

Year 6 Preliminary Examination
Higher 1

BIOLOGY

8875/01

Paper 1 Multiple Choice

27th September 2016

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name and shade your Index Number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** 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 Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

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

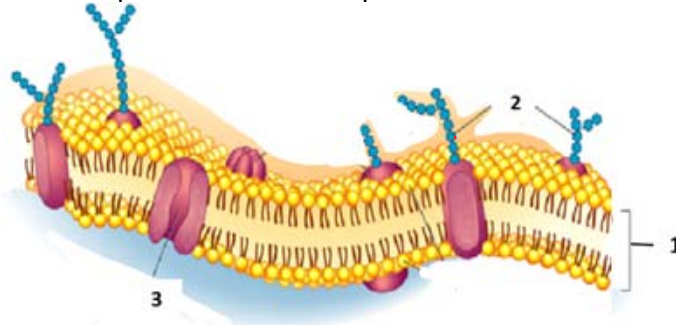
(Erase all mistakes completely. Do not bend or fold the OMR Answer Sheet).

This document consists of **22** printed pages.



Raffles Institution
Internal Examination

1. The diagram below shows a representation of the plasma membrane.



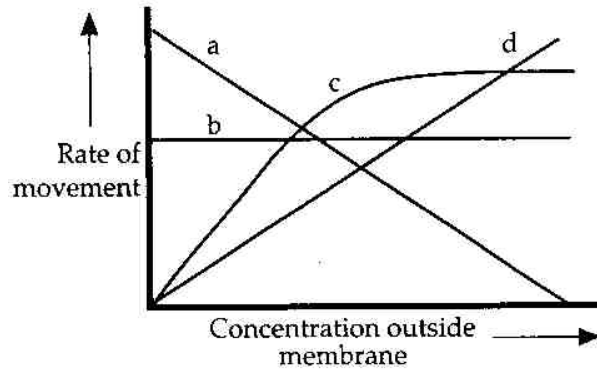
Which of the following structures are correctly matched with their role(s)?

	cell-cell recognition	maintenance of resting membrane potential	uptake of steroid hormones
A	2 only	1 and 3 only	1 only
B	2 only	1 only	1 and 3 only
C	2 and 3 only	1 only	3 only
D	3 only	1 and 3 only	1 only

2. During the production of fruit juice, enzymes are used to break down the components of cell walls. Which carbohydrate will be produced by this hydrolysis?

- A** Sucrose
- B** Maltose
- C** α -glucose
- D** β -glucose

3. Which of the following curves best represent the movement of substances by simple diffusion and facilitated diffusion?

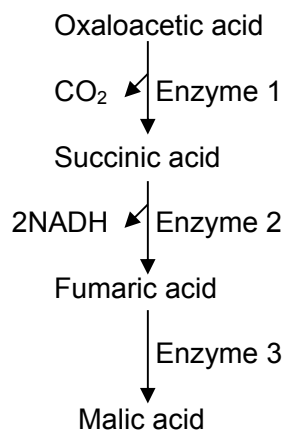


simple diffusion

facilitated diffusion

- | | | |
|----------|---|---|
| A | d | b |
| B | d | c |
| C | c | a |
| D | c | d |

4. The figure below shows an enzyme-catalysed pathway.

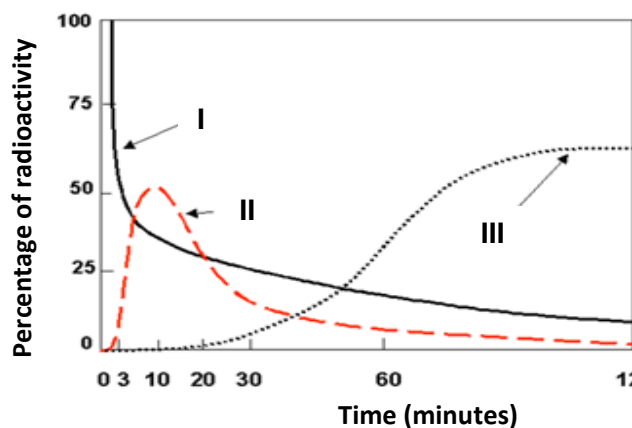


The addition of malonic acid results in no change in the concentration of oxaloacetic acid, an accumulation of succinic acid, and a very low concentration of both fumaric acid and malic acid.

