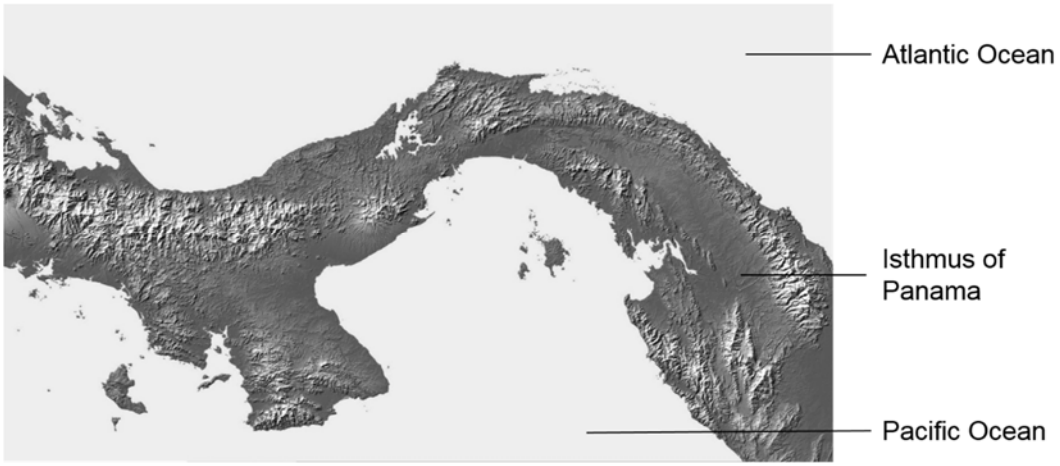
A Directional selection

B Disruptive selection

C Stabilising selection

D Artificial selection

23 The formation of the Isthmus of Panama around 3 *Mya* led to the separation of the Pacific and Atlantic oceans. Pistol shrimps of the *Alpheus* genus can be found in both oceans, surrounding the Isthmus. *Alpheus nuttingi* resides in the Atlantic ocean and *Alpheus millsae* resides in the Pacific ocean.



Despite being physically separated, *A. nuttingi* and *A. millsae* are morphologically and genetically very similar. The two species have also been shown to be capable of interbreeding in captivity. Which of the following statements are likely to be true?

1 *A. nuttingi* and *A. millsae* are derived from a common ancestral species.

2 The formation of the Isthmus resulted in geographical isolation of the two species 3 *Mya*.

3 *A. nuttingi* and *A. millsae* are two separate species because they are geographically isolated.

4 Similar environmental conditions around the Isthmus exerted similar selection pressures, leading to convergent evolution between *A. nuttingi* and *A. millsae*.

A 1 only

B 1 and 3

C 2 and 3

D 3 and 4

24 Myxomatosis is a viral disease of rabbits. It spreads rapidly and most rabbits die within 14 days of being infected. Myxomatosis has been deliberately used to reduce the number of rabbits in countries where they are a significant crop pest.

The initial release of the virus caused populations to fall by over 90%. Resistance to myxomatosis increased in the 70 years following initial release, so at the present time up to 50% of infected rabbits are able to survive.

Which of the following statements could explain the increasing frequency of resistance to myxomatosis in the years following release of the virus?

1 In populations with high incidences of myxomatosis, mutations leading to resistance are more likely to occur.

2 Infected rabbits die quickly, hence the alleles that code for myxomatosis are eliminated from the population.

3 The initial release of the virus led to death of large number of rabbits, greatly altering the frequency of alleles in rabbit populations.

4 During disease outbreaks there is greater food availability for the surviving rabbits, increasing the probability that they survive.

A 4 only

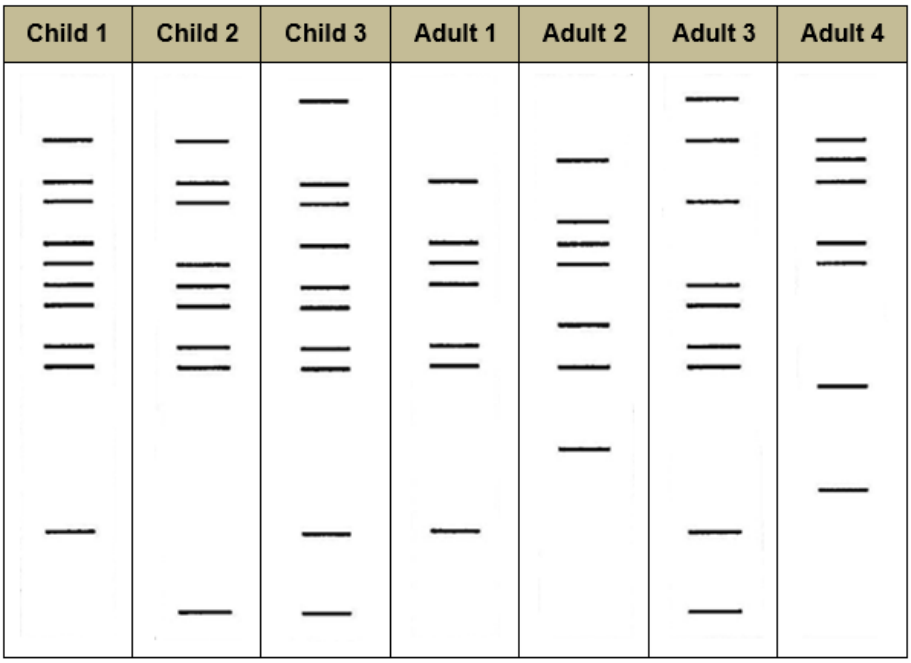
B 1 and 2 only

C 2 and 4 only

D 2, 3 and 4 only

25 Seven skeletons were found in an unidentified grave. To establish the relationship between these seven individuals, DNA were isolated from these skeletons and then analysed using gel electrophoresis.

The results obtained from the skeletons, three children and four adults, are shown below.



Other analysis showed that all three children have the same parents. Which two adults may be the parents of these children?

