



YISHUN INNOVA JUNIOR COLLEGE
JC2 PRELIMINARY EXAM
Higher 2

NAME

INDEX NO

CG

BIOLOGY**9744/02**

Paper 2 Structured Questions

31 Aug 2022

Candidates answer on the Question Paper.

2 hours

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index no. and CG on this cover page.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer all questions in the spaces provided on the Question paper.

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.

The number of marks is given in brackets [] at the end of each question or part question

At the end of the examination, **submit booklets A, B and C separately** to the invigilator.

For Examiner's Use	
Section A	
1	12
2	9
3	10
4	7
5	9
6	9
7	9
8	11
9	12
10	7
11	5
Total	100

This document consists of **29** printed pages and **1** blank page.

Answer all questions

- 1 Collagen is a major component of the cartilage found in some of the structures of the human gas exchange system. Cells that synthesise and secrete the components of cartilage are known as chondrocytes.

Fig. 1.1 is a transmission electron micrograph of a chondrocyte.

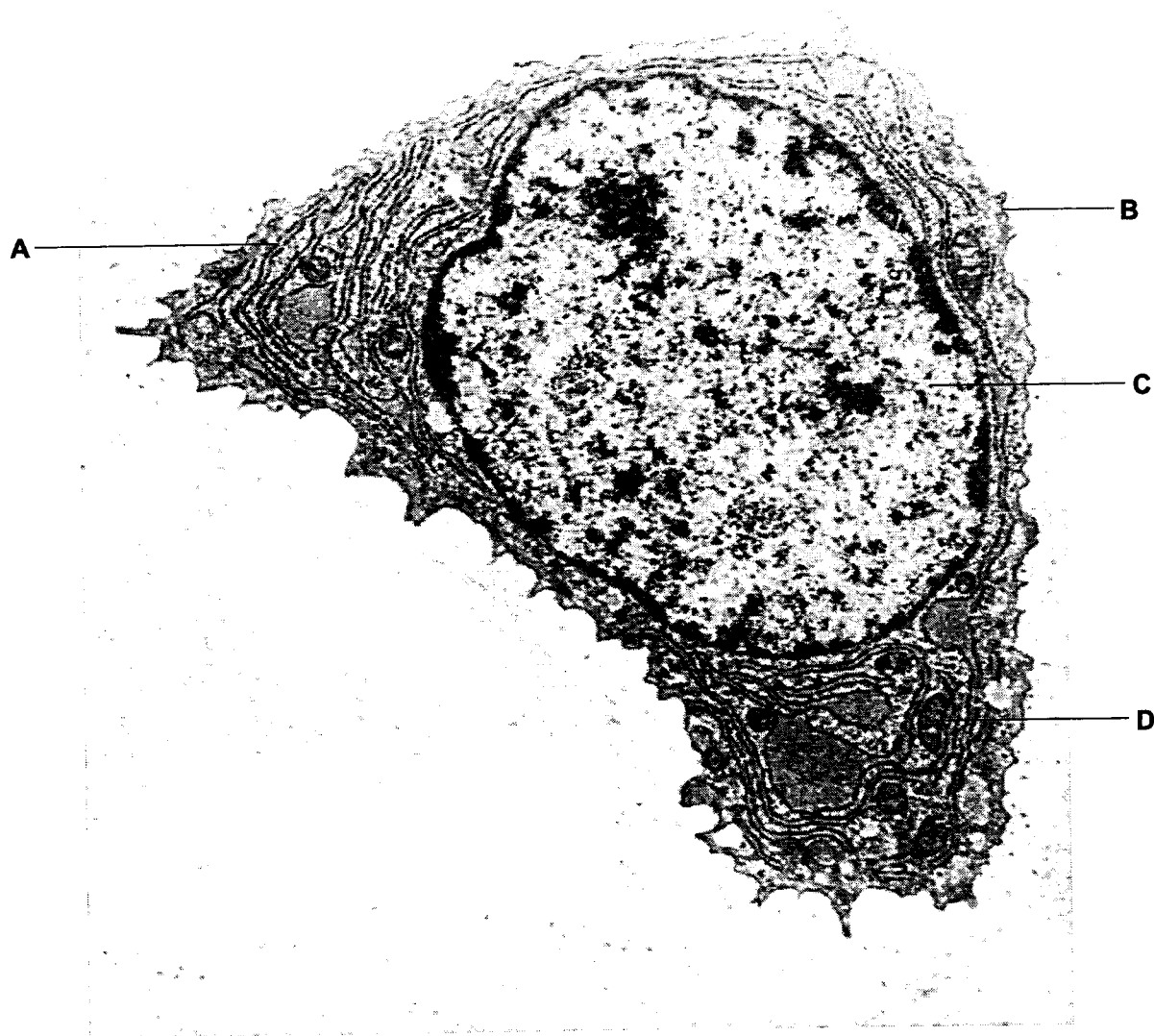


Fig. 1.1

- (a) Identify structures A - D.

A

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B

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C

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D

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[2]

- (b) With reference to Fig. 1.1, explain **two** features of the chondrocyte that show how the cell is adapted to its function.

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[2]

- (c) Collagen forms tropocollagen which is transported to the Golgi apparatus before being secreted out of the chondrocyte.

Describe the role of Golgi apparatus in collagen formation.

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[2]

- (d) Fig. 1.2 shows part of the primary structure of a collagen polypeptide.

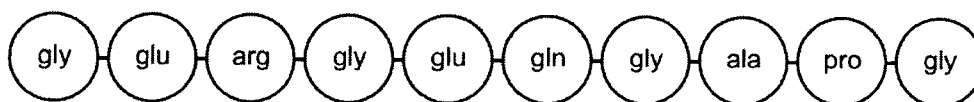


Fig. 1.2

With reference to Fig. 1.2, name the

- (i) type of covalent bond formed between the amino acids;

..... [1]

- (ii) enzyme that catalyses the formation of bond between the amino acids;

..... [1]

- (iii) reaction that forms the covalent bond between the amino acids.

..... [1]

(iv) Fig. 1.3 shows the molecular structure of the amino acid glycine (gly).

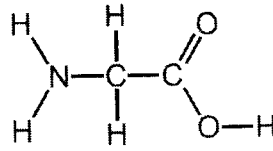


Fig. 1.3

With reference to Fig. 1.2 and Fig. 1.3 and the function of collagen, explain how the structure of a collagen polypeptide makes it suitable to form a collagen molecule.

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[3]

[Total: 12]

- 2 (a) The content of lysosomes in animal cells has a pH of 5.0. The cytosol has a pH of 7.2. The lysosomal membrane enclosing the lysosomal content, controls the passage of hydrogen ions from the cytosol into the lysosome. The low pH created by the entry of hydrogen ions is optimum for the action of acid hydrolase enzymes in the lysosome.

- (i) State and explain the transport mechanism used to move hydrogen ions from the cytosol of an animal cell into the lysosome.

Transport mechanism

Explanation

[3]

- (ii) Suggest how the structure of the lysosomal membrane allows hydrogen ions to be transported into the lysosome but does not allow the ions to leave the lysosome.

[2]

- (iii) The acid hydrolases in the lysosome cannot function in neutral conditions (pH 7.0) or alkaline conditions.

Explain the advantage to the animal cell of having acid hydrolases that cannot function in neutral, near neutral or alkaline conditions.

[2]

- (b) An analysis of a membrane protein located on the lysosomal membrane is carried out. The amino acid sequence that makes up the transmembrane segment of the protein is shown below.

...Ile - Thr - Leu - Ile - Tyr - Phe - Gly - Val - Met - Ala - Gly - Val - Ile - Gly - Thr - Ile - Leu - Leu - Ile - Ser...

Suggest why such an amino acid sequence would enable the protein to span the lysosomal membrane.

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[2]

[Total: 9]

- 3 Cyclooxygenase (COX) is an enzyme that catalyses the conversion of arachidonic acid (AA), into prostaglandins which are then involved in promoting inflammation, pain and fever.

There are two isoforms of the enzyme, COX-1 and COX-2 and they differ in the shape of their active sites.

Fig. 3.1 shows a simplified diagram of the active sites in COX-1 and COX-2.

