

INNOVA JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 1

CANDIDATE
NAME

CLASS

INDEX NUMBER

BIOLOGY

8875/01

Paper 1 Multiple Choice

15 September 2017

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.

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

Read the instructions on the Answer Sheet very carefully.

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

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

This document consists of **16** printed pages.

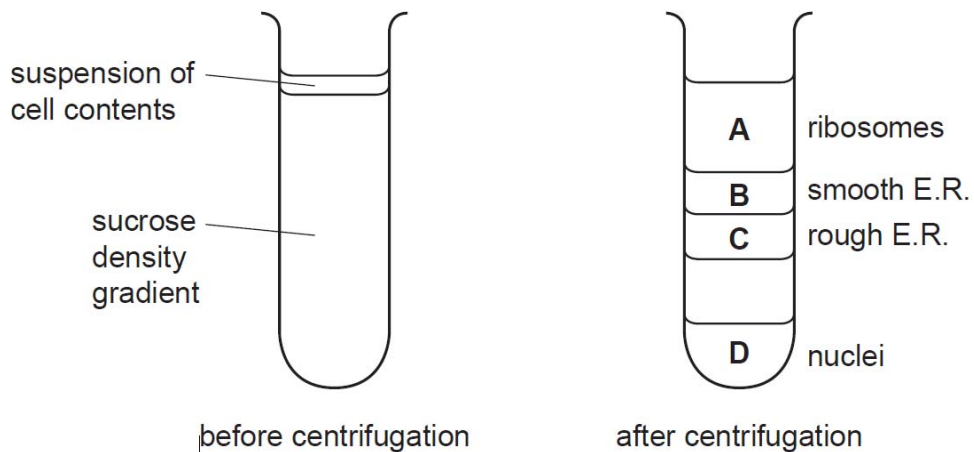


- 1 A certain organelle in a eukaryotic cell was isolated and analysed. It was found that the organelle contains proteins, nucleotides and phospholipids.

Which organelle(s) could it possibly be?

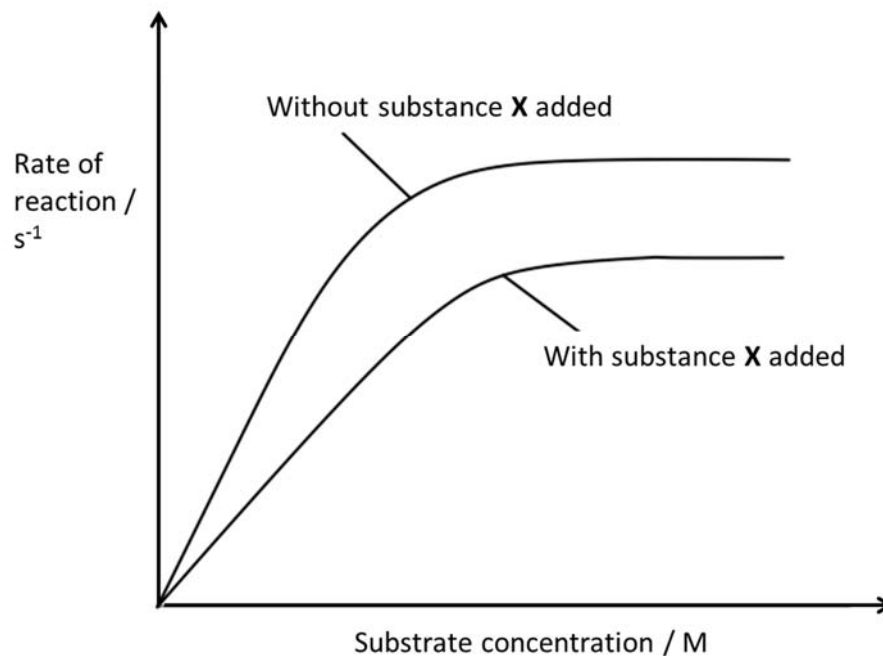
- 1 nucleus
 - 2 lysosome
 - 3 ribosome
 - 4 mitochondrion
- A** 1 only
- B** 2 and 3 only
- C** 1 and 4 only
- D** 1, 3 and 4 only
- 2 Sometimes, scientists need to isolate organelles. This can be achieved by taking a number of cells and breaking their cell surface membranes to release the contents of the cells into a buffer solution.

In zonal centrifugation, the suspension of cell contents is placed on top of a sucrose density gradient. The tube is then placed in a centrifuge and spun at high speed. The larger and denser particles will move towards the bottom of the tube faster than smaller and less dense particles as shown below.



If a sample of intact prokaryotes had been added to a suspension of eukaryotic cell contents, where would you expect them to be found?

- 3 Which statement shows a correct feature of collagen linked to a correct analysis of the amino acid sequence?
- A Collagen has polypeptides arranged parallel to each other and the sequence contains a large variety of amino acids with different sized R-groups.
- B Collagen has polypeptides that are arranged very closely together and the sequence has every third amino acid as glycine.
- C Collagen has three polypeptides that can fold into a globular structure and the sequence contains cysteine and amino acids with hydrophobic R-groups.
- D Collagen is an insoluble molecule and the sequence contains a large proportion of amino acids with hydrophilic R-groups.
- 4 The graph below shows the change in the rate of reaction of an enzyme with and without the addition of substance X.



Which of the following statements about substance X is true?

- A The effect of substance X cannot be reduced by increasing the substrate concentration.
- B Substance X binds to the active site of the enzyme and competes with the substrate.
- C Substance X binds reversibly to the enzyme and changes the shape of its active site.
- D The effect of substance X can be reduced by decreasing the enzyme concentration.

- 5 A chemical known to affect mitosis was added, at different stages of mitosis, to actively dividing plant cells with 12 chromosomes.

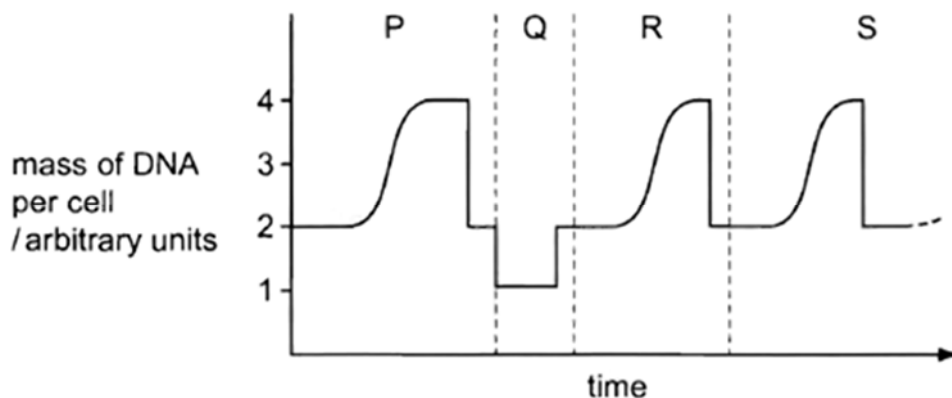
The results showed that adding this chemical during prophase resulted in cells with 24 chromosomes. Adding the chemical at any other stage resulted in cells with 12 chromosomes.

Which process during mitosis is affected by this chemical?

- A Condensing of chromosomes
 B Organizing the spindle
 C Producing the centromeres
 D Separating centrioles
- 6 The retinoblastoma protein (Rb protein) is coded for by the *RB1* gene. Rb protein prevents a cell from progressing into the S phase of a cell cycle when damaged DNA is detected. When both copies of the *RB1* gene are mutated and dysfunctional, cells with damaged DNA may continue to divide uncontrollably to form a tumour.

Which of the following statements is true?

- A *RB1* gene is a proto-oncogene.
 B The mutated *RB1* allele acts in a recessive manner.
 C The mutated *RB1* allele codes for a hyperactive Rb protein.
 D A gain-of-function mutation has occurred.
- 7 A single cell from a female mammal undergoes changes that result in an ovum being formed. If the ovum is fertilised then further changes occur to form an embryo. The graph shows the changes in the mass of DNA per cell during these events.



During which stages might variation occur as a result of changes in the number of sets of chromosomes?

- A P, Q and R only
 B Q, R and S only
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8 The descriptions below are of nucleic acids in eukaryotes.

- 1 A polynucleotide of variable length formed by base pairing.
- 2 A small polynucleotide with a specific three-dimensional shape.
- 3 A large polynucleotide with a specific shape associated with proteins.
- 4 A large polynucleotide with super coiled sections associated with proteins.

Which row correctly matches each description to its function?

	Stores coded information	Carries coded information	Carries specific amino acids	Provides a site for protein synthesis
A	3	4	1	2
B	3	4	2	1
C	4	1	2	3
D	4	3	1	2

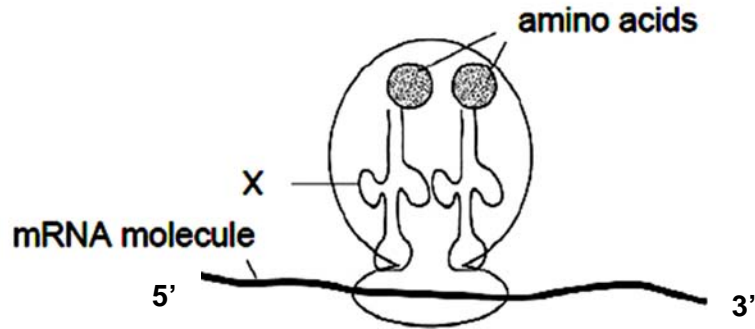
9 The mechanism of action of four drugs that inhibit DNA replication is stated below.

- 1 Aphidicholine inhibits DNA polymerase.
- 2 Cytarabine is converted into a molecule that can substitute for a DNA nucleotide and also inhibits DNA repair mechanisms.
- 3 Epirubicin inhibits an enzyme involved in the unwinding and separation of DNA strands.
- 4 Hydroxycarbamide inhibits an enzyme involved in the production of deoxyribonucleotides.

Which row correctly matches the effects of these drugs on DNA replication?

	Effects of Drug on DNA Replication			
	Decreased pool of available nucleotides inhibits chain elongation	DNA damaged during replication and cell death occurs	DNA strands not available as templates for replication	Exposed DNA template strands unable to be copied
A	aphidicholine	cytarabine	epirubicin	hydroxycarbamide
B	hydroxycarbamide	epirubicin	aphidicholine	cytarabine
C	epirubicin	hydroxycarbamide	cytarabine	aphidicholine
D	hydroxycarbamide	cytarabine	epirubicin	aphidicholine

- 10 The diagram below shows part of a molecule of mRNA bound to a ribosome.



Which of the following is **false** about molecule X?

- 1 It is formed by RNA polymerase in the nucleus.
 - 2 It is able to form hydrogen bonds with mRNA.
 - 3 An amino acid was attached to it by the enzyme amino-acyl tRNA transferase.
 - 4 It is held in the amino-acyl tRNA binding site of the ribosome.
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 B 4 only
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- 11 Gene mutations involve changes in the nucleotide sequence of DNA.

Which of the following descriptions regarding gene mutations is correct?

- A Frameshift mutations can be caused by base substitution.
 B Frameshift mutations can result from an inversion of bases.
 C Missense mutations can be selectively neutral.
 D Silent mutations may not be selectively neutral.

- 12 Two pure-bred lines of different plant varieties, which differed markedly in bean seed mass, were crossed. The mass of bean seeds produced by the two parental varieties and their offspring were measured to the nearest gram. The number of bean seeds in each mass category was counted.

The table below shows the results.

mass of bean / mg		51-150	151-250	251-350	351-450	451-550	551-650	651-750	751-850	851-950
number of beans	Parental	5	375	177				352	955	10
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Which statement **incorrectly** explains these experimental data?

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- B The greater variation in bean seed mass observed in the offspring generation as compared to the parental generation is due to crossing over between homologous chromosomes, random fusion of gametes, different survival rates of the gametes and zygotes.
- C The phenotypic effects of different nucleotide sequences at different chromosomal positions can be summated to determine the bean seed mass in each plant.
- D Various environmental factors affect the mass of bean seeds in plants.
- 13 The speech defect known as stuttering may involve two genes, **G** and **N**. Most people who are homozygous for the alleles **g** and **n** are not stutterers.

However, recent research has shown that the presence of either of the mutant alleles **G** or **N** can cause stuttering in heterozygotes.

Using this information, which proportion of the children of a couple, the father with genotype **Ggnn** and the mother **ggNn**, are likely to be stutterers?

- A 3/16
- B 6/16
- C 9/16
- D 12/16

- 14 A cross between a round-leafed, tall plant and round-leafed dwarf plant produced the following offspring:

121 round-leafed, tall plant

124 round-leafed, dwarf plant

42 oval-leafed, tall plant

37 oval-leafed, dwarf plant

Key

R – round leaf

r – oval leaf

T – tall

t – dwarf

What were the genotypes of the parents?

- A RrTt x Rrtt
 B RrTt x RRtt
 C RrTT x Rrtt
 D RrTT x RRtt
- 15 In fruit flies, one gene controls wing form (normal or vestigial) and one gene controls eye colour (red or normal brown). A fly with normal wings and normal brown eyes is crossed with a fly with vestigial wings and red eyes. All the F_1 are normal for both characteristics.