A Adults 1 and 2

B Adults 1 and 3

C Adults 2 and 3

D Adults 2 and 4

26 Which of the following statements about polymerase chain reaction are true?

1 Copy fragments of DNA
2 Amplify fragments of DNA
3 Translate fragments of DNA
4 Requires an excess of RNA primers
5 Requires DNA-dependent DNA polymerase

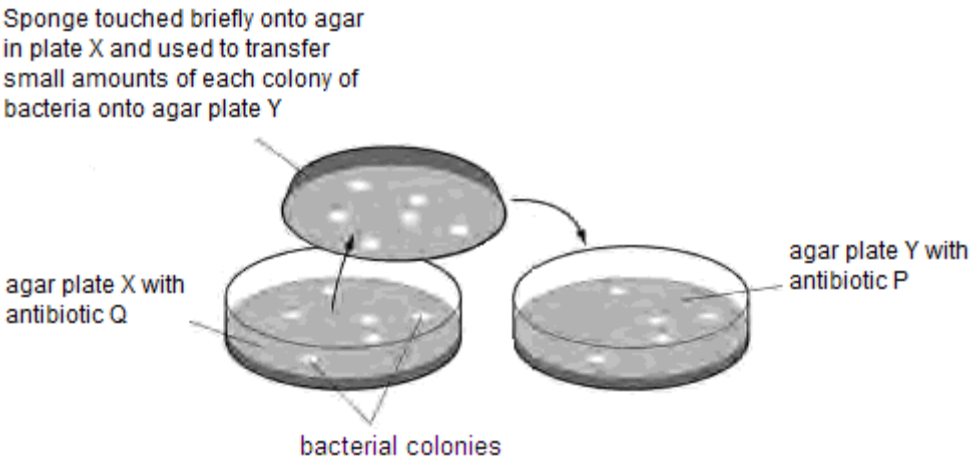
A 1 and 2

B 2 and 5

C 1, 2 and 4

D 1, 2 and 5

27 The diagram shows a method used to detect bacteria colonies which are successfully transformed during genetic engineering.



Which explains why other methods for detecting successful transformation are now preferred?

1 Incorporating heavy-metal esistance genes along with the desired genes means that you can easily kill cells that have not been transformed.

2 Presence or absence of non-toxic fluorescent markers is easy to detect using ultra-violet light.

3 The antibiotic resistance genes previously used as markers might have escaped into the environment.

4 The antibiotic resistance genes previously used as markers killed the transformed cells so they were difficult to use.

A 1 and 3

B 2 and 4

C 1, 2 and 3

D 1, 2, 3 and 4

28 Which of the following best explains why a genome project is not finished when the sequence has been completed?

A Genomes change too fast and must constantly be updated.

B Without knowing the number, the function, and the location of genes within a genome, the sequence is not very useful.

C Individuals within a species are so unique that having a single sequence is insufficient to characterise a species' genome.

D Many sections of a genome are too difficult to sequence and have not actually been included in 'complete' genomes.

29 Which of the following statements regarding stem cells are **not** correct?

1 Stem cells are present within various organs of the adult body.

2 Stem cells can develop into a whole organism when implanted into the womb.

3 Stem cells can be grown indefinitely in culture under appropriate culture conditions.

4 Stems cells isolated from a 3-5 day old human embryo can differentiate into only one kind of cells.

A 1 and 3 only

B 2 and 4 only

C 1, 2 and 3

D 2, 3 and 4

30 Maize varieties with leaves that produce protein toxic to insects are being developed. The DNA coding for these toxic proteins was inserted into a maize chromosome via a bacterial plasmid. Many people oppose to this process.

Which objection is **not** biologically valid?

A Beneficial insects may be killed if they eat genetically modified maize.

B Genes for antibiotic resistance are present in plasmids and these genes may be passed to harmful bacteria.

C Hybridisation may transfer the bacterial genes from maize to weeds, giving the weed species new and harmful characteristics.

D Mutations may be caused in cattle or humans that eat the genetically modified maize.

RIVER VALLEY HIGH SCHOOL
YEAR 6
PRELIMINARY EXAMINATION II

CANDIDATE NAME											
CENTRE NUMBER	S					CLASS		INDEX NUMBER				

H1 BIOLOGY **8875/02**

Paper 2 Core Paper **11 Sep 2017**

2 hours

Additional Materials: Answer Paper

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.

Section B
Answer **one** question.
Circle the question attempted on the cover page.

The use of an approved scientific calculator is expected, where appropriate.

At the end of the examination, fasten all your work securely together. The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	**/ 8**
2	**/ 12**
3	**/ 9**
4	**/ 11**
Section B	
5 or 6	**/ 20**
Total	**/ 60**

This Question Paper consists of **12** printed pages.

SECTION A

Answer **all** questions.

1 Fig. 1.1 represents the molecular structure of a type of phospholipid.

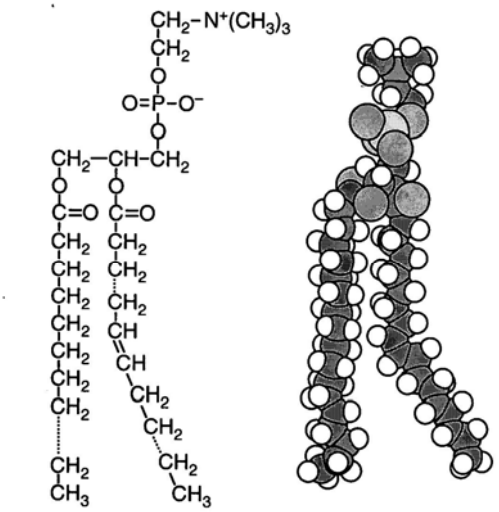


Fig. 1.1

(a) (i) Describe the arrangement of phopsholipids in cell membranes. [2]

(ii) Explain how the structure of phospholipids is related to this arrangement in cell membranes. [2]

Fig 1.2 shows a channel protein, aquaporin, which is necessary for the bulk flow of water molecules.