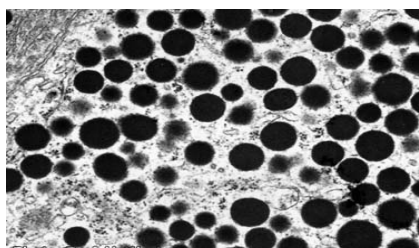
What does this information indicate about malonic acid?

- A It is an inhibitor of enzyme 1.
- B It catalyses the formation of succinic acid.
- C It is an inhibitor to enzyme 2.
- D Malonic acid is reduced in the process.

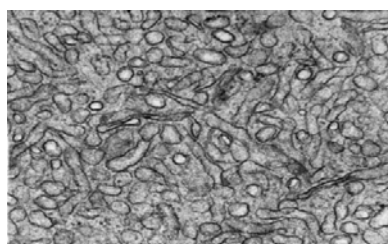
5. A pulse-chase experiment was used to trace the path taken by amino acids in a cell over a period of time. During the experiment, a cell producing salivary amylase was grown in a culture containing radioactive amino acids for a few minutes. The percentage of radioactivity at the various organelles was then measured and the results of the experiment are shown in the graph below.



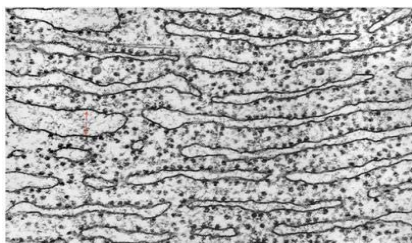
The micrographs of four different organelles from the cell producing salivary amylase are shown below.



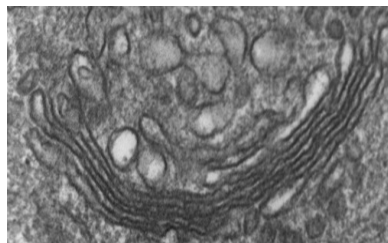
P



Q



R



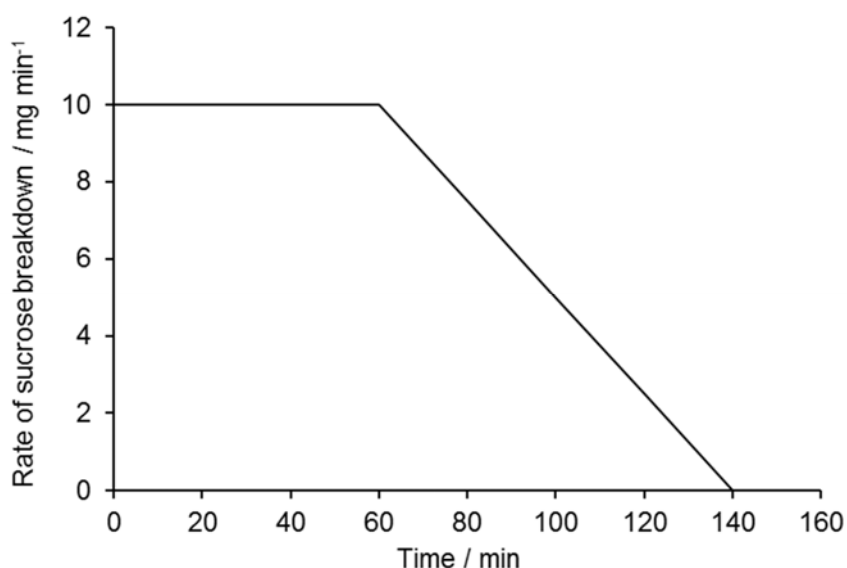
S

Each graph corresponds to an organelle in the cell where the radioactivity was measured.

Which of the organelles shown above are correctly matched with the graphs?

	graph I	graph II	graph III
A	R	S	P
B	P	R	S
C	Q	R	S
D	R	S	Q

6. The graph shows the results of an investigation using invertase, an enzyme that breaks down sucrose into glucose and fructose. 1 g of sucrose was dissolved in 100 cm³ of water and 2 cm³ of a 1% invertase solution was added.



Which conclusion can be drawn from this information?