However, when F_1 are crossed with each other, the resulting F_2 is:

45 normal wing, normal brown eye

17 normal wing, red eye

16 vestigial wing, normal brown eye

5 vestigial wing, red eye

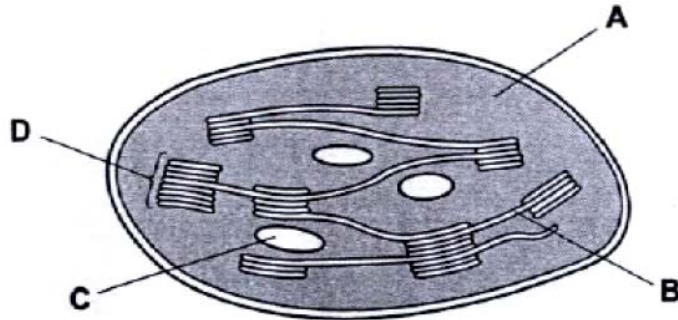
1 normal wing, orange eye

What is the **best** explanation for the results of this dihybrid cross?

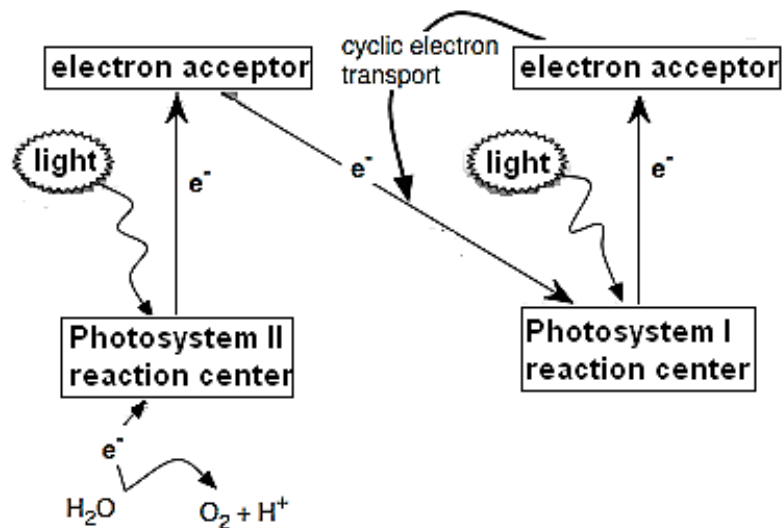
- A codominance
 B gene mutation
 C multiple alleles
 D sex linkage

16 The diagram shows a section through a chloroplast.

Where the products of photophosphorylation would be used?



17 The figure below shows the Z scheme for cyclic phosphorylation and non-cyclic phosphorylation.



Which of the following statements are true?

- 1 Hydrolysis of ATP occurs in both cyclic and non-cyclic phosphorylation.
- 2 Energy released from the electron transport chain is used to pump protons from the stroma into the thylakoid lumen.
- 3 NADP^+ is oxidized in non-cyclic phosphorylation.
- 4 The products of non-cyclic phosphorylation are NADPH, ATP and oxygen.

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

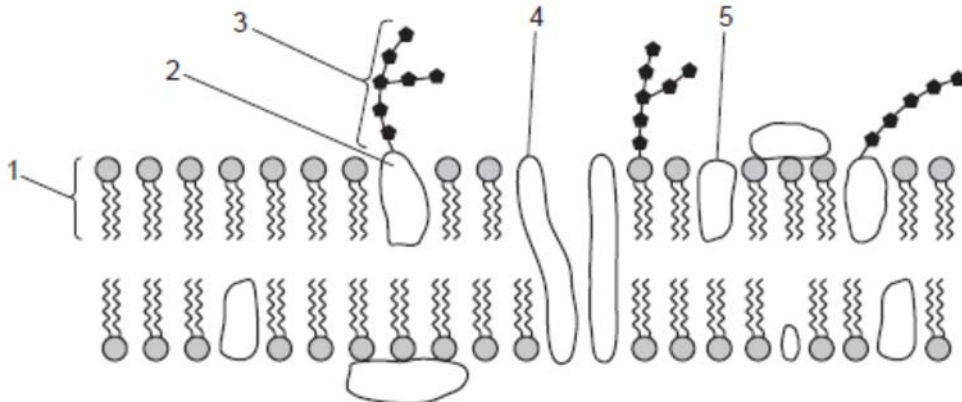
- 18 After vigorous exercise, changes occur in the muscle tissue. Compared with 'at rest' conditions, what will the changes be?

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

- 19 What is the 'link reaction' in eukaryotic respiration?

- A** Oxidation of NADH to yield electrons and protons
- B** Passage of coenzyme A through the mitochondrial membrane
- C** Pyruvate combining with coenzyme A to produce CO_2 and NADH/H^+
- D** Acetyl coenzyme A combining or joining with a C_4 compound to give C_6 + coenzyme

- 20 The diagram shows part of a cell surface membrane.

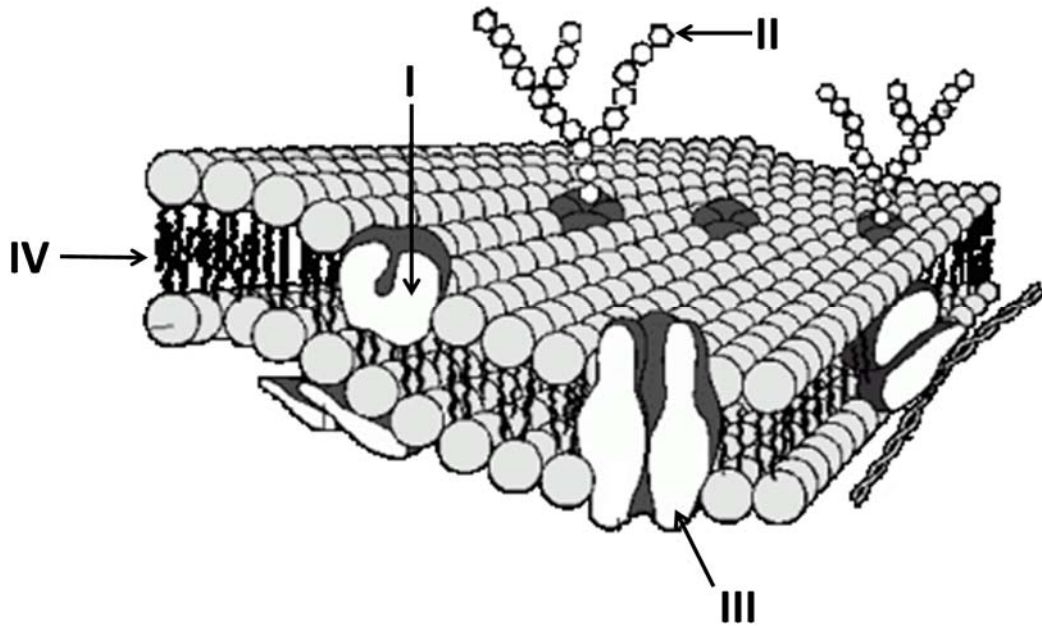


Which molecules have both hydrophobic and hydrophilic regions?

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

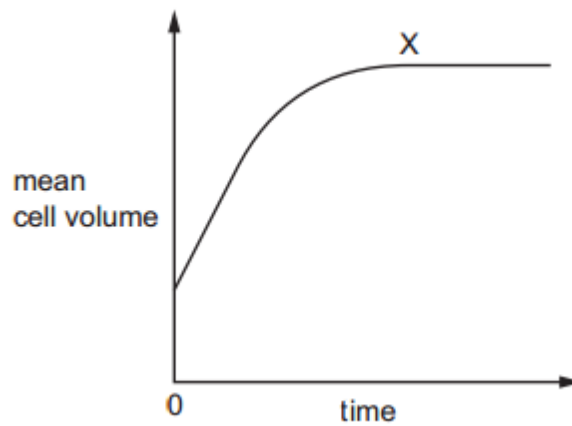
21 The diagram below shows a section of the cell surface membrane from an arctic fish.

Which of the following options regarding the labelled components of the membrane is correct?



	I	II	III	IV
A	Plays a role in cell-cell adhesion	Plays a role in cell-cell recognition	Allows transport of proteins like insulin	Contains a high amount of saturated lipids
B	Plays an enzymatic role	Variation in branching of oligosaccharide allows for cell-cell recognition	Allows transport of amino acids	Contains a high amount of cholesterol
C	Maintains the fluidity of the cell surface membrane	Variation in branching of amino acids allows cell-cell recognition	Plays a role in maintaining membrane potential	Is produced at the Rough Endoplasmic Reticulum
D	Is involved in active transport of ions	Is termed collectively with other glycolipids as the glycocalyx	Is localised to a specific region in the cell surface membrane	Plays a role in cell-cell recognition

- 22 A tissue composed of plasmolysed plant cells was put into distilled water. The graph shows how the mean cell volume changes with time.



What is the cause of the plateau at **X**?

- 1 water potential in the plant cell has become more negative
 - 2 cells have become fully turgid
 - 3 no net movement of water into cells
- A** 1, 2 and 3
B 1 and 2 only
C 1 and 3 only
D 2 and 3 only

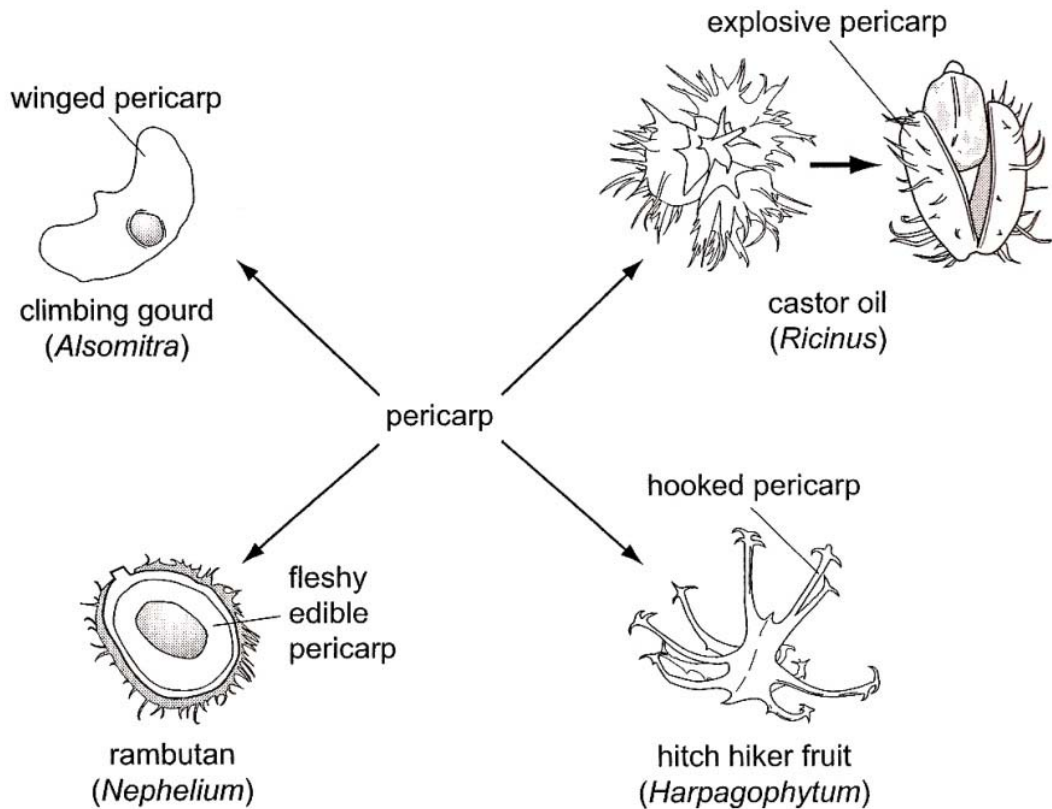
- 23 The graph shows the effect of pesticide treatment on houseflies over a number of years. A standard amount of pesticide was used each year in summer.



How is the effect of the pesticide best explained?

- A A few resistant flies reproduced more successfully and the resistance allele increased in frequency.
- B At every generation an increasing proportion of flies mutated to become resistant.
- C Repeated exposure to the pesticide caused the flies to become more resistant.
- D The allele for resistance mutated from the recessive form to the dominant form.
- 24 Which effect of natural selection is likely to lead to speciation?
- A Differences between populations are increased.
- B Favourable genotypes are maintained in the population.
- C Genetic diversity is reduced.
- D Selection pressure on some alleles reduces reproductive success.

- 25 The diagram illustrates variation in the pericarp (fruit wall) for a variety of methods of seed dispersal.

