

1 Which of the following is/are the most likely consequence(s) for an animal cell lacking functional Golgi bodies?

1. The cell dies because it is unable to make glycoproteins to detect stimuli from its environment.
2. The cell dies from a lack of enzymes to digest food taken in by endocytosis.
3. The cell dies because of the accumulation of worn-out organelles within itself.
4. The cell is unable to synthesise centrioles for cell division.
5. The cell is unable to export its enzymes or peptide hormones.

- A** 1 and 5 only  
**B** 2, 3 and 4 only  
**C** All except 4  
**D** All of the above

2 Which of the following options correctly matches the functional and structural features of cellulose, collagen, glycogen and triglycerides?

		Function	Structure		
			Linear/ Fibrous	Molecule held together by hydrogen bonds	Branched chains
<b>A</b>	Cellulose	Support	✓	×	✓
	Collagen	Strengthening	✓	✓	×
<b>B</b>	Cellulose	Support	✓	✓	×
	Triglyceride	Storage	×	×	×
<b>C</b>	Collagen	Strengthening	✓	✓	✓
	Glycogen	Storage	×	×	✓
<b>D</b>	Glycogen	Storage	×	✓	✓
	Triglyceride	Storage	×	✓	×

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

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

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

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

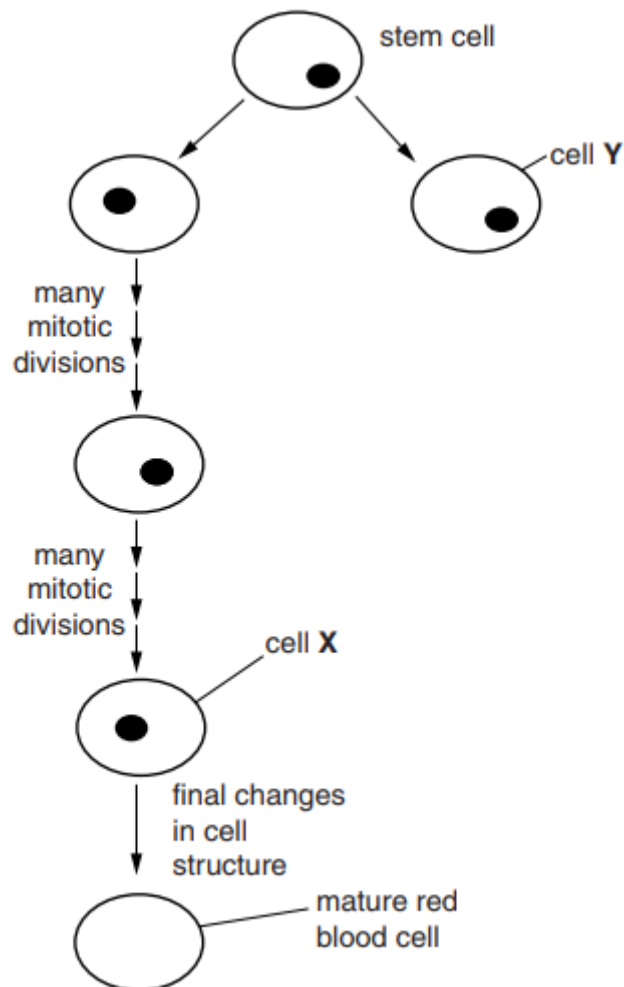
- 4 An unusual enzyme has been found in a tropical grass.

- It catalyses the hydrolysis of the fungal polysaccharide, chitin, into amino sugars.
- It also inhibits the activity of an enzyme in locust guts which catalyses the digestion of amylose.

What describes the actions of this unusual enzyme?

	<b>reaction catalysed</b>	<b>reaction inhibited</b>
<b>A</b>	hydrolysis of glycosidic bonds	condensation of glycosidic bonds
<b>B</b>	hydrolysis of glycosidic bonds	hydrolysis of glycosidic bonds
<b>C</b>	hydrolysis of peptide bonds	condensation of glycosidic bonds
<b>D</b>	hydrolysis of peptide bonds	hydrolysis of glycosidic bonds

- 5 Bone marrow contains many stem cells. Some of these stem cells are responsible for the replacement of red blood cells. During the production of red blood cells, a series of changes occur to the cell structure. The figure below shows the production of a red blood cell from one of these stem cells.



Which of the following correctly describes the changes that occur as cell X becomes a mature biconcave red blood cell?

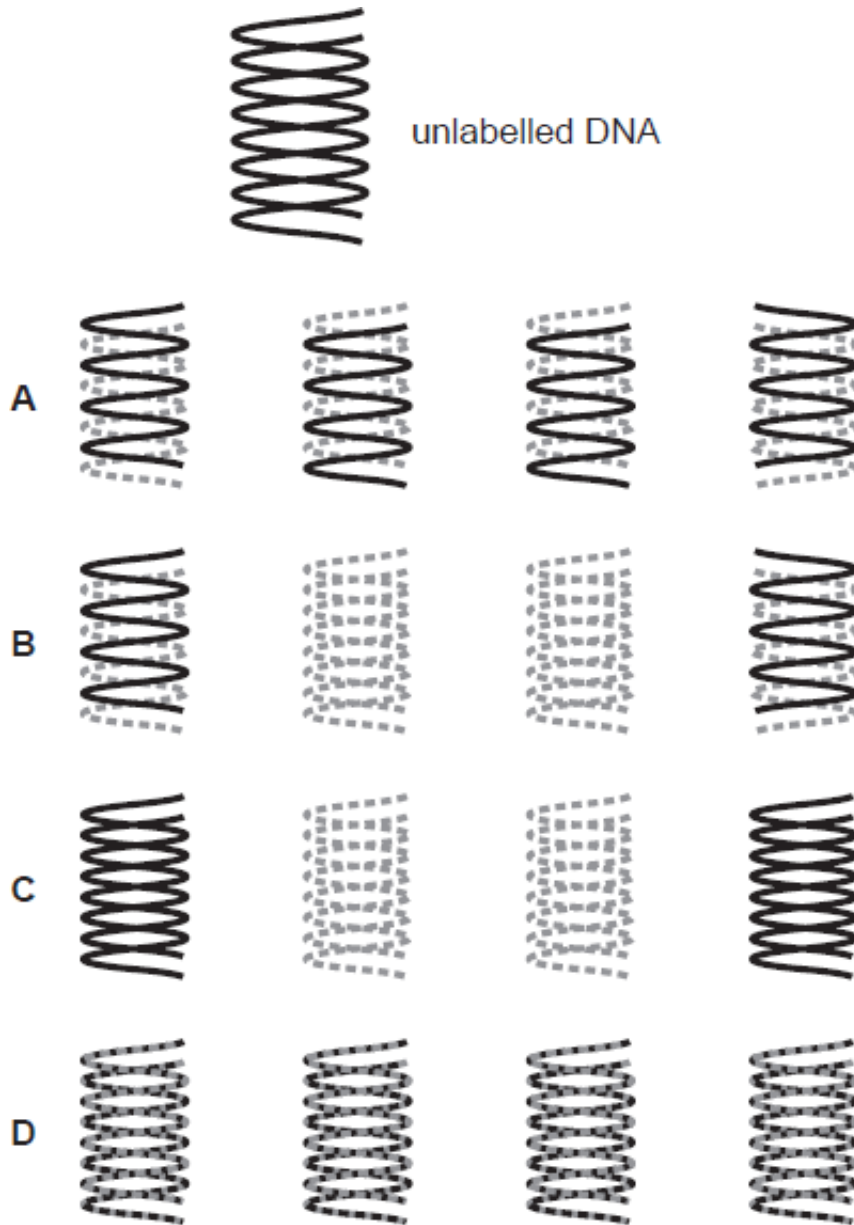
1. displays cell surface antigens such as ABO, CD4 and CD8
2. becomes multipotent
3. synthesises haemoglobin and carbonic anhydrase
4. loses its nucleus
5. loses organelles such as ribosomes, ER, mitochondria
6. loses telomerase activity

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

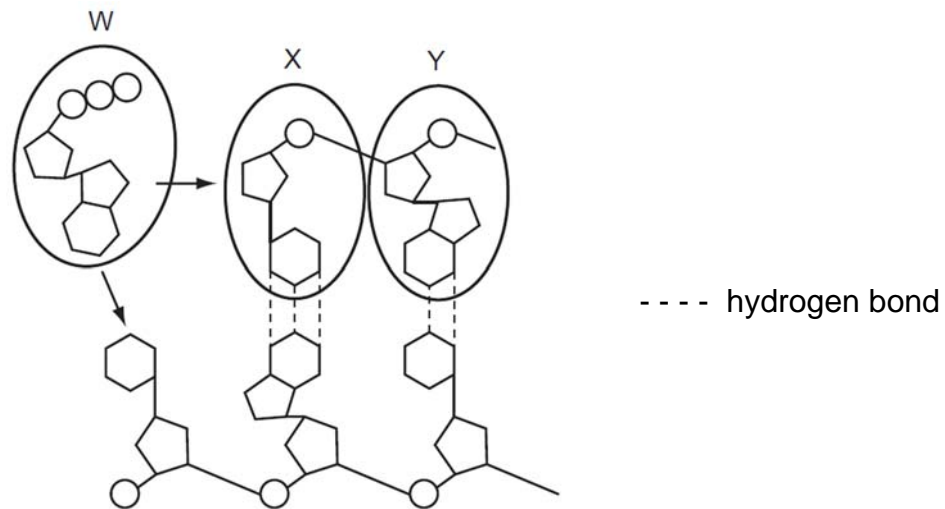
- 6 The sets of diagrams show four possible outcomes when an unlabelled molecule of DNA is allowed to replicate twice in the presence of  $^{15}\text{N}$ -labelled nucleotides.

Labelled sections of DNA are represented by dotted lines.

Which set of diagrams correctly shows the result of DNA replication?



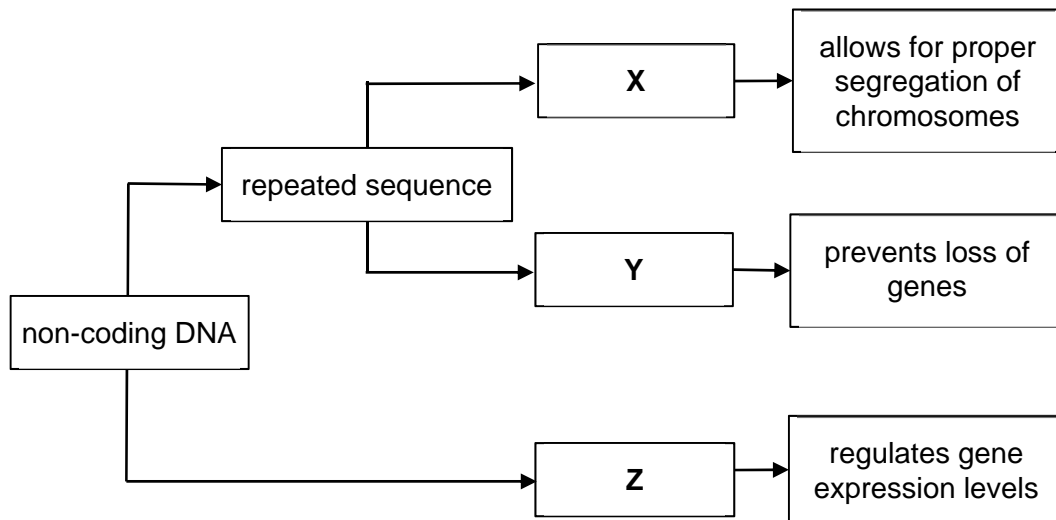
- 7 The diagram shows the synthesis of a polynucleotide. Molecule W is a nucleoside triphosphate.



Which statements are correct?

1. The base in X could be the pyrimidine, uracil
  2. The base in W could be the purine, adenine
  3. The base in X is the pyrimidine, cytosine
  4. The base in Y is the purine, guanine
- A** 1 and 4 only
- B** 2 and 3 only
- C** 3 and 4 only
- D** 1, 2, 3 and 4
- 8 Which statements correctly describe the structure and function of prokaryote ribosomes?
1. A prokaryote ribosome can accommodate only one amino acyl-tRNA at a time.
  2. Prokaryote ribosomes are smaller than eukaryote ribosomes and sediment at 70 S.
  3. In prokaryotes, ribosomes can begin translating mRNA before its synthesis has been completed.
  4. In prokaryotes, ribosomes translate mRNA in the same cellular compartment in which it is transcribed.
- A** 1 and 3 only
- B** 1, 2 and 4 only
- C** 2, 3 and 4 only
- D** 1, 2, 3 and 4

- 9 The flowchart shows the classification of several regions of non-coding eukaryotic DNA, **X**, **Y** and **Z**.



Which statement(s) correctly describes **X**, **Y** and **Z**?

1. Regions **X** and **Y** are made up of transcriptionally active tandem repeats.
  2. Regions **X** and **Y** are always associated with proteins, but DNA at region **Z** is only associated with proteins during gene expression.
  3. Region **Z** may involve DNA bending but region **Y** shortens during DNA replication.
  4. Regions **X**, **Y** and **Z** are conserved throughout the life of the organism.
- A** 2 only
- B** 3 only
- C** 1 and 4 only
- D** 2 and 3 only
- 10 Which of the following statement comparing the human immunodeficiency virus (HIV) and lambda phage is **incorrect**?
- A** The HIV enters by receptor-mediated endocytosis, but the lambda phage infects bacterial cells by injecting its DNA.
- B** The capsid of the HIV enters the host cell, but the capsid of the lambda virus does not.
- C** The genome of the HIV must be processed before it is integrated into the host chromosome, but the genome of the lambda virus can be directly integrated.
- D** New HIV are released from the host cell via budding, but new lambda virus are released via cell lysis.

- 11 The bacterium, *Pneumococcus pneumoniae*, forms two types of colonies whose cells are structurally different. Smooth (S) cells have thick outer capsules, but rough (R) cells lack this capsule. S cells cause the disease pneumonia.

In 1928, Frederick Griffith found that:

- when R cells were mixed with heat-killed S cells and the mixture injected into mice, some of the mice became infected and died.
- living S cells with capsules could be isolated from these dead mice.
- injection of heat-killed S cells alone or of living R cells alone did not cause disease in mice.

What can be concluded from these three observations to explain what happened when R cells were mixed with heat-killed S cells?

- A** A heritable genetic change occurred in the R cells.
- B** R and S cells conjugated when mixed.
- C** R cells were changed into S cells by transduction.
- D** R cells were transformed by DNA from heat-killed S cells.
- 12 The onset of puberty is triggered when cells in the hypothalamus region of the brain start to produce and secrete gonadotropin-releasing hormone (GnRH), which triggers the production and release of follicle-stimulating hormone and luteinising hormone from the anterior pituitary.