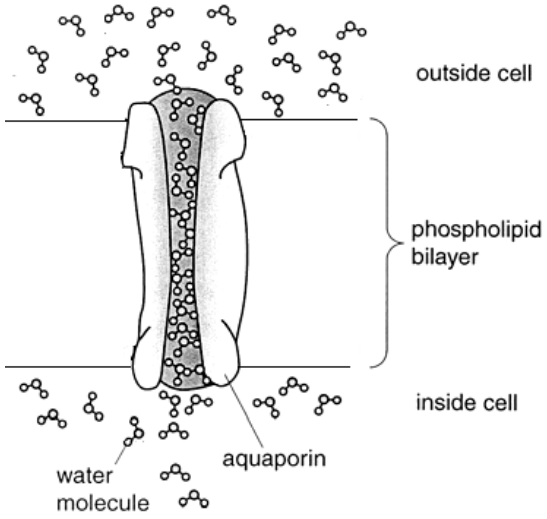


Fig 1.2

(b) With reference to Fig. 1.2, describe how water molecules move across a membrane. [2]

Diabetes insipidus is a condition characterised by large amounts of diluted urine. Fluid is not reabsorbed by the cells in the kidney due to changes in permeability of their surface membrane. Reduction of fluid intake by patients has little effect on the concentration of urine.

Diabetes insipidus is a result of mutation in the gene coding for aquaporin channels.

A clinician studied the surface membrane of kidney cells involved in reabsorption of fluid in individuals with diabetes insipidus and found that aquaporin channels are absent.

(c) Suggest how mutant aquaporin channels leads to diluted urine in individuals with diabetes insipidus. [2]

[Total: 8]

2 Fig. 2.1 is an electron micrograph of a mitochondrion.

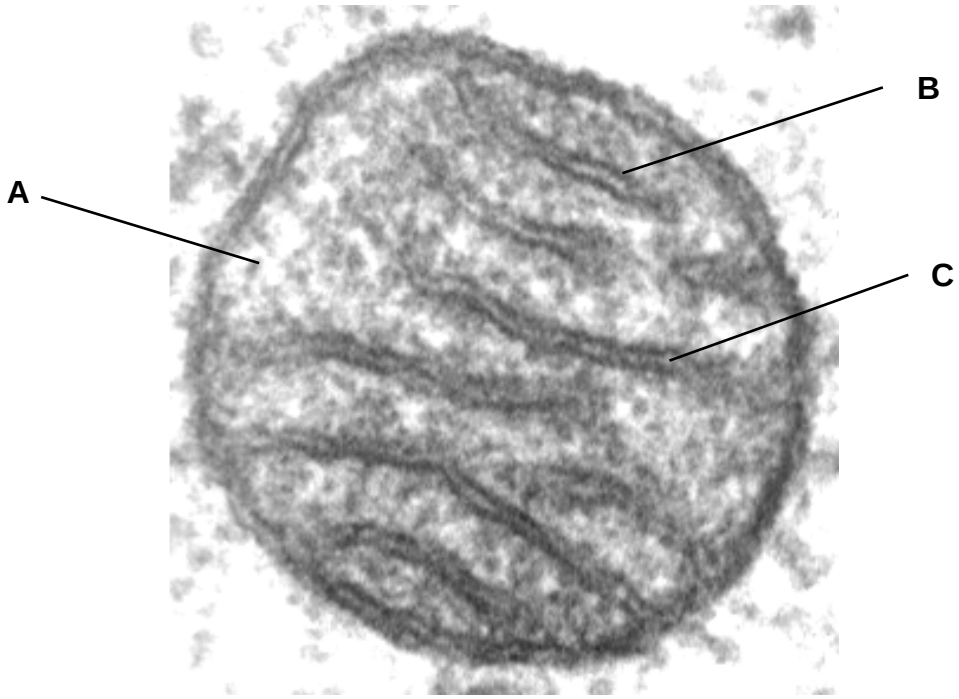


Fig. 2.1

(a) **(i)** Identify structures **A** and **B**. [2]

A _____

B _____

(ii) Describe how structure **A** is adapted to its function. [1]

_____

_____

(b) **(i)** State the role of high concentration of protons at **C**. [1]

_____

_____

(ii) Explain how the high concentration of protons is generated at **C**. [3]

In an investigation to determine the effect of chemical **M** on respiration, mitochondria were incubated in four ways:

1. with glucose
2. with pyruvate
3. with glucose and chemical **M**
4. with pyruvate and chemical **M**

After incubation, the results are summarised in Table 1.1.

Table 1.1

	CO_2 evolution	O_2 consumption	ATP production by oxidative phosphorylation
Glucose	x	x	x
Pyruvate	✓	✓	✓
Glucose + chemical **M**	x	x	x
Pyruvate + chemical **M**	✓	✓	x

(c) **(i)** Explain why carbon dioxide is produced when mitochondria are incubated with pyruvate but not when incubated with glucose. [3]

(ii) Suggest why when mitochondria are incubated with chemical **M**, oxygen consumption occurs but not ATP production. [2]

[Total: 12]

3 In lizard, a recessive mutant allele leads to black body colour as opposed to the normal brown body colour. A second recessive mutant allele at a separate locus leads to grey spots as opposed to normal white spots on the body.

A test cross was conducted for these loci. This test cross took F1 females from a standard dihybrid cross and crossed them with a male pure breeding for black body with grey spots. The following offspring were produced:

Brown body with white spots	160
Brown body with grey spots	155
Black body with white spots	156
Black body with grey spots	162

(a) Define the term *locus*. [1]

(b) Draw a genetic diagram to explain the observed results of this test cross. [4]

(b) A mutation occurs to the gene locus determining body colour and a new body colour red appeared in the population of lizards.

Table 3.1 shows the change in the frequency of the three different phenotypes.

Table 3.1

	Initial Population	Generation 10	Generation 20	Generation 30
Brown colour	 80%	 80%	 70%	 40%
Red colour	 10%	0%	0%	0%
Black colour	 10%	 20%	 30%	 60%

Using Table 3.1 and your knowledge of natural selection, explains the results. [4]

[Total: 9]

4 Genetically modified maize was widely grown in the maize-growing areas of the USA. One of the genetically modified varieties of maize contains a gene (*Bt*) from a bacterium, *Bacillus thuringiensis*. The gene codes for a toxin, which is expressed in the leaves and acts as an insecticide.

In USA, milkweed frequently grows around the edge of maize fields and is fed upon by caterpillars of the Monarch butterfly. In an investigation on the environmental effects of *Bt* maize, leaves of milkweed were divided into three groups, **A**, **B** and **C**, and treated as shown in Table 4.1.

Table 4.1

Treatment group	Treatment
A	dusted with pollen from genetically modified maize carrying the *Bt* gene;
B	dusted with pollen from maize that had not been genetically modified;
C	not dusted with pollen.

