Suggested Answers

NAME: _____ CLASS: _____ INDEX: _____

CATHOLIC JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION
Higher 2

BIOLOGY
STRUCTURED QUESTIONS

9744/02
21 August 2023
2 hours

READ THESE INSTRUCTIONS FIRST

Write your **name (as per NRIC)**, **class**, and **index number** on all the work you hand in.

Write in dark blue or black pen on both sides of the paper.

[PILOT FRIXION ERASABLE PENS ARE NOT ALLOWED]

You may use a soft pencil for any diagrams, graphs or rough working.

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

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

There are **11 questions with multiple subparts** in this paper.

Answer **all** questions in the spaces provided on the Question Paper.

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

Answer **all** questions

1 **(a)** *Thermotoga maritima* is a hyperthermophilic species of bacterium that lives in hot springs and thermal vents associated with volcanic activities. The bacteria can survive in waters at 80°C.

Two amino acids found in the primary structure of an enzyme in the bacterium are shown below:

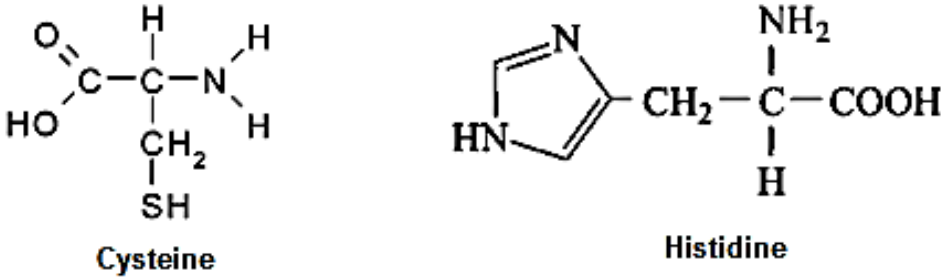
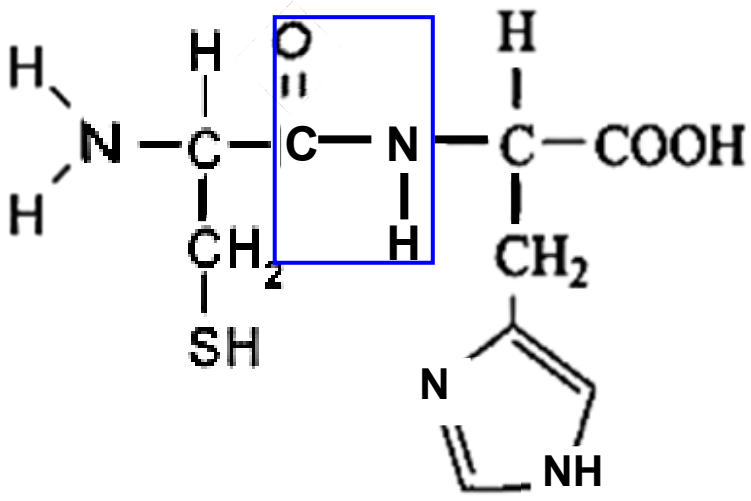


Fig. 1.1

(i) Part of the sequence of amino acids in the enzyme consist of Cys-His.

Draw a labelled diagram of the dipeptide that would result during this condensation. [2]

peptide linkage



[2]

1. Correct illustration of condensation (i.e. condensation of C_{α}–COOH of cysteine and –NH_2 of histidine rather than the R groups) with **peptide bond** clearly labelled
2. Proper orientation of the dipeptide such that the N- and C-terminus is discernible, N-Cysteine, C-Histidine.

(ii) "Cysteine is found to be more common than most other amino acids in the *Thermotoga maritima* enzyme compared to those found in other species".

Suggest why this may be so.

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…… [2]

1. Cysteine is the only amino acid that has **an –SH R group** (explains more common than most other amino acids); capable of **forming disufide bridges between their R-groups which are strong covalent bonds.**
2. Covalent bonds contribute to **high thermal stability**, and are unaffected by pH, thereby allowing the **maintenance of globular, 3Dstructure of the enzyme** at much higher temperature. ***OWTTE**

(b) Fig. 1.2 shows an example of one of the enzymes in *Thermotoga maritima*.