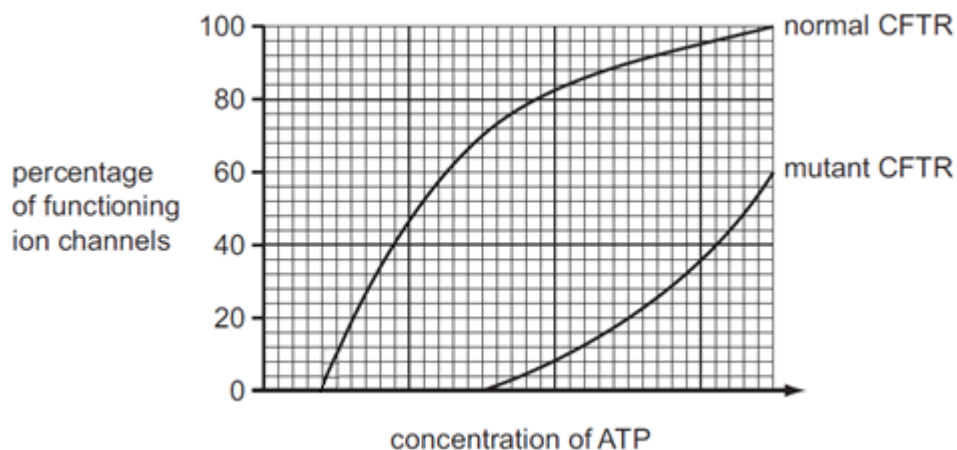
Which of the following statements are true during the onset of puberty?

1. DNA in the region containing the GnRH gene is methylated in cells of the hypothalamus.
  2. DNA in the region containing the GnRH gene is methylated in cells of the anterior pituitary.
  3. GnRH receptor is only expressed in cells of the anterior pituitary.
  4. GnRH triggers the activation of activators in cells of the anterior pituitary via signal transduction.
  5. The transcription initiation complex is formed at the enhancer controlling the GnRH gene in cells of the hypothalamus.
- A** 1 and 4
- B** 2 and 3
- C** 1, 4 and 5
- D** 2, 3 and 4

- 13 Which of the following correctly describes an advantage and limitation of the polymerase chain reaction (PCR)?

	Advantage	Limitation
<b>A</b>	Only requires a minute amount of template for amplification	Only able to amplify a small fragment of DNA
<b>B</b>	Able to produce $20^2$ copies of the target DNA after 20 cycles	Cannot amplify unknown sequences as primers cannot be made
<b>C</b>	Works on DNA from various species and sources	Time consuming and expensive to carry out
<b>D</b>	Highly accurate due to proof-reading function of DNA polymerase	The extent of amplification is limited by the amounts of nucleotides and primers

- 14 One of the many recessive mutations of the CFTR gene changes one amino acid in the region of the CFTR protein that binds ATP. The graph shows the effect of different concentrations of ATP on normal and mutant CFTR proteins.



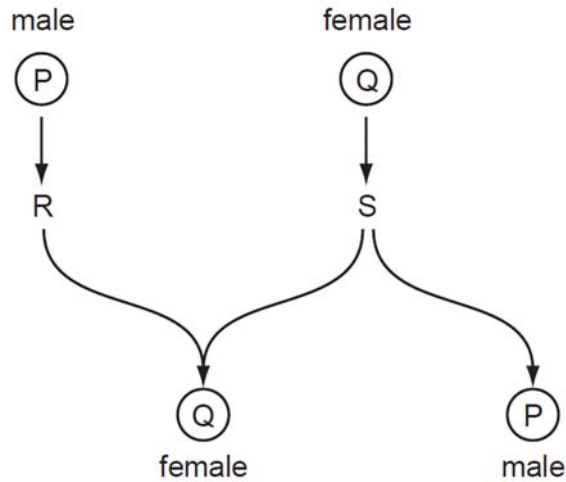
Which correctly describes individuals who are homozygous for this mutation?

1. Their CFTR protein cannot bind ATP and cannot act as an ion channel.
2. Their CFTR protein binds ATP less readily than normal CFTR protein.
3. These individuals produce a mutant CFTR protein that can bind ATP to function as an ion channel.
4. These individuals produce a mixture of normal and mutant CFTR protein, both of which can act as an ion channel.

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



- 15 Sex determination in some insects such as bees and wasps is not controlled by sex chromosomes.



Using the diagram, which row in the table shows how sex is determined in these insects?

	P	Q	R	S
<b>A</b>	n	n	mitosis	mitosis
<b>B</b>	n	2n	mitosis	meiosis
<b>C</b>	2n	n	meiosis	meiosis
<b>D</b>	2n	2n	meiosis	mitosis

- 16 The protein p53 is produced in a cell in response to DNA damage. This protein stops the cell cycle for a short time just before the DNA is replicated, so that the DNA can be repaired.

At which phase of the cell cycle will this stop occur?

- A** S
- B** M
- C** G1
- D** G2

- 17** In cattle, the gene responsible for normal development of hair and teeth, ectodysplasin 1 (*ED1*) is located on the X chromosome. Mutations in the *ED1* gene result in a rare genetic disorder, anhidrotic ectodermal dysplasia. Another character, the presence of horns, is determined by a gene on an autosome. The allele for the absence of horns (**H**) is dominant and the allele for the presence of horns (**h**) is recessive.

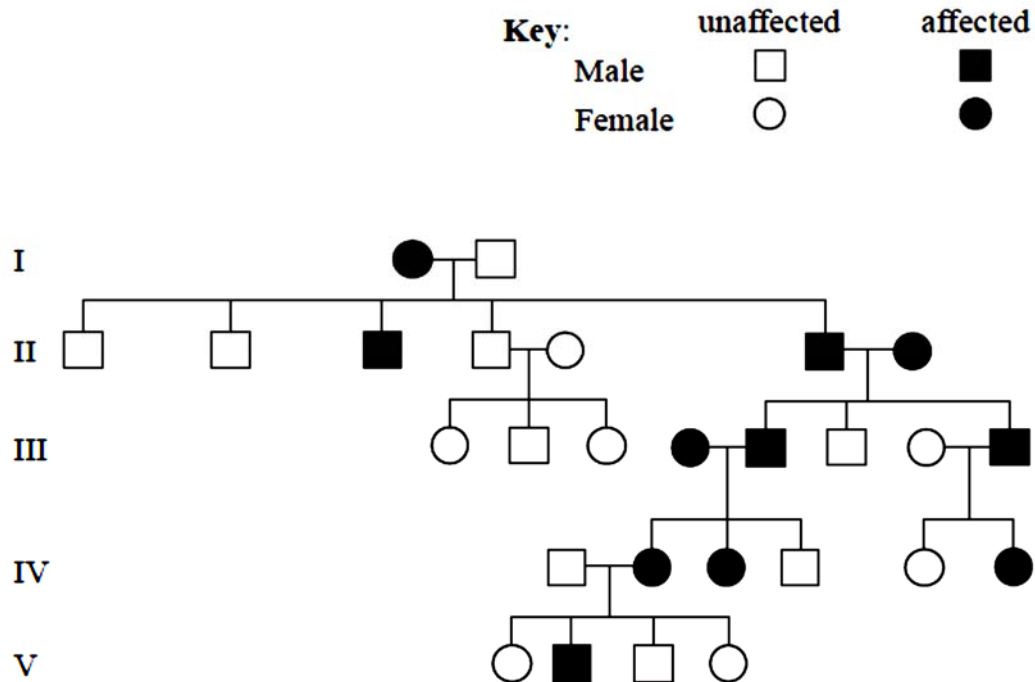
A horned bull with anhidrotic ectodermal dysplasia was mated on several occasions to the same female. A large number of offspring consisting of males and females in equal numbers in all combinations of phenotypes are shown in the table.

Offspring phenotypes
No anhidrotic ectodermal dysplasia, horns present
No anhidrotic ectodermal dysplasia, horns absent
Anhidrotic ectodermal dysplasia, horns present
Anhidrotic ectodermal dysplasia, horns absent

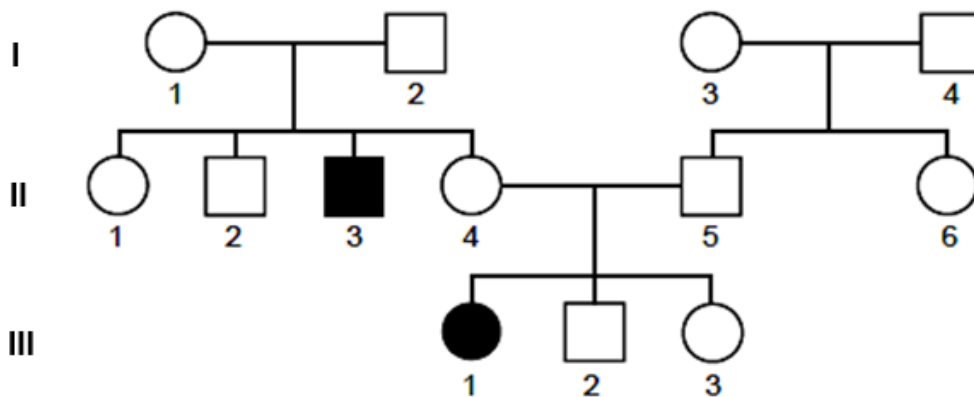
If  $X^E$  represents an X chromosome carrying the normal *ED1* allele and  $X^e$  represents an X chromosome carrying the *ED1* allele for anhidrotic ectodermal dysplasia, what is the genotype of the female parent?

- A**  $X^E X^E H H$
- B**  $X^E X^E H h$
- C**  $X^E X^e H H$
- D**  $X^E X^e H h$
- 18** Duchenne muscular dystrophy is a condition characterised by progressive muscle wasting. It is caused by a recessive mutation in the DMD gene, located on the X chromosome. The DMD gene codes for a protein known as dystrophin, which, in healthy individuals, prevents damage and weakening of muscle fibres.
- Which statement explains why not all affected males inherit the mutation from their mother?
- A** Some affected males inherit the mutation from their father, who has inherited the mutation from a carrier mother.
- B** Some affected males inherit the normal allele of a carrier mother but synthesise dystrophin molecules that have an altered tertiary structure.
- C** Some males with mothers who are not carriers of the mutated allele are affected as a result of a new mutation in the DMD gene.
- D** The single X chromosome of some affected males become inactivated and no dystrophin is synthesised.

- 19 The pedigree chart below shows the inheritance of a genetic disease in a family. What is the nature of the allele that causes this disease?



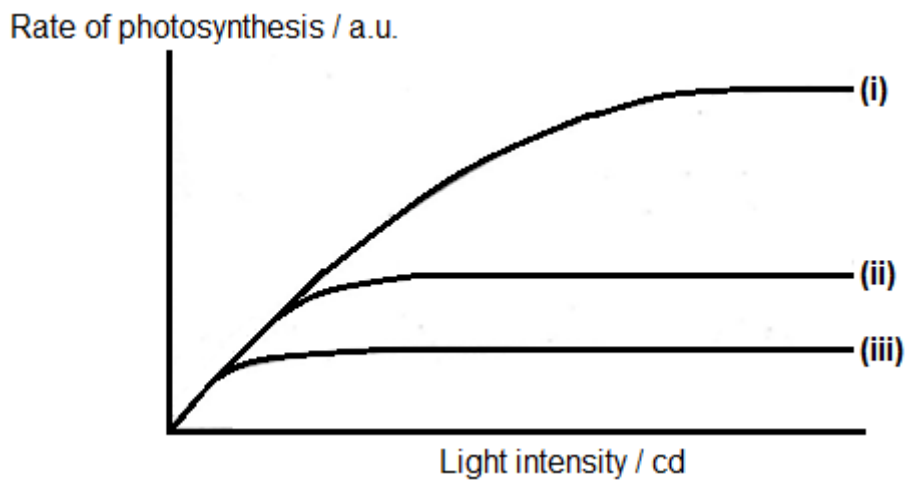
- A Dominant and sex-linked  
 B Dominant and autosomal  
 C Recessive and sex-linked  
 D Recessive and autosomal
- 20 ALDOA deficiency is a genetic condition in which affected individuals fail to produce the enzyme aldolase A, leading to haemolytic anaemia. The pedigree shows a family where two members have ALDOA deficiency.



If individual III-3 was to marry an affected man, what is the probability that their first child is an affected boy?

- A  $2/3$       B  $1/4$       C  $1/3$       D  $1/6$

- 21 The action spectrum and absorption spectrum of photosynthetic pigments are similar because
- A the amount of energy absorbed by the pigments is the activation energy needed for photosynthesis.
  - B only certain wavelengths of light provide enough energy to make ATP during the light reaction.
  - C photosynthesis occurs when the whole spectrum is absorbed.
  - D wavelengths of light absorbed by the pigments are the ones used in photosynthesis.
- 22 Cuttings of the same plant were kept in different conditions and the rates of photosynthesis were measured. The results were shown in the graph below.



Which of the following best explains the results shown?

- A The leaves in (i) are bigger than those in (iii) and thus are able to absorb more light for photosynthesis.
- B The temperature in (i) is at the optimum temperature of the enzymes in Calvin cycle while the temperature in (ii) is much higher.
- C The light compensation point in (ii) is higher than that in (iii).
- D The carbon dioxide concentration in (iii) is the lowest, limiting the rate of carbon fixation.

23 The table below shows a description of the activity of three drugs.

Drug	Description
1	Inhibit cAMP synthesis
2	Inhibit phosphatases
3	Inhibit Golgi body function

Which of the following combination shows the consequence for each of the three drugs on muscle cells in relation to blood glucose regulation?

	Drug 1	Drug 2	Drug 3
<b>A</b>	No effect	Decreased signal transduction efficiency	Increased cellular response
<b>B</b>	Decreased activation of signalling pathways	Decreased signal transduction efficiency	Increased cellular response
<b>C</b>	Decreased activation of signalling pathways	Increased signal transduction efficiency	Decreased cellular response
<b>D</b>	No effect	Increased signal transduction efficiency	Decreased cellular response

24 Which of the following **does not** explain why the population is the smallest unit that can evolve?

- A** Natural selection involves competition between individuals in a population.
- B** Evolution occurs when allele frequency in a population changes due to selection or chance events like genetic drift.
- C** Differential reproductive success is observed at the population level due to the phenotypic variations in the population.
- D** Evolution involves the introduction of advantageous mutations into the gene pool of a population as a result of a selective pressure.