Monarch caterpillars were then placed on the leaves and the survival of the caterpillars was measured over four days. The results of the experiment are shown in Fig. 4.1.

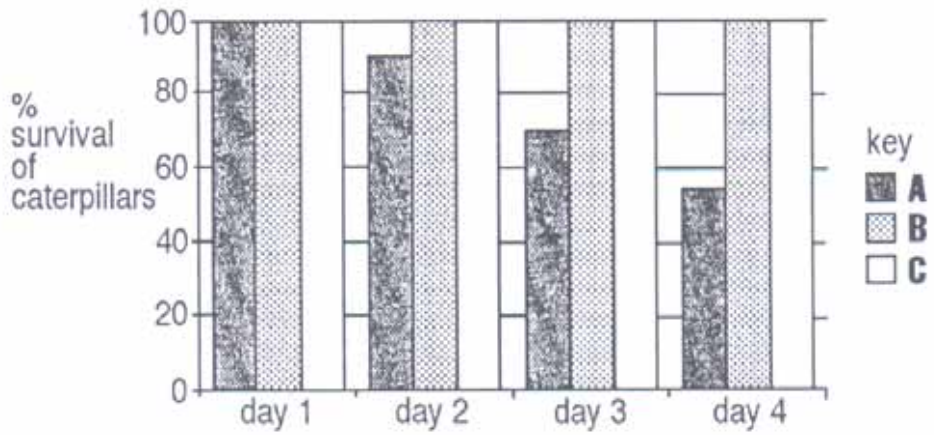


Fig. 4.1

(a) Explain why farmers in the USA grow maize carrying the *Bt* gene. [2]

(b) With reference to Fig. 4.1, comment on the effect of eating pollen from different maize plants on the survival of Monarch butterfly caterpillars. [2]

Plasmids are small circles of DNA, found in many bacteria, which can be used for genetic engineering of crop plants such as *Bt* corn.

(c) State and explain which **one** feature of plasmids means that they may be used for intermediate steps in gene cloning involving **any** species of organism. [2]

Fig. 4.2 shows a length of DNA from *Bt* maize. The DNA is cut with restriction enzyme, *Hae*III.

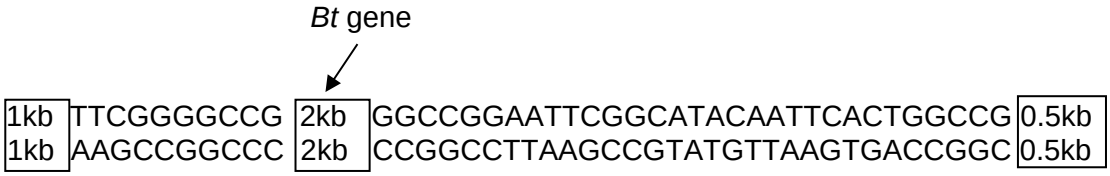


Fig. 4.2

Target site of *Hae*III

GGCC
CCGG

(d) Explain what is meant by a restriction enzyme. [2]

(e) With reference to Fig. 4.2, state how many fragments of DNA are produced after digestion with *Hae*III. [1]

Some companies claimed they have successfully introduced the *Bt* gene into the maize that they sell to the farmers. DNA from the maize plants were analysed using restriction enzymes *Hae*III and electrophoresis as shown in Fig. 4.3.

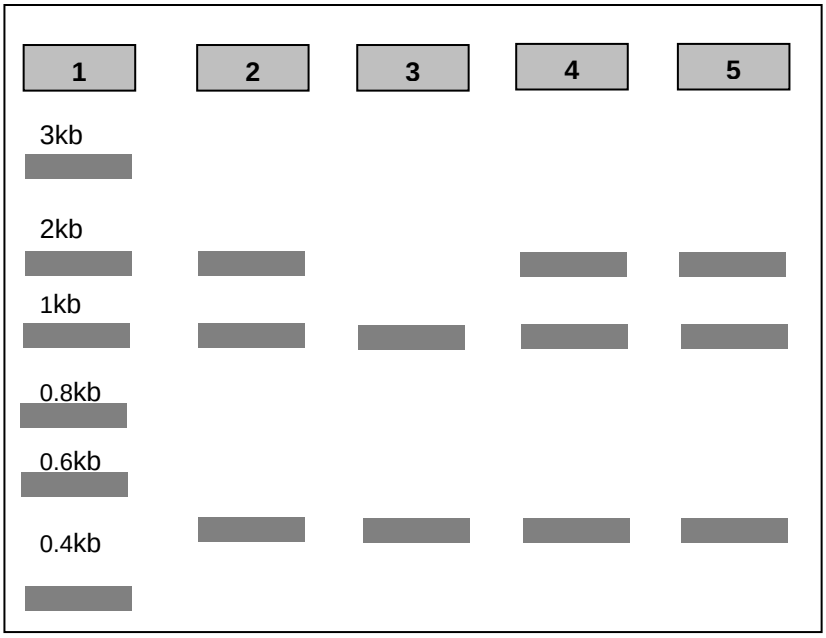


Fig. 4.3

(f) Identify and explain which company is likely to have sold non-genetically modified maize. [2]

[Total: 11]

SECTION B

Answer EITHER 5 or 6.

Write your answers on the separate answer paper provided.
Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.
Your answers must be in continuous prose, where appropriate.
Your answers must be set out in sections **(a)**, **(b)** etc., as indicated in the question.

Either

5 **(a)** Using a named example, describe how a gene mutation can lead to a disease phenotype. [7]

(b) Explain how temperature affects the rate of an enzyme-catalysed reaction. [7]

(c) Describe the main ways in which an enzyme differs from DNA. [6]

[Total: 20]

Or

6 **(a)** Describe how mitosis maintains genetic stability and its importance in growth, repair and asexual reproduction. [7]

(b) Describe the structure of an amino acid and how a peptide bond is formed with another amino acid. [6]

(c) Compare transcription and translation. [7]

[Total: 20]

RIVER VALLEY HIGH SCHOOL
YEAR 6
PRELIMINARY EXAMINATION II

CANDIDATE NAME											
CENTRE NUMBER	S					CLASS		INDEX NUMBER				

H1 BIOLOGY **8875/02**

Paper 2 Core Paper **11 Sep 2017**

2 hours

Additional Materials: Answer Paper

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.