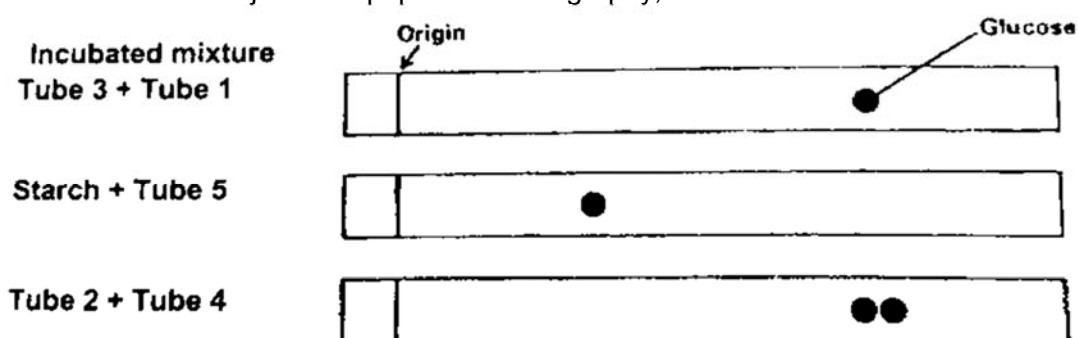
- A Between 0 and 60 min, the concentration of the substrate remains constant.
 - B After 60 min, the concentration of enzymes becomes the limiting factor.
 - C At 140 min, some of the enzyme molecules are denatured.
 - D Between 60 and 140 min, the concentration of the substrate is the limiting factor.
7. Vitamin C adds hydroxyl groups to two amino acids, proline and lysine. Without the presence of Vitamin C, the production of collagen is disrupted.

This is due to the inability to form

- A the tertiary structure of tropocollagen.
- B collagen fibrils.
- C the secondary structure of collagen.
- D disulfide bonds.

8. 3 samples of common carbohydrates and 3 samples of enzymes were randomly mixed in different combinations in 5 different tubes. The following statements are some observations of various tests that were conducted on the contents of the 5 tubes.

- I Sample in tube 2 is soluble in water. Sample in tube 3 was insoluble in water.
- II Tube 5 tested positive with Biuret's test.
- III All 6 individual samples tested negative with Benedict's test. However, certain mixtures showed positive test after incubation with other tubes.
- IV The mixtures were subjected to paper chromatography, and the results were shown below.

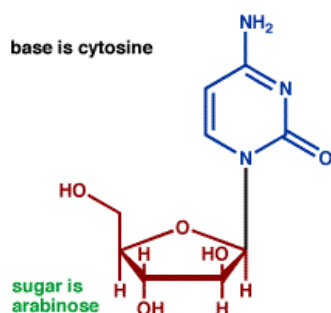


Which of the following correctly shows the contents of each tube?

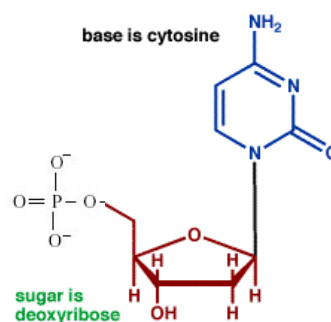
	tube 1	tube 2	tube 3	tube 4	tube 5
A	amylase	cellulose	sucrose	cellulase	sucrose
B	cellulase	sucrose	cellulose	sucrase	amylase
C	cellulose	sucrose	cellulose	sucrase	amylase
D	sucrose	cellulose	sucrase	amylase	cellulase

9. Cytarabine is a drug used to treat certain cancers. It consists of a cytosine base and an arabinose sugar.

The diagram below shows the structures of cytarabine and the deoxyribonucleotide, deoxycytidine triphosphate (dCTP).



Cytarabine



Deoxycytidine triphosphate

Which of the following statements are true?

- I Cytarabine has a hydroxyl group attached to carbon number 4 of its sugar while deoxycytidine triphosphate has a phosphate group attached to carbon number 4 of its sugar.
 - II Cytarabine prevents DNA replication.
 - III Deoxycytidine triphosphate molecule has a free 3' hydroxyl group that can form a phosphodiester bond with another ribonucleotide during DNA replication.
 - IV Cytarabine has a greater effect on cancer cells than healthy cells as cancer cells divide faster than healthy cells.
- A I and II only
- B II and IV only
- C I and III only
- D II, III and IV only

10. Fig. 9.1 and Fig. 9.2 are electron micrographs that show ribosomes (dark circular structures) involved in protein synthesis. One figure illustrates protein synthesis in a eukaryotic cell while the other illustrates protein synthesis in a prokaryotic cell.