25 Which of the following statements could **not** be used to describe a species?

- A** A group of organisms showing analogous body structures
- B** A group of organisms showing distinctly similar genetic sequence
- C** A group of organisms capable of mating to produce viable offspring
- D** A group of organisms sharing the same ecological niche

**26** The statements refer to the disease tuberculosis (TB).

1. The pathogen lives inside human cells so is not accessible to the immune system.
2. The bacterial pathogen reproduces slowly.
3. The pathogen is not very sensitive to antibiotics.

Which explains why treatment for TB with antibiotics such as penicillin takes a long time?

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

**27** Rabies is a viral disease which can be spread to humans by a bite from an infected animal. One method of treatment is to inject the patient with antibodies specific to the rabies virus.

Which statements about this treatment are correct?

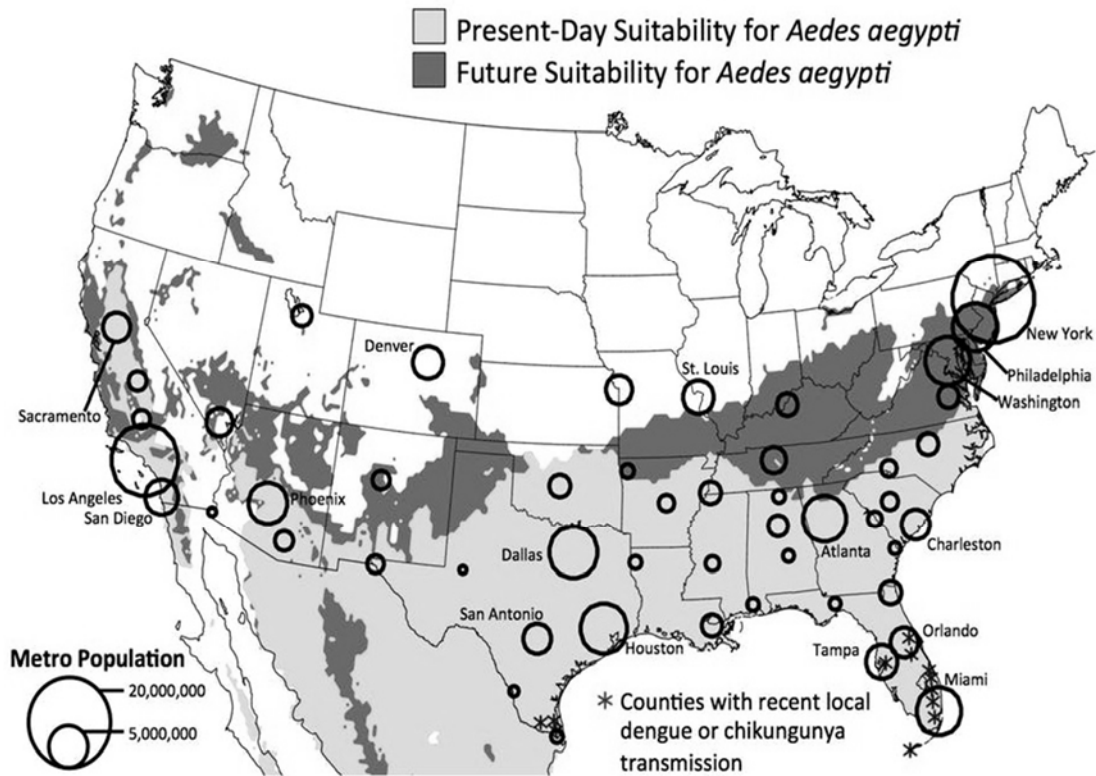
1. The patient will have natural passive immunity to rabies.
2. The injected antibodies will be broken down by the patient.
3. The patient's memory cells will be able to produce this antibody more rapidly in the future.
4. The immunity provided will only be of short duration.

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

**28** Which row is correct for malaria?

	Nature of disease	Method of transmission	Pathogen	Location
<b>A</b>	infectious	insect vector	species of <i>Plasmodium</i>	Can be found in sub-tropical regions due to global warming
<b>B</b>	infectious	water-borne	species of <i>Anopheles</i>	Endemic in south east Asia
<b>C</b>	non-infectious	human vector	species of <i>Anopheles</i>	Can be found in all regions with high humidity
<b>D</b>	non-infectious	aerosol-borne	species of <i>Plasmodium</i>	Endemic in Asia

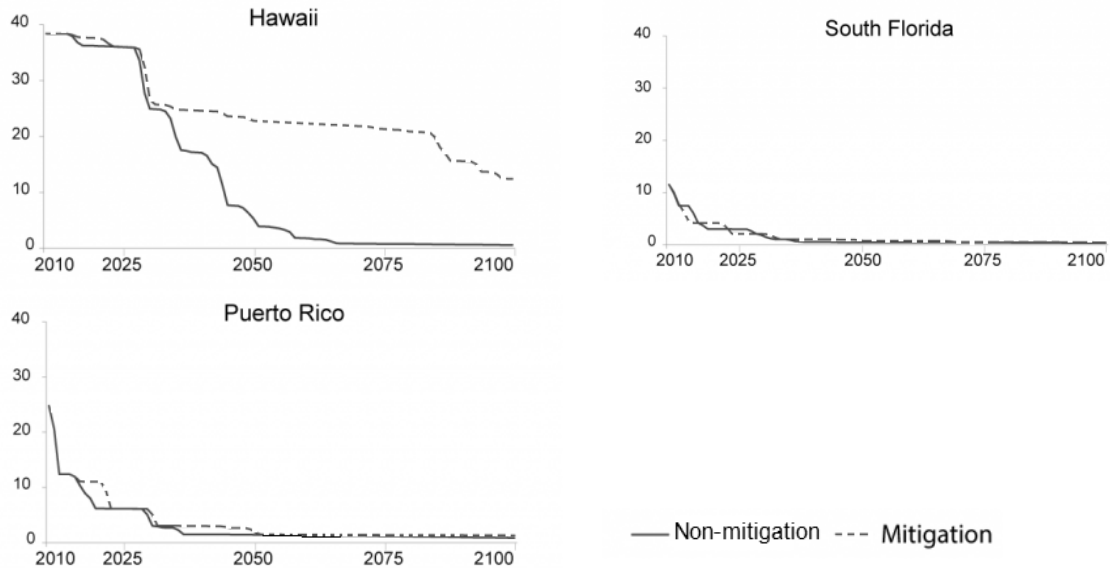
- 29 The figure below shows the current and potential spread of dengue and chikungunya across the United States.



Which of the following best explains the current or potential trends in the spread of these diseases as shown in the figure?

- A Most of the regions with recent local dengue or chikungunya transmission are coastal regions possibly because these regions receive more rainfall and provide more suitable breeding grounds for *Aedes aegypti*.
- B The larger the size of the metro population, the higher the chances of mosquitoes transmitting the diseases from person to person.
- C These diseases would spread higher in altitude in the future with increased global warming.
- D The diseases are unlikely to spread to the northern regions (in white) in the future because they are mostly mountainous regions that are too cold to be affected by global warming.

- 30** Some studies reveal that mitigating (reducing) global greenhouse gas emissions have varied effectiveness in reducing negative impact on coral growth. The figure below shows the projected coral reef cover (%) over time (year) in Hawaii (latitude 22.2°N), South Florida (24.5°N) and Puerto Rico (18.2°N) under mitigation and non-mitigation scenarios.

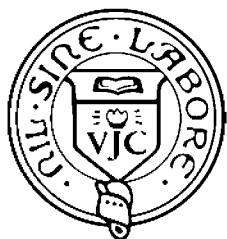


Based on the information given above, which of the following are possible explanations for the projected coral reef cover in the various locations after mitigation?

1. The coral reef cover in Hawaii is projected to improve significantly after mitigation because average sea temperatures there may not be significantly higher than the thermal limit of the corals.
2. It is projected that mitigation in South Florida and Puerto Rico would not significantly improve coral reef because these countries are closer to the equator as compared to Hawaii.
3. Recovery of coral cover after mitigation in South Florida is projected to be negligible because the extent of damage is already very high.

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





**VICTORIA JUNIOR COLLEGE**  
**JC 2 PRELIMINARY EXAMINATION 2018**

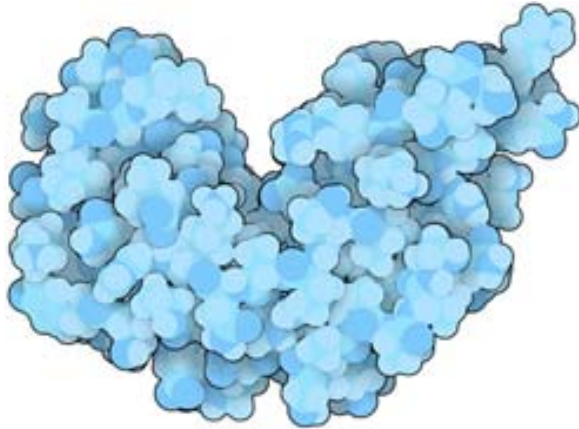
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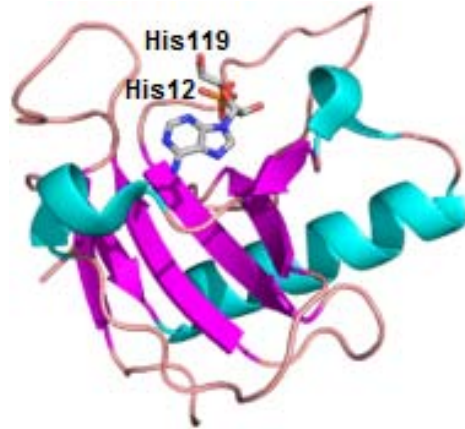
**Paper 1 Multiple Choice: Answers**

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

- 1 In eukaryotic cells, the degradation of mRNA is an essential part of the regulation of gene expression. It can be controlled in response to developmental, environmental, and metabolic signals. mRNA hydrolysis is catalysed by numerous types of nucleases, such as the endonuclease Ribonuclease A (RNAse A), shown in Fig. 1.1.



(A) Space-filling model



(B) Ribbon diagram

**Fig. 1.1**

- (a) Using a labelled and annotated diagram, illustrate the hydrolysis of the bond catalysed by RNAase.  
(A monomer has been drawn for you.)

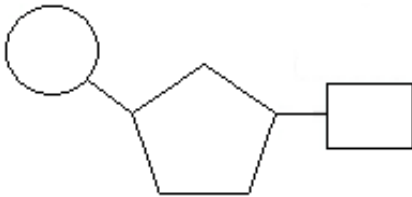


Fig. 1.1 B shows two important catalytic residues within the active site of RNase A, which are His12 and His119.

- (b) Explain how these two histidines, which are in position 12 and 119 of the 124 amino acid sequence, are brought together in the active site of the enzyme.

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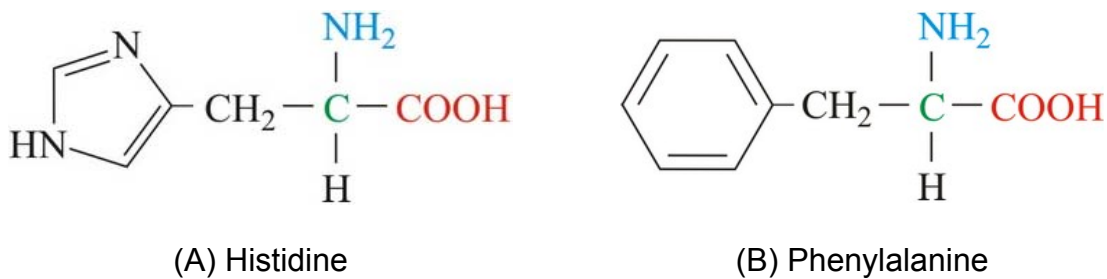
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..... [3]

Fig. 1.2 shows the structure of histidine and phenylalanine.



**Fig. 1.2**

- (c) Predict how the catalytic activity of RNase would be affected if both histidines were replaced by phenylalanines.

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..... [2]

[Total: 8]

- 2 Penicillin belongs to a group of antibiotics known as  $\beta$  lactams, which all act in the same way on bacteria.

Fig. 2.1 shows the membrane structure of a gram-positive and gram-negative bacteria.

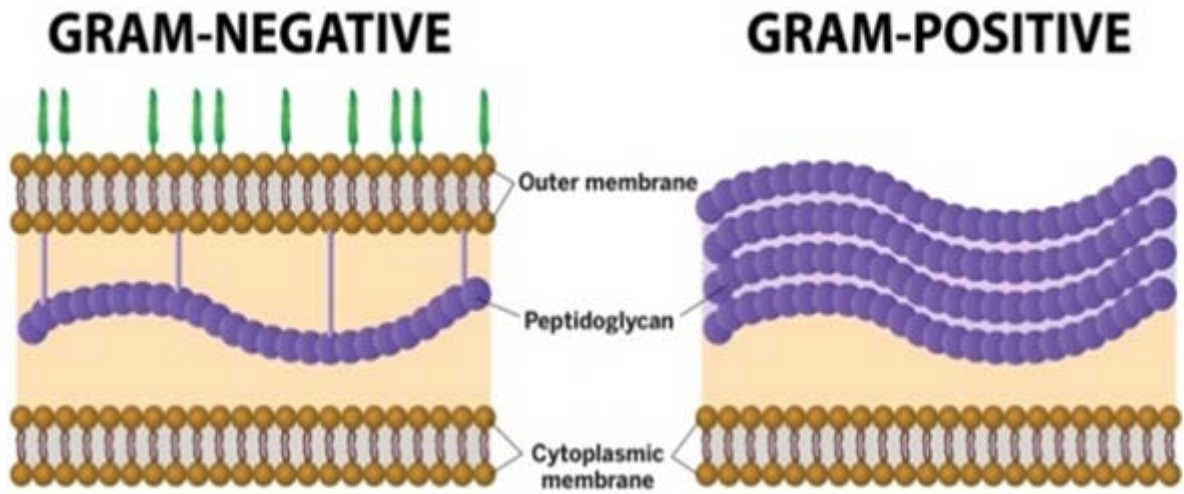


Fig. 2.1

- (a) Based on your understanding of penicillin and with reference to Fig. 2.1,
  - (i) deduce whether penicillin is more effective against gram-positive or gram-negative bacteria.

..... [1]

- (ii) suggest a reason for your answer in (a)(i).

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..... [3]



High blood sugar levels increase the chances of bacterial infections in those with diabetes, hence control of blood glucose levels is important in to prevent blood infections in diabetics.

**(ii)** Describe one similarity between the bacteria efflux pump and the glucagon receptor that is important to their function.

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..... [1]

**(iii)** Suggest two ways the structure of the bacterial efflux pump is different from an insulin receptor involved in blood glucose regulation.