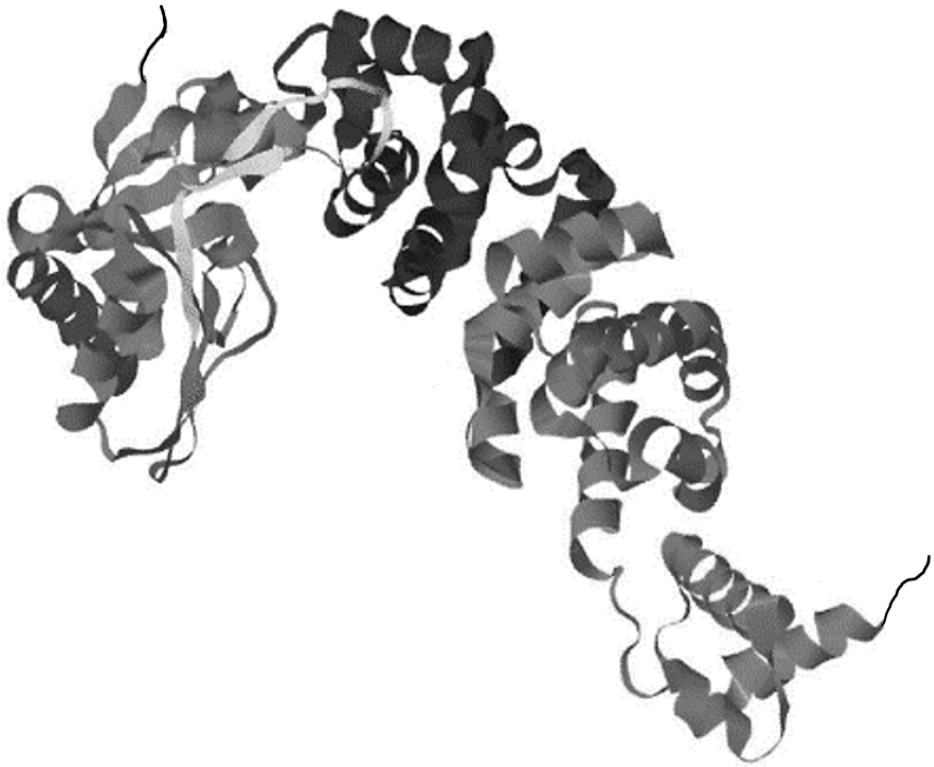

Fig. 1.2

With reference to the enzyme shown in Fig. 1.2,

(i) state the highest level of protein structure.

…….…….... [1]
tertiary structure

(ii) identify the predominant secondary structure.

…….…….... [1]
α-helix / α-helices

(iii) describe how the structure of this enzyme is maintained by various bonds.

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……..……..…… [3]

1. The single polypeptide chain contains a precise number, type and sequence of amino acids held together by **peptide bonds** within each chain (primary structure);
2. The polypeptide chain coils and folds into the regular repeating secondary structures (**α-helices)** held together by **hydrogen bonds between C=O and –NH groups (of peptide linkages) of the amino acids** in the main chain;
3. The polypeptide chain further bends, coils and folds, to form a 3D shape / specific tertiary structure, maintained by intramolecular **ionic bonds, hydrogen bonds, disulfide bonds and hydrophobic interactions** between **R groups** of amino acids;

(c) Fig. 1.3 shows the effect of ATP on enzymatic activity of the enzyme found in *Thermotoga maritima*.

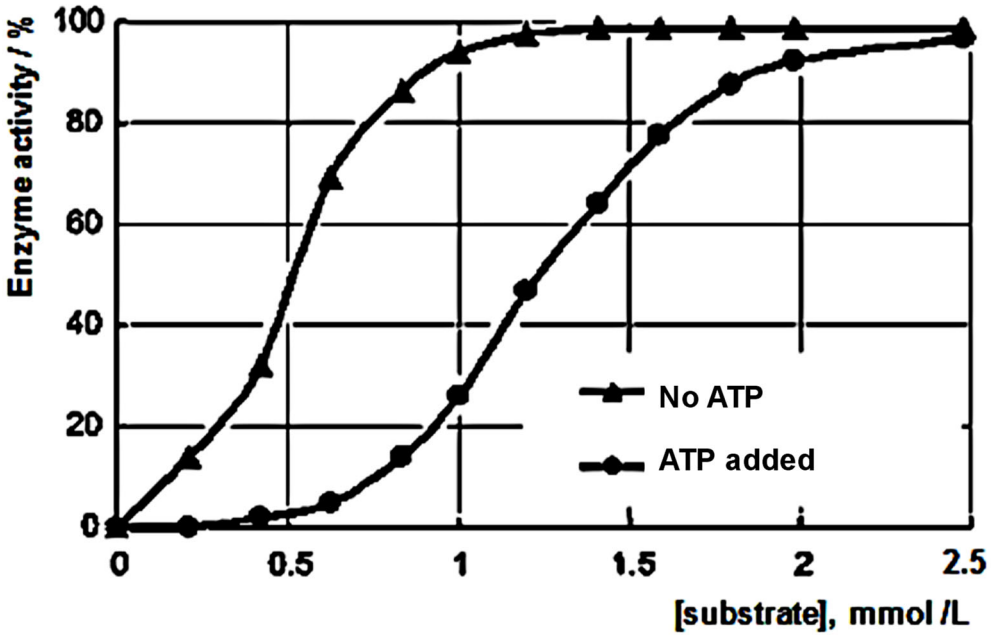

Fig. 1.3

(i) With reference to Fig. 1.3, state the type of inhibition ATP exerts on the enzyme from *Thermotoga maritime*. Explain how you derived at your answer.

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……..... [2]

1. Allosteric **competitive inhibition**
2. This is a competitive inhibition because **when the substrate concentration is increased / at higher substrate concentration**, **enzyme activity approaches Vmax / V max is reached.**
3. **Km value is increased,** requires more substrate to reach half Vmax**,** showing reduced affinity of enzyme for substrate;

(ii) With reference to Fig. 1.3, describe the effects of ATP on enzymatic activity of *Thermotoga maritima*.

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…….. [3]

1. Without ATP, as substrate concentration increases from 0 to 1.5 mmol / L, enzyme activity increases from 0% to 100%. Beyond 1.5 mmol / L, increase in substrate concentration does not result in enzyme relative activity / plateau off.
2. With ATP, enzyme activity is lowered / increased more slowly at low substrate concentrations. As substrate concentration increases from 0 to 1 mmol / L, enzyme activity only increased from 0% to 25%; as substrate concentration increases from 1 to 1.5 mmol / L, enzyme activity increased from 25% up to 75% only
3. With ATP, enzyme activity eventually approach 100% at high substrate concentration, when substrate level increases from 2 to 2.5 mmol / L.

[Total: 14]

2 Glucose transporter type 4 (GLUT4) is an example of a carrier protein that transports glucose across the plasma membrane of muscle cells.

Fig. 2.1 below illustrates the steps involved in the transport of glucose by GLUT4 across the plasma membrane of a muscle cell.