Fig. 9.1

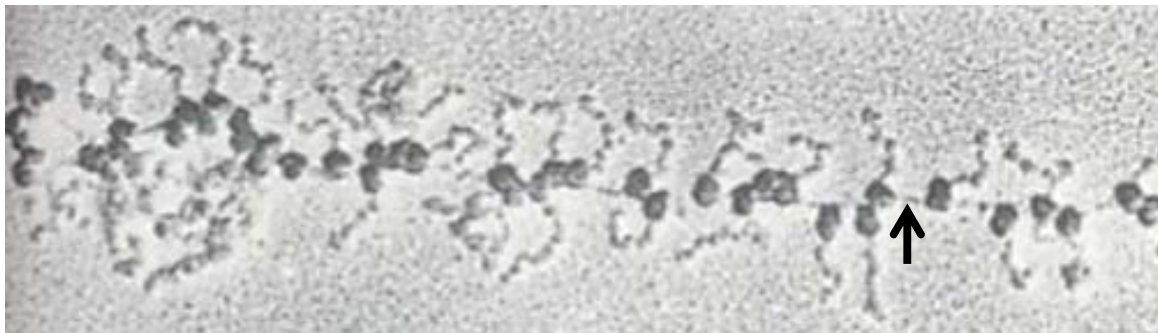


Fig. 9.2

Which of the following statement(s) is/are false?

- I Fig. 9.1 illustrates a process that occurs in prokaryotic cells while fig. 9.2 illustrates a process that occurs in eukaryotic cells.
 - II The arrows in both fig. 9.1 and fig. 9.2 are pointing to the chromosomal DNA.
 - III Complementary base pairing occurs between the rRNA in the mRNA binding site of the small ribosomal subunit and the mRNA.
 - IV The rRNA molecule in the ribosomal subunit catalyses the formation of a peptide bond between the amino group of the incoming amino acid at the P site and the carboxyl end of the growing polypeptide chain at the A site.
- A** II only
- B** II and IV only
- C** I and III only
- D** All of the above

- 11.** Sickle cell anaemia is caused by a mutation in the gene that codes for the β -globin polypeptide of haemoglobin.

The sequence of bases below is a small section of the template strand of DNA for both the normal allele (HbA) and the sickle cell allele (HbS).

HbA allele CTGACTCCTGAGGAGAAGTCT

HbS allele CTGACTCCTGTGGAGAAGTCT

How will the mutation in the HbS allele result in the production of a non-functional β -globin polypeptide?

- A** The mRNA transcribed from the HbS allele will contain the codon CAC instead of the codon CTC.
 - B** All the amino acids coded for after the mutation will differ from those in the HbA protein.
 - C** A tRNA molecule with the anticodon GUG will hydrogen bond to the altered codon on mRNA.
 - D** The ribosome will be unable to continue translation of the HbS mRNA after the altered codon.
- 12.** Which of the following statements about the genetic code are correct?
- 1** The genetic code has redundancy and is degenerate.
 - 2** There is only one codon for the amino acid methionine.
 - 3** Codons act as 'stop' and 'start' signals during transcription and translation.
 - 4** Prokaryotes generally use the same genetic code as eukaryotes.
 - 5** mRNA codons have the same nucleotide sequence as DNA triplet codes.
- A** 1, 2 and 3
 - B** 1, 2 and 4
 - C** 1, 3 and 5
 - D** 2, 4 and 5

13. The following events occur during the mitotic cell cycle.

- 1 Centrioles replicate and form the spindle.
- 2 Cytokinesis occurs.
- 3 DNA forms sister chromatids.
- 4 Organelles duplicate.

Which events ensure that the daughter cells are genetically identical?

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

14. In domestic cats, two gene loci that control different aspects of coat colour have the following alleles.

Gene locus for black coat colour	B : black fur b : brown fur
Gene locus for white spotting	S : white spotting in fur s : no white spotting in fur

A cat that is heterozygous at the S/s locus has less white spots in its fur than a cat that is homozygous at that locus.

Two cats were mated. The cross was **BbSs** x **BBSs**.

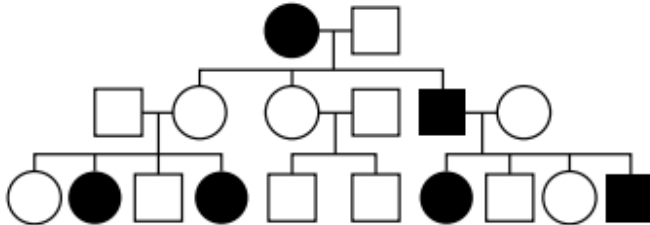
Which of the following is a correct result of such a cross?

- A Kittens could be brown with white spots.
- B Kittens have a one in two chance of having no white spots.
- C Some kittens could have more white spots than either of the parents.
- D Kittens would have a one in two chance of being homozygous dominant at both loci.