Section B
Answer **one** question.
Circle the question attempted on the cover page.

The use of an approved scientific calculator is expected, where appropriate. You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together. The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	**/ 12**
2	**/ 8**
3	**/ 9**
4	**/ 11**
Section B	
5 or 6*	**/ 20**
Total	**/ 60**

This Question Paper consists of **12** printed pages.

SECTION A

Answer **all** questions.

1 Fig. 1.1 represents the molecular structure of a type of phospholipid.

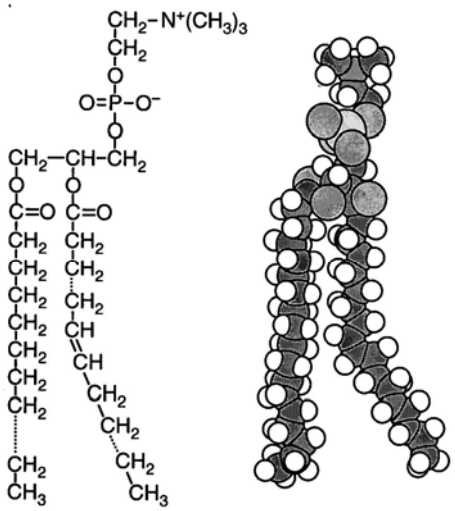


Fig. 1.1

	(a)	**(i)**	Describe the arrangement of phopsholipids in cell membranes.	[2]
			1. Phospholipids arranged into a bilayer;; **2. The (hydrophilic) phosphate heads of the phospholipids face outwards on both sides of the membrane;** **3. The (non-polar, hydrophobic) hydrocarbon tails face inwards;**	
		(ii)	Explain how the structure of phospholipids is related to this arrangement in cell membranes.	[2]
			1. Phospholipid is amphipathic; **2. The hydrophilic phosphate group of the phospholipid molecule; interact with the aqueous environment on both sides of membrane;;** **3. The non-polar/hydrophobic hydrocarbon chains/tail of the phospholipid molecule shielded from the aqueous medium;;**	

Fig 1.1 shows a channel protein, aquaporin, which is necessary for the bulk flow of water molecules.

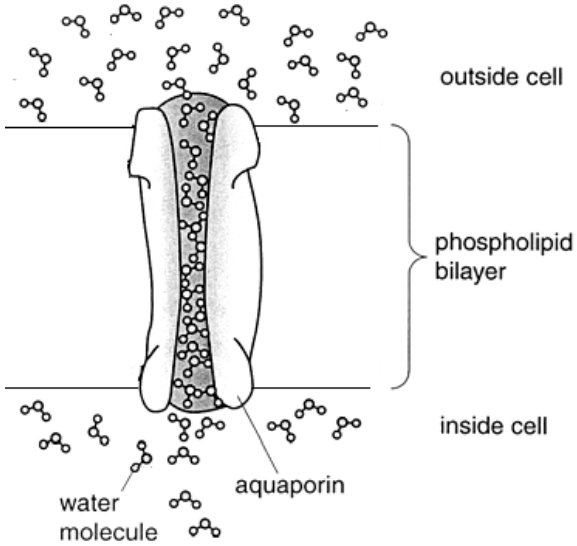


Fig 1.1

(b) With reference to Fig. 1.1, describe how water molecules move across a membrane. [2]

1. **As the cell has a more negative water potential compared to the surrounding water; *Reject: concentration of water***
2. **water molecules from the surrounding move into the cell;**
3. **through aquaporin channels;**
4. **down water potential gradient;**

Diabetes insipidus is a condition characterised by large amounts of diluted urine. Fluid is not reabsorbed by the cells in the kidney due to changes in permeability of their surface membrane. Reduction of fluid intake by patients has little effect on the concentration of urine.

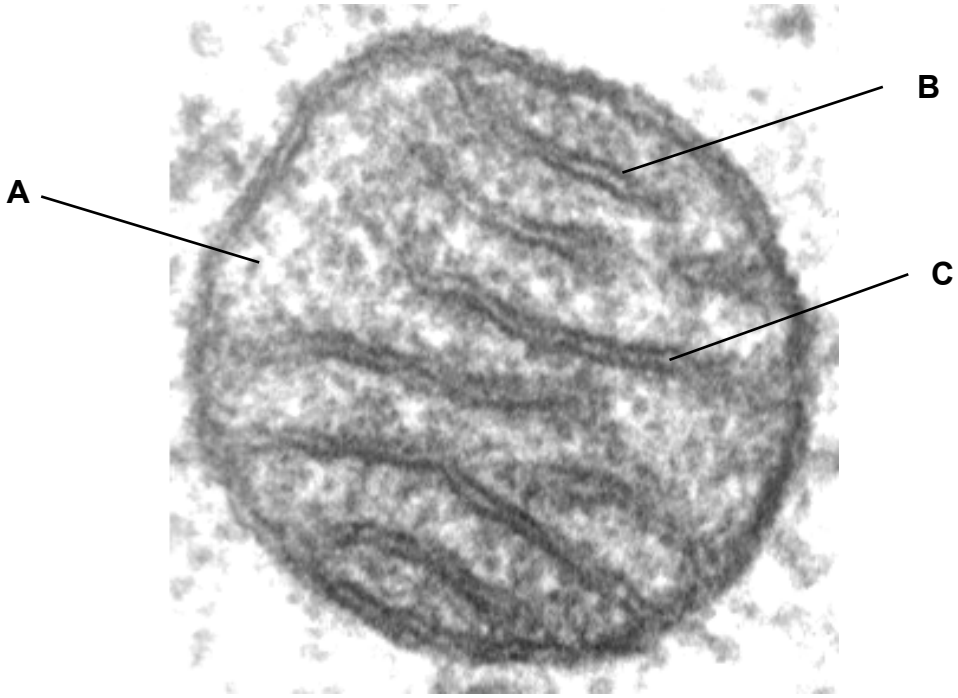
Diabetes insipidus is a result of mutation in the gene coding for aquaporin channels.

A clinician studied the surface membrane of kidney cells involved in reabsorption of fluid in individuals with diabetes insipidus and found that aquaporin channels are absent.