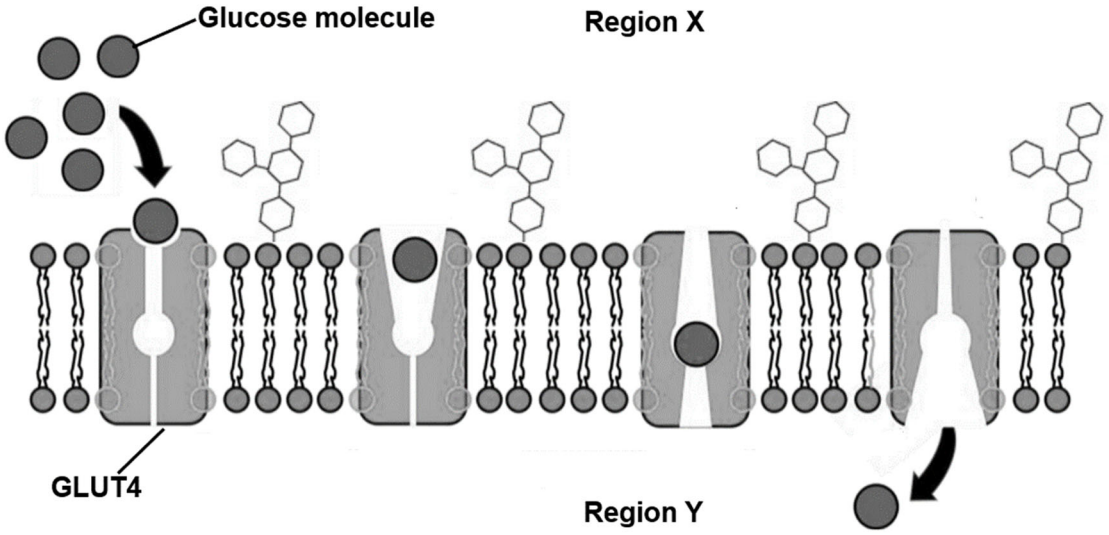

Fig. 2.1

With reference to Fig. 2.1,

(a) name the type of transport that is used to transport glucose across the plasma membrane.

…… [1]

1. Facilitated diffusion.

(b) provide two reasons for your answer in part **(a)**.

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…… [2]

Any 2 of the following:
1. Glucose molecules are transported along the concentration gradient / from the region of higher concentration to region of lower concentration.
2. The transport of glucose across the plasma membrane requires the help of a carrier protein / GLUT4 [REJECT: channel protein].
3. No ATP expenditure.

(c) explain how glucose is transported across the plasma membrane by GLUT4.

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…… [2]

1. Glucose **binds** to the **binding site of GLUT4**, **explanation:** glucose has a shape / structure that is complementary to the binding site of GLUT4.
2. Glucose is taken into GLUT4 and is released to the other side across the plasma membrane, **explanation: GLUT4** undergoes **conformation change**.

(d) **Region X** is the extracellular fluid and **Region Y** is the cytoplasm of a muscle cell. Do you agree? Justify your answer.

……

…… [1]

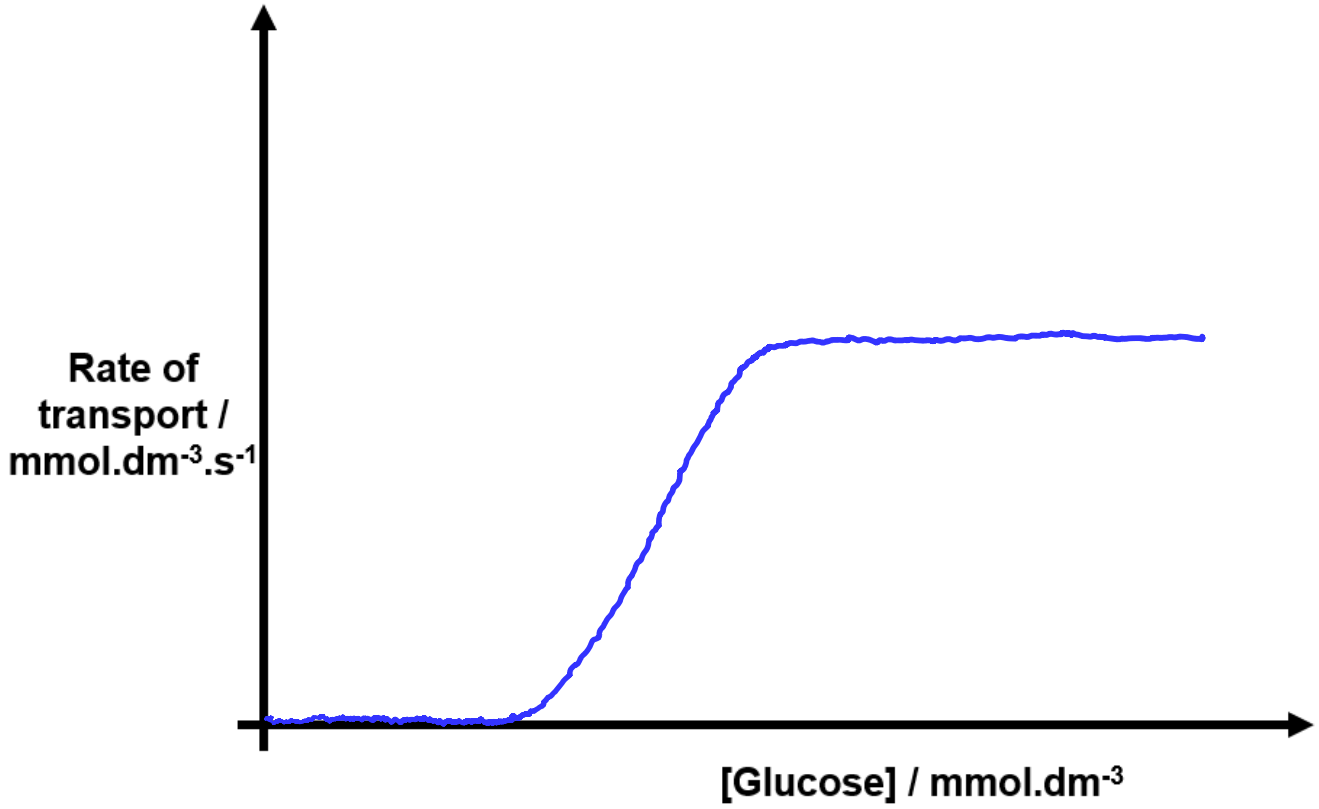
Agree **AND**

Any 1 of the following:

1. **Carbohydrate chain attached to the phospholipid** (**glycolipid**) is found on the layer facing the **Region X**.
2. Muscle cells do not transport glucose out of the cell, they usually take in the glucose.

An experiment was conducted to investigate the effect of glucose concentration on the rate of movement of glucose across the plasma membrane of muscle cells.

(e) Based on the information in Fig.2.1, sketch a graph of the result of the experiment. [1]



Explain your answer:

……

……... [1]

1. The rate of transport of a glucose across the plasma membrane is **directly related** to the concentration of the glucose but is **limited by the number of transport proteins in the membrane**.

[Total: 8]

3 **(a)** State how **one** structural feature of DNA contributes to its stability as a hereditary material.

……

…… [1]

Any one of the following
1. hydrogen bonds between base pairs to stabilise the structure of the double helix by preventing DNA separation ;
2. DNA molecule exists as a double helix / double stranded structure - protection of nitrogenous bases from degradation / resistant to spontaneous mutations ;
3. Each DNA strand serving as a template to repair any DNA damage, to maintain structure integrity
4. Association of DNA with histone proteins, packing, folding, compacting of DNA into chromosomes to prevent DNA damage ;
5. Ref to strong phosphodiester linkages in sugar-phosphate backbone – to prevent breaking up of the nucleotide sequences on the DNA strand

The "trombone" model of DNA replication postulates that two DNA polymerase enzymes work together in a protein complex during DNA replication.

Fig. 3.1 shows a DNA molecule undergoing DNA replication.

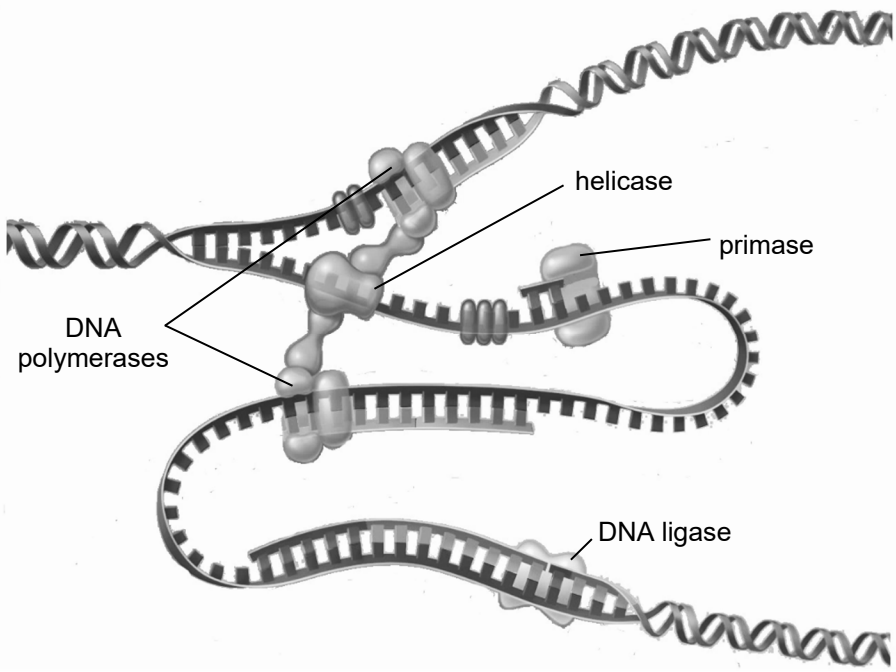


Fig. 3.1

(b) With reference to Fig. 3.1,

(i) compare how the synthesis of the lagging strand differs from that of the leading strand.

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…… [2]

Any <u>two</u> of the following:

1. Leading strand synthesis is continuous, while lagging strand synthesis is discontinuous
2. Leading strand synthesis towards replication fork / away from origin of replication, Lagging strand synthesis away from replication fork / towards origin of replication
3. Leading strand synthesis does not require DNA ligase, while lagging strand synthesis requires DNA ligase to join up the different Okazaki fragments
4. Accept: reference to multiple primers for lagging strand synthesis, one primer for leading strand. *[Reject: ref to many primase - only one visible]*

(ii) suggest why it is necessary for two DNA polymerase enzymes to work together in a protein complex during DNA replication.

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…… [2]

1. DNA polymerase only able to synthesize from 5' → 3' direction; antiparallel nature of DNA template strands,
2. 2 DNA polymerases grouped into a complex to synthesize in the same direction (i.e. elongation occurs in the same direction, from right to left), with looping of one of the template strand, to increase efficiency / prevent degradation of single stranded DNA.
3. *[Reject: simultaneous synthesis of leading and lagging strands]*

(c) Explain how the end replication problem arises.