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..... [4]

[Total: 13]

- 3 Telomeres have a nucleotide sequence that is repeated as many as 2000 times. This repetition is shown in Fig. 3.1. Attached to the DNA of the telomere are protein units.

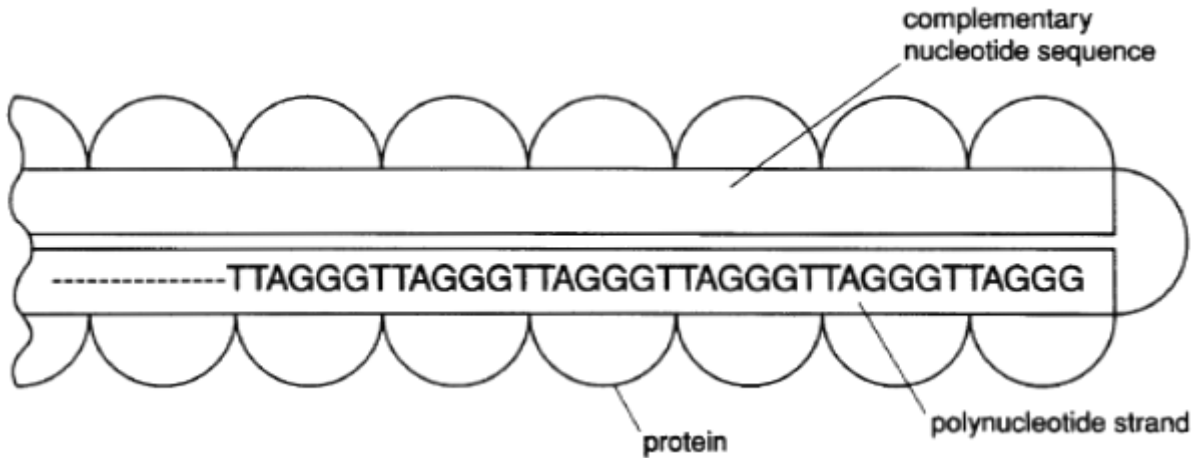


Fig. 3.1

- (a) (i) What sequence of bases is repeated in the complementary polynucleotide shown in Fig. 3.1?

..... [1]

- (ii) Suggest one reason for the presence of protein units in the telomere.

..... [1]

- (b) In the past, repeating sequences were referred to as “junk DNA”. Explain why the term “junk DNA” is misleading in the context of telomere.

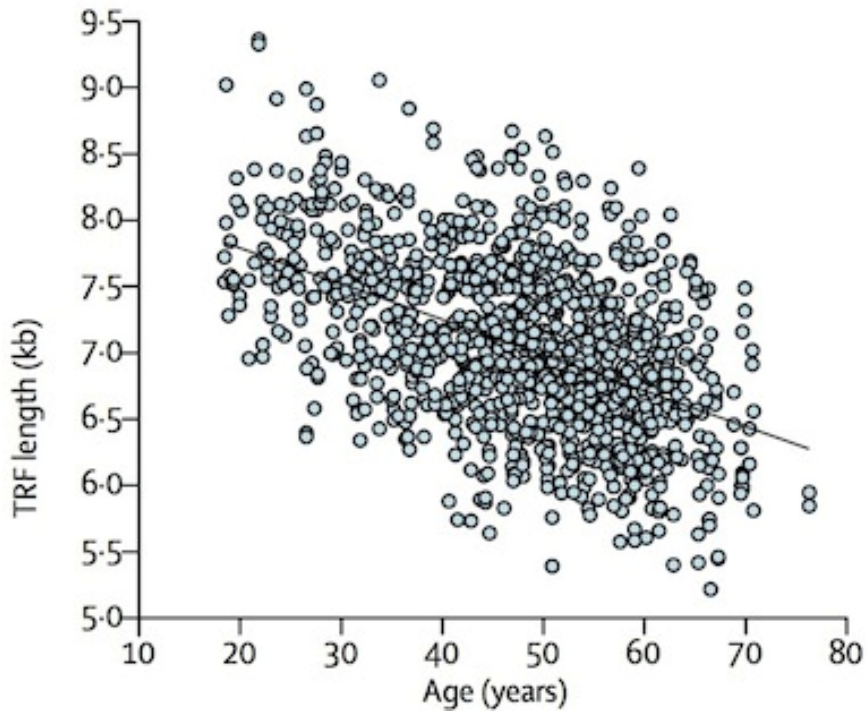
..... [2]

- (c) The repetitive base sequence of telomere DNA is an example of a non-coding base sequence.

Explain what is meant by non-coding.

..... [1]

(d) A study of individual telomere lengths and its correlation with age is shown in Fig. 3.2.



(Taken from [https://www.wired.com/images\\_blogs/wiredscience/2011/05/telomere\\_graph.jpg](https://www.wired.com/images_blogs/wiredscience/2011/05/telomere_graph.jpg))

**Fig. 3.2**

Account for the trend line shown in Fig. 3.2.

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[Total: 9]



4 (a) Explain why ATP is regarded as the universal energy currency in organisms.

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..... [2]

(b) Studies on cancer cells found that fast-growing cancer cells require much more energy than normal cells, which explains the much higher rate of glucose uptake into cancer cells. However, it is also found that, unlike normal cells, the higher glucose uptake reduces oxygen uptake into cancer cells. This respiratory inhibition is known the Crabtree effect. It is proposed that this is due to more mitochondrial damages in cancer cells.

(i) Besides the need for more energy for cell division, explain the process how cancer cells utilise glucose at a much higher rate than normal cells to produce energy.

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..... [3]

(ii) Compare the differences between respiration in cancer cells and yeast cells.

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..... [2]

[Total: 7]

5 *lac* operon consists of a promoter, an operator, a catabolite activator protein (CAP) binding site and structural genes such as *lacZ* which codes for  $\beta$ -galactosidase, an inducible enzyme. The operon switches on or off depending on the type of carbon source present.

(a) Define the term “inducible enzyme”, with respect to  $\beta$ -galactosidase.

.....  
 ..... [1]

(b) An experiment was conducted to determine the identity of Substance X and Substance Y. Both substances are known to have an effect on the expression of  $\beta$ -galactosidase in *Escherichia coli*. Substance X was added after 10 minutes, Substance Y was added after 20 minutes and both substances X and Y were added after 30 minutes. The results are shown in Fig. 5.1.

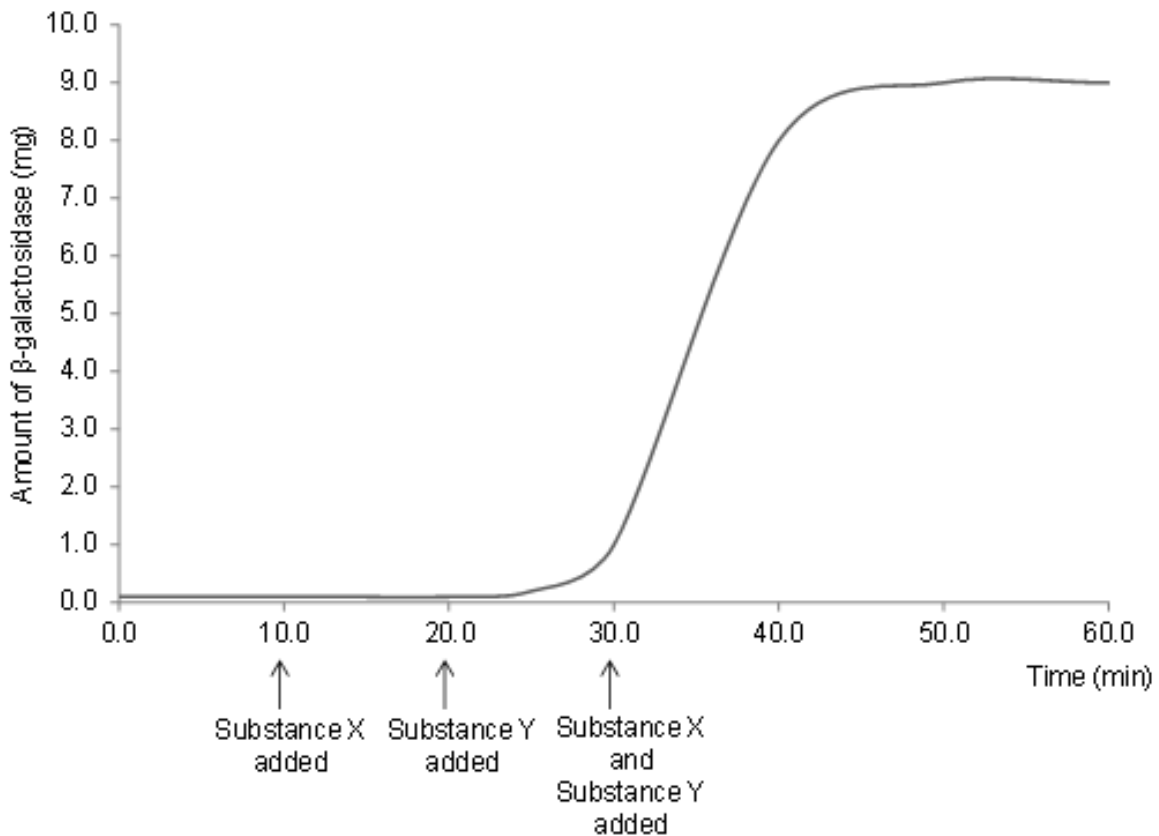


Fig. 5.1

With reference to Fig. 5.1,

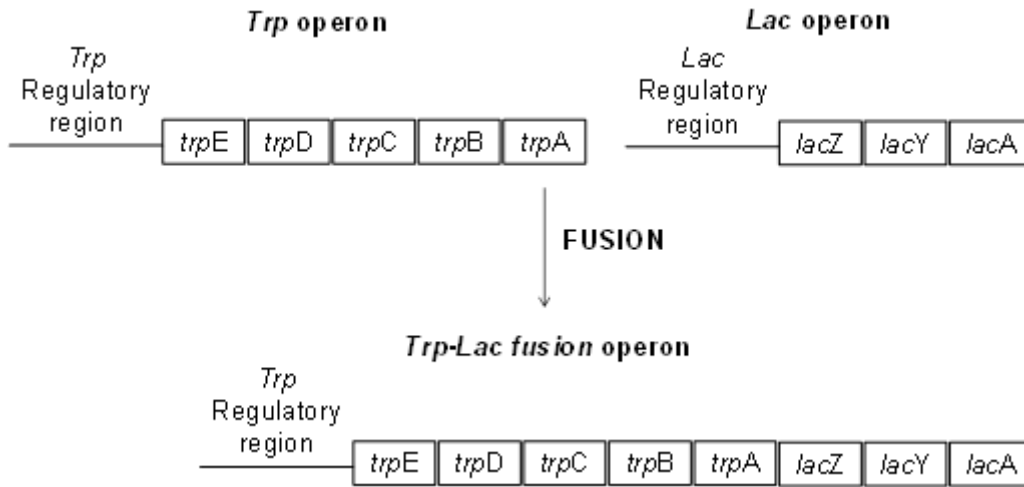
(i) suggest the identities for Substance X and Substance Y.

Substance X: .....

Substance Y: ..... [2]



(c) In another experiment, the *trp* operon and the *lac* operon of a bacteria cell were made to fuse together. The fusion process is illustrated in Fig. 5.2.



**Fig. 5.2**

Suggest the condition(s) needed for  $\beta$ -galactosidase to be expressed in this strain of bacteria that carries the fused operon. Explain your answer.

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.....

..... [4]

[Total: 12]

6 Some hormones circulating in the blood are able to trigger transcription within a cell, even though they are unable to enter the cell. Phosphatases and kinases then take part in cell activities that eventually result in genes switching on and transcription beginning.

(a) Suggest why the hormones, referred to in the passage, are unable to enter the cell.

.....  
.....  
.....  
..... [2]

(b) Use the information in the passage to outline the process of cell signalling.

.....  
.....  
.....  
.....  
..... [3]

(c) Explain the role of the following in cell signalling.

(i) Phosphatases

.....  
.....  
..... [2]

(ii) Kinases

.....  
.....  
..... [2]

[Total: 9]

- 7 Chickpeas may contain a lipase inhibitor that prevents the digestion of fats. There are two forms of lipase inhibitors – inhibitor **W** and inhibitor **X**.

Homozygous plants are known to produce one type of lipase inhibitor, depending on the allele which they are homozygous for.

A heterozygote plant, on the other hand, will two types of lipase inhibitor, inhibitor **W** and inhibitor **X**. A third recessive allele does not code for a lipase inhibitor.

- (a) Identify whether the inheritance of lipase inhibitor shows continuous or discontinuous variation. Give a reason for your choice.

.....

.....

.....

..... [2]

- (b) A second character, seed texture, is controlled by another gene located on a different chromosome and is controlled by two alleles. Smooth seed-coat, **T**, is dominant over wrinkled seed-coat, **t**.

Two chickpea plants were crossed. Their seeds were collected and counted. One of the parental chickpea plants is found to contain only inhibitor **X** and has smooth seed-coats. The progeny of the dihybrid cross is summarised in Table 7.1.

**Table 7.1**

<b>Inhibitor(s) present in seed</b>	<b>Number of seeds</b>	<b>Seeds with smooth seed-coat / %</b>
<b>W and X</b>	12	50
<b>W</b>	14	50
<b>X</b>	22	50

With reference to Table 7.1,

- (i) state and explain the mode of inheritance for the lipase inhibitor in the chickpeas.

.....

.....

.....

..... [2]

(ii) using suitable symbols, draw a genetic diagram to explain the results of this cross.

[5]

(c) Observed results of the above genetic cross differ from the expected results.

Suggest two reasons why such a discrepancy occurs, referring only to events that occur after meiosis.

.....

.....

.....

..... [2]

(d) Structure Q in Fig. 7.2 is a cell structure which is involved in nuclear division.

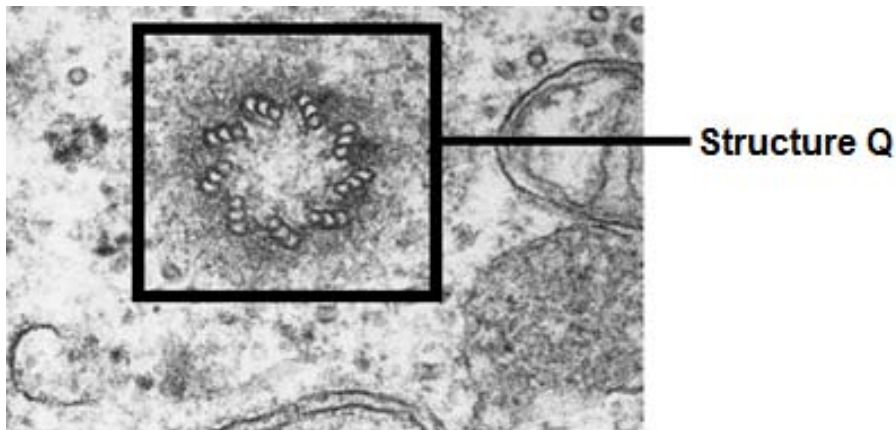


Fig. 7.2

Identify structure Q and describe its behaviour during meiosis.