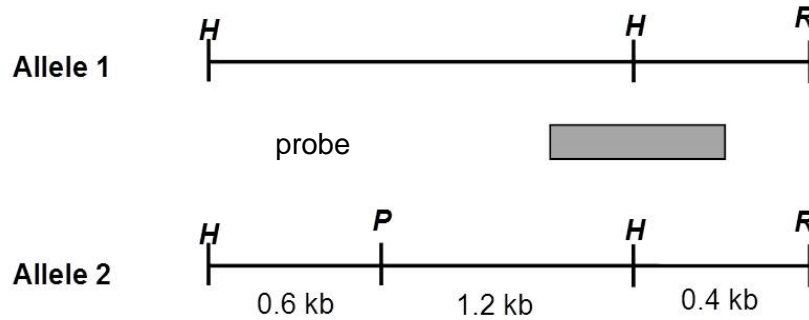


What do these examples illustrate?

- A The adaptive radiation of analogous structures showing convergent evolution.
 B The adaptive radiation of analogous structures showing divergent evolution.
 C The adaptive radiation of homologous structures showing convergent evolution.
 D The adaptive radiation of homologous structures showing divergent evolution.
- 26 Which of the following is **not** a reason for plasmids being used as cloning vector?
- A They are small.
 B They have an origin of replication.
 C They can undergo independent replication.
 D They always produce sticky ends when cut by restriction enzymes.

- 27 Cystic fibrosis is a genetic disease that affects the respiratory and digestive systems. Individuals with cystic fibrosis have two copies of the mutated *CFTR* allele.

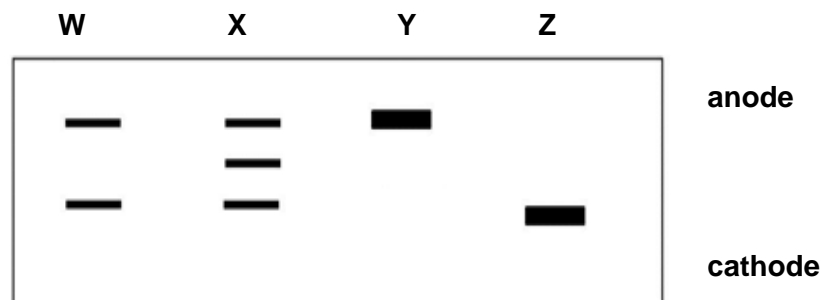
Diagram below shows the positions of various restriction sites of a segment of KM-19, an RFLP (restriction fragment length polymorphism) marker that is closely linked to the *CFTR* gene locus. Position complementary to a radioactive probe is also shown. Allele 2 is linked to the mutant *CFTR* allele.



Legend

- H** represents *Hind*III restriction site
P represents *Pst*I restriction site
R represents *Eco*RI restriction site

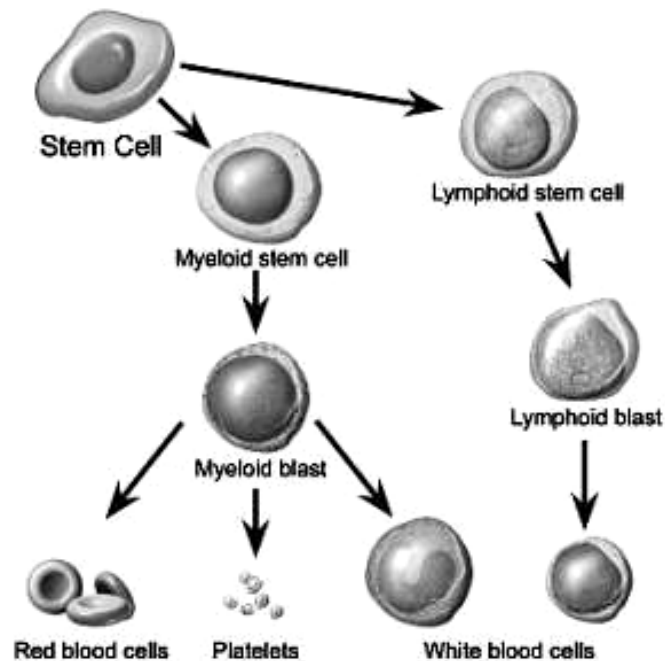
DNA from different individuals are digested using *Pst*I and separated using gel electrophoresis. Results of the autoradiograph are shown below.



Which of the following individual suffers from CF?

- A W
 B X
 C Y
 D Z
- 28 Why are primers added to polymerase chain reaction (PCR) mixture?
- A Because Taq polymerase cannot initiate synthesis of a polynucleotide strand.
 B So that there would not be leading and lagging strand.
 C To anneal to the 3' OH end to the target DNA.
 D To separate the double stranded DNA into 2 single strands.

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

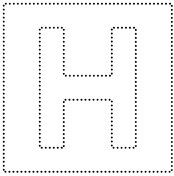


Which of these statements is **false** with regards to the stem cells shown?

- A The stem cells are multipotent.
 - B The stem cells can be found in both a fetus and an adult body.
 - C The stem cells can differentiate into the three germ layers in the adult body.
 - D The stem cells may be used in a bone marrow transplant to treat a patient with leukemia, a form of blood cancer.
- 30 Some scientists are concerned about the release of genetically modified microorganisms into their natural habitat.

What is the most likely reason for this concern?

- A The microorganisms may reproduce quickly.
- B The microorganisms may not survive.
- C The mutation rate of the microorganisms would increase.
- D The transfer of changed genes to other organisms.



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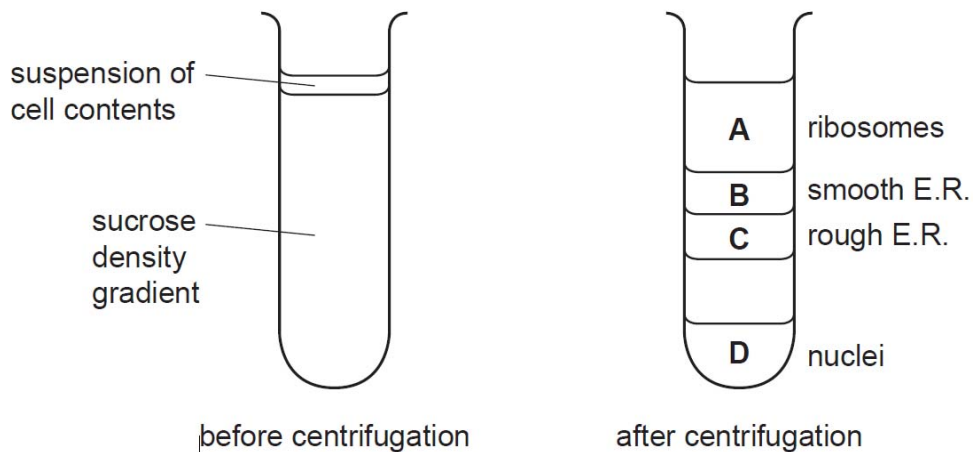


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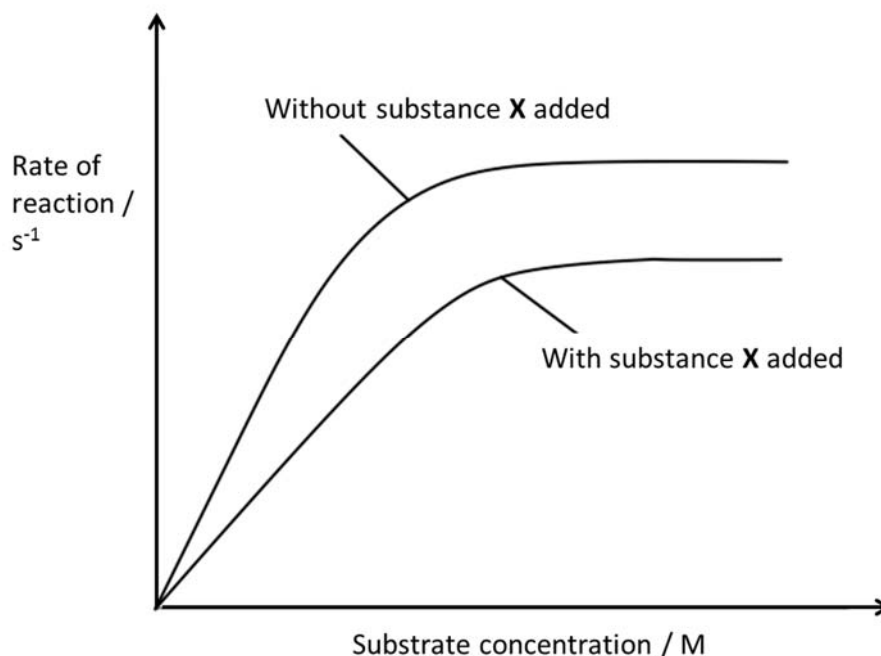
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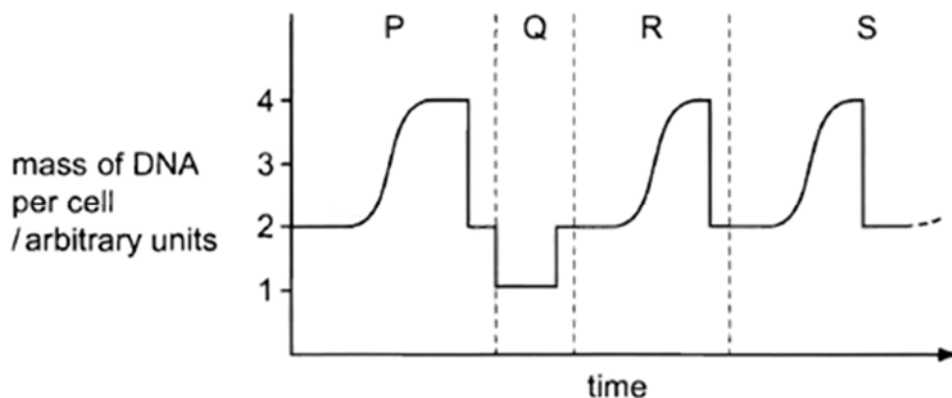
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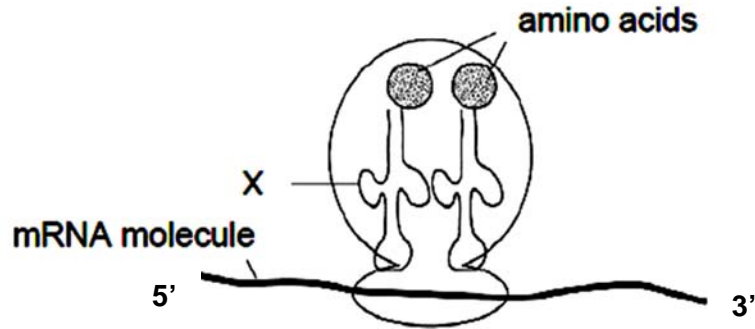
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16 vestigial wing, normal brown eye

5 vestigial wing, red eye

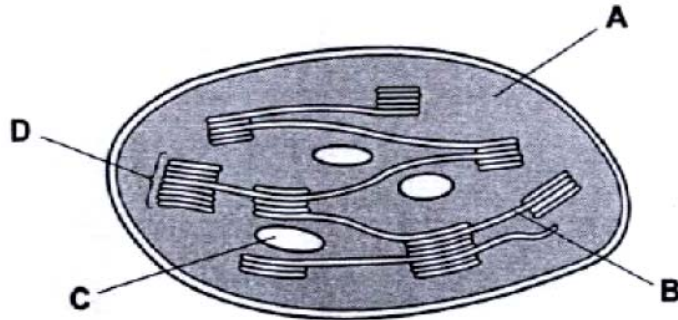
1 normal wing, orange eye

What is the **best** explanation for the results of this dihybrid cross?

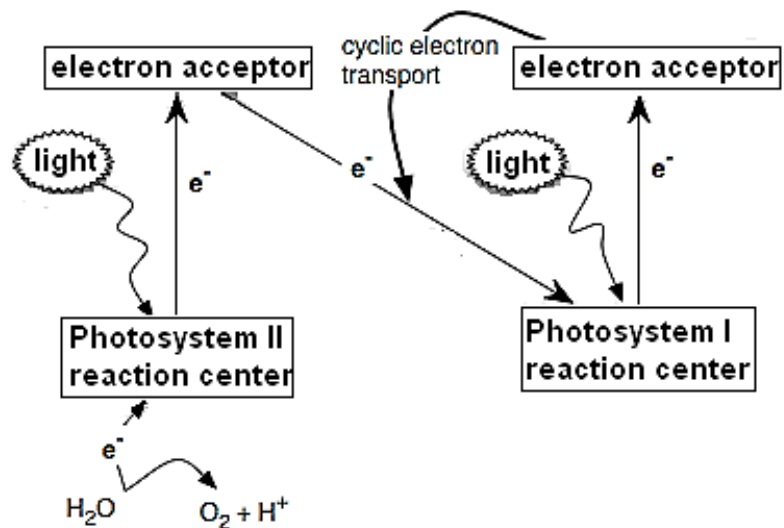
- A codominance
 B gene mutation
 C multiple alleles
 D sex linkage

16 The diagram shows a section through a chloroplast.

Where the products of photophosphorylation would be used?



17 The figure below shows the Z scheme for cyclic phosphorylation and non-cyclic phosphorylation.



Which of the following statements are true?