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…… [2]

1. Unable to fill gap after the **last RNA primer is removed** at the end of lagging strand / at 5' end of each daughter strand as there is no upstream free 3' OH available & DNA polymerase only add nucleotides to existing 3' OH end and elongation extends in a 5' → 3' direction
2. resulting in **shortening of / shorter daughter strand** compared to the parental template strand; 3' end of parental template not completely replicated.

[Total: 7]

4 Nucleolus is a large and dense region inside the nucleus. It consists of a fibrous part and a granular part. The large and small ribosomal subunits can be found within the granular part.

(a) Based on the information above as well as your knowledge on transcription and translation, outline how ribosomes are formed.

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……. [4]

1. Gene coding for rRNA transcribed in nucleolus to form rRNA while genes coding for ribosomal proteins transcribed in nucleoplasm to form mRNA respectively;
2. Ribosomal protein mRNA exits the nucleus via nuclear pores to the cytosol for translation at free ribosomes, forming ribosomal proteins;
3. **Ribosomal protein mRNA exits** the nucleus via nuclear pores to the cytosol for translation at free ribosomes, forming ribosomal proteins;
4. Ribosomal subunits leave the nucleus and **will assemble to form a functional ribosome** where mRNA for a protein is translated

Gene expression in eukaryotic cells is regulated at multiple levels.

Transferrin receptors (TfRs) are cell surface receptors and are involved in the uptake of extracellular iron.

The regulation of expression of transferrin receptors (TfRs) is illustrated in Fig. 4.1.
It involves the interaction between Iron Response Element-Binding Protein (IRE-BP) and Iron Response Element (IRE) which is a loop structure found on the mRNA.

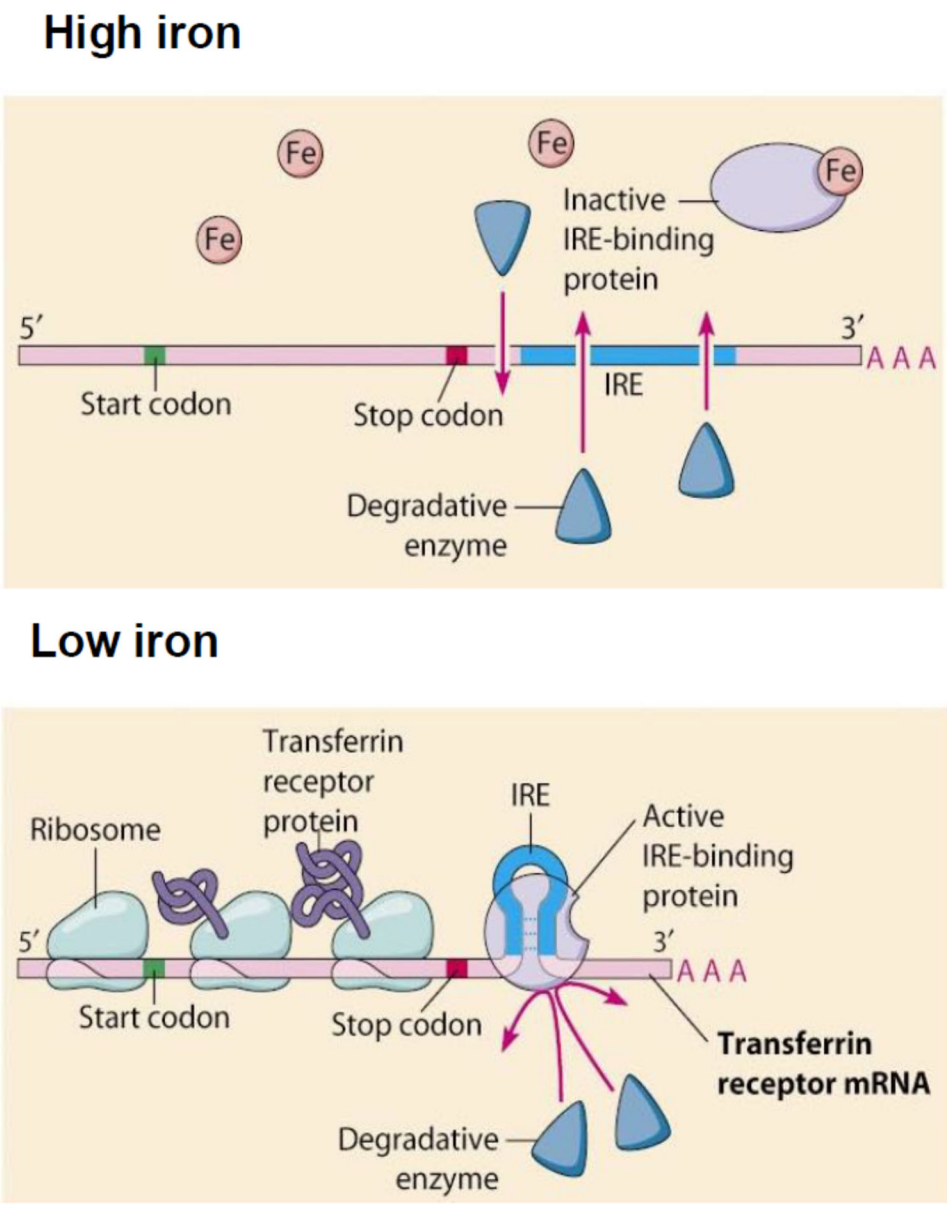

Fig 4.1

With reference to Fig 4.1.,

(b) **(i)** state the level of regulation shown.

…….. [1]

Translation.

(ii) explain how low cytosolic iron concentration results in an increased uptake of extracellular iron.