.....

.....

.....

.....

.....

..... [3]

[Total: 14]

8 (a) Define the term “phylogeny”.

.....

..... [1]

(b) In order to deduce the evolutionary relationships between different mammalian species, the amino acid sequence of a segment of the H1 histone protein is analysed and compared. Fig. 8.1 below shows the comparison.

**Histone H1 (residue 120-180)**

Human	KKASKPKKAASKAPTKKPKATPVKKAKKKLAATPKKAKKPKTVKAKPVKASKPKKAKPVK
Mouse	KKAAKPKKAASKAPSKKPKATPVKKAKKKPAATPKKAKKPKVVVKVPVKASKPKKAKTVK
Rat	KKAAKPKKAASKAPSKKPKATPVKKAKKKPAATPKKAKKPKAVKVKVPVKASKPKKAKTVK
Cow	KKAPKPKKAASKAPAKKPKATPVKKAKKKTAATPKKTKKPKKVKPKPVKASKPKKTKKVK
Chimpanzee	KKASKPKKAASKAPTKKPKATPVKKAKKKLAATPKKAKKPKTVKAKPVKASKPKKAKPVK



Number of differences in the amino acid sequence of Histone H1

	Human	Mouse	Rat	Cow	Chimpanzee
Human		6	6	8	0
Mouse	6		1	8	6
Rat	6	1		8	6
Cow	8	8	8		8
Chimpanzee	0	6	6	8	

**Fig. 8.1**

With reference to Fig. 8.1,

- (i) state, with reasons, the species that is most closely related to mouse.

.....

.....

.....

..... [2]

- (ii) construct a phylogenetic tree to show the evolutionary relationships between the species.

[2]

- (c) Explain how the amino acid sequences in Fig. 8.1 supports Darwin's theory of evolution.

.....

.....

.....

.....

..... [3]

(d) Describe a modification to the investigation in (b) to deduce the evolutionary relationships between the mammalian species and *E. coli*.

.....

.....

.....

..... [2]

(e) Biologists have disagreed over the evolutionary relationship between turtles and other reptiles, with morphological and molecular comparisons giving different results. Biologist studying morphological evidences used the absence of temporal openings in the skull of turtles as a shared derived character to construct the phylogenetic tree shown in Fig. 8.2. However, Biologists studying DNA sequences have constructed a different phylogenetic tree as shown in Fig. 8.3.

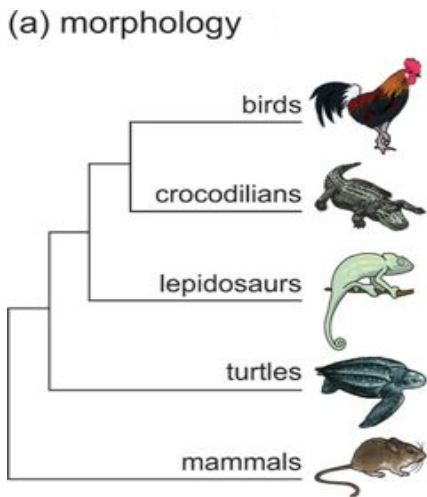


Fig. 8.2

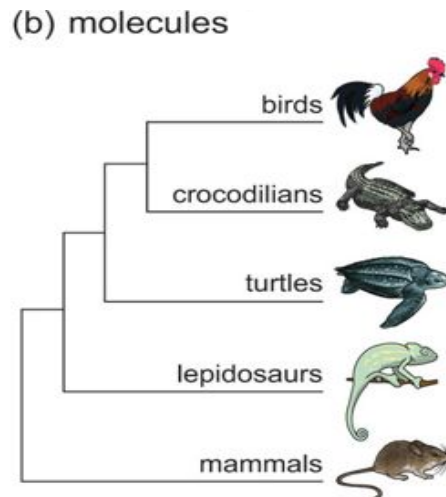


Fig. 8.3

With reference to the information given above,

(i) Explain the advantages of molecular methods in reconstructing phylogenetic relationships.

.....

.....

.....

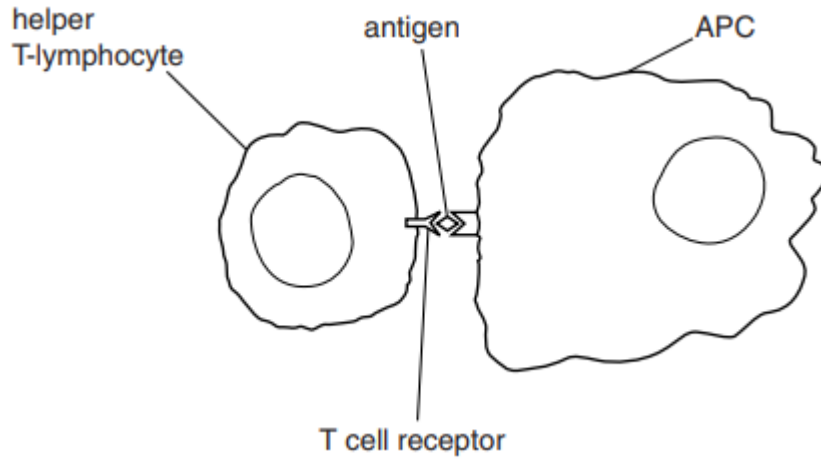
.....

.....

..... [3]



(b) Macrophages are antigen presenting cells (APCs). Antigens from pathogens are presented to helper T-lymphocytes as shown in Fig. 9.2.



**Fig 9.2**

Very few helper T-lymphocytes respond to the presence of APCs by binding in the way shown in Fig. 9.2. Suggest why this is so.

.....  
.....  
.....  
..... [2]

(c) During an immune response, cells divide by mitosis. Describe how mitosis is involved in an immune response.

.....  
.....  
.....  
.....  
..... [3]

(d) Complete the table to indicate how the following types of immunity can occur.

	<b>Acquired</b>	<b>Natural</b>
<b>Active</b>	<p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	<p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>
<b>Passive</b>	<p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	<p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>

[4]

[Total: 13]

----- End of paper -----

**Victoria Junior College  
2018 H2 Biology Prelim Paper 2  
Answer**

1 In eukaryotic cells, the degradation of mRNA is an essential part of the regulation of gene expression. It can be controlled in response to developmental, environmental, and metabolic signals. mRNA hydrolysis is catalysed by numerous types of nucleases, such as the endonuclease Ribonuclease A (RNase A), shown in Fig. 1.1.

(a) Using a labelled and annotated diagram, illustrate the hydrolysis of the bond catalysed by RNAase. [3]  
(A monomer has been drawn for you.)

- Accurate drawing of mRNA strand, at least 2 nucleotides (using symbols);;
- Accurate drawing of phosphodiester linkage + label;;
- Water;
- Hydrolysis ;
- Accurate drawing of correct number of nucleotides after hydrolysis;

Fig 1.1B shows two important catalytic residues within the active site of RNase A, which are His12 and His119.

(b) Explain how these two histidines, which are in position 12 and 119 of the 124 amino acid sequence, are brought together in the active site of the enzyme. [3]

- Primary structure (number, type and sequence of amino acid )determines how the polypeptide chain folds upon itself;;
- interactions between R groups of amino acids not located close to one another on the primary structure ;
- To form the tertiary structure with a compact globular 3D structure;
- Bringing faraway amino acids together within the active site;

(c) Predict how the catalytic activity of RNase would be affected if both histidines were replaced by phenylalanines. [2]

- Histidine has an R-group that is polar whereas phenylalanine has an R-group that is non-polar;;
- This causes the change in the interaction between the catalytic residues and the substrate at the active site; therefore; RNAase catalytic activity will be greatly reduced / lost;;

2 (a) Based on your understanding of penicillin and with reference to Fig. 2.1,

(i) deduce whether penicillin is more effective against gram-positive or gram-negative bacteria. [1] **Gram positive;;**

(ii) suggest a reason for your answer in (a)(i). [3]

- Penicillin binds irreversibly to the enzyme DD-transpeptidase;;
- which is responsible for the catalysis of cross-link formation within the peptidoglycan cell wall;;
-

- Gram positive bacteria have thicker peptidoglycan cell wall hence more affected than Gram negative bacteria;;
- Penicillin is a hydrophilic molecule;
- Unable to pass through the hydrophobic core of outer membrane;
- Gram positive bacteria has no outer membrane hence allowing penicillin easier access to the peptidoglycan cell wall;;

(bi) Outline how the bacterium produces an efflux pump from a gene on a plasmid. [4]

- RNA polymerase binds to the promoter;
- catalyses phosphodiester bonds between ribonucleotides
- transcribes mRNA from DNA template strand;
- mRNA binds to small ribosomal unit of 70S ribosome;
- and undergoes simultaneous translation;
- Idea of triplet code;
- peptidyl transferase; catalyses formation of peptide bonds;
- between amino acids carried by tRNA on ribosomal A and P sites;
- Formation of efflux pump polypeptide;
- folds to form tertiary structure;

(ii) Describe one similarity between the bacteria efflux pump and the glucagon receptor that is important to their function. [1]

- Both are transmembrane proteins that span the membrane;;
- The transmembrane sections of both proteins have hydrophobic amino acid residues that can form hydrophobic interactions with the hydrophobic core of the phospholipid bilayer;;

(iii) Suggest two ways the structure of the bacterial efflux pump is different from an insulin receptor involved in blood glucose regulation. [4]

	RTK	Efflux pump
Number of transmembrane regions	• One transmembrane section;;	• 2 transmembrane section;;
Important binding domains	• Extracellular domain binds to insulin hormone;;	• Intracellular region binds to antibiotic to pump it out of the cell;;
Shape of active protein	• Active receptor is made of 2 subunits that have dimerised;;	• Efflux pump is a channel protein with a central hydrophilic core that allows hydrophilic molecules like antibiotics to pass through;;
Presence of enzyme	• Contain tyrosine kinase for cross phosphorylation of tyrosine residues on cytoplasmic domains	• No tyrosine kinase in cytoplasm domain

3 Telomeres have a nucleotide sequence that is repeated as many as 2000 times. This repetition is shown in Fig. 3.1. Attached to the DNA of the telomere are protein units.

(a) (i) What sequence of bases is repeated in the complementary polynucleotide shown in Fig. 3.1? [1]

- AATCCC / adenine adenine thymine cytosine cytosine cytosine;; (first 6)

(ii) Suggest one reason for the presence of protein units in the telomere. [1]

- Protect the DNA from degradation;;
- Prevent binding of transcription factors and RNA polymerase to the DNA;;
- Enables homologous chromosomes to pair during meiosis;;
- AVP;;

(b) In the past, repeating sequences were referred to as “junk DNA”. Explain why the term “junk DNA” is misleading in the context of telomere. [2]

- “Junk” implies no, function / purpose;; ora
- Repeating sequences of telomeres serve to protect genes from being eroded via successive rounds of replication, maintain the integrity of chromosomal end, and limit the lifespan of cells;;

(c) The repetitive base sequence of telomere DNA is an example of a non-coding base sequence.

Explain what is meant by non-coding. [1]

- Not transcribed to form a product (protein / polypeptide / amino acid sequence);;



**(d)** A study of individual telomere lengths and its correlation with age is shown in Fig. 3.2.

Account for the trend line shown in Fig. 3.2. [4]

1. Increase in age from 20 to 70, decrease in telomere length from 7.8 kb to 6.5 kb;
2. More, cell division / generations of cells / mitosis / replication;
3. Loss of, telomere / DNA / nucleotides / part of chromosome, at each replication;
4. Due to end replication problem;
5. During DNA replication, when the last RNA primer is removed / excised;
6. At the 3' end of parental template strand / 5' end of daughter strand, it is not replaced by corresponding DNA sequence;
7. As DNA polymerase cannot add new nucleotides; without an existing 3'OH end;
8. Idea of resulting daughter DNA strand being shorter than the parental DNA strand;

[Total: 9]

4 (a) Explain why ATP is regarded as the universal energy currency in organisms. [2]

- Found in all organisms;;
- Loss of phosphate / hydrolysis, leads to, energy release / release of 30.5 kJ (per mole);;
- $ADP + P_i \rightarrow ATP$  / reversible reaction;;
- Small / water soluble, so can move around cell;;
- Link between energy yielding and energy requiring reactions / AW;;
- Example of use e.g. active transport / muscle contraction / Calvin cycle / protein synthesis;;

(b) Studies on cancer cells found that fast-growing cancer cells require much more energy than normal cells, which explains the much higher rate of glucose uptake into cancer cells. However, it is also found that, unlike normal cells, the higher glucose uptake reduces oxygen uptake into cancer cells. This respiratory inhibition is known the Crabtree effect. It is proposed that this is due to more mitochondrial damages in cancer cells.

(i) Besides the need for more energy for cell division, explain the process how cancer cells utilise glucose at a much higher rate than normal cells to produce energy. [3]

- Ref. to anaerobic respiration;;
- Ref. to glycolysis producing 2 net ATP;;
- Pyruvate acting as the alternative hydrogen acceptor to regenerate NAD;;

(ii) Compare the differences between respiration in cancer cells and yeast cells. [2]

	<b>Cancer cells</b>	<b>Yeast cells</b>
<b>Type of fermentation;;</b>	• Lactate fermentation	• Alcoholic fermentation
<b>Products (besides ATP);;</b>	• Lactate / Lactic acid	• Ethanol and carbon dioxide
<b>Enzyme(s) involved;;</b>	• Lactate dehydrogenase	• Pyruvate decarboxylase and alcohol dehydrogenase

[Total: 7]

5 *lac* operon consists of a promoter, an operator, a catabolite activator protein (CAP) binding site and structural genes such as *lacZ* which codes for  $\beta$ -galactosidase, an inducible enzyme. The operon switches on or off depending on the type of carbon source present.