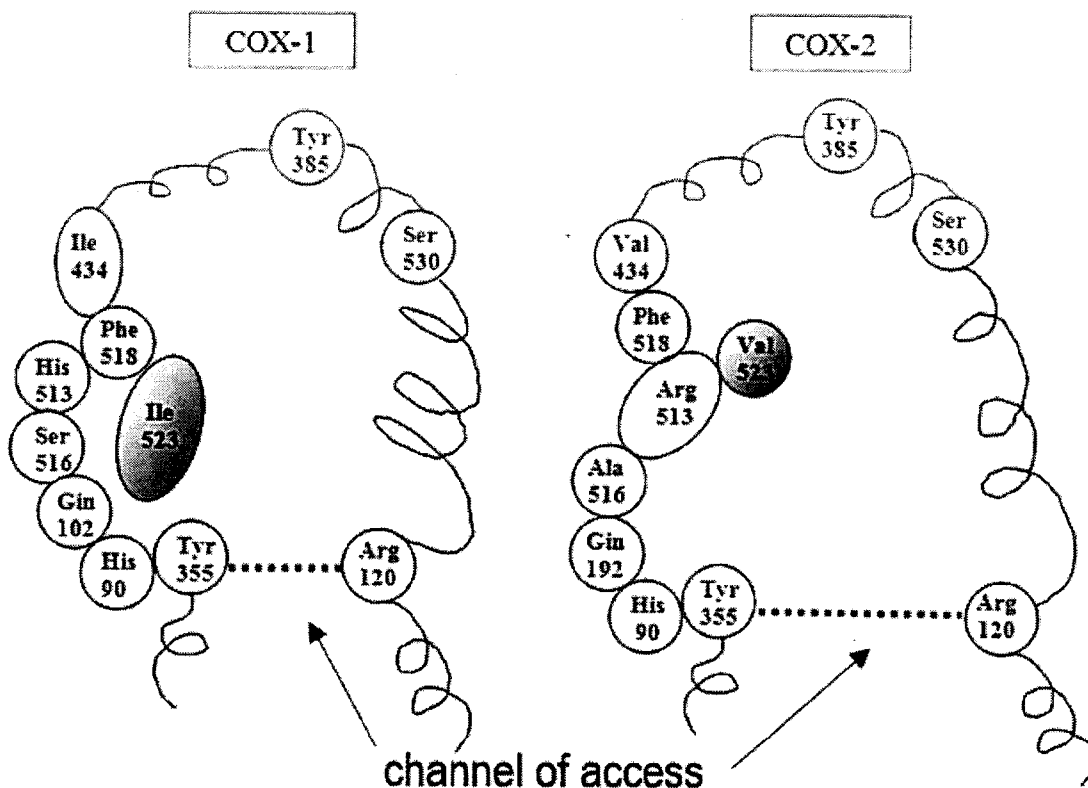


Fig. 3.1

- (a) With reference to Fig. 3.1, describe how the differences in amino acids result in a change in the configuration of the active site in COX-1 and COX-2.

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[4]

COX enzymes are targets of nonsteroidal anti-inflammatory drugs (NSAIDs) e.g., ibuprofen, to reduce the inflammatory symptoms.

Fig. 3.2 shows COX-1 when bound to AA and when ibuprofen is present.

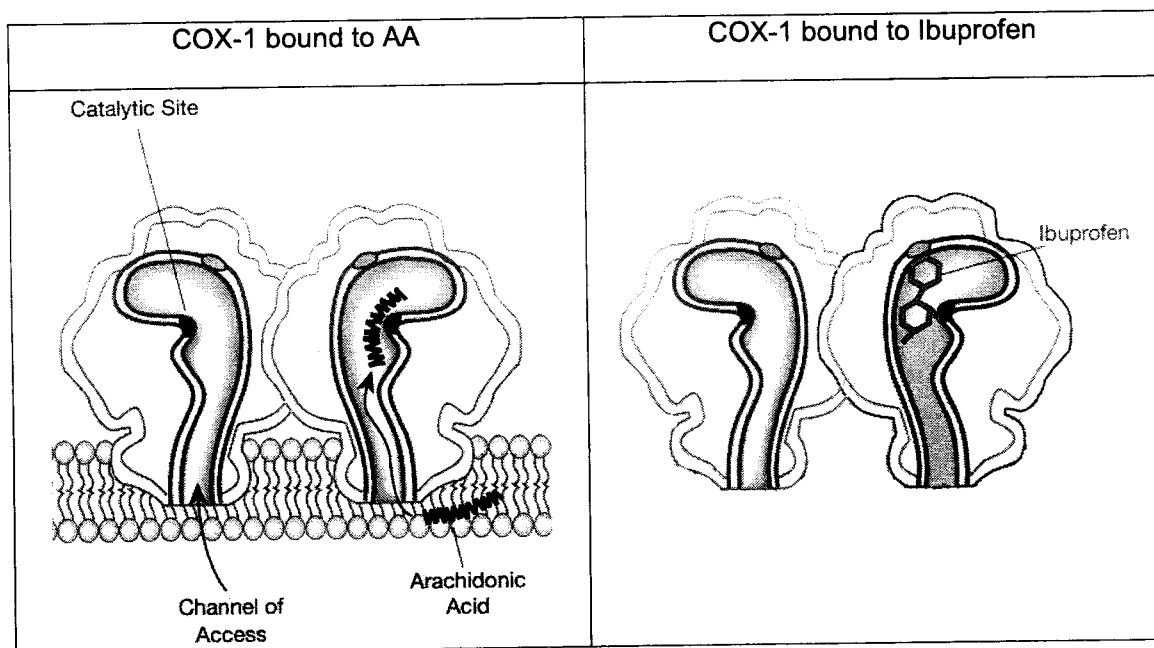


Fig. 3.2

(b) With reference to Fig. 3.2,

(i) explain how ibuprofen reduces the effects of inflammation.

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[3]

(ii) explain how ibuprofen can bind to the same active site.

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[2]

- (c) Inhibition of COX-1 by NSAIDs has been strongly implicated in gastric ulceration and bleeding. Newer drugs have been developed to selectively inhibit only COX-2.

Using information from Fig. 3.1 and 3.2, suggest how selective inhibition could occur.

----- [1]

[Total: 10]

- 4 To investigate the mode of DNA replication in a unicellular organism, 3 separate cultures of the cells were grown. The first was grown in a medium containing ^{14}N , the common isotope of nitrogen and the second was grown in a medium containing ^{15}N , the heavy isotope of nitrogen.

The cells of the third culture were grown in a medium containing ^{15}N for many generations first. Cells in early interphase were then transferred to a medium containing the common nitrogen form, ^{14}N . The cells were allowed to grow for one generation and then they were fixed at the next metaphase.

DNA was isolated from cells of all three cultures and separated into single strands by mild chemical treatment. The density of this single-stranded DNA was measured using density gradient centrifugation. The results of Tubes A, B and C are shown in Fig 3.1 below.

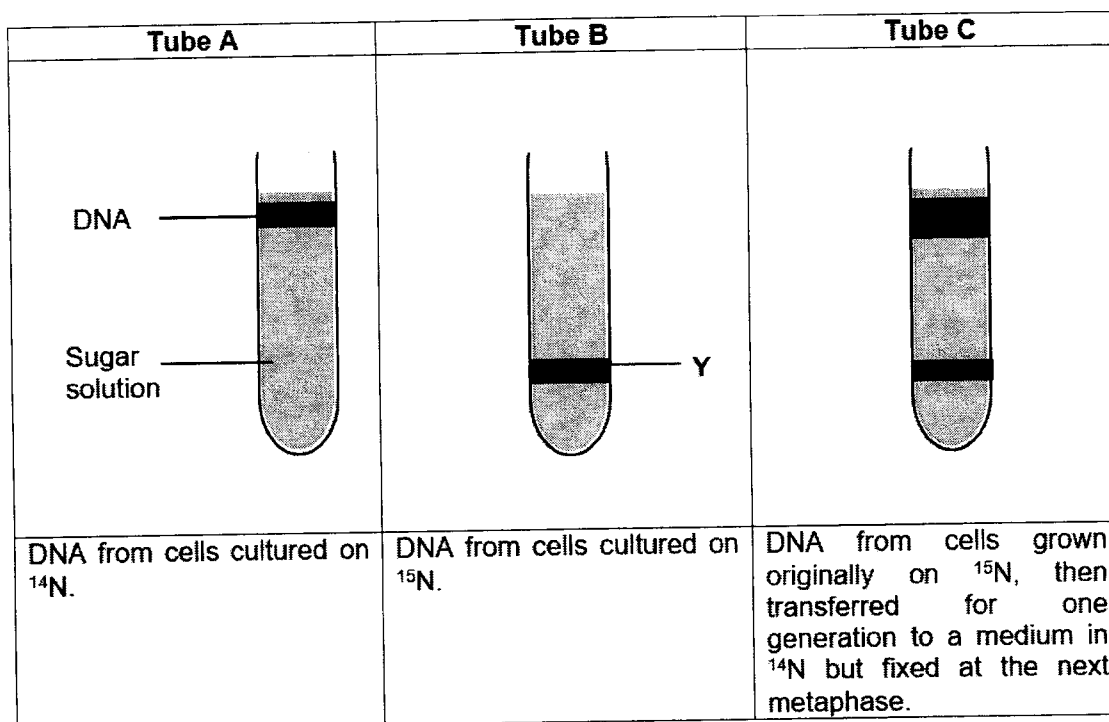


Fig. 4.1

- (a) (i) Assuming that DNA replication in the unicellular organism occurred through a similar mechanism to humans, what is the expected relative amount of each type of DNA in **Tube C**?