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..... [4]

When there is a decrease / low cytosolic iron concentration; **IRE-BP is active**

1. Recognise and **bind to IRE**; At 3' untranslated region;
2. Increases transferrin receptor mRNA stability / half-life / **preventing degradative enzyme from digesting the mRNA;**
3. mRNA is **translated** more frequently and more transferrin receptor polypeptides synthesised
4. TfR proteins are brought to cell surface membrane; via **secretory vesicles**;

Another example of a protein, Ferritin proteins; are involved in the storage of iron taken into the cell by TfRs.

The regulation of ferritin expression is illustrated in Fig. 4.2.

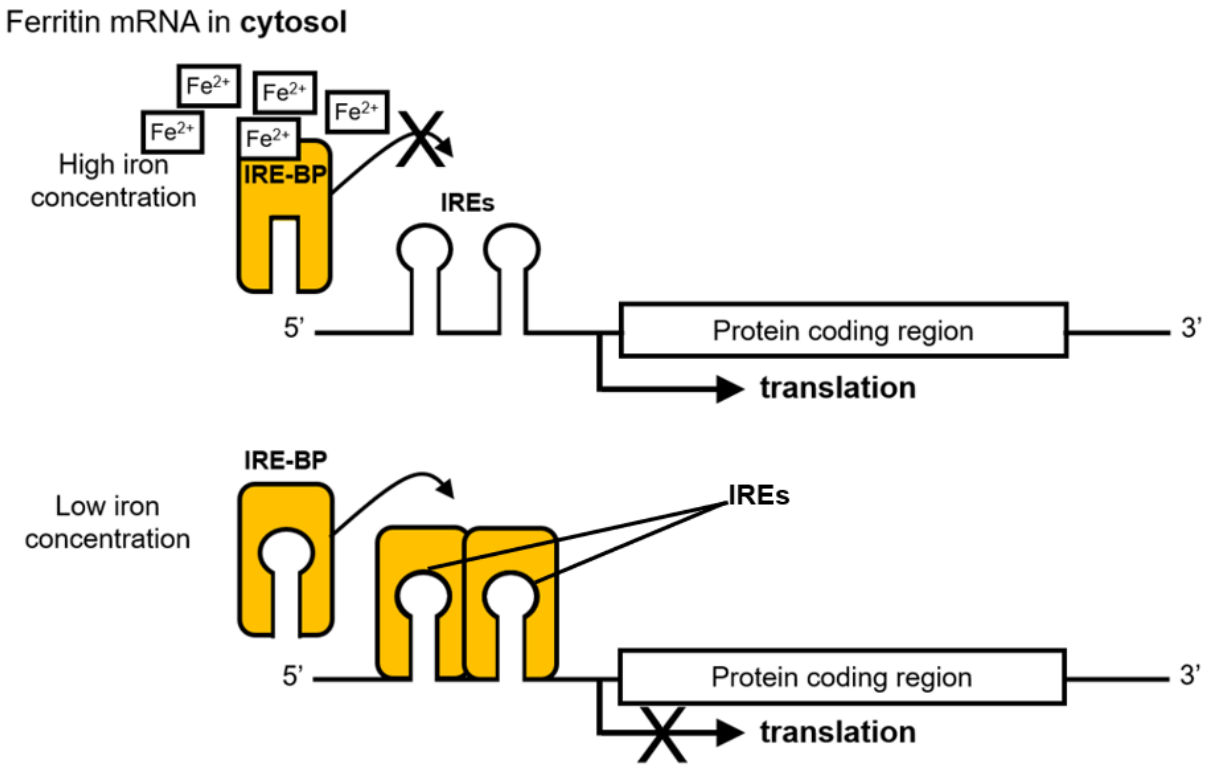

Fig 4.2

(c) Outline two differences in the regulation of ferritin and TfR expression.

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…… [2]

[Total: 11]

Comparison Feature	Regulation of expression of	
	Ferritin	**Transferrin receptor (TfR)**
1. effect of cytosolic iron conc. on expression	High [iron] results in increased expression of ferritin / translation of ferritin mRNA	High [iron] results in decreased expression of TfR / translation of TfR mRNA;; A: reverse argument
~~2.~~ Effect of IRE-BP binding to IRE	Results in translational repression	Results in higher rate of translation;; A: reverse argument
3. Location where IRE-BP binds	In 5' UTR/ **Upstream** of coding sequence.	In 3' UTR; **Down stream** of coding sequence.
4. Degrative enzymes endonucleases	Absence of endonucleases.	Presence of degrative enzymes to cut the IRE at the 3' end

5 **(a)** Fig. 5.1 below shows a 18kb piece of DNA with positions of the restriction sites for restriction enzyme ***HaeIII***.

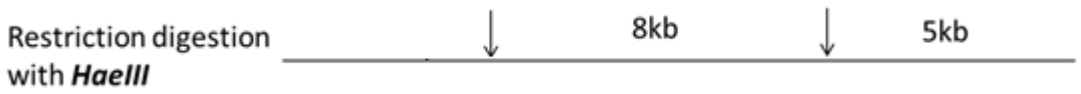
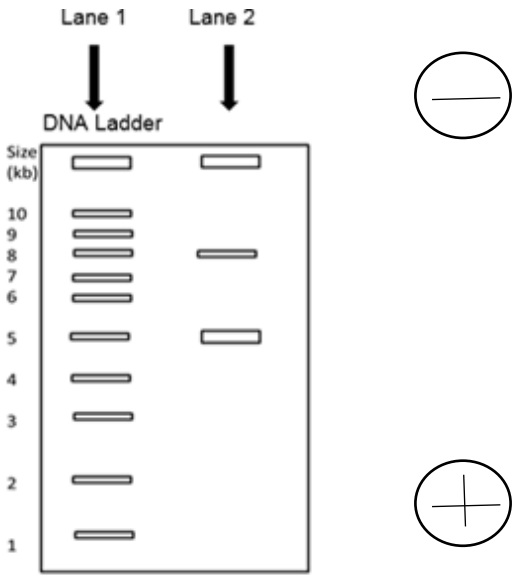


Fig 5.1

A restriction digestion using ***HaeIII*** enzyme was performed, followed by gel electrophoresis.