- 1 Hydrolysis of ATP occurs in both cyclic and non-cyclic phosphorylation.
- 2 Energy released from the electron transport chain is used to pump protons from the stroma into the thylakoid lumen.
- 3 NADP^+ is oxidized in non-cyclic phosphorylation.
- 4 The products of non-cyclic phosphorylation are NADPH, ATP and oxygen.

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

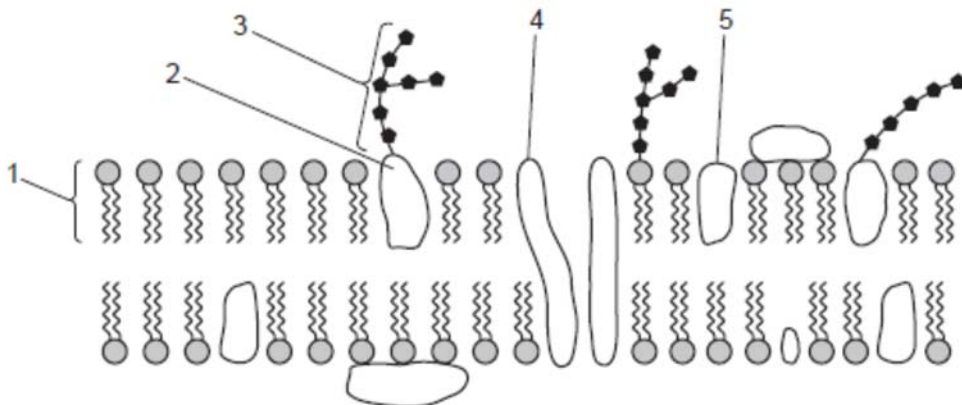
- 18 After vigorous exercise, changes occur in the muscle tissue. Compared with 'at rest' conditions, what will the changes be?

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

- 19 What is the 'link reaction' in eukaryotic respiration?

- A** Oxidation of NADH to yield electrons and protons
- B** Passage of coenzyme A through the mitochondrial membrane
- C** Pyruvate combining with coenzyme A to produce CO_2 and NADH/H^+
- D** Acetyl coenzyme A combining or joining with a C_4 compound to give C_6 + coenzyme

- 20 The diagram shows part of a cell surface membrane.

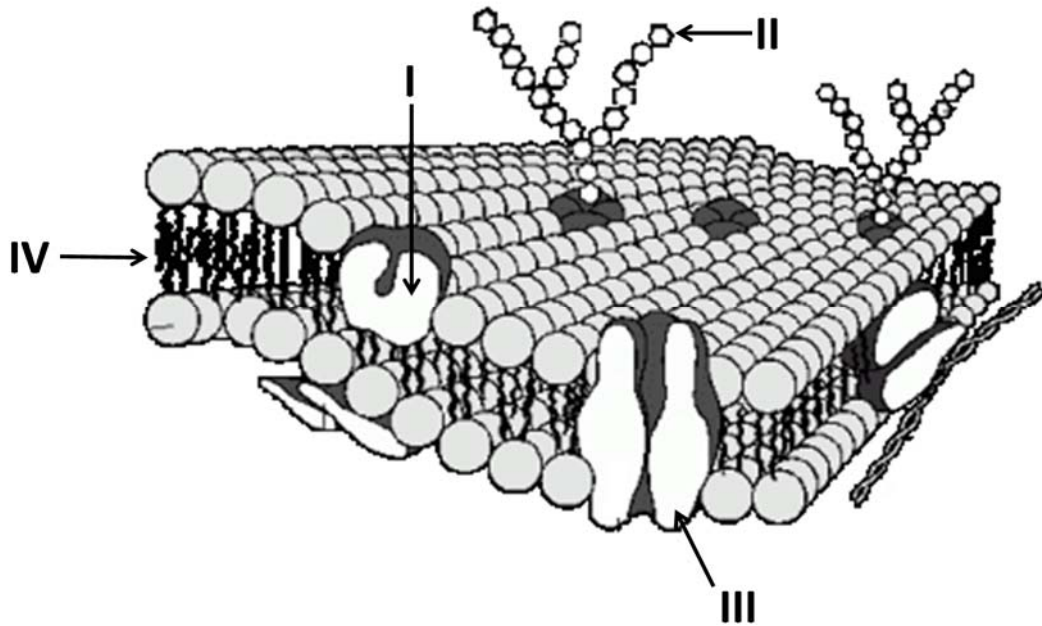


Which molecules have both hydrophobic and hydrophilic regions?

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

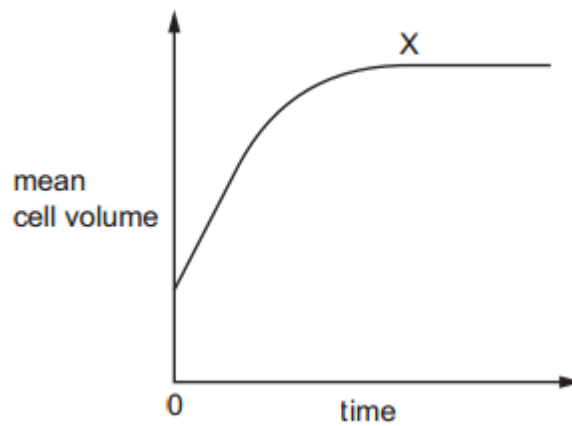
21 The diagram below shows a section of the cell surface membrane from an arctic fish.

Which of the following options regarding the labelled components of the membrane is correct?



	I	II	III	IV
A	Plays a role in cell-cell adhesion	Plays a role in cell-cell recognition	Allows transport of proteins like insulin	Contains a high amount of saturated lipids
B	Plays an enzymatic role	Variation in branching of oligosaccharide allows for cell-cell recognition	Allows transport of amino acids	Contains a high amount of cholesterol
C	Maintains the fluidity of the cell surface membrane	Variation in branching of amino acids allows cell-cell recognition	Plays a role in maintaining membrane potential	Is produced at the Rough Endoplasmic Reticulum
D	Is involved in active transport of ions	Is termed collectively with other glycolipids as the glycocalyx	Is localised to a specific region in the cell surface membrane	Plays a role in cell-cell recognition

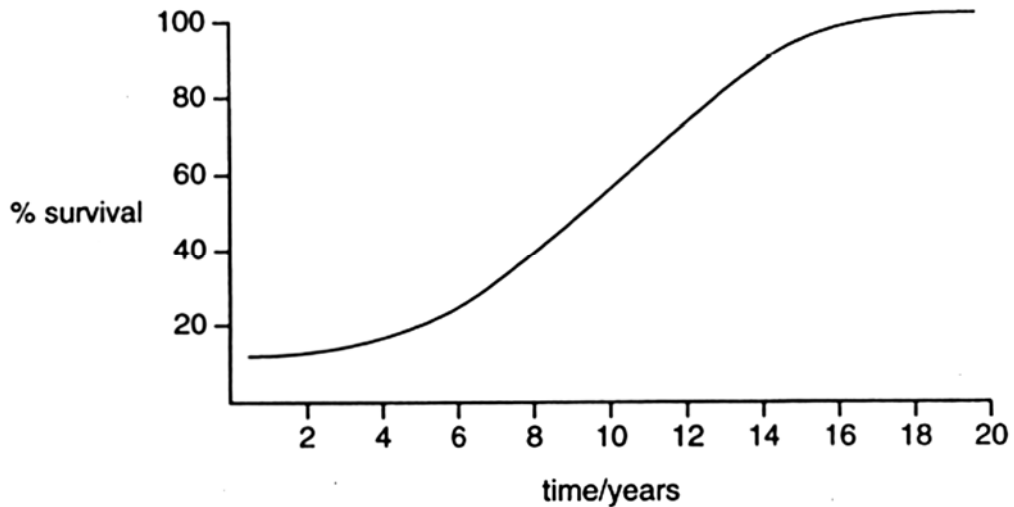
- 22 A tissue composed of plasmolysed plant cells was put into distilled water. The graph shows how the mean cell volume changes with time.



What is the cause of the plateau at **X**?

- 1 water potential in the plant cell has become more negative
 - 2 cells have become fully turgid
 - 3 no net movement of water into cells
- A** 1, 2 and 3
B 1 and 2 only
C 1 and 3 only
D 2 and 3 only

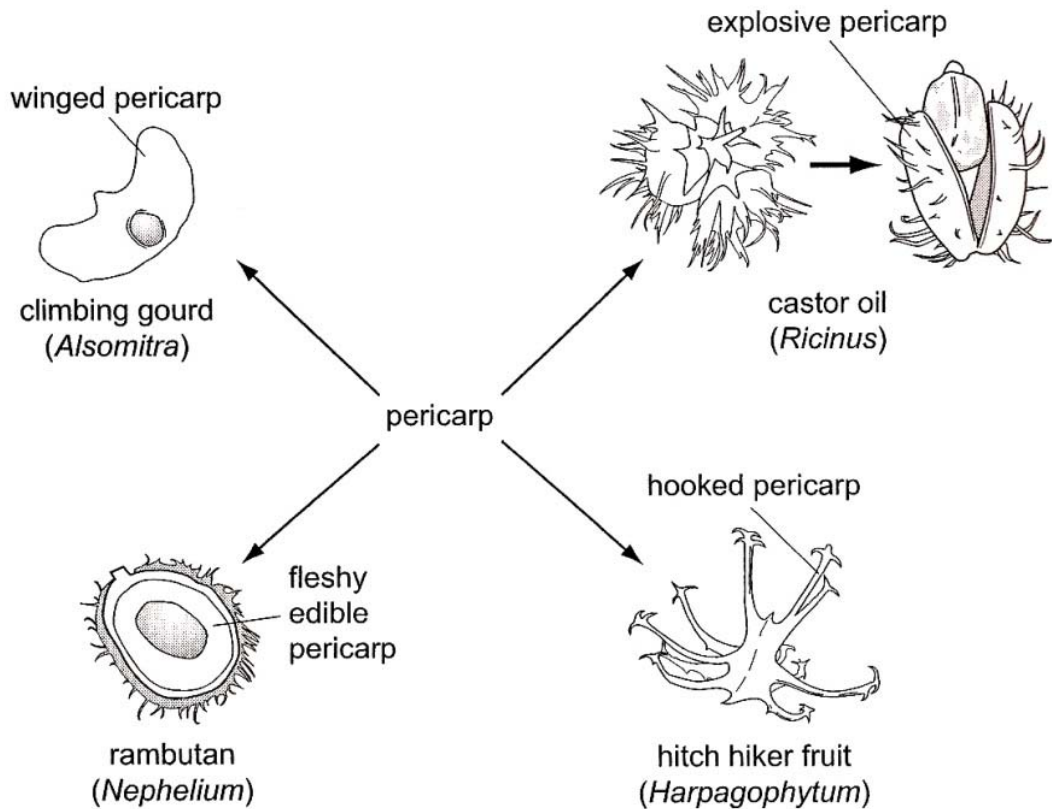
- 23 The graph shows the effect of pesticide treatment on houseflies over a number of years. A standard amount of pesticide was used each year in summer.



How is the effect of the pesticide best explained?

- A A few resistant flies reproduced more successfully and the resistance allele increased in frequency.
- B At every generation an increasing proportion of flies mutated to become resistant.
- C Repeated exposure to the pesticide caused the flies to become more resistant.
- D The allele for resistance mutated from the recessive form to the dominant form.
- 24 Which effect of natural selection is likely to lead to speciation?
- A Differences between populations are increased.
- B Favourable genotypes are maintained in the population.
- C Genetic diversity is reduced.
- D Selection pressure on some alleles reduces reproductive success.

- 25 The diagram illustrates variation in the pericarp (fruit wall) for a variety of methods of seed dispersal.



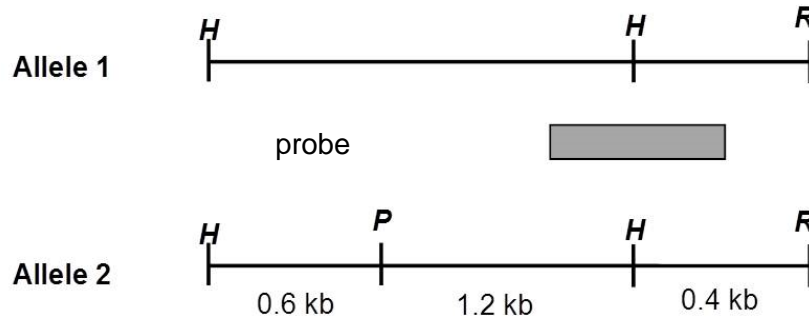
What do these examples illustrate?

- A The adaptive radiation of analogous structures showing convergent evolution.
 - B The adaptive radiation of analogous structures showing divergent evolution.
 - C The adaptive radiation of homologous structures showing convergent evolution.
 - D The adaptive radiation of homologous structures showing divergent evolution.
- 26 Which of the following is **not** a reason for plasmids being used as cloning vector?

- A They are small.
- B They have an origin of replication.
- C They can undergo independent replication.
- D They always produce sticky ends when cut by restriction enzymes.