[1]

- (ii) Explain your answer to (a)(i).

[2]

Studies were then carried out to determine the nitrogenous base composition of the band of DNA marked Y in Tube B. This involved finding values for each individual (+ or -) DNA strand. Table 4.1 below shows the results obtained.

Table 4.1

DNA sample	Percentage of base present in DNA sample / %				Ratio of (A+G) to (C+T)
	A	G	C	T	
+ strand	28	15			0.75
- strand	32	25		28	1.33

(b) (i) Fill in the missing values in Table 4.1. [1]

(ii) State the ratio of (A+G) to (C+T) in the band of DNA marked "Y" in Tube B in Fig. 4.1. Explain your answer.

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..... [2]

(iii) State why the ratios of (A+G) to (C+T) in the + and – strands of DNA do not follow the ratio stated in (b)(ii).

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..... [1]

[Total: 7]

- 5 Occasionally during meiosis, homologous chromosomes fail to separate at anaphase. This is known as non-disjunction.

Turner's syndrome is the most common chromosome mutation in human females that occurs during gamete formation. Errors during meiosis led to some resulting gametes missing an X chromosome or when one of the pair of X chromosomes is damaged.

Fig. 5.1 is a diagram of a normal X chromosome and two variants of 'damaged' X chromosomes, X_1 and X_2 .

- In X_1 , a section of the 'p' arm of the chromosome is missing.
- In X_2 , a section of the 'q' arm of the chromosome is missing.

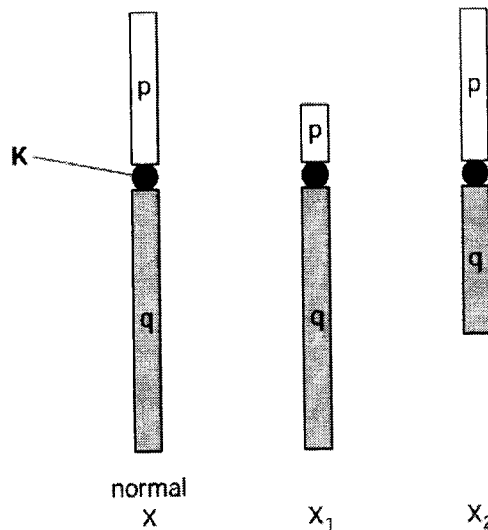


Fig. 5.1

- (a) State the function of structure K.

..... [1]

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- (b) Suggest how variants X_1 and X_2 can be produced.

..... [2]

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- (c) Explain how spindle fibres play an important role in ensuring a gamete with normal number of chromosomes is produced.

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[3]

- (d) The genes on the X chromosomes are involved in the development of the female reproductive organs.

Suggest why females with Turner's syndrome are sterile.

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[1]

Unlike meiosis which occurs in the cells within reproductive organs, mitosis occurs in somatic cells found throughout the body.

At various points during the mitotic cell cycle, there are checkpoints to ensure that only genetically identical daughter cells to each other and to the parent cell are produced. Other cells which did not pass the checkpoints undergo apoptosis to prevent uncontrolled cell division.

Vincristine and 5-fluorouracil are drugs which have been developed to cause cellular apoptosis.

- Vincristine binds to spindle microtubules and prevents the spindle apparatus from carrying out its function.
 - 5-fluorouracil prevents the synthesis of thymine nucleotides.
- (e) Complete Table 5.1 to show which event in the cell cycle will occur when Vincristine or 5-fluorouracil are added to healthy dividing cells at the start of the interphase stage of the cell cycle.

Place a tick (✓) if the event will occur or a cross (×) if the event will not occur. All boxes in the table should be completed.

Table 5.1

Cell cycle event Drug	Interphase	Prophase	Metaphase	Anaphase
Vincristine				
5-fluorouracil				

[2]

[Total: 9]

6 Fig. 6.1 shows the unpacking of bacterial circular chromosome.

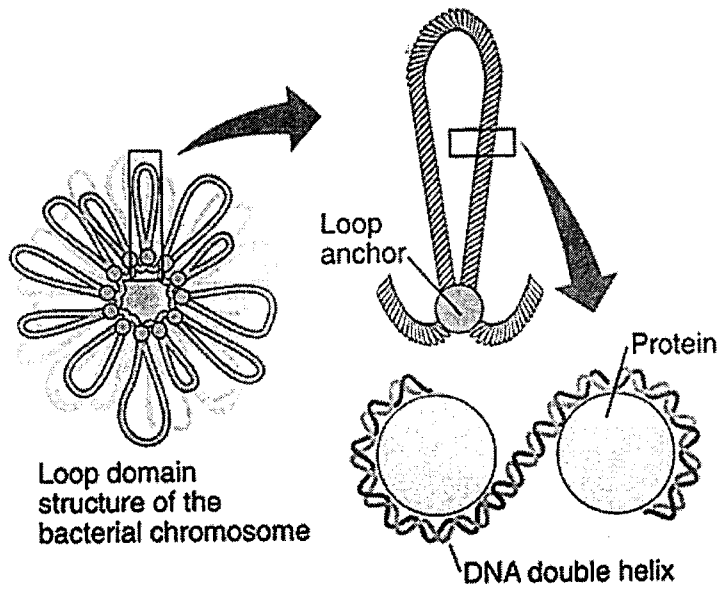


Fig. 6.1

(a) Using the information from Fig 6.1 and your own knowledge, describe how the bacterial chromosome is packed in a bacterial cell.

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[4]

Fig. 6.2 shows the production of defective phages during bacteriophage replication that results in gene transfer between bacteria.

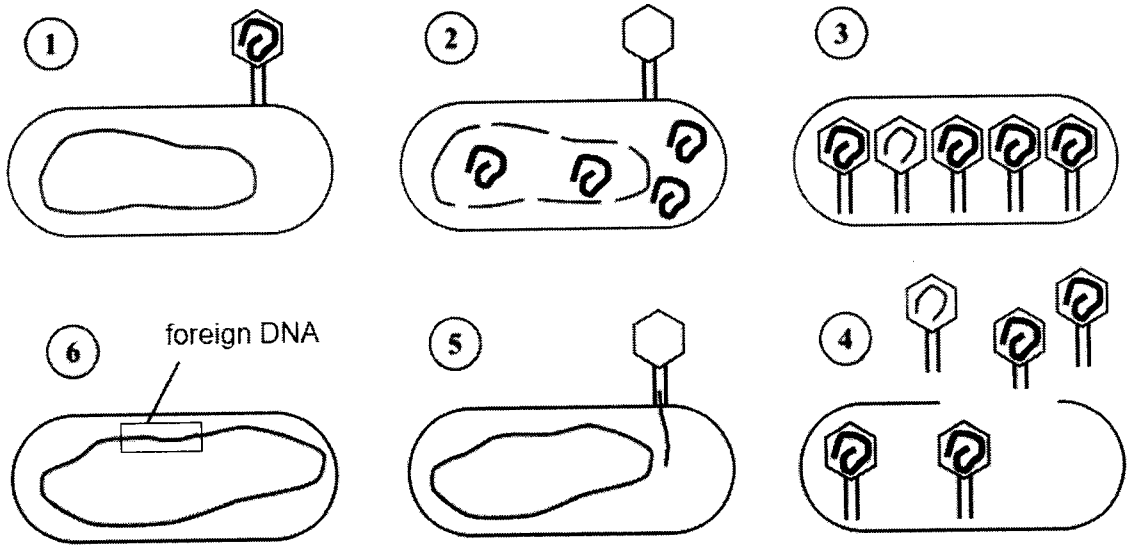


Fig. 6.2

(b) With reference to Fig. 6.2,

(i) suggest why Stage 2 occurs.

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[2]

(ii) describe how the bacteria cells obtain new genetic material.

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[3]

[Total: 9]

- 7 The interpupillary distance (IPD) is the distance in millimetres between the centres of the pupils of the eyes. Fig. 7.1 shows how IPD is measured.

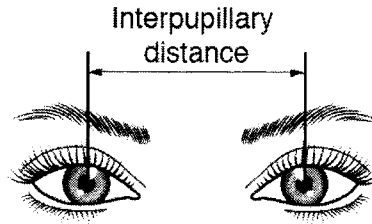


Fig. 7.1

IPD is one example of a characteristic of human facial structure that shows variation. Fig. 7.2 shows the pattern of variation in IPD in a large sample of adults.