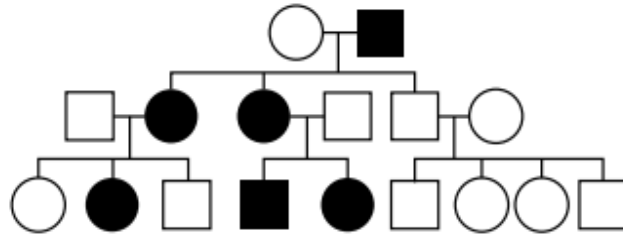
15. Kearns-Sayre syndrome is a rare genetic trait caused by a deletion of up to 10 000 nucleotides from the mitochondrial DNA (mtDNA). Most individuals with this syndrome have weak eye muscles, drooping eyelids, vision loss and, often, short stature.

Which pedigree shows a family affected by Kearns-Sayre syndrome?

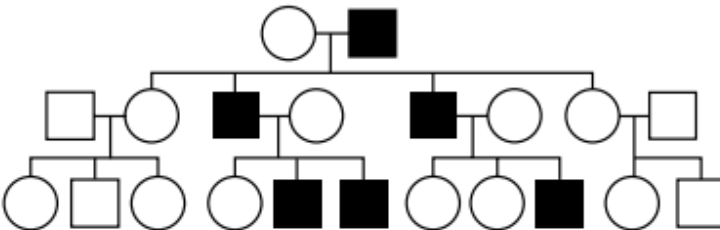
A



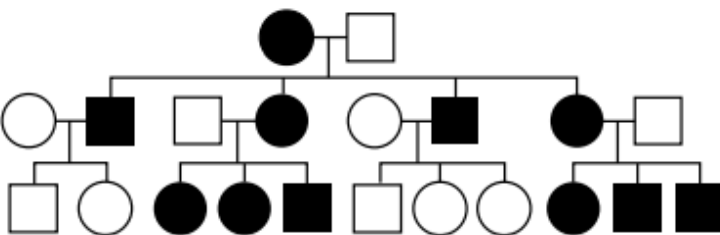
B



C



D



16. Flamingos are birds that live by lakes. The feather colour of flamingos may vary from white to pink to red. To investigate the inheritance of feather colour, a scientist performed the following crosses and recorded the feather colour of all the offspring when they were one year old. The diet of the offspring was also recorded.

cross	feather colour of parents	feather colour of all one-year old offspring	diet of offspring
1	white x white	white	aquatic plants
2	red x white	white	aquatic plants
3	white x white	pink	algae and crustaceans
4	red x white	pink	algae and crustaceans

Based on the above information, which of the following is a correct conclusion?

- A Both the parents in cross 1 must be homozygous for white feather colour.
- B White feather colour is recessive to red feather colour.
- C The feather colour of flamingos is influenced by their environment.
- D Two pink-feathered parents would only produce one year old offspring with pink feathers.
17. In an experiment, chloroplast extracts were first treated with a chemical that 'snatches' away the electron that was accepted by the electron acceptor in photosystem I. The extracts were then treated with 2 hours of light and were provided with ample carbon dioxide and water.

Which of the following correctly shows the products that were formed after the experiment?

	O ₂	ATP	reduced NADP	glucose
A	+	+	–	–
B	–	+	+	+
C	+	–	–	–
D	–	–	+	–

Key: (+) = present, (–) = absent

18. The blue dye DCPIP can be converted to colourless DCPIP as shown below:



A suspension of chloroplasts was made by grinding fresh leaves in buffer solution and centrifuging the mixture. Tubes were then prepared and treated in the following ways.

tube	contents	treatment	colour	
			at start	after 20 minutes
1	1 cm ³ chloroplast suspension + 5 cm ³ DCPIP	illuminated strongly	blue green	green
2	1 cm ³ buffer solution + 5 cm ³ DCPIP	illuminated strongly	blue	blue
3	1 cm ³ chloroplast suspension + 5 cm ³ DCPIP	left in the dark	blue green	blue green

Which one of the following statements is a possible conclusion for the observation above?

- A** Electron transfer from reduced NAD to DCPIP causes the decolourisation of DCPIP.
- B** NADP was oxidised and the electron was used to decolourise DCPIP.
- C** Light dependent reaction which occurs in the chloroplasts yield free electrons which reduced DCPIP.
- D** Either strong illumination or the buffer solution used in the extraction of chloroplasts could oxidise DCPIP.