A DNA ladder, which is a set of DNA fragments of known lengths, is used to estimate the size of unknown DNA molecules, in lane 1.

On the diagram below,



Correct position;;
Correct thickness (roughly 2x; award only if position is correct);;

(i) label the electrode / terminus with "**+**" or "**–** " in the circles provided. [1]

(ii) show the band pattern of the sample after the restriction digestion and gel electrophoresis in **lane 2**. [2]

(b) Explain how the separated DNA bands in the agarose gel can be visualised.

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..... [2]

1 Gel is stained with ethidium bromide ;

2 DNA appear as orange red bands under UV light.

(c) Sometimes, DNA bands do not appear as distinct bands but as a smear instead.

Fig. 5.2. shows an example of the smear.

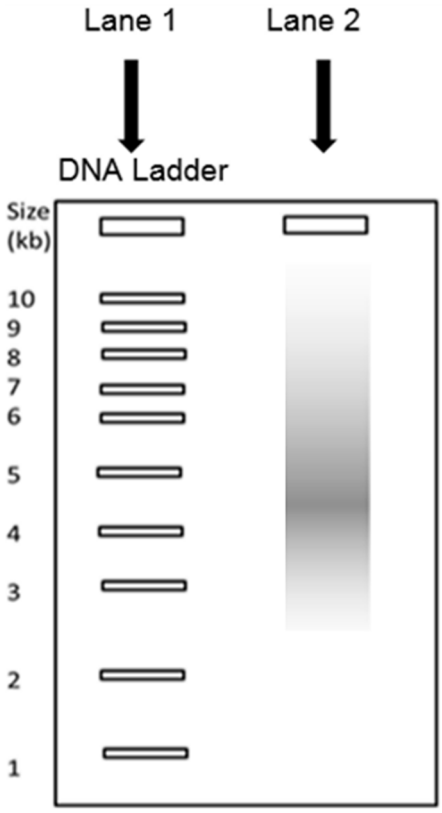

Fig 5.2

Suggest how the smear in Fig. 5.2 is formed.

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…… [2]

1. Fragments of varied sizes are produced;
2. due to excision of DNA sequence by restriction enzyme at various different restriction sites;
3. Inaccurate prior PCR process and other valid points.

(d) Polymerase Chain Reaction (PCR) is a molecular technique commonly performed before agarose gel electrophoresis.

Discuss the advantage and limitation of PCR.

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…… [2]

Advantages **(max 1)**

1 **Speed -** Produces large numbers of copies in a **relatively short span of time;/** fast amplication
2 **Cell-free method** of DNA replication-requires no cleanup of unwanted cellular debris or vector DNA;
3 **Ease of use** – in setting up PCR reaction and thermocycler/ fully automated
4 **Robustness** – A broad range of nucleic acid sources can be used
5 **Specificity -** A specific process that targets only the desired DNA to be copied, (hence starting material does not have to be purified DNA)
6 **Sensitivity -** Only requires a trace amount of DNA;

Limitations **(Max 1)**

7 **Prior sequence information** is usually necessary to **construct the primers**
8 **High error rate** due to lack of a built-in proofreading activity in ***Taq* DNA polymerase**, PCR produces a higher than normal frequency of replication errors
9 **Limited size range of DNA sequences (0.1 – 5 kb) cloned by PCR**
10 **Non-specific/partial binding of primers leads to non-specific amplification of sequence**

[Total: 9]

6 Pineapples have three types of leaves: spiny, spiny-tipped and non-spiny.

There are two gene loci involved in the formation of leaves in pineapple, the loci for **A**/**a** and **B**/**b** respectively.

The presence of allele **B** results in the formation of spiny-tipped leaves, while the presence of allele **b** results in the formation of spiny leaves.

The presence of allele **A** will prevent the formation of spiny-tipped leaves as well as spiny leaves.

In a particular study, homozygous plants were crossed to produce the F1 generation, which were then allowed to interbreed with the following results:

(a) Complete the table below. [2]

Cross	Phenotypes		
	Parents	**F_1 Ratio**	**F_2 Ratio**
1	**Non-spiny X spiny**	**All non-spiny**	**12 non-spiny: 3 spiny-tipped: 1 spiny**
2	**Spiny X Spiny**	**All Spiny**	**All Spiny**
3	**Spiny tipped X Spiny**	**All Spiny tipped**	**3 spiny-tipped: 1 spiny**

(b) Draw a genetic diagram to explain cross 1. [5]

[L2] (Source: Novel)

1m awarded for correct gametes and circle of gametes.

Parental phenotype: spiny non-spiny
Parental genotype: aabb X AABB

gametes: ab AB

1

F_1 genotype: AaBb
F_1 phenotype: All non-spiny
F_1 generation (selfing): AaBb X AaBb

gametes: AB aB Ab ab

1

Punnett square to show random fusion of gametes by the F_1 generation – 2 marks

♂ gametes / ♀ gametes	AB	aB	Ab	ab
AB	AABB NS	AaBB NS	AABb NS	AaBb NS
aB	AaBB NS	aaBB ST	AaBb NS	aaBb ST
Ab	AABb NS	AaBb NS	AAbb NS	Aabb NS
ab	AaBb NS	aaBb ST	Aabb NS	aabb Spiny

Fig. 6.1 below shows the inheritance of colour blindness.