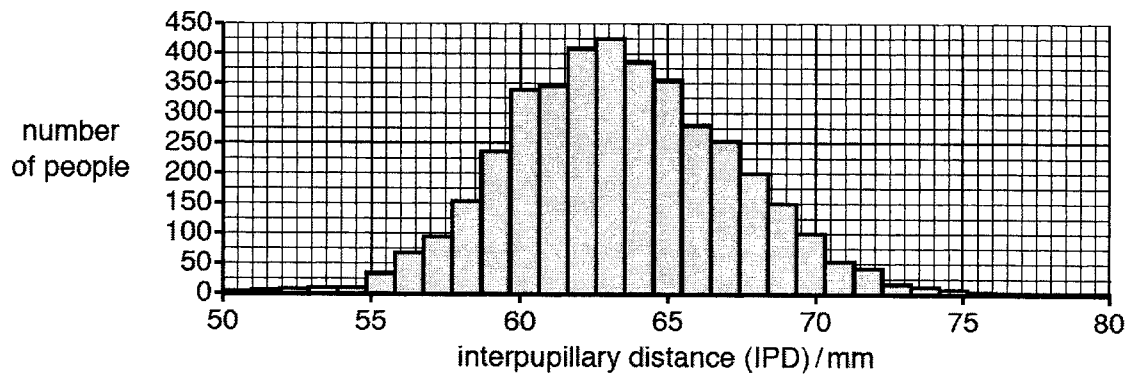


Fig. 7.2

- (a) (i) Name the type of variation shown in Fig. 7.2.

[1]

- (ii) Explain how genes and the environment contribute to variation in IPD in humans.

[3]

An investigation was carried out on the difference in IPD of males and females. Table 7.1 shows the results of the investigation.

Table 7.1

individual	IPD / mm	
	male	female
1	70	65
2	72	62
3	68	59
4	73	69
5	72	66
6	65	63
7	66	67
8	62	58
9	67	62
10	68	68
mean (\bar{x})	68	64
standard deviation (s)	3.50	3.73
variance (s^2)		

- (b) (i) Complete Table 7.1 by calculating the variance (s^2) for the IPD for each gender. [1]

- (ii) A t-test can be used to determine whether there is any significant difference between the IPD in males and females.

Calculate the value of t and the number of degrees of freedom, using these formulae:

$$t = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}} \quad v = n_1 + n_2 - 2$$

key to symbols

s = standard deviation

\bar{x} = mean

n = sample size (number of observations)

v = degrees of freedom

Show your working.

value of t =

degree of freedom =

[2]

(iii) For this t-test, the proposed null hypothesis is:

there is no difference between the IPD between males and females.

Table 7.2 shows the critical values for several different probabilities and degrees of freedom.

Table 7.2

degrees of freedom	probability, p				
	0.5	0.1	0.05	0.01	0.001
1	1.00	6.31	12.71	63.66	636.62
2	0.82	2.92	4.30	9.92	31.60
3	0.76	2.35	3.18	5.84	12.92
4	0.74	2.13	2.78	4.60	8.61
5	0.73	2.02	2.57	4.03	6.87
6	0.72	1.94	2.45	3.71	5.96
7	0.71	1.89	2.36	3.50	5.41
8	0.71	1.86	2.31	3.36	5.04
9	0.70	1.83	2.26	3.25	4.78
10	0.70	1.81	2.23	3.17	4.59
11	0.70	1.80	2.20	3.11	4.44
12	0.70	1.78	2.18	3.05	4.32
13	0.69	1.77	2.16	3.01	4.22
14	0.69	1.76	2.14	2.98	4.14
15	0.69	1.75	2.13	2.95	4.07
16	0.69	1.75	2.12	2.92	4.01
17	0.69	1.74	2.11	2.90	3.97
18	0.69	1.73	2.10	2.88	3.92
19	0.69	1.73	2.09	2.86	3.88
20	0.69	1.72	2.09	2.85	3.85

Use Table 7.2 and your answers to **(b)(ii)** to decide whether the null hypothesis should be accepted or rejected.

Explain your answer.

accept or reject null hypothesis

explanation

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[2]

[Total: 9]

8 Photosynthesis is a complex process involving a light-dependent stage and a light-independent stage.

(a) (i) Name the products of the light-dependent stage that are needed in the light-independent stage.

[1]

(ii) Describe the role of chlorophyll b in photosynthesis.

[1]

A student carried out an experiment to investigate the effect of light intensity and light wavelength on the rate of photosynthesis.

An aquatic plant, *Elodea canadensis*, was put into a beaker containing sodium hydrogencarbonate solution as a source of carbon dioxide. A lamp was placed at different distances from the beaker to change light intensity. The number of bubbles released by the aquatic plant in 1 minute was counted as a measure of the rate of photosynthesis. All other variables were controlled.

At each distance from the lamp, the experiment was repeated using a red filter in front of the lamp to give a different wavelength of light. The experiment was repeated using a blue filter and then using a green filter. Each filter transmitted the same light intensity.

Fig. 8.1 shows a graph of the results.

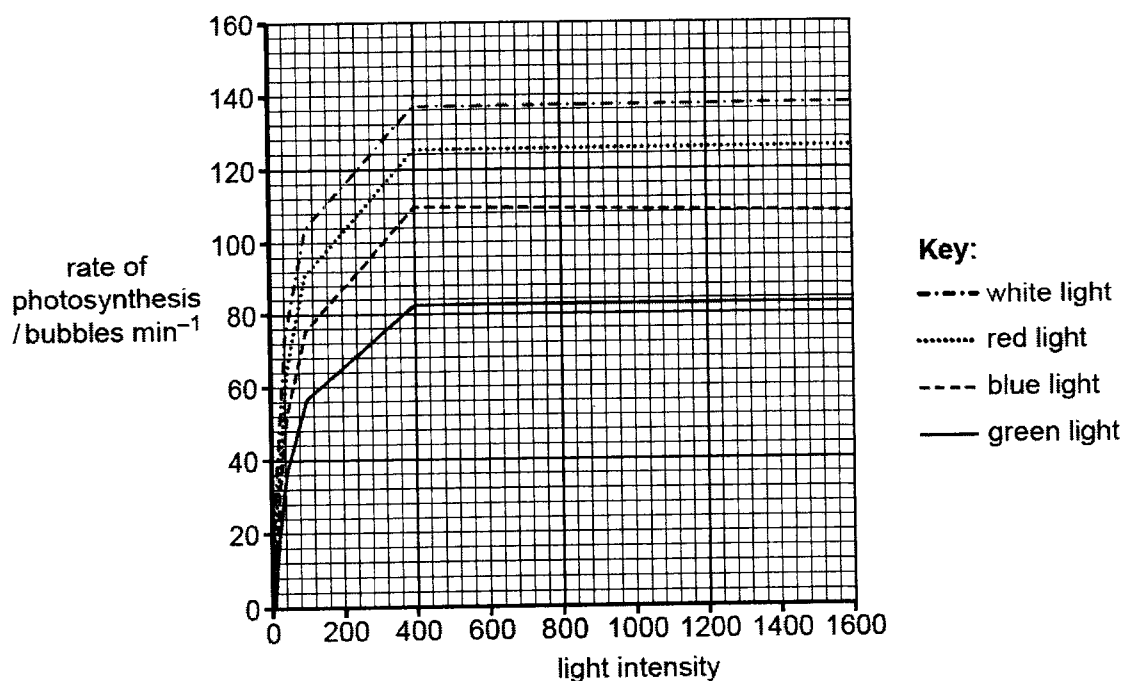


Fig. 8.1

(b) With reference to Fig. 8.1,

(i) state the range over which light intensity is the limiting factor;

[1]

(ii) explain what factor may be limiting the rate of photosynthesis above the range of light intensity stated in (c)(i).

[2]

(iii) At a light intensity of 1600, explain why different colour filters result in different rates of photosynthesis.

[3]

(iv) Predict and explain the effect on the number of bubbles produced if a rubisco inhibitor was added.

[3]

[Total: 11]

- 9 The aye-aye, *Daubentonia madagascariensis*, is a primate native to Madagascar. Aye-ayes are nocturnal (active at night) and make their nests high up in trees. They feed on insect larvae in the trunks of trees.

Fig. 9.1 shows an aye-aye.



Fig. 9.1

The International Union for Conservation of Nature (IUCN) is the world's largest global environmental organisation. The IUCN Red List of Threatened Species™ evaluates the conservation status of plant and animal species.

The aye-aye is categorised as endangered on the IUCN Red List, which means that it faces a very high risk of becoming extinct in the wild.

- (a) (i) Table 9.1 shows the taxonomic classification of aye-aye.

Table 9.1

	Eukarya
	Animalia
Phylum	Chordata
	Mammalia
Order	Primates
	Daubentoniidae
Genus	
Species	

Complete Table 9.1.

[3]

- (ii) Suggest **one** reason why aye-ayes have become endangered.