(a) Define the term “inducible enzyme”, with respect to  $\beta$ -galactosidase. [1]

- Synthesis of  $\beta$ -galactosidase can be stimulated when lactose is available;;

<b>Feature</b>	<b>Inducible system</b>	<b>Repressible system</b>
<b>Example</b>	• <i>lac</i> operon	• <i>trp</i> operon

<b>Characteristics</b>	<ul style="list-style-type: none"> <li>• Expression of the structural genes is switched on in the presence of the substrate e.g. lactose</li> <li>• Substrate binds to and inactivates the repressor</li> </ul>	<ul style="list-style-type: none"> <li>• Expression of the structural genes is switched off in the presence of the end product e.g. tryptophan</li> <li>• End product serves as the co-repressor, binds to and activates the repressor</li> </ul>
<b>Product</b>	<ul style="list-style-type: none"> <li>• Inducible enzymes which catalyse the uptake and metabolism of lactose <ul style="list-style-type: none"> <li>➤ <math>\beta</math>-galactosidase, lactose permease, galactoside transacetylase</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• 5 repressible enzymes which catalyse the biosynthesis of tryptophan</li> </ul>

(b) An experiment was conducted to determine the identity of Substance X and Substance Y. Both substances are known to have an effect on the expression of  $\beta$ -galactosidase in *Escherichia coli*. Substance X was added after 10 minutes, Substance Y was added after 20 minutes and both substances X and Y were added after 30 minutes. The results are shown in Fig. 5.1.

With reference to Fig. 5.1,

(i) suggest the identities for Substance X and Substance Y. [2]

- Substance X: cAMP;;
- Substance Y: Lactose / Allolactose;;

(ii) explain how the expression levels of  $\beta$ -galactosidase are affected by Substance X and Substance Y between 10 minutes to 40 minutes. [5]

- From 10 minutes to 20 minutes, the amount of  $\beta$ -galactosidase remained constant at 0.1mg;;
- This is because even with the presence of Substance X/cAMP, the *lac* operon is off due to the absence of lactose;;
- From 20 minutes to 30 minutes, the amount of  $\beta$ -galactosidase increased slightly from 0.1mg to 1.0mg;;
- Substance Y / Lactose /.Allolactose binds to the repressor, making the repressor inactive  $\rightarrow$  RNA polymerase can bind to promoter, the *lac* operon is on, but rate of transcription is low;;
- From 30 minutes to 40 minutes, the amount of  $\beta$ -galactosidase increased greatly from 1.0mg to 9.0mg;;
- Substance Y/Lactose/Allolactose binds to the repressor, hence the *lac* operon is on. Substance X/Glucose/cAMP binds and activates CAP. Binding of cAMP-CAP complex to CAP binding site facilitates binding of RNA polymerase at the promoter, resulting in a high rate of transcription;;

(c) In another experiment, the *trp* operon and the *lac* operon of a bacteria cell were made to fuse together. The fusion process is illustrated in Fig. 5.2.

Suggest the condition(s) needed for  $\beta$ -galactosidase to be expressed in this strain of bacteria that carries the fused operon. Explain your answer. [4]

- Only when tryptophan is absent;;
- Fusion of *trp* and *lac* operon means that the genes in the *lac* operon are now under the control of the regulatory region of the *trp* operon;;
- In the absence of tryptophan, the repressor is inactive and is therefore unable to bind to the operator;;
- RNA polymerase is able to bind to the promoter and transcribe lacZ genes that encode  $\beta$ -galactosidase;;

[Total: 12]

6 Some hormones circulating in the blood are able to trigger transcription within a cell, even though they are unable to enter the cell. Phosphatases and kinases then take part in cell activities that eventually result in genes switching on and transcription beginning.

(a) Suggest why the hormones, referred to in the passage, are unable to enter the cell. [2]

- Hormones are protein / peptide;
- Too large to cross membrane;
- Hydrophilic / water soluble; A not, hydrophobic / lipid soluble
- Unable to pass through hydrophobic core / AW, of phospholipid bilayer;

(b) Use the information in the passage to outline the process of cell signalling. [3]

- Chemicals / signalling molecules released are circulating hormones;;
- Hormones bind to cell surface receptors on target cells/ cells where transcription is triggered;;
- Signal is transduced into the cell / reference to extracellular signals are converted into intracellular signals;;
- Action of kinases and phosphatases (within the cell) lead to (specific) response;;

(c) Explain the role of the following in cell signalling.

(i) Phosphatases [2]

- Enzymes that catalyse the removal of phosphate groups from proteins, (must have);;
- Making them inactive to end the signal transmission;;
- Making the proteins in the cell signalling pathway available for reuse;;

(ii) Kinases [2]

- Enzymes that catalyse the addition of phosphate groups from ATP to a protein, causing conformation change and the activation of the protein;;
- When a kinase is activated, it phosphorylates the next kinase which continues sequentially down the pathway in a phosphorylation cascade;;

[Total: 9]

- 7 Chickpeas may contain a lipase inhibitor that prevents the digestion of fats. There are two forms of lipase inhibitors – inhibitor **W** and inhibitor **X**.

Homozygous plants are known to produce one type of lipase inhibitor, depending on the allele which they are homozygous for.

A heterozygote plant, on the other hand, will two types of lipase inhibitor, inhibitor **W** and inhibitor **X**. A third recessive allele does not code for a lipase inhibitor.

- (a) Identify whether the inheritance of lipase inhibitor shows continuous or discontinuous variation. Give a reason for your choice. [2]

- Discontinuous variation;;
- Discrete phenotypes (inhibitor W and X) / distinct groups / no intermediates;;

- (b) A second character, seed texture, is controlled by another gene located on a different chromosome and is controlled by two alleles. Smooth seed-coat, **T**, is dominant over wrinkled seed-coat, **t**.

Two chickpea plants were crossed. Their seeds were collected and counted. One of the parental chickpea plants is found to contain only inhibitor **X** and has smooth seed-coats. The progeny of the dihybrid cross is summarised in Table 7.1.

Table 7.1

Inhibitor(s) present in seed	Number of seeds	Seeds with smooth seed-coat / %
<b>W and X</b>	12	50
<b>W</b>	14	50
<b>X</b>	22	50

With reference to Table 7.1,

- (i) state and explain the mode of inheritance for the lipase inhibitor in the chickpeas. [2]

- The type of lipase inhibitor is determined by co-dominance, since in the heterozygous condition, both alleles are equally expressed;;

- (ii) using suitable symbols, draw a genetic diagram to explain the results of this cross. [5]

Let  $C^W$  be the (co)dominant allele that produces inhibitor W  
 $C^X$  be the (co)dominant allele that produces inhibitor X  
 $C^O$  be the recessive allele for that produces no inhibitor  
**T** be the dominant allele for smooth seed-coat  
**t** be the recessive allele for wrinkled seed-coat

Parental phenotypes: Inhibitor X, smooth coat x Inhibitors W and X, wrinkled coat

Parental genotypes:  $C^XC^Ot$  x  $C^WC^xtt$



Gametes:  $(C^XT)$   $(C^Xt)$   $(C^Ot)$   $(C^Ot)$  x  $(C^Wt)$   $(C^xt)$

Punnett square to show random fusion of gametes by the F<sub>1</sub> generation:

F<sub>1</sub> genotypes:

♂ gametes	$C^XT$	$C^Xt$	$C^Ot$	$C^Ot$
♀ gametes	$C^Wt$	$C^xt$	$C^Wt$	$C^xt$
	$C^WC^XTt$	$C^WC^Xtt$	$C^WC^Ot$	$C^WC^Ott$
	$C^XC^XTt$	$C^XC^Xtt$	$C^XC^Ot$	$C^XC^Ott$

F <sub>1</sub> Genotypic Ratio:	1 $C^XC^XTt$	1 $C^XC^Ot$	1 $C^XC^Xtt$	1 $C^XC^Ott$	1 $C^WC^Ot$	1 $C^WC^Ott$	1 $C^WC^XTt$	1 $C^WC^Xtt$ ;
F <sub>1</sub> Phenotypic Ratio:	2 Inhibitor X & smooth seed-coat		2 Inhibitor X & wrinkled seed-coat		1 Inhibitor W & smooth seed-coat	1 Inhibitor W & wrinkled seed-coat	1 Inhibitor W & X & smooth seed-coat	1 Inhibitor W & X & wrinkled seed-coat;;

(c) Observed results of the above genetic cross differ from the expected results.

Suggest two reasons why such a discrepancy occurs, referring only to events that occur after meiosis. [2]

- Sample size is too small;;
- Variation is due to chance/ insignificant;;
- Differential survival of gametes/ non-random mating;;
- Differential survival of fertilised zygotes/ some individuals die before being sampled;;

(d) Structure Q in Fig. 7.2 is a cell structure which is involved in nuclear division.

Identify structure Q and describe its behaviour during meiosis. [3]

- Centrioles;;
- During S phase, they are duplicated along with DNA replication;;
- Centrioles act as the microtubule-organising centres (MTOC), involved in spindle fibre formation;;
- In animal cells, the centrioles move to opposite ends of the cell. From each pair of centrioles, short microtubules develop and form a star-shaped structure called an aster;;

[Total: 14]

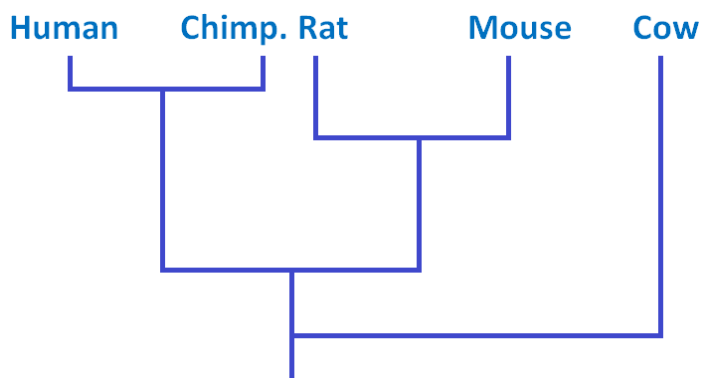
8 (a) Define the term “phylogeny”. [1]

- The organisation of species to show their evolutionary relationships;;

(b) (i) state, with reasons, the species that is most closely related to mouse. [2]

- Rat;;
- Least number of differences in amino acid sequence, 2 differences;;

(ii) construct a phylogenetic tree to show the evolutionary relationships between the species. [2]



- Correct grouping of human and chimpanzee, rat and mouse, cow;;
- Human and chimpanzee diverged the latest, followed by rat and mouse, cow the earliest;;

(c) Explain how the amino acid sequences in Fig. 8.1 supports Darwin’s theory of evolution. [3]

- Ref. to molecular homology and descent with modifications;;
- Having the same protein with similar amino acid sequence shows that the species had a common ancestor;;
- Differences in the amino acid sequence are accumulated during the evolution of the different species due to natural selection;;

(d) Describe a modification to the investigation in (b) to deduce the evolutionary relationships between the mammalian species and *E. coli*. [2]

- Ref. to the use of the sequence of a homologous gene / protein present in the mammalian species and *E. coli*;;
- E.g. RNA polymerase / ribosomal protein / AVP;;

**(e) (i)** Explain the advantages of molecular methods in reconstructing phylogenetic relationships. [3]

- Objective and unambiguous;;
- Quantitative and can be easily converted to numerical form for mathematical and statistical analysis;;
- Amino acid and DNA sequences can be easily obtained from electronic databanks;;
- More points of comparison as each nucleotide / amino acid can be regarded as a character for comparison;;

**(ii)** Explain why reptiles do not constitute a monophyletic grouping. [2]

- Does not consist of an ancestral species and all its descendants;;
- Ref. to birds as a descendant but are not reptiles;;

[Total: 15]

**9 (a)** Explain how macrophages function to protect the lungs from becoming infected. [4]

- recognise, non-self/ foreign, antigens on pathogen ;
  - receptors (on macrophage) bind antigens (on pathogen) ;
  - infolding of macrophage cell surface membrane around/ engulf/ phagocytosis of,
  - pathogen ; R engulf antigen
  - vacuole/ vesicle/ phagosome, forms ;
  - ref. to lysosomes ;
  - hydrolytic / digestive/named, enzymes ;
  - e.g. lysozyme/ protease/ nuclease
  - A pathogen broken down by enzymes
  - hydrolysis of named compound(s) ;
  - ref. to destroying/ killing, pathogen ;
  - ref. to antigen presentation ;
- accept idea even though does not occur in alveoli

**(b)** Very few helper T-lymphocytes respond to the presence of APCs by binding in the way shown in Fig. 9.2. Suggest why this is so. [2]

- idea that only, a few/ some/ small number / AW, with correct specificity;
- different T-lymphocytes are specific to different antigens;
- T cell receptor is, complementary (in shape to antigen);
- AVP; e.g. this may be during a primary immune response so no memory cells or, e.g. disease state (HIV / AIDS and leukaemia) or treatment where few T-lymphocytes in the body

**(c)** During an immune response, cells divide by mitosis. Describe how mitosis is involved in an immune response. [3]



- occurs in both primary and secondary (immune) responses;
- selected / specific / AW;
- lymphocytes / B -cells / T-cells / divide (by mitosis);
- clonal expansion / described in terms of producing, clone / many cells;
- A idea that different types of immune cell can result;
- reference mitosis in memory cells (for rapid) secondary response;

(d) Complete the table to indicate how the following types of immunity can occur. [4]

	<b>Acquired</b>	<b>Natural</b>
<b>Active</b>	Vaccination using live, attenuated pathogens	Infection by a pathogen
<b>Passive</b>	Injection of antibodies against pathogen	Ingestion of maternal antibodies by an infant through its mother's milk;; or Transfer of maternal antibodies across the placenta to the fetus

[Total: 13]

**Section A**

Answer **all** the questions in this section.

- 1 Pneumonia is disease caused by the gram-positive pneumococcal bacteria. Pneumococcal infections result in an inflammatory condition of the lung affecting primarily the small air sacs known as alveoli. Hence, the symptoms of pneumonia include dry cough, chest pain, fever, and difficulty in breathing.

Pneumonia affects approximately 450 million people globally (7% of the population) and results in about 4 million deaths per year. Up to 40% of these infections were caused by pneumococcal bacteria that were resistant to at least one antibiotic.

Due to the severity of pneumonia and the rise in antibiotic resistance among bacteria, vaccines have been developed to protect individuals against the disease.

- (a) Evaluate the effectiveness of vaccines against the rise of antibiotic-resistant strains of pneumococcal bacteria.

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..... [4]

With the continuing threat of antibiotic resistance, bacteriophage therapy is employed as a mean to treat bacterial infections.

- (b) Describe how a typical T4 bacteriophage can work against an antibiotic-resistant bacterium.

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..... [3]

**(c)** A subset of the bacteriophage population, termed as “superspreaders”, is observed to release substantial amounts of intact, transformable bacteria plasmid DNA along with the release of its progeny from the host.