19. Six tubes were set up as shown in the table and incubated.

tube	contents
1	glucose + homogenized plant cells
2	glucose + mitochondria
3	glucose + cytoplasm from liver cells lacking organelles
4	pyruvate + homogenized liver cells
5	pyruvate + mitochondria
6	pyruvate + cytoplasm from liver cells lacking organelles

Which of the following tubes will contain lactate?

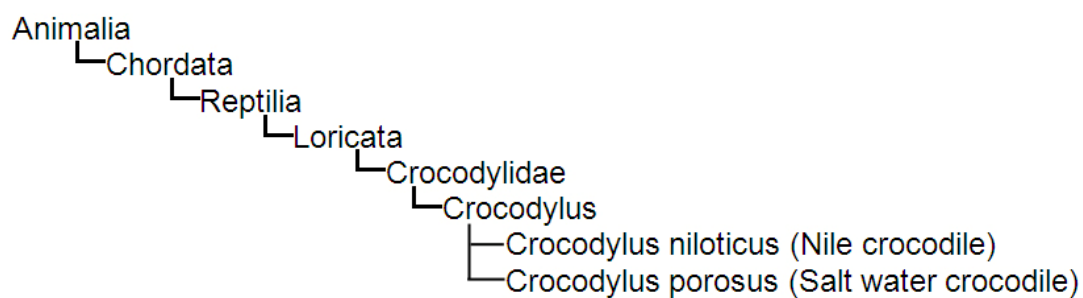
- A** 1 and 3 only
- B** 2, 3, 5 and 6 only
- C** 4, 5, and 6 only
- D** 3 and 6 only

20. It has been found that an aqueous suspension of isolated chloroplasts will evolve oxygen if illuminated in the presence of a certain type of compound.

What type of compound must be present and what quality of light is required for maximum oxygen evolution?

	type of compound	quality of light at which maximum oxygen evolution occurs
A	electron acceptor	blue and green
B	electron acceptor	blue and red
C	electron donor	green and red
D	electron donor	blue and red

21. The chart below shows the hierarchical classification of two species of crocodiles.



To which class do these crocodiles belong?

- A Chordata
- B Crocodylidae
- C Loricata
- D Reptilia

22. Two areas of molecular biology that have received considerable attention in evolutionary studies are the genetic code and cytochrome C. Cytochrome C is an essential component of all respiratory electron transport chains.

Which statements lend evidence to the following 2 ideas?

Idea 1: All living organisms are related, and

Idea 2: There is a single, rather than a multiple, origin of life?

1	The almost universal nature of the genetic code is a result of evolutionary convergence from multiple lineages.
2	The sequence of amino acids in cytochrome C is similar in organisms that are from similar environments or with similar metabolic demands.
3	The majority of organisms have the same, or similar, amino acid sequences for cytochrome C.
4	When transferred into a very dissimilar organism, a gene coding for cytochrome C will lead to the expression of a protein that will function in the other organism.

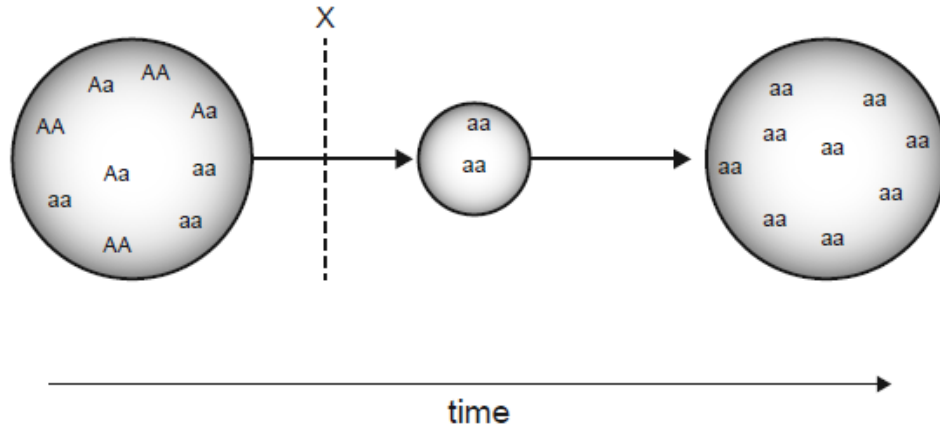
- A 1 and 2 only
 B 2 and 3 only
 C 3 and 4 only
 D 1, 3 and 4 only