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[1]

There are two main aye-aye populations on the island of Madagascar, one in the west and one in the east.

Fig. 9.2 is a map of Madagascar showing the location of the two main populations.

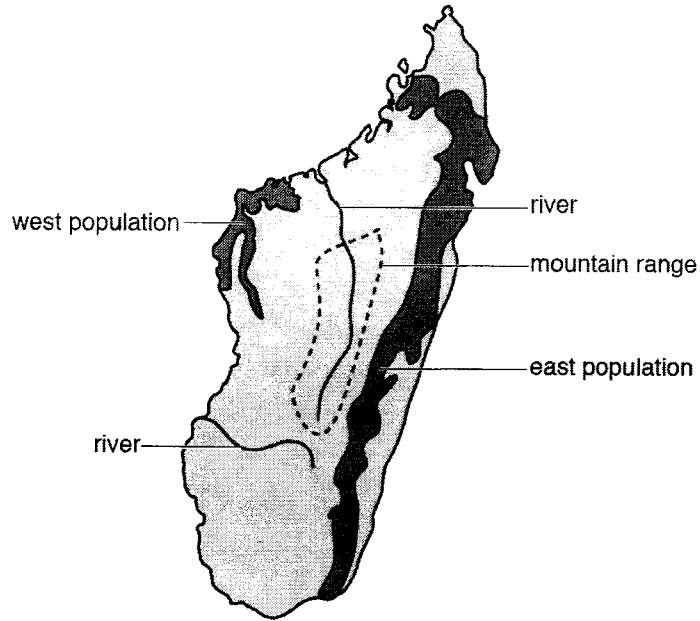


Fig. 9.2

A study into the variation in the DNA nucleotide sequence of aye-ayes showed that there is a large genetic difference between the west and east populations. The two populations of aye-ayes may be evolving into separate species.

(b) (i) State one advantage of using DNA nucleotide sequence in this study.

[1]

(ii) With reference to Fig. 9.2, suggest why there is a large genetic difference between the two populations.

[4]

(iii) Name the type of speciation that may be occurring.

[1]

(iv) Suggest **and** explain a pre-zygotic isolating mechanism that could prevent successful reproduction between aye-eyes of the two populations.

[2]

[Total: 12]

10 Tuberculosis (TB) is a major cause of ill health worldwide.

- (a) The World Health Organization (WHO) Global Tuberculosis Report for 2019 published data on the estimated number of deaths from TB and HIV/AIDS in 2018. All deaths of HIV-infected people from TB were also counted as deaths of people with HIV/AIDS.

Fig. 10.1 shows these data. The dark grey boxes show the estimated number of deaths of people from TB who were also counted as deaths of people with HIV/AIDS.

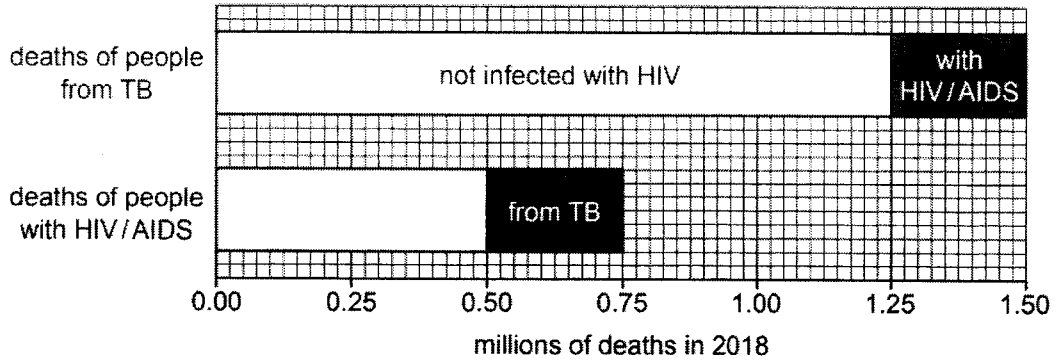


Fig. 10.1

A student used the data in Fig. 10.1 to predict that measures to control the spread of HIV will decrease the number of deaths from TB.

Discuss whether the data in Fig. 10.1 support this prediction.

[3]

- (b) In healthy people, the number of T-helper cells ranges from 500 to 1200 cells per cm³ of blood. In untreated people infected with HIV, the number of T-helper cells can decrease to below 200 cells per cm³ of blood.

Explain how a low number of T-helper cells makes it more likely that untreated people infected with HIV will die if they are also infected with TB

[4]

[Total: 7]

- 11 Frogs are ectothermic animals. This means that their body temperature will vary as the environmental temperature varies.

Several species of the frog genus, *Rana*, can be found in North America. Many of these species inhabit areas within a range of latitudes from the colder north to the warmer south.

Table 11.1 shows data for four of these species, *R. clamitans*, *R. palustris*, *R. pipens* and *R. sylvatica*.

Table 11.1

Species	Body temperature of frog / °C			
	lower lethal, below which frog dies	minimum to start development	maximum to complete development	upper lethal, above which frog dies
<i>R. clamitans</i>	10.0	11.0	35.0	37.0
<i>R. palustris</i>	5.0	7.0	30.0	31.0
<i>R. pipens</i>	3.0	6.0	28.0	30.0
<i>R. sylvatica</i>	0.0	2.0	24.0	25.0

- (a) Using the information in Table 11.1, suggest why global warming will result in a decrease in species diversity in frogs in the current habitats.

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[3]

- (b) Explain how human activities could have contributed to an increase in greenhouse gases that resulted in the rise of global temperatures.

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[2]

[Total: 5]

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YISHUN INNOVA JUNIOR COLLEGE
JC2 PRELIMINARY EXAM
Higher 2

NAME

INDEX NO

CG

BIOLOGY**9744/03**

Paper 3 Long Structured and Free-Response Questions

13 Sep 2022

Candidates answer on the Question Paper.

2 hours

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and class in the spaces at the top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section AAnswer **all** questions in the spaces provided on the Question Paper.**Section B**Answer any **one** question in the spaces provided on the Question Paper.

Indicate the question you have attempted at the top of page 18.

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.

The number of marks is given in brackets [] at the end of each question or part question.

For Examiner's Use	
Section A	
1	30
2	10
3	10
Section B	
4 or 5	25
Total	75

This document consists of **25** printed pages and **1** blank page.

Section A

Answer all questions in this section.

1 Estrogen receptors (ER) are expressed in mammary cells. Fig. 1.1 shows how an ER serves its functions at target cells:

- as an intracellular receptor activated by the steroid hormone estrogen (E), when E binds to complementary ligand binding site on ER,
- and as a transcriptional activator, after two ER bound with E dimerised and enters the nucleus.

Estrogens induce transcription of genes in their target cells. Such genes have estrogen response elements (ERE) as enhancers.