(c) Suggest how mutant aquaporin channels leads to diluted urine in individuals with diabetes insipidus. [2]

1. **Mutation leads to change in three-dimensional conformation of aquaporin protein;;**
2. **Aquaporin not embedded in cell membrane;**
3. **Water not reabsorbed into kidney cells;**

[Total: 8]

2	Fig. 2.1 is an electron micrograph of a mitochondrion.  **Fig. 2.1**				
	(a)	**(i)**	Identify structures **A** and **B**.		[2]
			A	**(mitochondrial) Matrix;;**	
			B	**Cristae / inner membrane;;**	
		(ii)	Describe how structure **A** is adapted to its function.		[1]
			Matrix contains enzymes of Krebs cycle;;		
	(b)	**(i)**	State the role of high concentration of protons at **C**.		[1]
			proton gradient as a source of potential energy for the synthesis of ATP;;		
		(ii)	Explain how the high concentration of protons is generated at **C**.		[3]
			1. electrons from NADH / $FADH_2$; **2. passes along a chain of electron carriers (releasing energy in a series of small steps);** **3. free energy released;** **4. is used to pump protons;** **5. from matrix into intermembrane space;**		

			6. inner mitochondrial membrane is impermeable to ions;	
		In an investigation to determine the effect of chemical **M** on respiration, mitochondria were incubated in four ways: 1. with glucose 2. with pyruvate 3. with glucose and chemical **M** 4. with pyruvate and chemical **M** After incubation, the results are summarised in Table 1.1. **Table 1.1** CO_2 evolution / O_2 consumption / ATP production by oxidative phosphorylation Glucose: x / x / x Pyruvate: ✓ / ✓ / ✓ Glucose + chemical **M**: x / x / x Pyruvate + chemical **M**: ✓ / ✓ / x	
	(c)	**(i)**	Explain why carbon dioxide is produced when mitochondria are incubated with pyruvate but not when incubated with glucose.	[3]
			1. no glycolytic enzymes in mitochondria; **2. glycolysis does not occur in the mitochondria / glycolysis can only occur in the cytosol;** **3. glucose cannot be oxidised to form pyruvate;** **4. pyruvate can enter mitochondria but glucose cannot;** **5. CO_2 produced by decarboxylation in link reaction;** **6. and Krebs cycle;**	
		(ii)	Suggest why when mitochondria are incubated with chemical **M**, oxygen consumption occurs but not ATP production.	[2]
			1. Chemical M only block ATP synthase so no phosphorylation of ADP/no flow of H^+ down concentration gradient (through ATP synthase);; **2. Chemical M does not affect ETC to transfer electrons to oxygen;;**	
				[Total: 12]

3 In lizard, a recessive mutant allele leads to black body colour as opposed to the normal brown body colour. A second recessive mutant allele at a separate locus leads to grey spots as opposed to normal white spots on the body.

A test cross was conducted for these loci. This test cross took F1 females from a standard dihybrid cross and crossed them with a male pure breeding for black body with grey spots. The following offspring were produced:

Brown body with white spots	160
Brown body with grey spots	155
Black body with white spots	156
Black body with grey spots	162

(a) Define the term *locus*. [1]

Locus refers to the position of a gene/allele on a chromosome or within a DNA molecule;;

(b) Draw a genetic diagram to explain the observed results of this test cross. [4]

F1 Parental phenotype **Brown body white spots x Black body grey spots**

F1 Parental genotypes **BbWw x bbww ;;**

Gametes **(BW) (bW) x (bw) ;**

(Bw) (bw)

	(BW)	(Bw)	(bW)	(bw)
(bw)	**BbWw** **Brown body white spots**	**Bbww** **Brown body grey spots**	**bbWw** **black body white spots**	**bbww** **brown body grey spots**

Correct genotype;;
Correct corresponding phenotypes;;

F2 phenotypic ratio **1 Brown body white spots: 1 Brown body grey spots: black body white spots: 1 brown body grey spots ;**

(b) A mutation occurs to the gene locus determining body colour and a new body colour red appeared in the population of lizards.

Table 3.1 shows the change in the frequency of the three different phenotypes.

	Initial Population	Generation 10	Generation 20	Generation 30
Brown colour	 80%	 80%	 70%	 40%
Red colour	 10%	0%	0%	0%
Black colour	 10%	 20%	 30%	 60%

Using Table 3.1 and your knowledge of natural selection, explains the results. [4]

1. **Mutations leads to variations;**
2. **appearance of red phenotype;**
3. **Red phenotype and brown phenotypes are selected against;**
4. **Red phenotype disappeared after 10 generations;**
5. **Brown phenotype decreased in frequency;**
6. **Black phenotype is favoured;**
7. **Survive and reproduce;**
8. **Pass on the allele to the offspring;**
9. **Population size of black phenotype greater than brown phenotype after 30 generations;**
10. **Quote values: 60% black phenotype vs 40% brown phenotypes;**

[Total: 9]

4 Genetically modified maize was widely grown in the maize-growing areas of the USA. One of the genetically modified varieties of maize contains a gene (*Bt*) from a bacterium, *Bacillus thuringiensis*. The gene codes for a toxin, which is expressed in the leaves and acts as an insecticide.

In USA, milkweed frequently grows around the edge of maize fields and is fed upon by caterpillars of the Monarch butterfly. In an investigation on the environmental effects of *Bt* maize, leaves of milkweed were divided into three groups, **A**, **B** and **C**, and treated as shown in **Table 4.1**.

Table 4.1

Treatment group	Treatment
A	dusted with pollen from genetically modified maize carrying the *Bt* gene;
B	dusted with pollen from maize that had not been genetically modified;
C	not dusted with pollen.

Monarch caterpillars were then placed on the leaves and the survival of the caterpillars was measured over four days. The results of the experiment are shown in Fig. 4.1.