23. Which of the following shows the correct sequence of events?

I	adaptation of a population	→	competition and predation leading to natural selection	→	behavioural isolation	→	allopatric speciation
II	adaptation of a population	→	competition and predation leading to natural selection	→	physiological isolation	→	allopatric speciation
III	competition and predation leading to natural selection	→	physiological isolation	→	adaptation of isolated populations	→	sympatric speciation
IV	competition and predation leading to natural selection	→	geographical isolation	→	adaptation of isolated populations	→	allopatric speciation

- A III only
 B I and II only
 C III and IV only
 D I, III and IV only

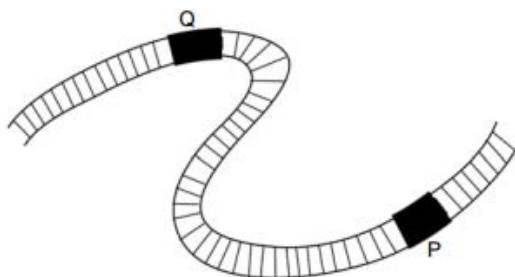
24. Consider the diagram below that models changes in allele frequencies for one trait in a population over two generations. The original population is shown on the left.



If the diagram above models the founder effect, then event X is _____.

- A migration.
- B a natural disaster.
- C random mating.
- D a random assortment of alleles

- 25 The genome of a small virus is depicted below, showing the positions of restriction sites P and Q for two different restriction enzymes.



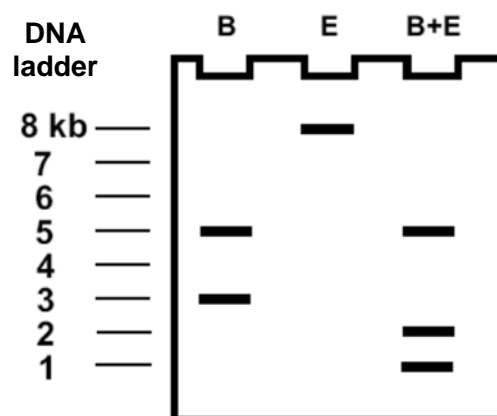
The length of DNA fragments obtained when using these restriction enzymes is shown in the table alone.

restriction site	restriction enzyme	length of DNA fragments obtained (kb)
Q	<i>EcoRI</i>	3, 7
P	<i>BamHI</i>	8, 2

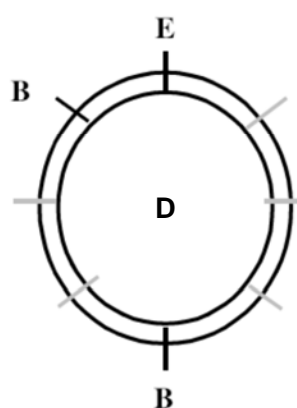
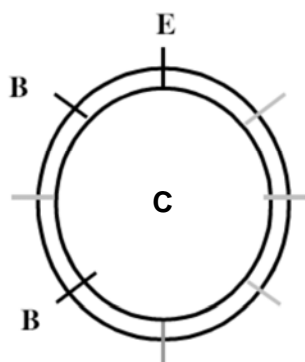
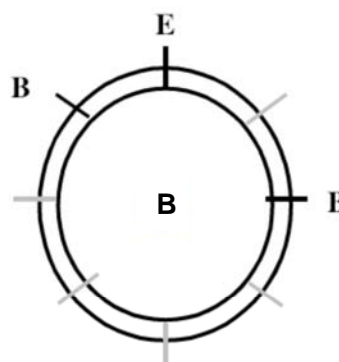
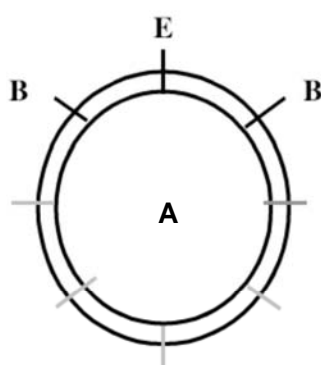
If both *EcoRI* and *BamHI* are used to cut this viral DNA, what will the length (in kb) of the DNA fragments obtained be?

- A 1, 2, 7
- B 1, 3, 6
- C 2, 3, 5
- D 2, 3, 7

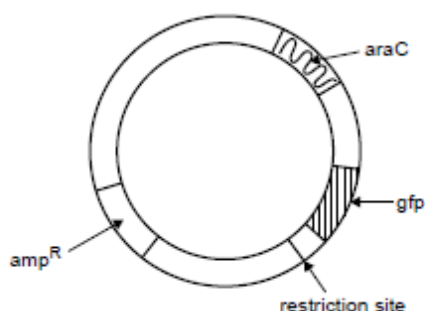
- 26 An 8 kb plasmid is digested with *EcoRI* (E) and/or *BamHI* (B), and the digests are run on an agarose gel and stained. The results are shown below.