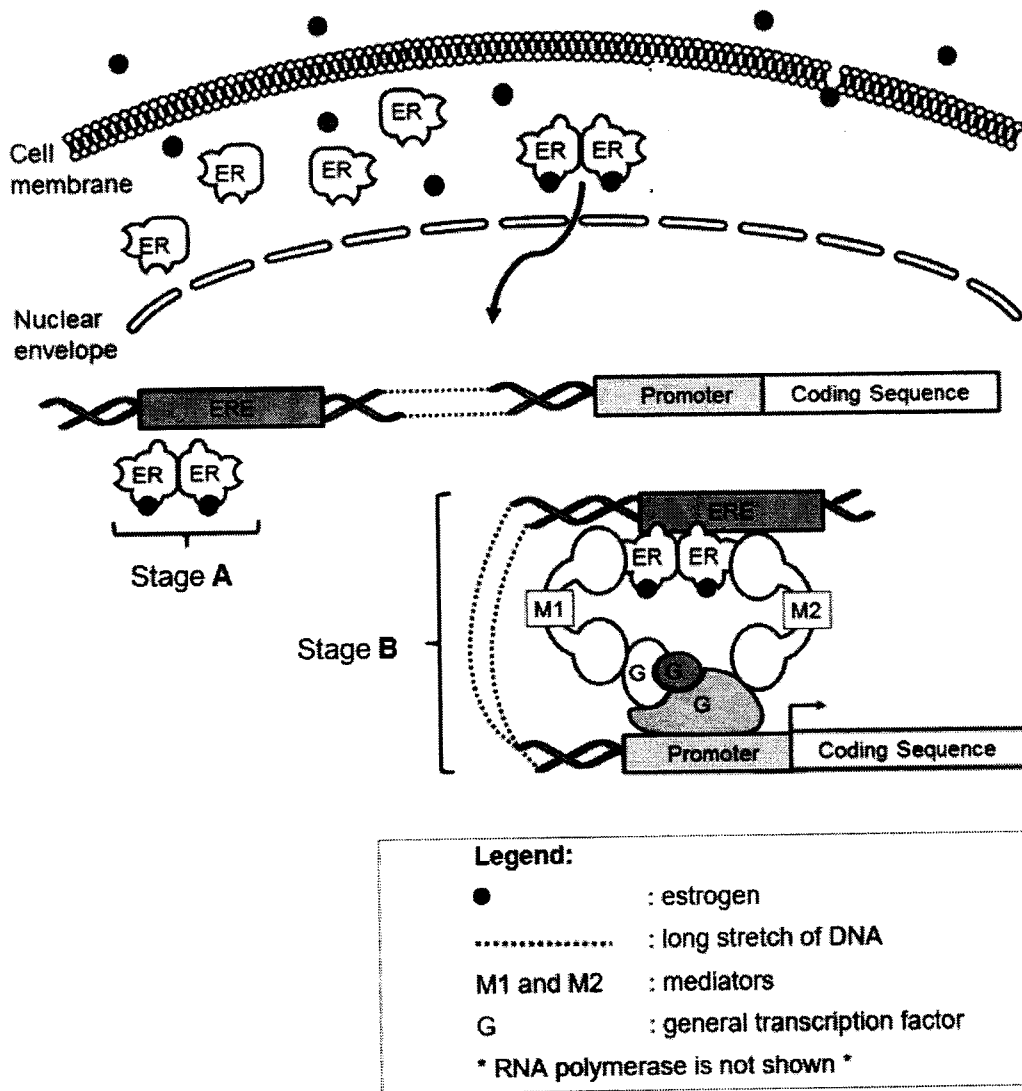


Fig. 1.1

(a) With reference to Fig. 1.1, describe stages **A** to **B**.

Stage A:

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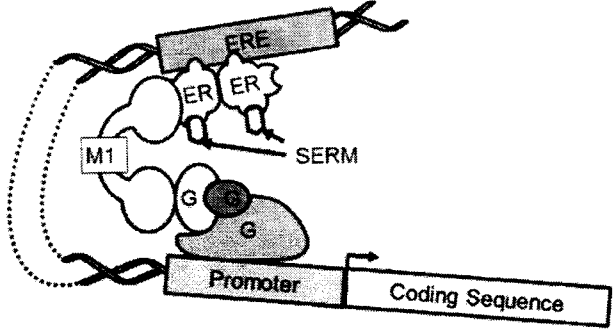

Stage B:

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[4]

Estrogen receptors are over-expressed in around 70% of breast cancer cases. Research into the treatment of metastatic breast cancer focused on the use of drugs such as selective estrogen-receptor modulator (SERM) and estrogen receptor downregulator (ERDR) as shown in Table 1.1.

Table 1.1

drug	function of drug	presence of drug-receptor complex in the nucleus	effect of drug on the target gene
SERM ○		✓	
ERDR ★		✗	Basal rate of transcription

(b) With reference to Table 1.1,

(i) explain how SERMs can be used in the treatment of breast cancer.

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[3]

(ii) suggest why ERDRs might be more effective than SERMs.

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[2]

(c) Cancer is described as a multi-step process. Explain how mutations may lead to uncontrolled proliferation in cells lining the milk ducts, leading to breast cancer.

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[4]

Fig. 1.2 shows that in breast cancer cells, there is an overexpression of human epidermal growth factor receptor 2 (HER2) proteins. HER2 functions as a receptor protein on the cell surface membrane to send a signal to the nucleus for the cell to undergo cell division.

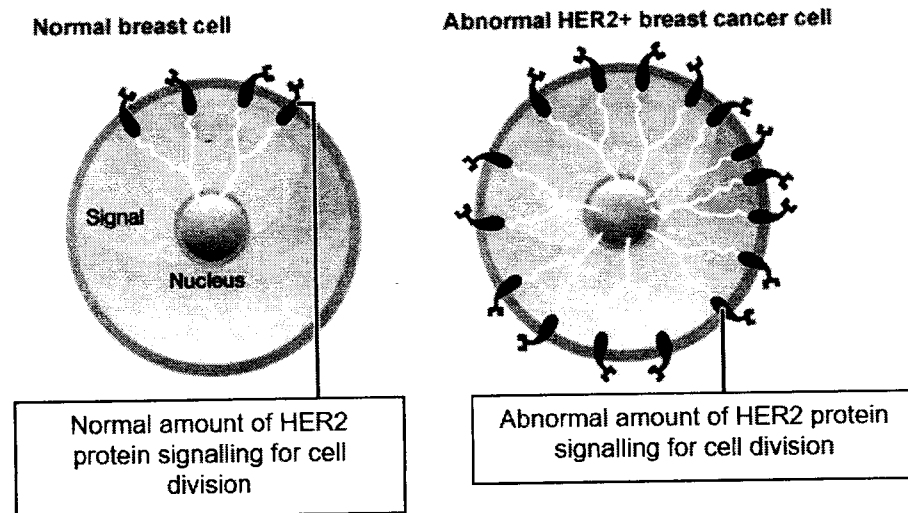


Fig. 1.2

Trastuzumab, an antibody specific to HER2, is an effective treatment for early-stage HER2+ breast cancer. However, advanced-stage HER2+ breast cancer patients tend to develop resistance to the treatment.

HER2+ breast cancer cells also overexpress CD47, a surface protein that helps cancer cells evade macrophage phagocytosis. Research has shown that blockage of CD47 using an antibody specific to CD47 (α -CD47 mAb) is also an effective treatment for HER2+ breast cancer.

An investigation was conducted to determine the effectiveness of treating HER2+ breast cancer cells with both trastuzumab and α -CD47 mAb.

Groups of genetically identical breast cancer cells were subjected to 3 different treatments:

1. incubation with α -CD47 mAb
2. incubation with trastuzumab
3. incubation with both trastuzumab and α -CD47 mAb

The investigation was done twice, with 3 replicates for each treatment.

The percentage of phagocytosis by macrophages was assessed and shown in Fig. 1.3.

Data are presented as mean \pm S.D. (standard deviation).

Statistical differences between the two groups of cells are marked by asterisk ($P \leq 0.0001$).

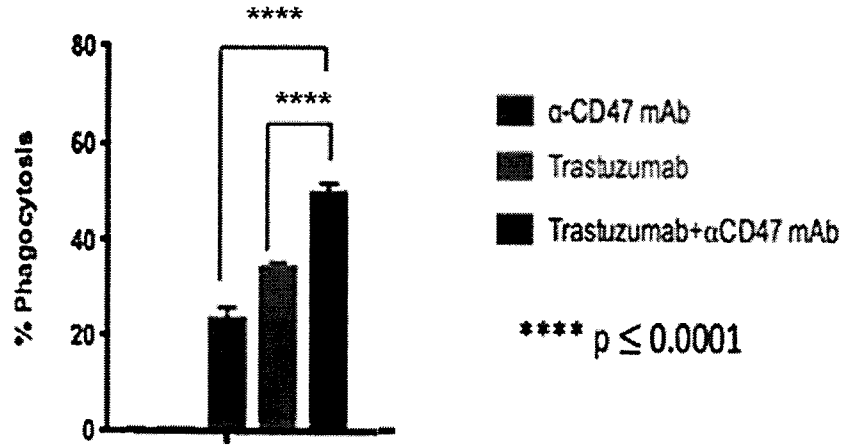


Fig. 1.3

(d) Using Fig. 1.3 and the information provided, comment on the effectiveness of the combined treatment versus a treatment using either trastuzumab, or α -CD47 mAb alone in humans. Discuss on the confidence of the presented data.

[4]

An early diagnosis of many types of cancer can result in successful treatment.

The BRCA2 protein is involved in suppressing the development of tumours.

Several different dominant alleles of the gene, *BRCA2*, code for faulty versions of the BRCA2 protein. The presence of any one of these faulty alleles leads to an increased chance of developing several types of cancer, including breast and lung cancers. Not everyone with one of these alleles develops cancer. This is because environmental factors, including lifestyle, are also involved.

Fig. 1.4 is a pedigree (family tree) showing the occurrence of cancers in four generations of a family. The presence of a faulty *BRCA2* allele was confirmed in person 15. The other individuals with cancer were not tested for the presence of the allele.