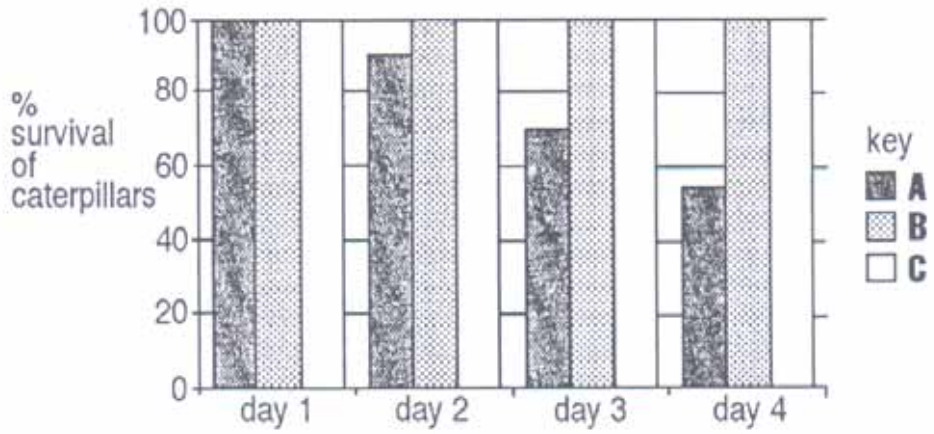


Fig. 4.1

(a) Explain why farmers in the USA grow maize carrying the *Bt* gene. [2]

1. **maize carrying *Bt* gene produces a toxin in its leaves which kills insects that attack them;;**
2. **reduce use of insecticides which are harmful to humans / environment;**
3. **higher yield of crop;**

	(b)	With reference to Fig. 4.1, comment on the effect of eating pollen from different maize plants on the survival of Monarch butterfly caterpillars.	[2]
		1. caterpillars that consumed pollens from non-genetically modified and leaves without pollen were unaffected; **2. 100% survival of caterpillars throughout the 4 days;** **3. caterpillars that consumed pollens from *Bt* maize decreased with time;** **4. % survival of caterpillars decreased from 100% to 55%;**	
	Plasmids are small circles of DNA, found in many bacteria, which can be used for genetic engineering of crop plants such as *Bt* corn.		
	(c)	State and explain which **one** feature of plasmids means that they may be used for intermediate steps in gene cloning involving **any** species of organism.	[2]
		1. Plasmids have multiple restriction sites; **2. that can be recognized and cleaved by different restriction enzymes;** **3. a wide range of DNA fragment isolated from any species by restriction digestion;** **4. can be inserted into the plasmid if cut with the same restriction enzyme;**	
	Fig. 4.2 shows a length of DNA from *Bt* maize. The DNA is cut with restriction enzyme, *Hae*III. *Bt* gene ↓ 1kb TTCGGGGCCG 2kb GGCCGGAATTCGGCATACAATTCACTGGCCG 0.5kb 1kb AAGCCGGCCC 2kb CCGGCCTTAAGCCGTATGTTAAGTGACCGGC 0.5kb **Fig. 4.2** Target site of *Hae*III GGCC CCGG		

	(d)	Explain what is meant by a restriction enzyme.	[2]
		A restriction enzyme: **1. recognises and binds a specific palindromic DNA base sequence / restriction site;;** **2. cuts double-stranded DNA molecules by breaking internal phosphoester bonds;;**	
	(e)	With reference to Fig. 4.2, state how many fragments of DNA are produced after digestion with *Hae*III.	[1]
		4;;	

Some companies claimed they have successfully introduced the *Bt* gene into the maize that they sell to the farmers. DNA from the maize plants were analysed using restriction enzymes *Hae*III and electrophoresis as shown in Fig. 4.3.

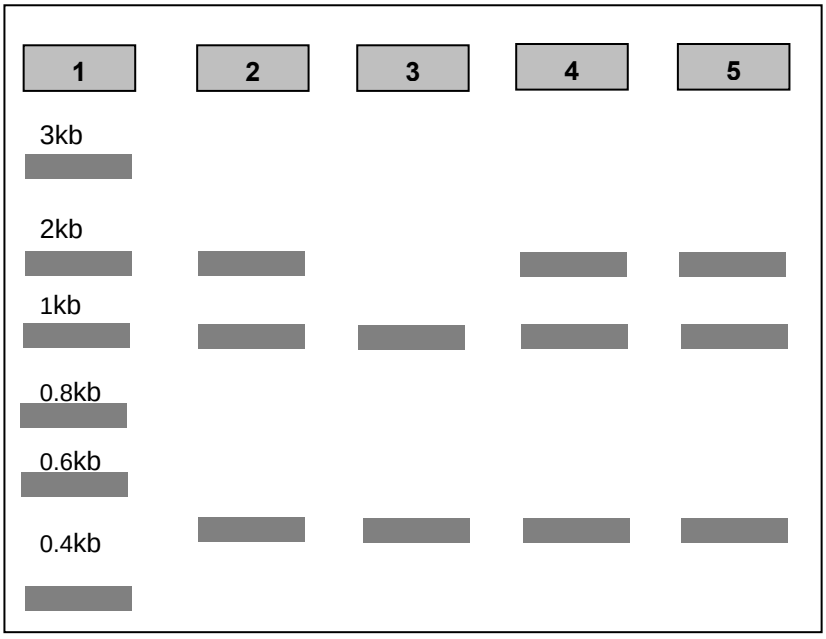


Fig. 4.3

	(f)	Identify and explain which company is likely to have sold non-genetically modified maize.	[2]
		1. Company X;; **2. 2kb band is missing which means the *Bt* gene is not incorporated into the DNA of the maize;;**	
			[Total: 11]

SECTION B

Answer EITHER 5 or 6.

Write your answers on the separate answer paper provided.
Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.
Your answers must be in continuous prose, where appropriate.
Your answers must be set out in sections **(a)**, **(b)** etc., as indicated in the question.