Based on the results of the gel, which plasmid map is correct?



27. A diagram of a plasmid used in cloning is shown below.



This plasmid contains a restriction site and three genes:

- *amp^R* – confers resistance to the ampicillin antibiotic
- *gfp* – encodes the green fluorescent protein (GFP), which fluoresces under UV light
- *araC* – encodes a protein that enables the expression of *gfp* when arabinose is present

E. coli were transformed with the above plasmids.

Untransformed bacteria were grown on nutrient agar plates W and X, while transformed bacteria were grown on nutrient agar plates Y and Z.

The results of the experiment are shown in the table below.

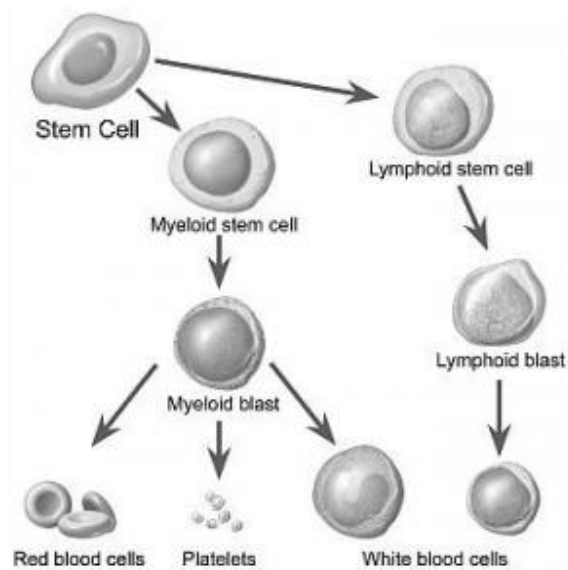
Plate	W untransformed bacteria only	X untransformed bacteria only	Y transformed bacteria	Z transformed bacteria
Diagram of plate				
Added to plate	nutrient agar only	nutrient agar and ampicillin	nutrient agar, ampicillin and arabinose	nutrient agar and ampicillin
Description of result	lawn of bacteria	no growth	bacterial colonies present	bacterial colonies present

Which one of the following statement(s) is/are true?

- I Plate W shows that the nutrient agar promoted the growth of viable bacteria.
- II Plate Y and Z contained bacteria that are ampicillin resistant and are able to produce arabinose.
- III Plate Y contains bacteria that fluoresce under UV light.
- IV Plate X is the negative control.

- A III and IV only
- B III only
- C I, III and IV only
- D I and III only

28. The following diagram shows how a stem cell can differentiate into different specialized cell types.



Which of these statements is false with regards to the stem cells shown?

- A The stem cells are multipotent.
- B The stem cells can be found in both a developing fetus and adult.
- C The stem cells can differentiate into the endothelial layers in the blood vessels in the adult body.
- D The stem cells may be used in to treat a patient suffering from SCID.

29. Corn is a major crop grown in Europe. In the past, it was either ruined by attack from the corn borer larvae or intensively sprayed with pesticides each year. The biotech company Novartis gained approval to insert a *Bt* gene into corn. This gene codes for a protein that kills the larvae feeding on the corn. The genetically engineered *Bt* corn initially thrived without the addition of any pesticides, but later suffered damage from pests again.

Which of the following are possible reasons why the yield of *Bt* corn decreased again over a few generations?

- I A strain of resistant larvae has emerged due to a chance mutation. The frequency of the gene conferring resistance as well as the number of larvae with resistance has increased. The *Bt* gene is now ineffective.
 - II Corn is being attacked by other pests which are not killed by the *Bt* gene protein.
 - III Mutations in corn may have led to the loss of the *Bt* allele.
- A I and II only
 - B I and III only
 - C II and III only
 - D All of the above

30. Salmon has been genetically modified to increase its yield within a shorter period of time.

Which of the following is incorrect?

- A Growth hormone gene from another species of salmon is inserted to greatly enhance growth.
- B Gene coding for antifreeze protein is inserted to allow salmon to grow faster despite the cold waters.
- C Transgenic salmon are allowed to mate with wild fish to produce stable transgenic lines in fish hatcheries.
- D The increase in yield of transgenic salmon is due to its ability to grow throughout the year and increased efficiency in feed conversions.

End of Paper