- 27 Cystic fibrosis is a genetic disease that affects the respiratory and digestive systems. Individuals with cystic fibrosis have two copies of the mutated *CFTR* allele.

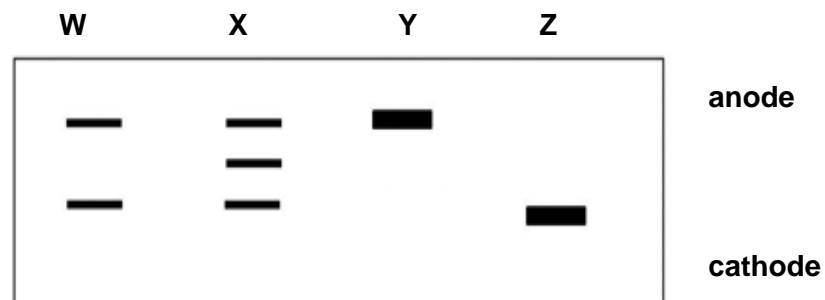
Diagram below shows the positions of various restriction sites of a segment of KM-19, an RFLP (restriction fragment length polymorphism) marker that is closely linked to the *CFTR* gene locus. Position complementary to a radioactive probe is also shown. Allele 2 is linked to the mutant *CFTR* allele.



Legend

- H** represents *Hind*III restriction site
P represents *Pst*I restriction site
R represents *Eco*RI restriction site

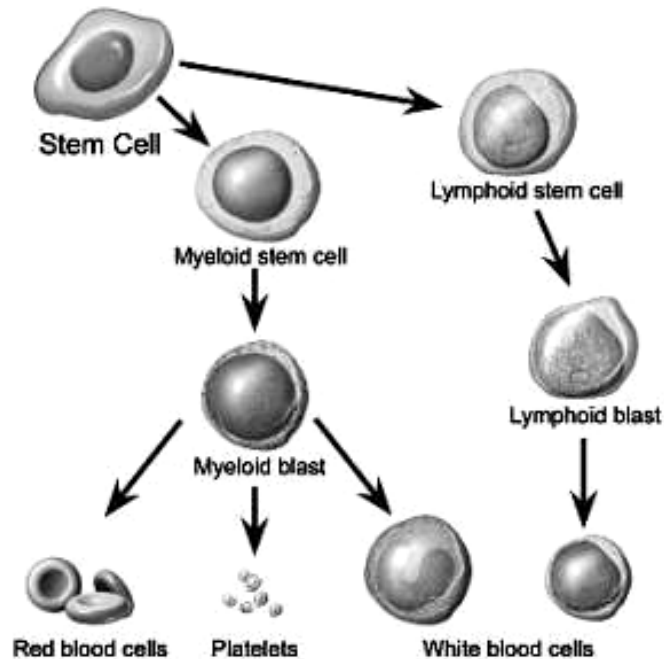
DNA from different individuals are digested using *Pst*I and separated using gel electrophoresis. Results of the autoradiograph are shown below.



Which of the following individual suffers from CF?

- A W
 B X
 C Y
 D Z
- 28 Why are primers added to polymerase chain reaction (PCR) mixture?
- A Because Taq polymerase cannot initiate synthesis of a polynucleotide strand.
 B So that there would not be leading and lagging strand.
 C To anneal to the 3' OH end to the target DNA.
 D To separate the double stranded DNA into 2 single strands.

- 29 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?

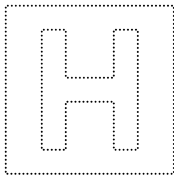
- A The stem cells are multipotent.
 - B The stem cells can be found in both a fetus and an adult body.
 - C The stem cells can differentiate into the three germ layers in the adult body.
 - D The stem cells may be used in a bone marrow transplant to treat a patient with leukemia, a form of blood cancer.
- 30 Some scientists are concerned about the release of genetically modified microorganisms into their natural habitat.

What is the most likely reason for this concern?

- A The microorganisms may reproduce quickly.
- B The microorganisms may not survive.
- C The mutation rate of the microorganisms would increase.
- D The transfer of changed genes to other organisms.

Answers

1	C	16	A
2	D	17	C
3	B	18	A
4	A	19	C
5	B	20	D
6	B	21	B
7	C	22	D
8	C	23	A
9	D	24	A
10	D	25	D
11	C	26	D
12	B	27	C
13	D	28	A
14	A	29	C
15	B	30	D



INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
 in preparation for General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME

CLASS INDEX NUMBER

BIOLOGY

8875/02

Paper 2

29 August 2017

2 hours

Additional Materials: Answer Paper
 Cover Page

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
 Write in dark blue or black pen on both sides of the paper.
 You may use an HB pencil for any diagrams, graphs or rough working.
 Do not use staples, paper clips, glue or correction fluid.

Section A

Answer **all** questions.

Section B

Answer **one** question.

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 the brackets [] at the end of each question or part question.

For Examiner's Use	
Section A	
1	14
2	14
3	12
Section B	
4 OR 5	20
Total	60

This document consists of **11** printed pages and **1** blank page.



Section A
Answer **all** questions.

1 (a) Describe the importance of ATP in cells, giving **two** examples of processes in which it is used.

.....

.....

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.....

.....

..... [3]

Cells generate ATP by adding a phosphate group (P_i) to ADP. During the complete oxidation of glucose, cells have two ways of doing this:

- Substrate level phosphorylation
- Oxidative phosphorylation

Fig 1.1 and 1.2 are diagrams that show the main details of these two processes (not drawn to the same scale).

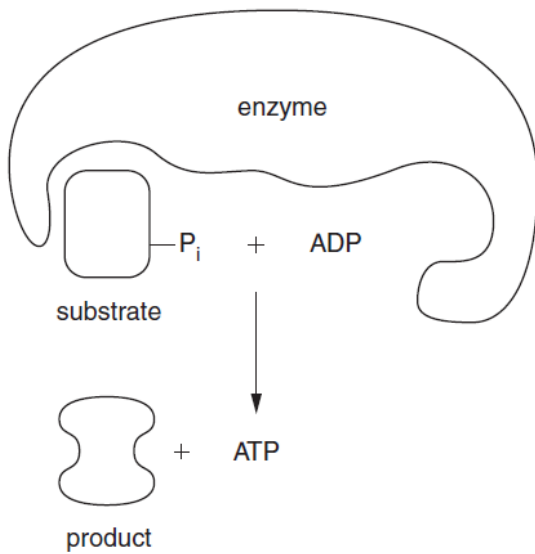


Fig. 1.1

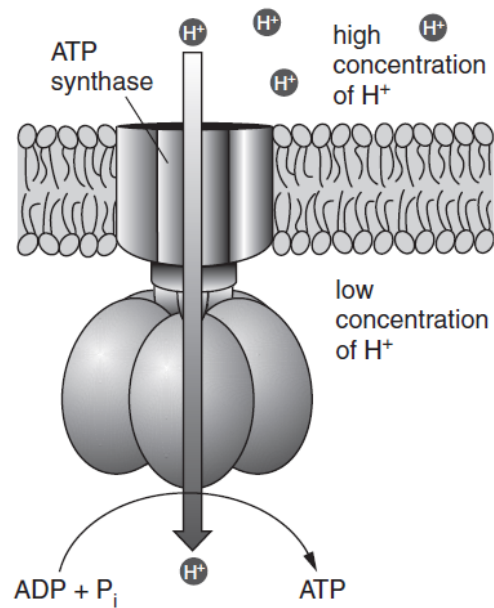


Fig. 1.2

(b) State precisely where these two processes occur in a cell.

substrate level phosphorylation;

.....

oxidative phosphorylation.

..... [2]

- (c) Compare the relative amounts of ATP produced by the two processes when a molecule of glucose is completely oxidised.

.....

.....

.....

.....

[2]

- (d) Only substrate level phosphorylation is possible in the absence of oxygen.
Explain why oxidative phosphorylation is not possible in the absence of oxygen.

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[3]

- (e) Fig. 1.3 shows how glucose is transported into a cell via a transport protein held within the cell surface membrane.

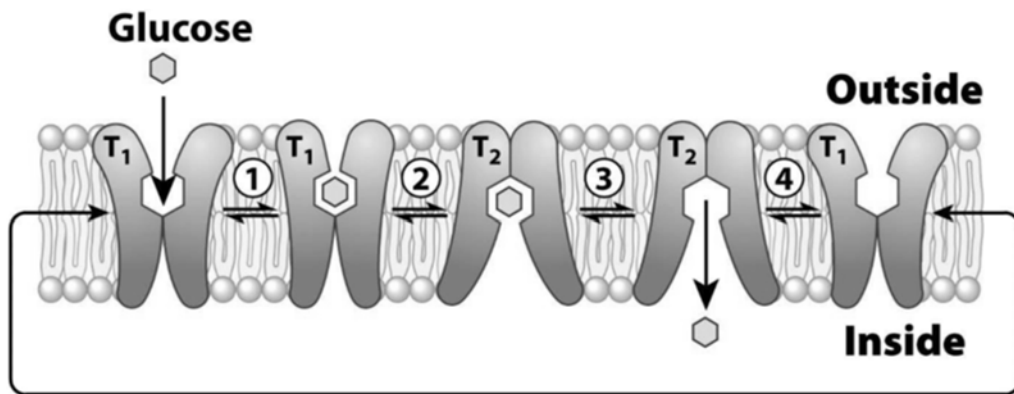


Fig. 1.3

- (i) Describe the structure of the cell surface membrane shown in Fig. 1.3.

.....

.....

.....

.....

[2]

- (ii) With reference to Fig. 1.3, describe how glucose is transported into the cell.

.....

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.....

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[2]

[Total: 14]

- 2 Fig. 2.1 shows a diagram of DNA replication.

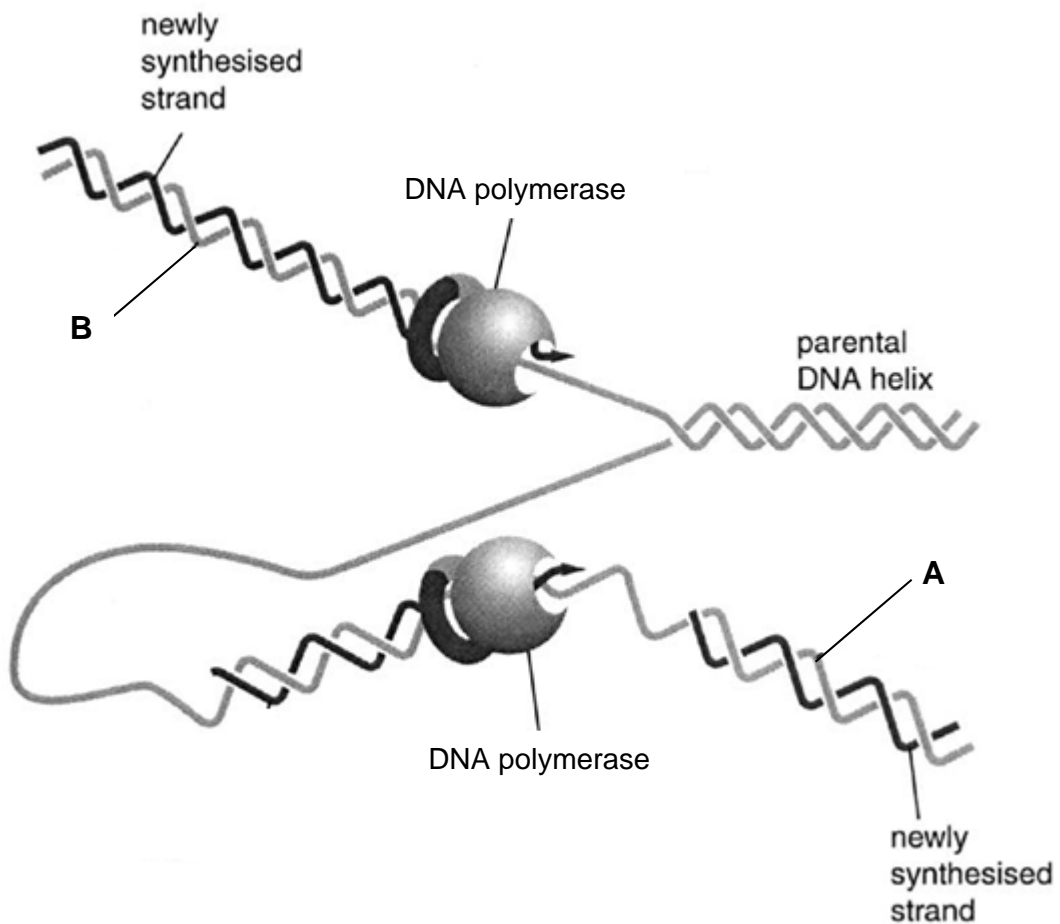


Fig. 2.1

- (a) (i) On Fig. 2.1, indicate 3' and 5' ends on both the parental template strands of the DNA molecule. [1]
- (ii) Circle which strand, A or B, is the lagging strand template used in the synthesis of new DNA daughter strand resulting in Okazaki fragments. [1]

- (b) Explain why the newly synthesised strand is formed continuously from the leading strand template while Okazaki fragments are formed using the lagging strand template.