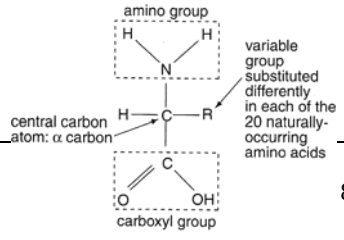
5	**(a)**	Using a named example, describe how a gene mutation can lead to a disease phenotype.	[7]
		1. Sickle cell anemia;; **2. Base pair substitution;** **3. thymine replaced by adenine;** **4. of β globin gene;** **5. This changes codon 6 on mRNA;** **6. GAA to GUA;** **7. resulting in missense mutation;** **8. that changes glutamic acid to valine;** **9. from a negatively charged/hydrophilic amino acid;** **10. to a neutral/hydrophobic amino acid;** **11. This changes the folding / three dimensional conformation of haemoglobin / β globin;** **12. generating a sticky patch;** **13. on the surface of haemoglobin;** **14. The deoxygenated form of mutant haemoglobin;** **15. is insoluble in red blood cells;** **16. forming crystalline arrays;** **17. This causes red blood cells to form a sickle shape;** **18. Sickle-shaped red blood cells are rigid;**	
	(b)	Explain how temperature affects the rate of an enzyme-catalysed reaction.	[7]
		1. at low temperature, enzyme is inactive; **2. the rate of reaction increases with temperature until the optimum temperature is reached;** **3. the rate of reaction is doubled for every increase of 10°C;** **4. increasing temperature increases the kinetic energy of the enzyme and substrate molecules;**	

5. increase in the frequency of effective collisions between the enzyme and substrate molecules;
6. more enzyme/substrate complexes are formed per unit time, rate of reaction increases;
7. optimum temperature is the temperature at which the enzyme is functioning at its maximum rate;
8. above optimum temperature, the rate of reaction decreases rapidly
9. the enzyme are denatured;
10. atoms which make up the enzyme molecule vibrate vigorously;
11. bonds (hydrogen and hydrophobic interactions) holding the enzyme molecule in its precise shape begin to break;
12. change in active site conformation;
13. substrate unable to fit into the active site of the enzyme;
14. less successful enzyme-substrate complexes formed per unit time;
15. graph;

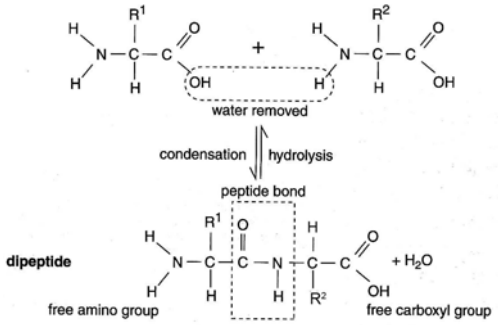
(c) Describe the main ways in which an enzyme differs from DNA. [6]

	Features	Enzyme	DNA
1	Monomer	Amino acid	Deoxyribonucleotide
2	Choice of monomers	Twenty types, dependent on R-groups	Four types, dependent on nitrogenous bases
3	Links between monomers	Peptide linkage	Phosphoester linkage
4	Secondary structure	Single polypeptide chain	Double polynucleotide chains
5	Higher order structures	Folding of single polypeptide chain Conjugation of various polypeptide chains	Coiling of double helix around histones
6	Bonds responsible	Hydrogen, disulphide, ionic bonds, hydrophobic interactions	Hydrogen bonds between complementary bases
7	Location of synthesis	Cytoplasm	Nucleus, chloroplast, mitochondria
8	Function	Catalysis of reaction	Transmission of genetic information

		[Total: 20]	

6	**(a)**	Describe how mitosis maintains genetic stability and its importance in growth, repair and asexual reproduction.	[7]
		1. Mitosis forms 2 daughter nuclei ; **2. Which are genetically identical to the parent cell;** **3. With the same number of chromosomes as the parent cell;** **4. S phase of interphase ;** **5. amount of DNA is doubled;** **6. Semi-conservative replication ensures that all genetic information is retained;** **7. Crossing over or pairing up of homologous chromosomes do not occur;** **8. Ensures that there is no genetic variation / maintains genetic stability;** **Growth** **9. Mitosis plays a role in the growth in tissues;** **10. Increase in cell numbers;** **11. results in increase in size of organisms (growth) in multicellular organisms;** **12. New cells are identical with existing cells so that they carry out the same function;** **Repair** **13. Mitosis is important for the repair / replacement of worn-out parts of the body;** **14. Important for tissues that replaced damaged cells with exact copies of the original cells in order for the tissue to function properly;** **Asexual reproduction** **15. Mitosis forms the basis of asexual reproduction as the separated cells / plant parts become new offspring;** **16. Forms clones that are genetically identical with parents facilitates successful colonization of habitats by species;**	
	(b)	Describe the structure of an amino acid and how a peptide bond is formed with another amino acid.	[6]
		1. reference to a central carbon atom (i.e. the α-carbon atom); to which is bonded: **2. an amino group ($-NH_2$);** **3. a carboxyl group (-COOH);**  	

4. a hydrogen atom; and
5. an R-group (or side chain);
6. which is variable amongst the 20 different amino acids; occurring in nature.
7. Show the structure of an amino acid;
8. a condensation reaction occurs;
9. between the carboxyl group of one amino acid;
10. and the amino group of another;
11. a molecule of water is removed in the condensation reaction;
12. condensation reaction is catalysed by peptidyltransferase;
13. a component of the large ribosomal subunit;
14. show how 2 amino acids are joined together;;



(c) Compare the transcription and translation. [7]

Similarity

1. Both processes require a template;;
2. Both processes are catalysed by enzymes;;
3. Both processes involve complementary base-pairing;;
4. Ref to modification of products with elaboration;;

Differences (max 5)

	Feature	Transcription	Translation
1	location	In nucleus	Ribosomes
2	Template	DNA template	mRNA
3	Enzyme	RNA polymerase catalyses formation of phosphoester bond between adjacent ribonucleotides	Peptidyl transferase catalyses the formation of peptide bond
4	Bond between	Bond is formed between the	Bond is formed between carboxyl

			monomers	phosphate group of one nucleotide and carbon atom 3 of ribose of the next nucleotide	group of one amino acid and the amino group of the next amino acid
		5	Reading of genetic message	RNA polymerase moves along DNA template	Ribosome moves along mRNA
		6	Involved of tRNA	Not involved	tRNA carries amino acids to ribosomes
		7	Raw materials	Free ribonucleotides	Amino acids attached to tRNA
		8	Products	mRNA, rRNA and tRNA	polypeptide
		9	Fate of products	Products exit nucleus and migrate to the cytoplasm	Polypeptide chain remain in the cytoplasm or secreted out of the cell
		10	AVP: Involvement of ribosome	Not involved	Ribosome is the binding site for mRNA and amino acid tRNA complex
		1 mark for each comparative statement			
					[Total: 20]