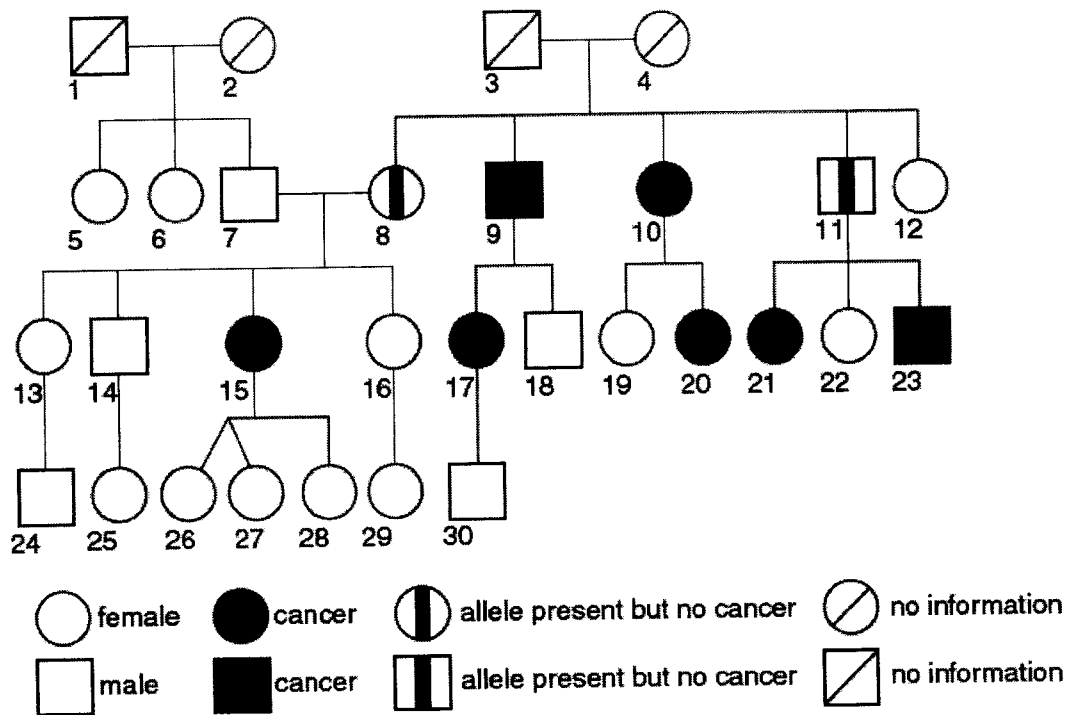


Fig. 1.4

- (e) Discuss the extent to which Fig. 1.4 provides evidence that a faulty *BRCA2* allele increases the risk of a person developing cancer.

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- (f) Traditionally, stem cells from bone marrow have been used to treat patients with leukaemia, a cancer of the blood or bone marrow.

Recent studies have shown that stem cells taken from umbilical cord blood may be more effective in treating leukaemia than stem cells taken from bone marrow.

Table 1.2 shows the results from patients with leukaemia after treatment with stem cells from unrelated sources over a two-year period.

Table 1.2

source of stem cells	probability / %	
	leukaemia-free survival	death from immune rejection of transplant
cord blood	34	12
bone marrow	33	31

Using information from Table 1.2 and your knowledge on stem cells, suggest why stem cells from the cord blood may be more preferred in the treatment of leukaemia.

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(g) Embryonic stem cells have been known to express a specific set of genes that enable them to behave like stem cells, but these genes are turned off in normal somatic cells. Researchers have discovered that they can convert human fibroblast cells into embryonic stem cells by switching on the specific set of genes. These cells have been cultured in labs all over the world, and they are termed induced pluripotent stem cells (iPSCs).

(i) Describe the characteristics of an induced pluripotent stem cell (iPSC).

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(ii) Suggest an ethical concern regarding the use of embryonic stem cells which is no longer relevant with the development of iPSCs.

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[1]

The histone tails of different regions of chromatin are covalently modified during the formation of the human fibroblast cell. These modifications are added and removed by enzymes. The main effect of modifying histone tails is to attract specific proteins to a stretch of chromatin.

Fig. 1.5 shows the action of one of these enzymes, histone methyl transferase.

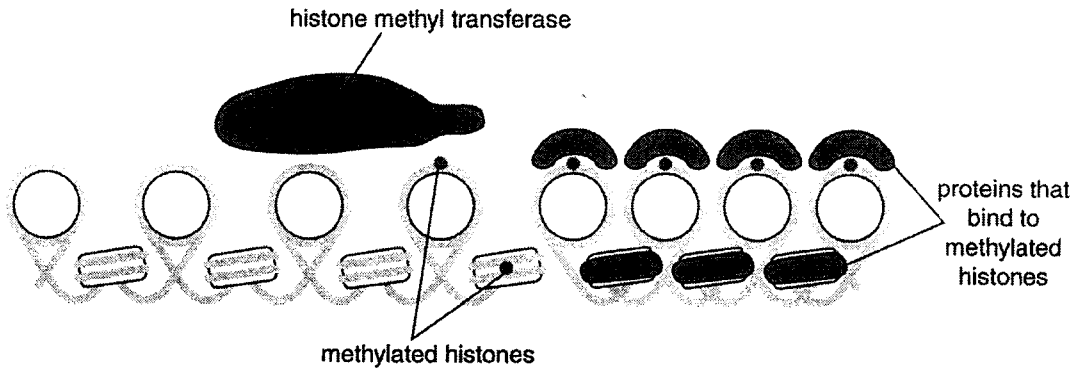


Fig. 1.5

(iii) Suggest why histone methylation occurs over large areas of chromatin during the formation of the human fibroblast cell.

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[Total: 30]

2 Today, viruses are considered an exception to the cell theory which states that the simplest units of life are cells. Viruses have also been referred to as "organisms at the edge of life".

(a) State **one** characteristic of viruses that may classify them as being

(i) living,

[1]

(ii) non-living.

[1]

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by a novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

Fig. 2.1 shows the mechanism used by SARS-CoV-2 to infect the cells in the airways of human hosts.

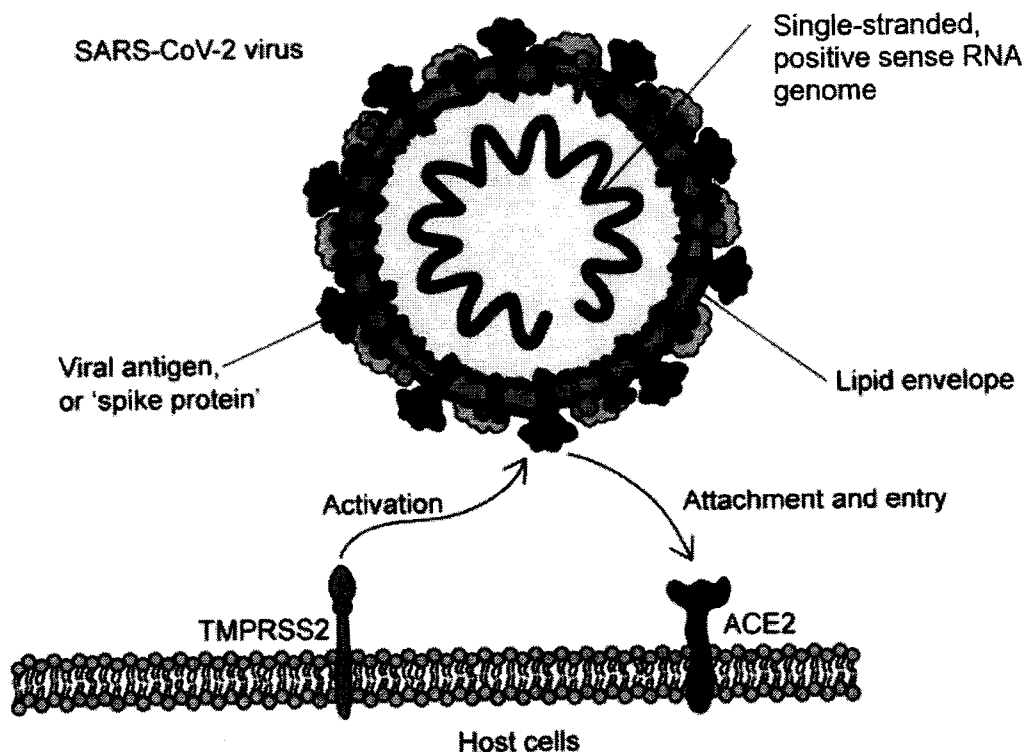


Fig. 2.1

- (b) With reference to Fig. 2.1, suggests how SARS-CoV-2 infects human cells.

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A drug currently being trialled for the treatment of COVID-19 is Nafamostat, a drug that is currently licensed for the treatment of other conditions.

During one trial, scientists investigated the effect of Nafamostat on the activity of TMPRSS2, and the results are shown in Fig. 2.2 below.