.....

.....

.....

..... [2]

- (c) Describe how gene mutations may occur during replication of DNA.

.....

.....

..... [2]

Cell cycle checkpoints are used by a cell to monitor and regulate the progress of the cell cycle. Checkpoints prevent cell cycle progression at specific points, allowing verification of necessary phase processes and repair of DNA damage. The cell cannot proceed to the next phase until checkpoint requirements have been met.

Checkpoints typically consist of a network of regulatory proteins that monitor and dictate the progression of the cell through the different stages of the cell cycle. However, these checkpoints may be dysregulated which can result in uncontrolled cell division and eventually cancer.

Fig. 2.2 shows a typical cell cycle with the various checkpoints.

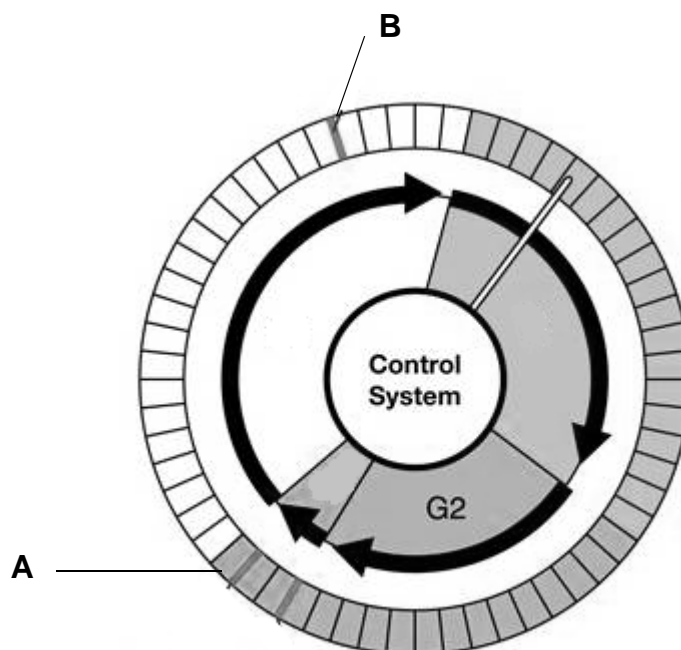


Fig. 2.2

(d) With reference to Fig. 2.2,

(i) name checkpoints **A** and **B**;

A

.....

B

.....

[1]

(ii) Describe the role of checkpoints **A** and **B**.

A

.....

B

.....

[1]

(iii) Explain what occurs in the G2 phase of cell cycle.

.....

.....

.....

.....

[2]

(e) Describe how dysregulation of the checkpoints in cell cycle may lead to cancer.

.....

.....

.....

.....

[2]

(f) Some types of cancer can be treated by chemotherapy, which involves the injection of chemicals into the bloodstream.

Vincristine is a drug used for chemotherapy. This drug works partly by binding to the tubulin protein, stopping the cell from proceeding in the M phase of the cell cycle.

Explain how the use of vincristine will stop the proliferation of cancer cells.

.....

.....

.....

.....

[2]

[Total: 14]

- 3 The fruitfly, *Drosophila*, has many different species. Three of these species, *Drosophila pseudoobscura*, *D. persimilis* and *D. miranda*, are thought to be closely related.

Samples of these three species were collected from the western United States of America.

Fig. 3.1 shows where these species naturally occur.

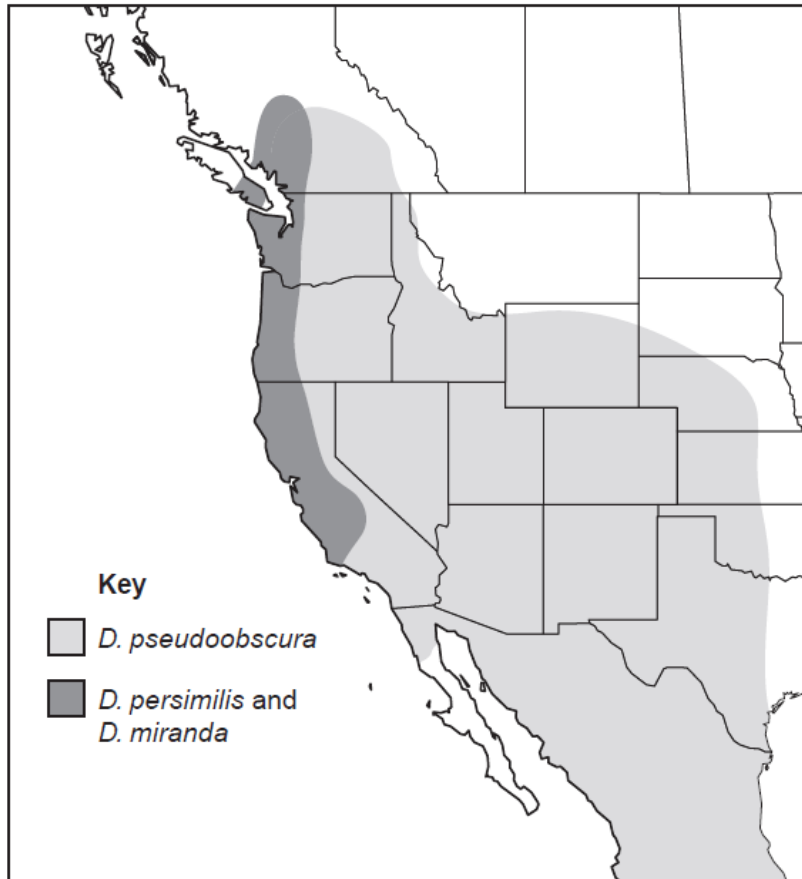


Fig. 3.1

- (a) State what must exist in a population for natural selection to occur.

----- [1]

The base sequences of four regions of DNA of each species were sequenced. The divergence of these base sequences in *D. pseudoobscura* and *D. persimilis* from the sequences in *D. miranda* was calculated. The results are shown in Table 3.

Table 3

DNA region	<i>Drosophila</i> species	percentage divergence of base sequence from that of <i>D. Miranda</i> /%
1	<i>pseudoobscura</i>	2.5
	<i>persimilis</i>	2.4
2	<i>pseudoobscura</i>	8.1
	<i>persimilis</i>	7.3
3	<i>pseudoobscura</i>	2.1
	<i>persimilis</i>	1.7
4	<i>pseudoobscura</i>	1.9
	<i>persimilis</i>	1.7

- (b) With reference to Table 3, describe the evidence that *D.miranda* may be more closely related to *D.persimilis* than to *D.pseudoobscura*.

.....

.....

.....

..... [2]

- (c) Suggest why there is more divergence in some regions of DNA than in others.

.....

..... [1]

- (d) Explain how *D.persimilis* and *D.pseudoobscura* could have speciated from *D.miranda*.

[4]

Beside molecular homology, scientists can also use anatomical homology to study the evolutionary relationship among vertebrate species.

Fig. 3.2 shows the relationship between six vertebrate species by comparing the bone arrangement in the forelimbs.

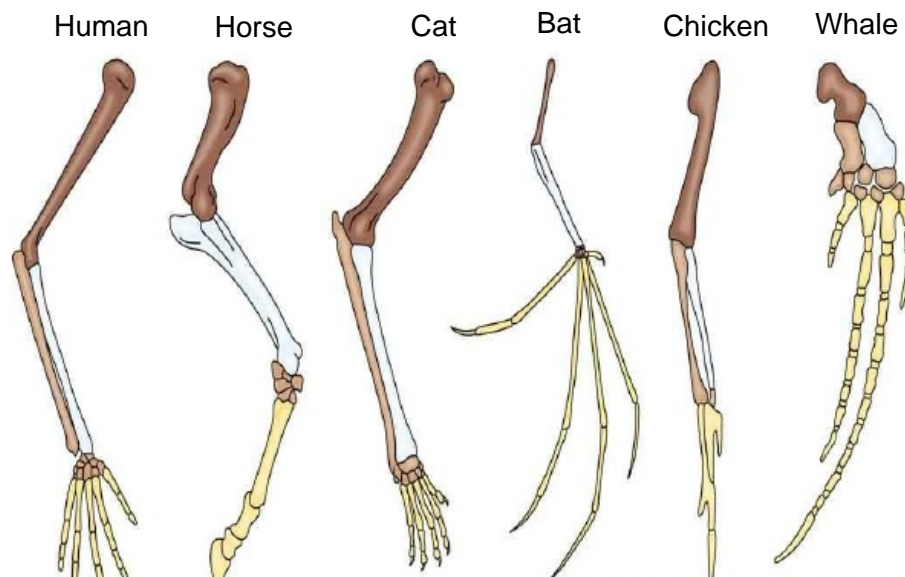


Fig. 3.2

(e) Explain what is meant by 'homology'.

----- [1]

(f) Explain how the anatomical homology shown in Fig. 3.2 supports Darwin's theory of evolution.

----- [3]

[Total: 12]

Section B**Answer EITHER 4 OR 5.**

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 section **(a)**, **(b)** etc., as indicated in the question.

Either

- 4 (a) Describe the polymerase chain reaction and explain the advantages and limitations of the procedures. [12]
- (b) Explain how gel electrophoresis is used to analyse DNA. [8]

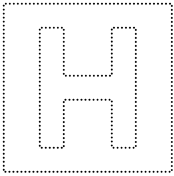
[Total: 20]

Or

- 5 (a) Describe the unique features of zygotic stem cells, embryonic stem cells and blood stem cells and explain the normal functions of stem cells in a living organism. [10]
- (b) With reference to two examples, explain how genetic engineering can be used to improve quality and yield of crop plants. [10]

[Total: 20]

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INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
 in preparation for General Certificate of Education Advanced Level
Higher 1

CANDIDATE
NAME

ANSWERS

CLASS

INDEX NUMBER

BIOLOGY

8875/02

Paper 2

29 August 2017

2 hours

Additional Materials: Answer Paper
Cover Page

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For Examiner's Use	
Section A	
1	
2	
3	
Section B	
4 OR 5	
Total	

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



Section A
Answer **all** questions.

- 1 (a) Describe the importance of ATP in cells, giving **two** examples of processes in which it is used.

1. **ATP is the universal energy carrier in living org**

where hydrolysis of phosphate grps releases energy;;

2. **muscle contraction;; OR**

3. **DNA replication;; OR**

active transport, cell movement, amino acid activation, AVP;;

[3]

Cells generate ATP by adding a phosphate group (P_i) to ADP. During the complete oxidation of glucose, cells have two ways of doing this:

- Substrate level phosphorylation
- Oxidative phosphorylation

Fig 1.1 and 1.2 are diagrams that show the main details of these two processes (not drawn to the same scale).

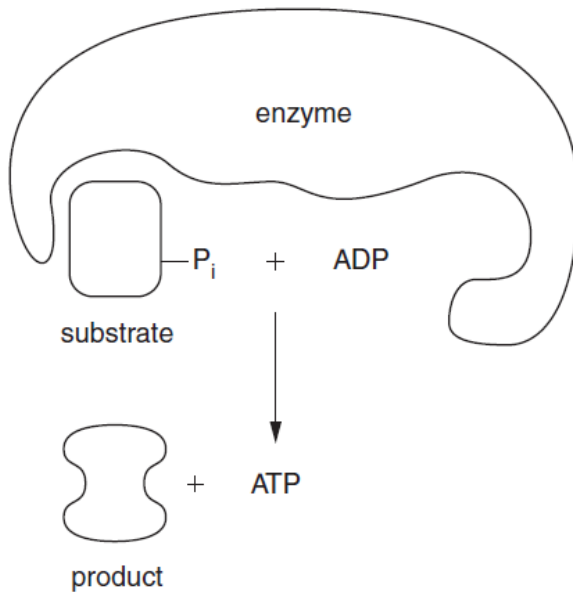


Fig 1.1

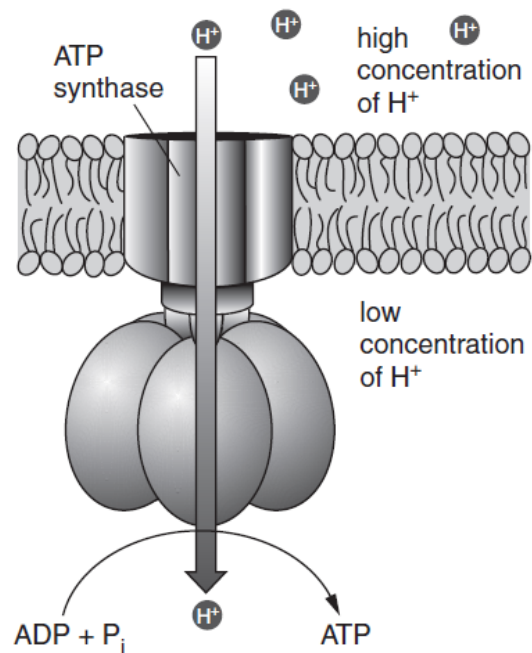


Fig 1.2

- (b) State precisely where these two processes occur in a cell.

substrate level phosphorylation

Cytoplasm @cytosol (during glycolysis)/ mitochondrion matrix (during Krebs cycle);;

oxidative phosphorylation

inner memb of mitochondrion;;

[2]

- (c) Compare the relative amounts of ATP produced by the two processes when a molecule of glucose is completely oxidised.