These plasmid DNA molecules, however, are not found within the nucleocapsid of the bacteriophages.

These “superspreaders” are deemed to have the potential to promote antibiotic resistance among bacteria.

The use of antibiotics instead of decreasing numbers appears to increase the numbers of antibiotic resistance bacteria.

**(i)** Using the information given, describe how a bacterium could have acquired antibiotic resistance due to the release of such plasmid DNA.

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.....  
.....[2]

**(ii)** Suggest how this could lead to an increase in the proportion of bacteria with antibiotic resistance in the population.

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.....[3]

T4 bacteriophages generally contain phage-encoded endonucleases. The phage-encoded endonucleases serve to hydrolyse the bacteria chromosome. It is hypothesised that the “superspreaders” may lack hydrolytic endonucleases, hence are able to release intact plasmid DNA during exit from the host cell.

A group of researchers decided to carry out an experiment on two strains of “superspreaders”, namely SUSP1 and SUSP2, as well as T4 bacteriophage.

The 3 types of viruses are then exposed to *Escherichia coli* bacteria containing a chromosomal DNA molecule and an extra-chromosomal 130bp plasmid DNA molecule. In the control setup, the bacteria are not exposed to any virus.

Fig.1.2 shows the result of the experiment.

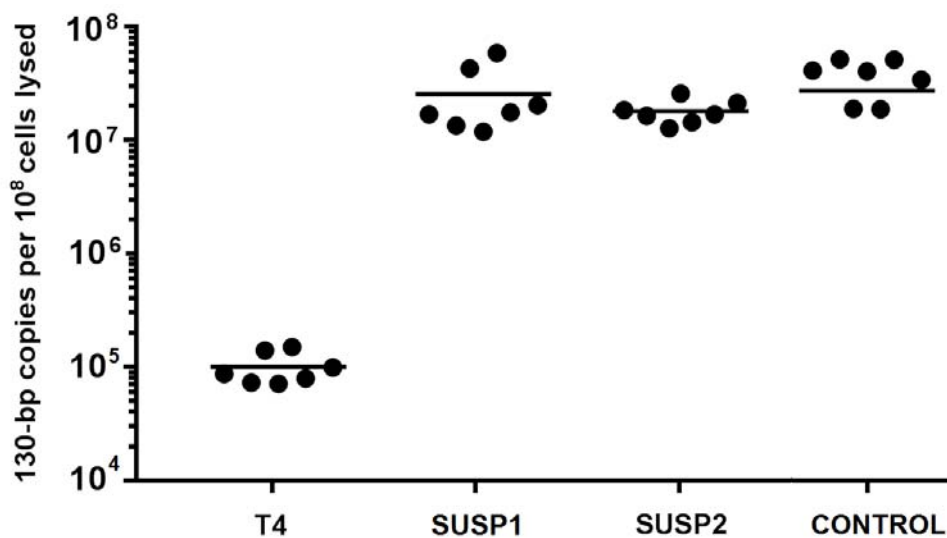


Fig. 1.2

(d) Briefly comment on the validity of the hypothesis based on the results shown in Fig. 1.2.

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..... [3]

To further confirm their hypothesis, researchers decide to amplify the genome of the three viruses and run a gel electrophoresis.

**(e)** As a good Biology student, name and describe a procedure that the researchers should undertake to determine the presence or absence of the hydrolytic endonucleases in the “superspreaders”.

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..... [4]

With climate change, environmental scientists predict that there will be a surge in the emergence of new viral and bacterial infectious diseases to the current human population.

**(f)** Besides mutation, suggest how the environmental scientists’ prediction might come true.

.....

..... [1]

[Total: 20]

2 The mitotic cell cycle consists of a sequence of carefully orchestrated events that a cell passes through between one division and the next. It is tightly regulated to ensure that cells will only undergo division when conditions are optimal.

Fig. 2.1 shows the mitotic cell cycle.

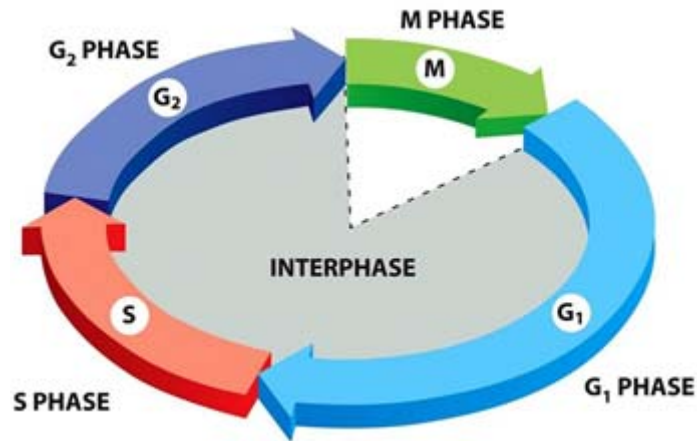


Fig. 2.1

(modified from <https://mrrittner.weebly.com/unit-4-cell-cycle.html>)

(a) (i) On Fig. 2.1, label and name two critical positions where a cell can be regulated in the mitotic cell cycle. [2]

(ii) Explain the significance of the critical positions labelled in (a) (i) to the regulation of the cell cycle.

Position 1 .....

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.....

.....

Position 2 .....

.....

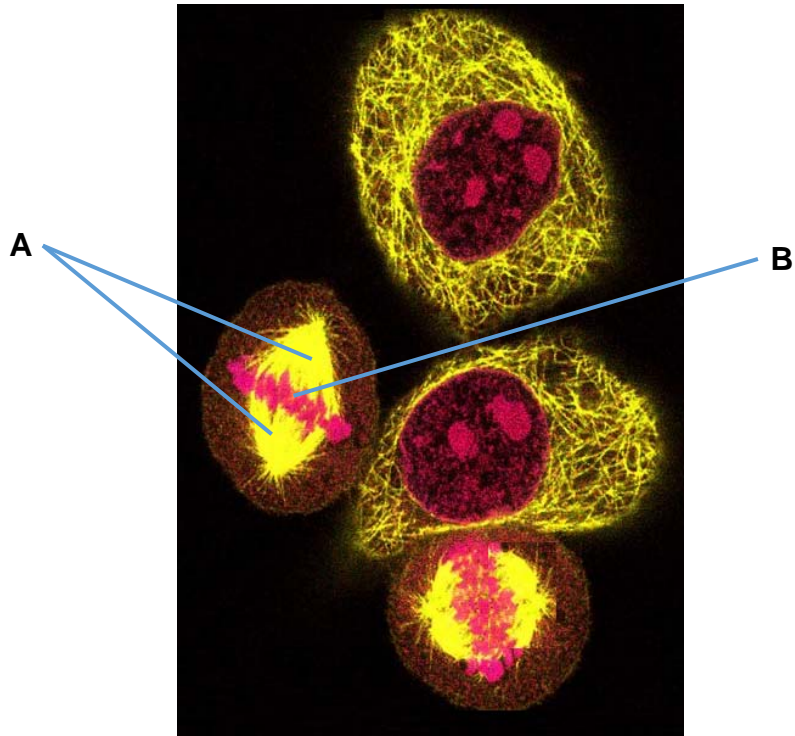
.....

..... [4]

Dysregulation of cell cycle leads to cancer.

Skin cancer cells may be grown in culture and examined using the technique of immunofluorescence in which antibodies are used to attach fluorescent dyes to specific molecules within the cells.

Fig. 2.2 is an immunofluorescent light micrograph of skin cancer cells. There are two cells in the process of nuclear division, one of which has areas stained with two different fluorescent dyes, labelled **A** and **B** on Fig. 2.2.



**Fig. 2.2**

**(b)** Identify the two areas labelled **A** in the dividing cell in **Fig. 2.2** and outline their function.

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..... [3]

**(c)** Before the skin cancer cells could be stained with antibodies, the cells had to be fixed and treated with a mild detergent to increase the permeability of the cell surface membranes.

**(i)** Explain why it is necessary to increase the permeability of the cell surface membranes before staining cells using the technique of immunofluorescence.

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.....  
..... [2]

**(ii)** Suggest one advantage of using immunofluorescence to study the changes that occur in cells during cell division.

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..... [1]

Scientists have detected telomerase activity in more than 90% of human tumour samples. Recent advances in reprogramming somatic cells into induced pluripotent stem cells (iPSCs) showed that these cells also express high levels of telomerase, behaving like embryonic stem cells. Research on these iPSCs showed that they are able to provide functional neuronal cells, blood cells, and retinal cells, which would be a useful source for transplantation.

**(d) (i)** Explain why embryonic stem cells do not give rise to tumour.

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..... [3]



**(ii)** Discuss one ethical concern that iPSC research attempts to address.

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..... [2]

[Total: 17]

**3** Lizards are ectotherms. They bask in the sun to warm up when environmental temperatures are cool and stay in the shade when the temperatures get too hot. They are susceptible to negative effects of rising temperatures and can forage for food only when environmental temperatures are favourable for activity.

**(a)** Explain why ectotherms are “susceptible to the negative effects of rising temperatures”.

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..... [2]



Scientists, Barry Sinervo and colleagues, studying the effects of global warming on the lizard populations in Mexico, predicted that they will go extinct, partly due to the effect of high temperature on their foraging activity.

(c) Explain why the change in the foraging activity due to increased temperatures can lead to the extinction of the local lizard populations.

.....  
..... [1]

The scientists also studied two types of lizards – one viviparous (live bearing), the other oviparous (egg laying) and predicted their probability of extinction due to global warming.

Fig. 3.2 shows the predicted probability of extinction of the two lizard species against the difference in elevation from the midpoint of their geographic range (demarcated 0).

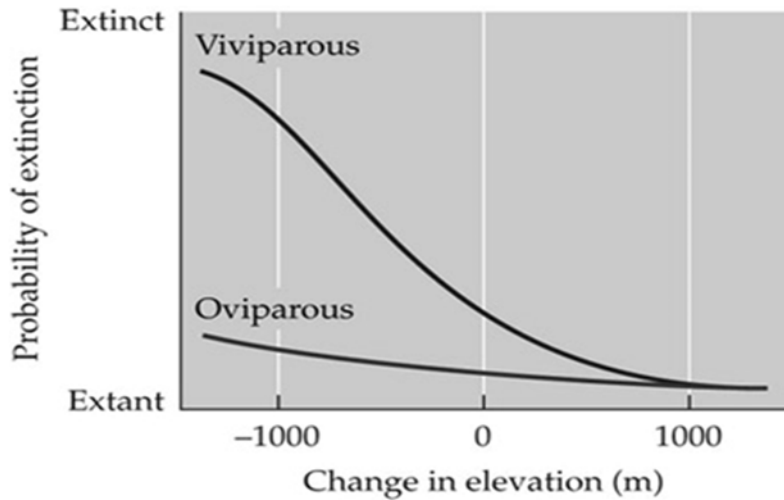


Fig. 3.2

(d) Justify the predictions made by the scientists as shown in Fig. 3.2.

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..... [3]

(e) Suggest how the live-bearing and egg-laying lizards evolved to become different species from a common egg-laying ancestor.

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..... [4]

[Total: 13]

**Section B**

Answer **one** question in this section.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answer must be set out in parts **(a)** and **(b)**, as indicated in the question.

- 4 **(a)** Compare the differences between B and T lymphocytes and describe how cell signalling helps B lymphocytes to play a role in the production of high-affinity antibodies with different effector function. [13]
- (b)** Describe how bacteria reproduce asexually and suggest advantages of such a process. [12]

[Total: 25]

- 5 **(a)** Environmental factors affect the phenotype of organisms. For example, fur colour of Himalayan rabbit is affected by temperature.

Explain the significance of the environment on variation and the formation of new species. [13]

- (b)** The Polymerase Chain Reaction (PCR) was a revolutionary method developed by Kary Mullis in the 1980s.

Outline the main principles of PCR and discuss how DNA replication by PCR differs from the process of how lambda phage replicates its genome via a lysogenic cycle within its host cell. [12]

[Total:25]

Section A

Answer all the questions in this section.

- 1 (a) Evaluate the effectiveness of vaccines against the rise of antibiotic resistant strains of pneumococcal bacteria. [4]

[Max 4]

- Highly effective/effective to a large extent;
- Antibiotic is administered when a bacterial infection has already occurred;
- Ref. to the idea that bacteria have reached a population large enough to cause disease / symptoms;
- Ref. to the idea that bacteria have multiplied many times;
- Ref. to the idea that each time the bacteria divide, their DNA is copied and mistakes in this process can create variations within the population;
- Antibiotic resistance can be one of the variations;
  
- Presence of antibiotics can act as a selective pressure;
- Select for more resistant bacteria;
- Resistant bacteria survive and reproduce;
- Pass down their antibiotic resistance alleles;
- Increase the frequency of the antibiotic resistance alleles within the bacterial population;
  
- Vaccines are administered prior to an infection;
- Ref. to the idea that infection can be brought under control before bacteria has the chance to multiply;
  
- Antibiotics tend to target one specific bacterial protein / mechanism;
  
- Vaccines can expose the immune system to a huge number of bacterial proteins / antigens;
- Promotes the development of a vast repertoire of antibodies that can fight against the bacterial infection in various ways;
- Ref. to action of antibodies: e.g. opsonisation, agglutination, neutralisation
- Ref. to idea that chances of bacteria simultaneously evolving resistance to counter every type of antibody produced is slim;
- Vaccines can curb overuse of antibiotics;

- (b) Describe how a typical T4 bacteriophage can work against an antibiotic-resistant bacterium. [3]

- T4 bacteriophage binds to specific receptors on antibiotic-resistant bacterium;
- The T4 phage penetrates the bacterium cell wall by contracting its contractile sheath of the tail which drives the hollow tube of the tail into the host bacterium; facilitating the entry of viral DNA;
- The phage then replicates its genome and uses the bacterium's protein synthesis machinery to synthesise phage proteins and structural components;
- The T4 phage components assemble around the viral genome to form new mature phage particles;

- A phage-coded lysozyme breaks down the peptidoglycan cell wall of the host cell, causing cell lysis and release of the new T4 bacteriophages;
- Resulting in the death of the bacterium;

**(c)** (i) Using the information given, describe how a bacterium appears to have acquired antibiotic resistance due to the release of such plasmid DNA. [2]

- Competent bacteria cells within the population will take up the plasmid DNA via transformation;;
- Plasmid DNA may contain genes for antibiotic resistance;;

(ii) Suggest how this could lead to an increase in the proportion of bacteria with antibiotic resistance in the population. [3]