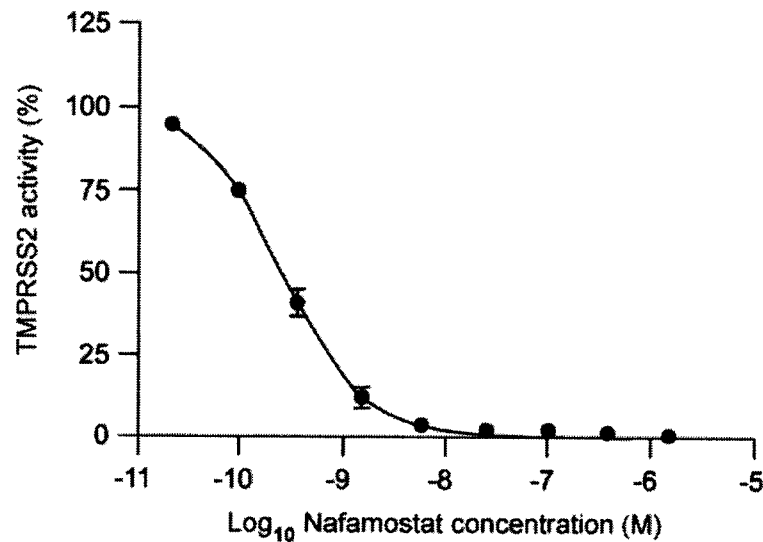


Fig. 2.2

- (c) With reference to Fig. 2.1 and and Fig. 2.2, suggest how Nafamostat might function as a treatment for COVID-19.

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Fig. 2.3 shows the reproductive cycle of the coronavirus SARS-CoV-2.

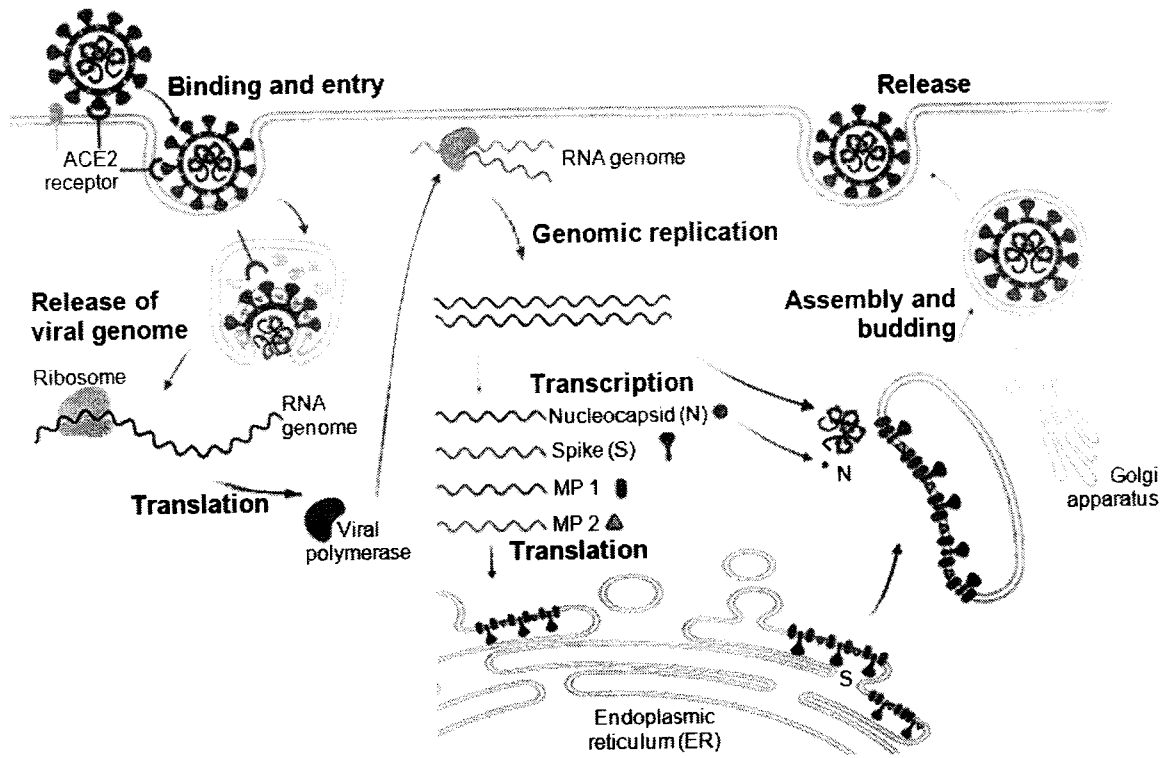


Fig. 2.3

(d) Compare between the reproductive cycles of SARS-CoV-2 and the influenza virus.

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[Total: 10]

- 3 Table 3.1 shows dengue incidences and precipitation pattern in a tropical country from 2013 to 2017.

Table 3.1

Year	Average annual rainfall/mm	Number of cases of Dengue Fever	Average Maximum Temperature/°C	Average Minimum Temperature /°C
2013	665	20270	32.3	23.2
2014	585	19902	33.9	23.2
2015	578	18910	33.8	24.2
2016	695	4260	34.8	24.5
2017	564	2145	36.2	25.0

- (a) With reference to Table. 3.1, comment on the relationship between dengue fever prevalence and climate factors.

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To reduce the transmission of dengue fever through decreasing vector numbers, scientists used high doses of radiation on male *A. aegypti* before releasing large numbers into the wild.

- (b) Suggest how releasing the treated male mosquitoes may reduce transmission of dengue fever.

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[2]

Recently a new method was developed to control *A. aegypti*. Scientists produced transgenic males carrying a 'lethal gene' which kills their offspring before they can reproduce.

The scientists released transgenic males every week in one area of a city in Brazil. At regular intervals they determined the number of *A. aegypti* per km² in the area where transgenic males were released and in a control area where no transgenic males were released.

Fig. 3.1 shows their results.

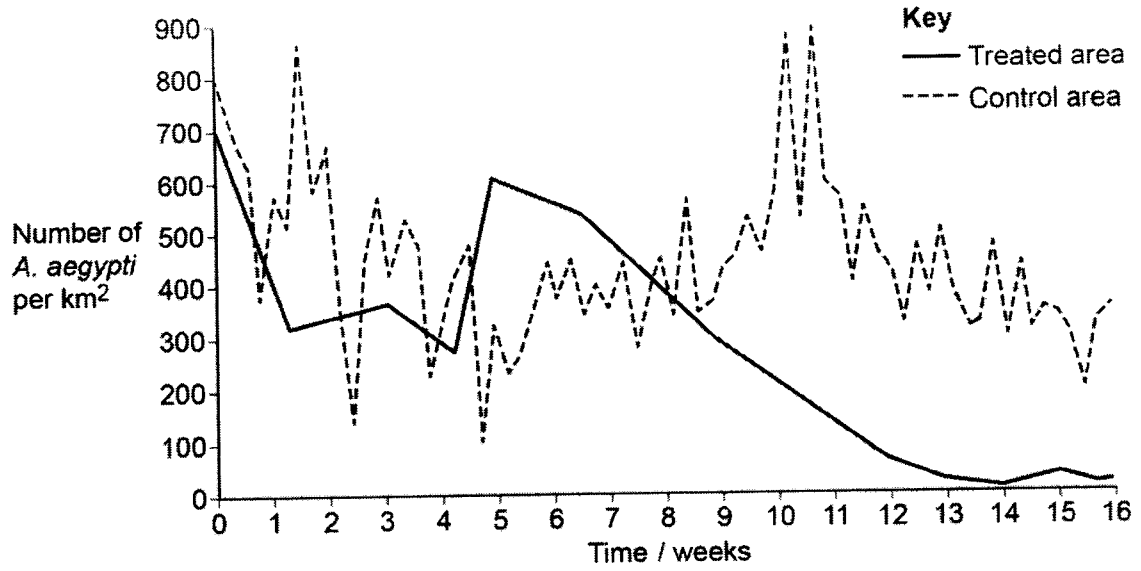


Fig. 3.1

- (c) (i) With reference to Fig. 3.1, conclude whether the release of transgenic males successfully reduced the vector population.

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- (ii) Suggest why the scientists released more transgenic males every week.

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[1]

[Total: 10]

Section B

Answer **ONE** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.
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 parts **(a)**, **(b)**, etc., as indicated in the question.

- 4 (a) DNA can be replicated *in vivo* (in cells) or *in vitro* (outside cells) by processes like the polymerase chain reaction (PCR).

Compare the process of DNA replication in cells with PCR. [10]

- (b) Both DNA replication in cells and PCR may harbour mutations resulting in changes to DNA base sequences.

Discuss the impact of mutations to organisms. [15]

[Total: 25]

- 5 (a) Both eukaryotic cells and bacterial cells are able to divide to give daughter cells. Eukaryotic cells can divide by mitosis to produce cells for growth and repair or meiosis to produce gametes. Bacterial cells, however, can only divide by binary fission to result in clones.

Compare the process of mitosis in eukaryotic cells and binary fission in bacterial cells. [10]

- (b) Discuss how genetically varied cells can arise despite binary fission being the only mode of cell division for bacterial cells. [15]

[Total: 25]

Question _____

@YJC

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[Turn Over

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Handwriting practice area consisting of 22 horizontal dashed lines.

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