1. **OP pdces more ATP than SLP;;**

2. **SLP pdces 4 ATP (2 in glycolysis, 2 in Krebs Cycle) while OP pdces 28 ATP;;**

[2]

- (d) Only substrate level phosphorylation is possible in the absence of oxygen. Explain why oxidative phosphorylation is not possible in the absence of oxygen.

1. **O_2 is final e- & proton acceptor in ETC**

producing water in process, catalyzed by cytochrome oxidase;;

2. **w/o O_2 , there is no flow of e- down ETC**

thus electrochemical proton grad is not generated across inner mitochondrial memb;;

3. **H^+ ions does not diffuse across inner mitochondrial memb via ATP synthase catalytic sites of ATP synthase not activated, thus no phosphorylation of ADP with P_i ;;**

[3]

- (e) Fig 1.3 shows how glucose is transported into a cell via a transport protein held within the cell surface membrane.

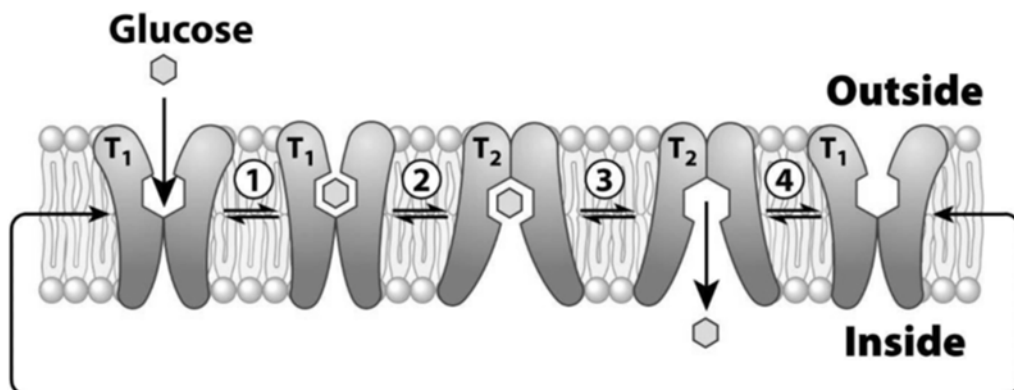


Fig 1.3

- (i) Describe the structure of the cell surface membrane shown in Fig 1.3.

1. **It has a fluid mosaic model composed of phospholipid bilayer & prots;;**

2. **hydrophilic phosphate heads faces aqueous medium while hydrophobic hydrocarbon tails face each other away from aqueous medium;;**

[2]

- (ii) With reference to Fig 1.3, describe how glucose is transported into the cell.

1. **high conc of glucose outside cell, glucose binds complementarily to binding site of carrier prot in T1 conformation;; @transport protein**

2. **upon binding, carrier prot changes from T1 conformation to T2 conformation, where it releases glucose inside of cell;;**

[2]

[Total: 14]

2 Fig. 2.1 shows a diagram of DNA replication.

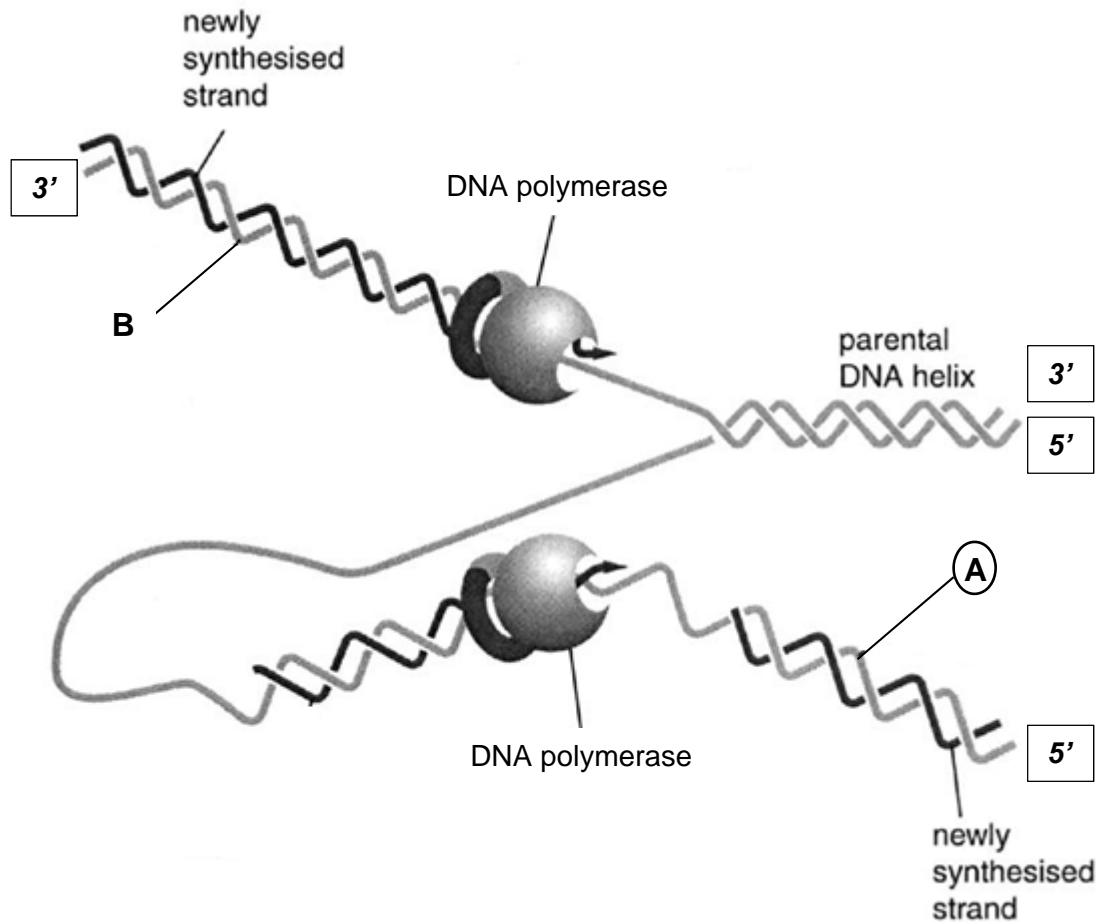


Fig. 2.1

- (a) (i) On Fig. 2.1, indicate 3' and 5' ends on both the parental template strands of the DNA molecule. [1]
- (ii) Circle which strand, A or B, is the lagging strand template used in the synthesis of new DNA daughter strand resulting in Okazaki fragments. [1]
- (b) Explain why the newly synthesised strand is formed continuously from the leading strand template while Okazaki fragments are formed using the lagging strand template.

1. 2 DNA strands synthesized are antiparallel

DNA pol can only add nucleotides to 3' end of growing daughter strand in 5' to 3' direction

2. leading strand synthesised in 5' to 3' direction continuously towards replication fork

lagging strand synthesised as Okazaki fragments in 5' to 3' direction away from replication fork

[2]

- (c) Describe how gene mutations may occur during replication of DNA.
error in complementary base pairing occurs during DNA replication by DNA pol III;;
point substitution mutations not corrected by DNA repair prots or DNA pol III during proofreading;;

[2]

Cell cycle checkpoints are used by a cell to monitor and regulate the progress of the cell cycle. Checkpoints prevent cell cycle progression at specific points, allowing verification of necessary phase processes and repair of DNA damage. The cell cannot proceed to the next phase until checkpoint requirements have been met.

Checkpoints typically consist of a network of regulatory proteins that monitor and dictate the progression of the cell through the different stages of the cell cycle. However, these checkpoints may be dysregulated which can result in uncontrolled cell division and eventually cancer.

Fig. 2.2 shows a typical cell cycle with the various checkpoints.

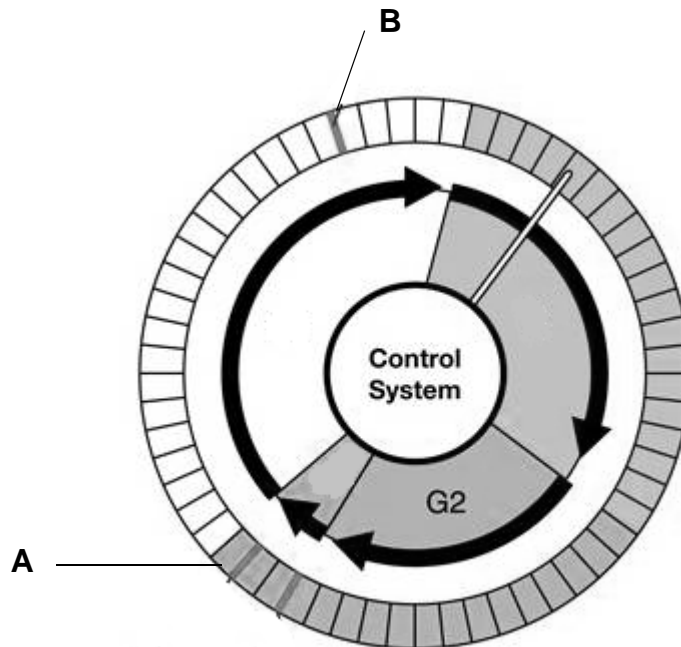


Fig. 2.2

- (d) With reference to Fig. 2.2,

- (i) name checkpoints A and B;

A *spindle/ M phase checkpoint;*

B *G1/ restriction checkpoint/ DNA damage checkpoint;*

[1]

(ii) Describe the role of checkpoints **A** and **B**.

A *checks chromosomes are all properly attached to spindle fibres before cell cycle continues;*

B *checks for presence of growth factors, DNA damage, cell size, nutrients*

[1]

(iii) Explain what occurs in the G2 phase of cell cycle.

1. cell's growth phase after DNA replication in S phase of interphase

cells continue to build up synthesis ATP (energy), synthesises proteins and organelles (mitochondrion, rER);;

2. duplication of centrosome occurs, each containing pair of centrioles

prepare cell to enter M phase of cell cycle;;

[2]

(e) Describe how dysregulation of the checkpoints in cell cycle may lead to cancer.

1. cells will continue to proceed to next phase of cell cycle continuously bypassing checkpoints

cells are not checked for their readiness to proceed to next phase of cell cycle;;

2. leads to uncontrolled cell division & over - proliferation of cells

resulting in formation of a mass of non-functional cells called tumour resulting in cancer;;

[2]

(f) Some types of cancer can be treated by chemotherapy, which involves the injection of chemicals into the bloodstream.

Vincristine is a drug used for chemotherapy. This drug works partly by binding to the tubulin protein, stopping the cell from proceeding in the M phase of the cell cycle.

Explain how the use of vincristine will stop the proliferation of cancer cells.

1. tubulin is a component of spindle fibre/ microtubules

when drug binds to tubulin, spindle fibre/ microtubules could not be formed;;

2. cells are unable to pass the spindle/ M phase checkpoint

Thus does not divide successfully thereby stopping proliferation of cancer cells;;

[2]

[Total: 14]

- 3 The fruitfly, *Drosophila*, has many different species. Three of these species, *Drosophila pseudoobscura*, *D. persimilis* and *D. miranda*, are thought to be closely related.

Samples of these three species were collected from the western United States of America.

Fig. 3.1 shows where these species naturally occur.

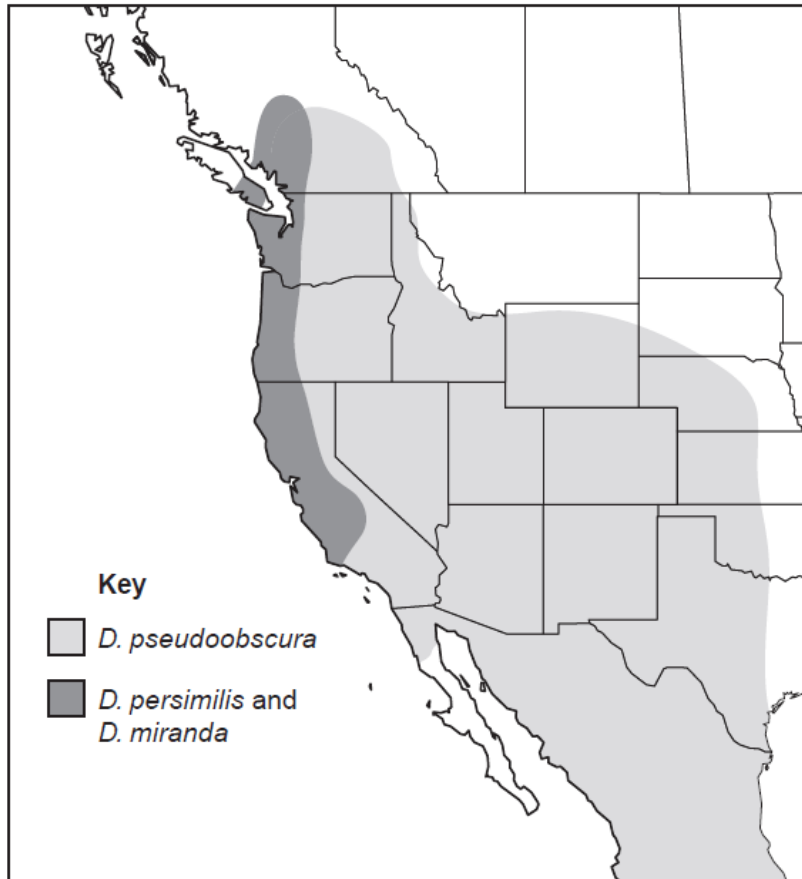


Fig. 3.1

- (a) State what is must exist in a population for natural selection to occur.
variation;;

[1]

The base sequences of four regions of DNA of each species were sequenced. The divergence of these base sequences in *D. pseudoobscura* and *D. persimilis* from the sequences in *D. miranda* was calculated. The results are shown in Table 3.