- The transformed bacteria cells can then undergo conjugation with the bacteria near them; or binary fission
- Within the population, there are now antibiotic resistant bacteria and those that are not;
- Use of antibiotics act as a selection pressure;
- Antibiotic resistant bacteria have a selective advantage and they are selected for;
- These selected bacteria will survive, reproduce and pass on their alleles to the next generation;
- increasing frequency of antibiotic-resistant bacteria within the population;

**(d)** Briefly comment on the validity of the hypothesis based on the results shown in Fig. 1.2. [3]

- The hypothesis seems valid;;
- T4 bacteriophage results in less intact plasmid and chromosomal DNA within the bacteria whereas bacteria that have interacted with SUSP1 and SUSP2 has more intact plasmid and chromosomal DNA;;
- Endonucleases present in the T4 bacteriophages allows for the digestion of the bacteria's plasmid and chromosomal DNA whereas these endonucleases are absent in SUSP1 and SUSP2;;

**(e)** As a good Biology student, name and describe a procedure that the researchers can undertake to determine the presence or absence of the hydrolytic endonucleases in the "superspreaders". [4]

- Southern Blotting;
- Place the gel in a mixture of alkali and salt to denature the double stranded DNA fragments into single stranded DNA;
- The gel is then covered with a nitrocellulose filter;
- Additional absorbent papers are added on top of the nitrocellulose filter to draw up the single stranded DNA from the gel by capillary action and transferred them onto the nitrocellulose filter;
- Nitrocellulose filter is baked at 80°C so that the DNA is permanently bound to the filter;
- The filter is then exposed to a solution containing radioactively labeled single-stranded DNA probes;

- ref to nucleic acid
- which are complementary to the DNA sequence of the endonucleases;
- Excess probes are then washed off and the bands are visualised under autoradiography;

(f) Besides mutation, suggest how the environmental scientists' prediction might come true. [1]

- As temperature rises, permafrost melting occurs;;
- releasing new bacteria and viruses, which were once trapped in the frozen soil, into the environment;;

OR

- As sea level rises, flooding of low lying lands occurs, less land available;;
- different species of organisms may find themselves in closer proximity, allow for greater antigenic shift in viruses to occur, resulting in new strains of viruses formed;;

- AVP

[Total: 20]

2 (a) (i) Label on Fig. 2.1, two critical positions where a cell can be regulated in the mitotic cell cycle. [2]

- label - metaphase checkpoint; DNA damage checkpoint; G2 checkpoint

(ii) Explain the significance of the critical positions where a cell can be regulated in the mitotic cell cycle. [2]

- metaphase checkpoint – ensure all chromosomes are attached to mitotic spindle
- G2 checkpoint – check no DNA damage and chromosomes all replicated
- G1 checkpoint – cell size is large enough, nutrients available, growth factors present.

3 Identify the two areas labelled A in the dividing cells in Fig. 2.2 and outline their function. [3]

- spindle apparatus / spindle fibres; Accept spindle / microtubules / tubulin / centrioles / microtubule organising centres / MTOCs [1]

*function to max 2*

- attach to chromosomes / kinetochores ;
- detail of, elongation / structure / shortening, of microtubules ;
- for movement of chromosomes ;
- during mitosis ;

*Accept if centrioles given as identity*

- forms poles of the cell ;
- organises the spindle ;



4 (i) Explain why it is necessary to increase the permeability of the cell surface membranes before staining cells using the technique of immunofluorescence. [2]

- Membrane has as hydrophobic hydrocarbon core;
- Antibodies are hydrophilic;
- Antibody molecules too large to fit between phospholipid molecules in the bilayer;;

(ii) Suggest one advantage of using immunofluorescence in studying the changes that occur in cells during cell division. [1]

- locate position of specific, proteins / structures ;
- antibody molecules have complementary shape to target, proteins / structures ;
  
- can see distribution of, proteins / structures, in light microscope ;
- do not need to prepare sections for the electron microscope ;
- easier to look at a large number of cells than in EM ;
  
- higher degree of specificity than using other staining techniques ;
- idea of variable regions of antibodies giving greater specificity ;

5 (i) Explain why embryonic stem cells do not give rise to tumour. [3]

1. They are able to divide continuously but not excessively/uncontrollably;  
Cell division of stem cells can be regulated;  
Stem cells will only divide when necessary e.g. presence of growth factors;
2. As they obey cell cycle control/ stop appropriately at cell cycle checkpoints when conditions at previous stage are not met;;  
Accept if students refer to arrest of cell cycle to repair DNA damage/ cells send to apoptosis when DNA damage is irreparable;
3. Tumor suppressor genes (TSG) and proto-oncogenes are both functional / not mutated;;

Note: A maximum of 2 marks is awarded if there is no mention of TSG and proto-oncogenes anywhere in the answer.

Others: stem cells show contact inhibition;

(ii) Discuss one ethical concern that this type of research attempts to address. [2]

Ethical concerns: (any 1 with elaboration)

- Using adult cells does not involve use and destruction of embryos;;
- Reason – destruction of embryos (even excess embryos from IVF programme) is morally unacceptable/ repugnant to a sector of society that considers the embryo as life or potential of life;;
- AVP

[Total: 17]

6 (a) Explain why ectotherms are “susceptible to the negative effects of rising temperatures”. [2]

- Ectotherms cannot regulate body temperature;
- Increased temperatures may result in the lizard’s body temperature exceeding an upper critical temperature;
- Exceed optimum temperature of enzymes;
- can inhibit biochemical processes;

(b) With reference to Figure 3.1, account for two effects of global warming on the lizard’s foraging period. [3]

- Global warming decreases the total length of foraging period / to about 2/3 of the period before global warming;;
- Only one foraging period instead of two / no more foraging period towards end of the day;;
- Global warming increases atmospheric temperature which increases minimum and maximum operative temperatures of lizard throughout the day (as they are ectotherms);;
- Pushes operative temperatures above acceptable range / narrows timeframe where operative temperatures fall within acceptable range;;
- E.g. minimum operative temperature towards the end of the day remains higher than acceptable range;;

(c) Explain why the change in the foraging activity due to increased temperatures can lead to the extinction of the local lizard populations.[1]

- Limited food acquisition due to shorter foraging periods will mean that the lizards feed less;;
- This leads to lower growth rates of lizards;;
- Idea of limiting reproduction: Eg. Limit the energy they have available for reproduction/ or limit the number of offspring they have;;
- Decrease in number of offspring in subsequent generations/ Without new individuals to replace those that die, the population will eventually go extinct;;

(d) Justify the predictions made by the scientists as shown in Fig 3.2. [3]

- When lizards move higher up in terms of elevation or towards higher latitude where the temperature is lower;
- Longer foraging period, more food and energy and
- hence probability of extinction is lower;
  
- Probability of extinction is greater at the lower elevation of the lizards’ distributions and lower latitude/ latitude that is closer to the equator;

- Temperature at lower elevation and latitude is already high / near critical limit of lizards;
- Global warming leads to an increase in temperature at the lower elevation and lower latitude, resulting in decrease in foraging;
- Less energy for growth and reproduction, resulting in extinction;
- Viviparous (live-bearing) lizards have a higher probability of extinction than oviparous(egg laying) lizards as live bearing lizards would need more energy to sustain the development of the embryo;
- A decrease in foraging activity due to increased temperatures would decrease their intake of food, decrease energy available to sustain embryo growth and development;;
- Compared to those who lay eggs/ oviparous as the egg yolk provides the source of energy for the developing embryo;;

(e) Suggest how the live-bearing and egg-laying lizards evolved to become different species from a common egg-laying ancestor.[4]

- Different populations of the ancestral egg laying species are separated from each other due to physical barriers (allopatric) or behavioural reasons (sympatric) / idea of isolation;
- \* No gene flow between the groups;;
- \* Mutations also arise independently in each population ;;
- Fertile individuals from the different populations are no longer able to mate with each other (i.e. absence of gene flow) and so result in two distinct gene pools.
- \*Over a long period of time, the genetic variations in the different populations increase (eg ability to bear young live);

[Natural selection – cap at 2 mk]

- Different environments have different selection pressures on the organisms;
- One group faces high predation (egg eating predators);
- hence live-bearing individuals in that area are selected for;
- survive and reproduce and pass down advantageous alleles to offspring;

\* MUST HAVE POINTS

[Total: 13 marks]

- 4 (a) Compare the differences between B and T lymphocytes and describe how cell signalling helps B lymphocytes to play a role in the production of high-affinity antibodies with different effector function. [13]

*Difference between B & T cells [max 8]*

- Naïve B cells develop from immature B cells in the bone marrow;;
- Naïve T cells develop from immature T cells in the thymus;;
  
- B lymphocytes are important in humoral immunity in which antibodies neutralise and eradicate extracellular microbes and toxins;;
- T lymphocytes are important in cell-mediated immunity in which cytotoxic T cells eradicate intracellular microbes/microbes that have infected body cells;;
  
- Only B cells lymphocytes can secrete antibodies;;
- Helper T cells secrete cytokines to activate other cells of the immune system e.g. phagocytes to destroy microbes and activate B cells to class switch and become antibody-secreting plasma cells;
- Cytotoxic T cells secrete perforins and granzymes to kill infected cells by apoptosis;
  
- B lymphocytes express membrane antibodies (BCR) that recognise intact antigens which could be found on the surface of the pathogen
- T lymphocytes express T-cell receptors (TCR) that recognise peptide fragments of protein antigens displayed on other cells
  
- B cells ingest protein antigens, degrade them and display peptides bound on MHC molecules
- T helper cells with complementary receptors bind to MHC bound peptides and
- release cytokines to cause the B cell to differentiate to form plasma cells

*Cell signalling*

- Cytokines released by T helper cells then bind to cytokine receptors on the B cell,
- there is a conformation change in the receptor that
- results in a signal transduction into the B cell through the triggering of a phosphorylation cascade/ signal amplification
- Which leads to a cellular response that causes the gene for cytidine oxidase to be switched on
- The enzyme cytidine oxidase causes hypermutation of the VDJ regions of the antibody genes
- To produce antibodies of higher affinity/ specificity to the antigen
- Hence T helper cells also stimulate the production of antibodies with higher affinity for the antigen through the process of affinity maturation

- Another cellular response is to cause genetic recombination of the antibody genes to result in heavy chain class-switching to produce antibodies of different classes (IgG, IgA or IgE) of the same specificity.
- (b) Describe how bacteria reproduce asexually and suggest some advantages of such a process. [12]
- Binary fission;; [MUST HAVE]

#### DNA attachment

- First the DNA attaches itself to the cell membrane or to a mesosome which is a highly folded region of the cell membrane.

#### DNA replication

- Replication of the DNA starts at the origin (Ori C) that is attached to the cell wall, near the midpoint of the cell.
- As the DNA uncoils, a new complementary strand is being constructed on each strand in a semi-conservative manner.
- Replication occurs bidirectionally.
- This is helped by the enzyme called DNA gyrase which removes positive supercoiling.
- DNA replication ends at the termination sequence situated opposite the origin of replication.
- Plasmids are replicated the same way as the bacterial chromosome.

#### Cell growth and division

- After DNA replication, cell growth occurs. As the cell elongates, each circular DNA strand which is still attached to the cell membrane separate.
- When the cell divides, the cell membrane folds inwards between the DNA molecules to form a double layer across the long axis of the cell.
- New cell wall layers are secreted within the membrane layers.
- This divides the cell into two smaller, identical cells which may remain together or may separate.

#### Advantages (max 3)

- It allows for rapid populating.
- Ref. idea that it conserves energy and resources.
- Ref. to idea that daughter cells are genetically identical to the parents → all favourable alleles from the parents are guaranteed to be passed down

QSE: Candidates must be able to name and describe the process of binary fission and suggest at least 2 advantages.

- 5 (a) Environmental factors affect the phenotype of organisms. For example, fur colour of Himalayan rabbit is affected by temperature.

Explain the significance of the environment on variation and the formation of new species. [13]

Max 12m for (1) + (2) + (3)  
1m for QWC

(1) Effect of environment on phenotype [Max 6]

- Effects of environment increases variation between individuals;;
- Ref. to space / nutrients for growth / Environment affecting gene expression;;
- Plays a part in continuous variation which is controlled by the combined (additive) effects of many genes (polygenes) and environmental factors;;

(2) Role of environment on natural selection

- Genetic variation within population (giving rise to variation in phenotype further enhanced by effects of the environment) due to mutations / meiosis / sexual reproduction;;
- Environment factors serving as the selective pressure;;
- E.g. Source of food / Predator / etc.;;
- Variations in phenotype give rise to differential reproductive success;;
- Favourable alleles are passed down to later generations;;
- Change in allele frequency between generations;;

(3) Formation of new species

- Geographical / behavioural / physiological isolation between populations;;
- No gene flow between populations;;
- Accumulation of different genetic changes in each populations;;
- Correct definition of new species based on a named species concept;;
- Correct ref. to allopatric / sympatric speciation;;

QWC

- Answer includes at least 2 points from each section;;

(b) The Polymerase Chain Reaction (PCR) was a revolutionary method developed by Kary Mullis in the 1980s. Outline the main principles of PCR and discuss how DNA replication by PCR differs from the process of how lambda phage replicates its genome via a lysogenic cycle within its host cell. [12]

*Principles of PCR [max 6]*

- PCR is based on using the ability of DNA polymerase to synthesize a new strand of DNA complementary to the offered template strand.
- ref to semi-conservative replication
- ref to complementary base pairing
- A thermostable Taq polymerase is used which works at an optimum temperature of 72°C

- so that the PCR reaction can be carried out in a thermocycler.
- Because DNA polymerase can add a nucleotide only onto a preexisting 3'-OH group,
- a primer is needed to which it can add the first nucleotide.
- PCR involves the use of a forward and a reverse primer to flank the region to be amplified
- This makes it possible to delineate /mark out a specific region of template sequence that the researcher wants to amplify.
- As the PCR involves cycles of denaturation, annealing and elongation, at the end of 20-30 cycles, the specific sequence will be accumulated in billions of copies

*Difference between PCR and DNA replication in prokaryotes [ max 6]*

PCR	DNA replication of lambda phage
DNA primers, a forward and a reverse primer designed in the laboratory, are used	RNA primers, which are synthesized by primase, are used
Specific DNA sequences is being synthesized/copied	Entire genome on the circular chromosome is being copied
Replication starts where the forward and reverse primers bind	Replication starts at the single origin of replication
High temp (95oC) is being used to denature (break hydrogen bonds) and separate the DNA into single strands	Helicase is used to unwind DNA into single strands
Variation in temperature required in 1 cycle	Temperature is fairly constant throughout the entire process
No Okazaki fragments formed	Okazaki fragments formed in lagging strand
Does not require DNA ligase, primase	Requires DNA ligase, primase