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	<i>persimilis</i>	2.4
2	<i>pseudoobscura</i>	8.1
	<i>persimilis</i>	7.3
3	<i>pseudoobscura</i>	2.1
	<i>persimilis</i>	1.7
4	<i>pseudoobscura</i>	1.9
	<i>persimilis</i>	1.7

(b) With reference to Table 3, describe the evidence that *D. miranda* may be more closely related to *D. persimilis* than to *D. pseudoobscura*.

1. **% divergence of *D. persimilis* from *D. miranda* is less than that of *D. pseudoobscura* from *D. miranda***

for all 4 DNA regions;;

2. **at DNA region 4, % divergence of *D. persimilis* is 1.7 & 1.9 for *D.pseudoobscura***

at DNA region 2, % divergence of *D. persimilis* is 7.3 & 8.1 for *D.pseudoobscura*;;

[2]

(c) Suggest why there is more divergence in some regions of DNA than in others.

1. **some regions of DNA have higher mutation rates / more prone to mutations**

mutation changes are less harmful when exact seq of amino acid is not critical to survival of org;; OR

2. **lower divergence / mutation rates if DNA is part of an impt gene**

mutations in some regions are likely to be fatal hence not seen in popn;

[1]

(d) Explain how *D.persimilis* and *D.pseudoobscura* could have speciated from *D.miranda*.

1. **variations exist in the 2 popns of *D. miranda***

due to diff genetic makeup;;

2. **diff selection pressures in diff env^{tal} cond^{ns}**

those with favourable phenotypes are selected for;;

3. **survive to reproductive age & pass down advantageous/ favourable alleles to offspring,**

leading to changes in freq of alleles in gene pool;;

4. **2 popns cannot interbreed due to geographical barrier (water bodies/ high mountains), there will be accumulation of genetic differences over time which results in the formation of different species, unable to interbreed to give viable, fertile offspring;;** [4]

Beside molecular homology, scientists can also use anatomical homology to study the evolutionary relationship among vertebrate species.

Fig. 3.2 shows the relationship between six vertebrate species by comparing the bone arrangement in the forelimbs.

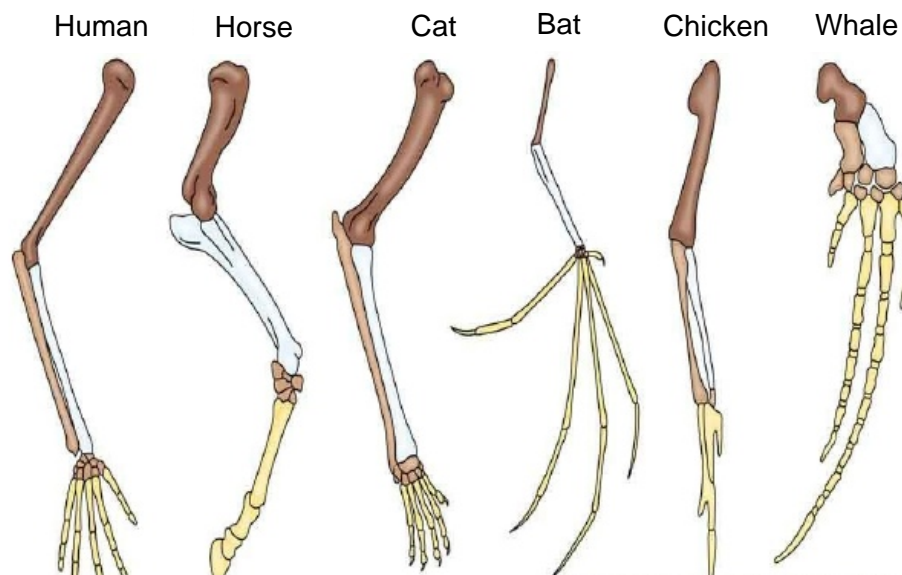


Fig. 3.2

(e) Explain what is meant by 'homology'.

1. Homology refers to similarities due between diff species due to a common ancestor;;

[1]

(f) Explain how the anatomical homology shown in Fig. 3.2 supports Darwin's theory of evolution.

1. forelimbs of various species hv same basic pentadactyl/ five digit forelimb struc

differences in shape which are largely due to specialisation for a particular function;;

2. e.g. whale for swimming, bat for flying etc;;

3. struc likely to have originated/ derived from a common ancestor

indicating descent with modification over time;;

[3]

[Total: 12]

Section BAnswer **one** question.

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 section **(a)**, **(b)** etc., as indicated in the question.

- 4 (a) Describe the polymerase chain reaction and explain the advantages and limitations of the procedures. [12]

PCR Process (max 6m)

1. ***PCR is an in vitro method of replicating short DNA seq into millions of copies/amplifying short DNA seq within short period of time***
2. ***PCR rxn requires forward & reverse primers, heat-stable Taq pol, free deoxyribonucleotides, & target DNA seq to be amplified & buffer soln***
3. ***PCR is carried out in a thermal cycler in 3 step cycle – denaturation, annealing and elongation to take place***
4. ***denaturation takes place at 95°C to separate ds DNA into ss DNA by breaking H-bonds b/w compl bp. ss DNA will then act as template for elongation***
5. ***annealing occurs when rxn mixture is cooled to 55°C to allow forward & reverse primers to bind to complementary seq flanking target seq via H-bonds b/w compl bp.***
6. ***elongation occurs at 72°C when Taq pol synthesizes compl DNA strands by adding free deoxyribonucleotides to free 3'OH ends of primers using target DNA seq as template***

each cycle results in doubling of the target DNA seq (2ⁿ)

Advantages (max 3m)

7. ***Rapid and efficient***

Each cycle takes only 3 - 5 min thus large number of DNA molecules to be amplified.

8. Relatively easy

PCR can be performed using relatively simple equipment, a thermal cycler. The process is fully automated with initial setting of conditions, adding all reagents in appropriate amounts and the cycles can run unattended overnight.

9. Sensitive and robust

The process is sensitive and can amplify minute amounts of target DNA.

10. Specific

The elongation process in PCR synthesises the target DNA sequence that lies specifically between the forward and reverse primers.

11. Relatively high fidelity

The amplification is relatively accurate with error rates ranging between 1 in 10,000 bases to 1 in 100,000 bases. Error rates vary with the choice of polymerase.

Limitations (max 3m)**12. Primer design**

base sequence flanking the target sequence needs to be known first in order to synthesize specific primers.

13. Limited length of target sequence

The length of target DNA restricted to 0.1 to 5 kb with an optimum length of 2 to 3 kb. Further increase in length of target sequence decreases efficiency of amplification because polymerase tends to detach before chain extension is complete.

14. Error in replication

Taq polymerase lacks proofreading activity. This results in an error rate of approximately 1 in 10,000 bases. If the error occurs early in the PCR cycle, the erroneous sequence will be amplified together with the target sequence.

(b) Explain how gel electrophoresis is used to analyse DNA. [8]

(max 8m)

1. **Agarose gel electrophoresis is used in the separation of DNA fragments after digestion by restriction enzymes.**
2. **Agarose powder is dissolved buffer and poured into gel casting tray. A comb is inserted to form wells. After the gel is cooled and harden, it placed in the gel chamber together with buffer and the comb removed.**
3. **DNA fragments are mixed with loading and tracking dye and loaded in wells of the agarose gel near the cathode using a micropipette.**
4. **The loading dye contains glycerol that helps weigh the DNA fragments into the wells.**
5. **Tracking dye containing a low and a high molecular weight coloured compound is added during loading. These coloured compounds act as front and back markers of migration.**
6. **A voltage between 90V to 150V is applied across the gel. The buffer maintains appropriate pH and contains ions that conduct a direct current across the gel.**
7. **DNA fragments which are negatively charged due to presence of phosphate groups, will migrate across the gel from the negative electrode (cathode) towards the positive electrode (anode).**
8. **Agarose gel acts as a molecular sieve to separate nuclei acids by size/ molecular weight/ fragment length. Smaller fragments are less impeded by the gel and migrate faster (further) than larger fragments. @vice versa, idea of migrate rate is inversely proportional to fragment length/ size**
9. **After electrophoresis, DNA fragments of the same size/ length are localised in the same region of the gel forming a band.**
10. **As DNA molecules are not visible to the naked eye. Gels need to be stained with methylene blue/ ethidium bromide for the DNA bands to be seen.**

[Total: 20]

- 5 (a) Describe the unique features of zygotic stem cells, embryonic stem cells and blood stem cells and explain the normal functions of stem cells in a living organism. [10]

Features

1. ***Zygotic stem cells are produced from the fusion of an egg and sperm cell are they are totipotent;;***
2. ***They can differentiate into any cell types to form whole organisms, and so are also pluripotent and multipotent;;***
3. ***Embryonic stem cells from the inner cell mass of blastocyst (a hollow ball-shaped mass of cell formed a week after fertilisation) are pluripotent. They are the descendants of totipotent cells;;***
4. ***These cells can differentiate into almost any cell type to form any organ or type of cell except extra-embryonic tissues and so are not totipotent but are multipotent;;***
5. ***Blood stem cells are from the bone marrow are multipotent;;***
6. ***Blood / hematopoietic stem cells are multipotent as they can only differentiate into a limited range of cell type - red blood cells, white blood cells, platelets. They are not totipotent or pluripotent;;***

Functions

7. ***Embryonic stem cells give rise to all derivatives of the three primary germ layers: ectoderm, endoderm and mesoderm during development;;***
8. ***These germ layers subsequently give rise to the multiple specialized cell types that make up the heart, lung, skin, and other tissue;;***
9. ***Adult stem cells like blood stem cells maintain the steady state functioning of a cell;;***
10. ***by generating replacements for cells lost through disease, tissue injury or normal wear-and-tear;;***

- (b) With reference to two examples, explain how genetic engineering can be used to improve quality and yield of crop plants. [10]

Example 1: Bt Corn (max 5m)

1. **Corn are often damaged by the larvae (caterpillar) of the moth, European corn borer. The larvae bore and eat into the stem of the corn plant, damaging and often killing it;;**
2. **The use of spray insecticides is ineffective as the larva is protected from the insecticides once it enters the stem;;**
3. **Bt corn - corn plant genetically modified to be resistant to insects like the European corn borer by introducing a gene coding for a toxin that kills the larvae;;**
4. **The cry gene isolated from soil bacterium Bacillus thuringiensis is transformed into corn plants via the use of the Ti plasmid from the bacterium Agrobacterium tumefaciens;;**
5. **Corn that has been transformed with the cry gene (i.e. Bt corn) is able to produce Bt toxin;;**
6. **When a larvae feeds on any tissue of the Bt corn plant, it ingests the Bt toxin. The Bt toxin is cleaved by intestinal protease, active Bt toxin binds to receptors on the surface of epithelial cells and inserts into the cell membrane, forming pores. This causes gut cells of insect to lyse, eventually leading to insects' death;;**
7. **This reduced the use of insecticides while ensuring that corn plants are enable to grow healthily to maturity, thereby ensuring increase in yield;;**

Example 2: Golden Rice (max 5m)

8. **In developing countries, vitamin A deficiency is a leading cause of vision impairment and blindness in children;;**
9. **Rice grain is a staple food in many developing countries. But the precursor to vitamin A - β -carotene is produced in the rice leaves and not the rice grain which is eaten;;**
10. **The rice plant can be genetically modified to express β -carotene in its rice**

grain. GM rice is known as Golden Rice due to its yellow-orange colour;;

- 11. In Golden Rice, two β -carotene biosynthesis genes are inserted into the rice genome to produce enzymes that synthesise and accumulate β -carotene in the rice grain::*
- 12. they are psy gene from the plant daffodil coding for phytoene synthase and crt1 gene from soil bacterium that codes a bacterial phytoene desaturase which produces the substrates for the subsequent steps to conversion to β carotene::*
- 13. This allowed β carotene to be produced in the rice grain, improving the quality (nutritional content) of the rice. Golden rice consumed by people will then allow our bodies to produce Vitamin A without the consumption of additional supplements::*

[Total: 20]