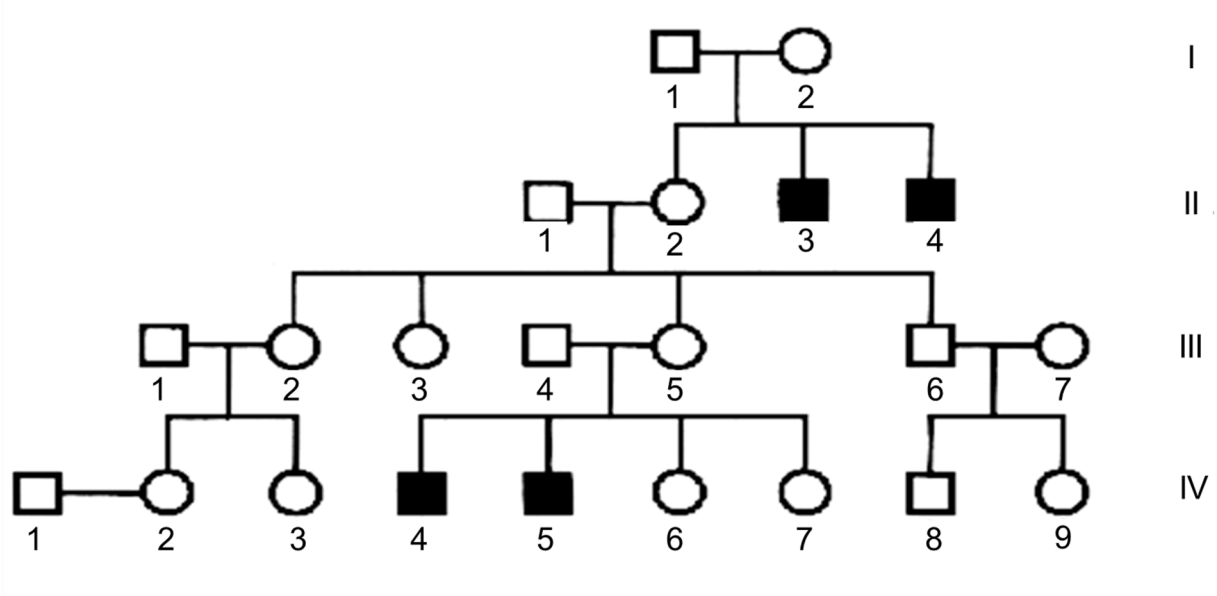

Fig 6.1

With reference to the Fig.6.1**,**

(c) explain the mode of inheritance of colour blindness.

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…… [2]

1. Sex linked, X-linked recessive;
2. Skipping of generations (GEN III);
3. Normal parents giving rise to all diseased male offsprings only.

(d) Calculate the probability that the offspring of individual **Gen IV-1** and individual **Gen IV-2**, is a carrier. Show your working. [2]

Appropriate workings; on the probablity of GEN 4 Mom carrier
On probability of child being girl and inheriting one Diseased allele.

0.5 ^ 4 = 0.0625.

[Total: 11]

7 Arabinose operon (*ara* operon) is an example of operon in *Escherichia coli*.

This operon has three structural genes, *araB*, *araA* and *araD*, which encode for enzymes needed for the catabolism of arabinose, a five-carbon sugar that can be used by *E. coli* as an alternative carbon source. These genes are not normally expressed in *E. coli*. However, when arabinose is present in the environment, the three Ara enzymes are produced.

(a) Based on the information above, state if the *ara* operon is an inducible or repressible system.

…… [1]

1. inducible.

Fig. 7.1 shows the structure of the *ara* operon as well as its regulatory genes.

The promoter site is situated within *araI* and the CAP site (CAP-binding site) is the site where cAMP-CAP binds.

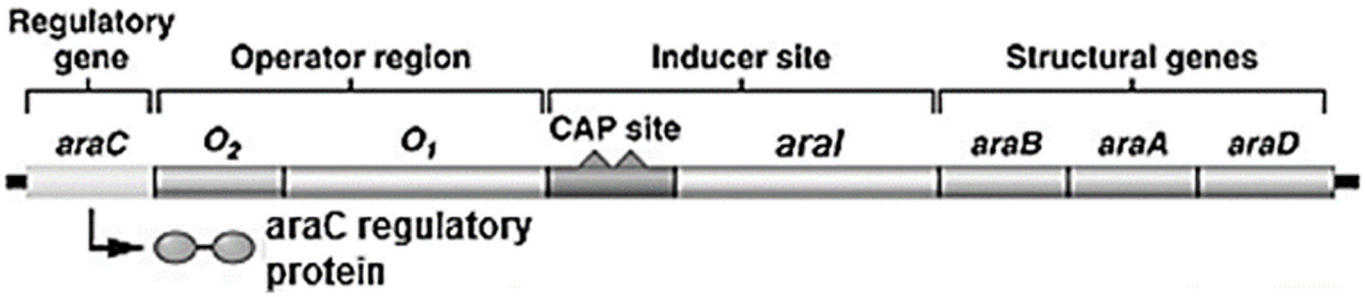

Fig. 7.1

(b) Compare the structure of the *ara* operon and *lac* operon.

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…… [4]

Similarities:
1. Both operons comprise **3 structural genes**.

2. Both operons contain **CAP site near and upstream the promoter**.

Differences:

3. The ***ara* operon** contains **2 operators** whereas the ***lac* operon** contains only **1 operator**.
4. The **operator region** of in the ***ara* operon** is located **upstream the promoter** whereas the **operator region** in the ***lac* operon** is located **downstream the promoter**.

The *ara* operon has both positive and negative regulation, being activated in the presence of arabinose. This is illustrated in Fig. 7.2 below.

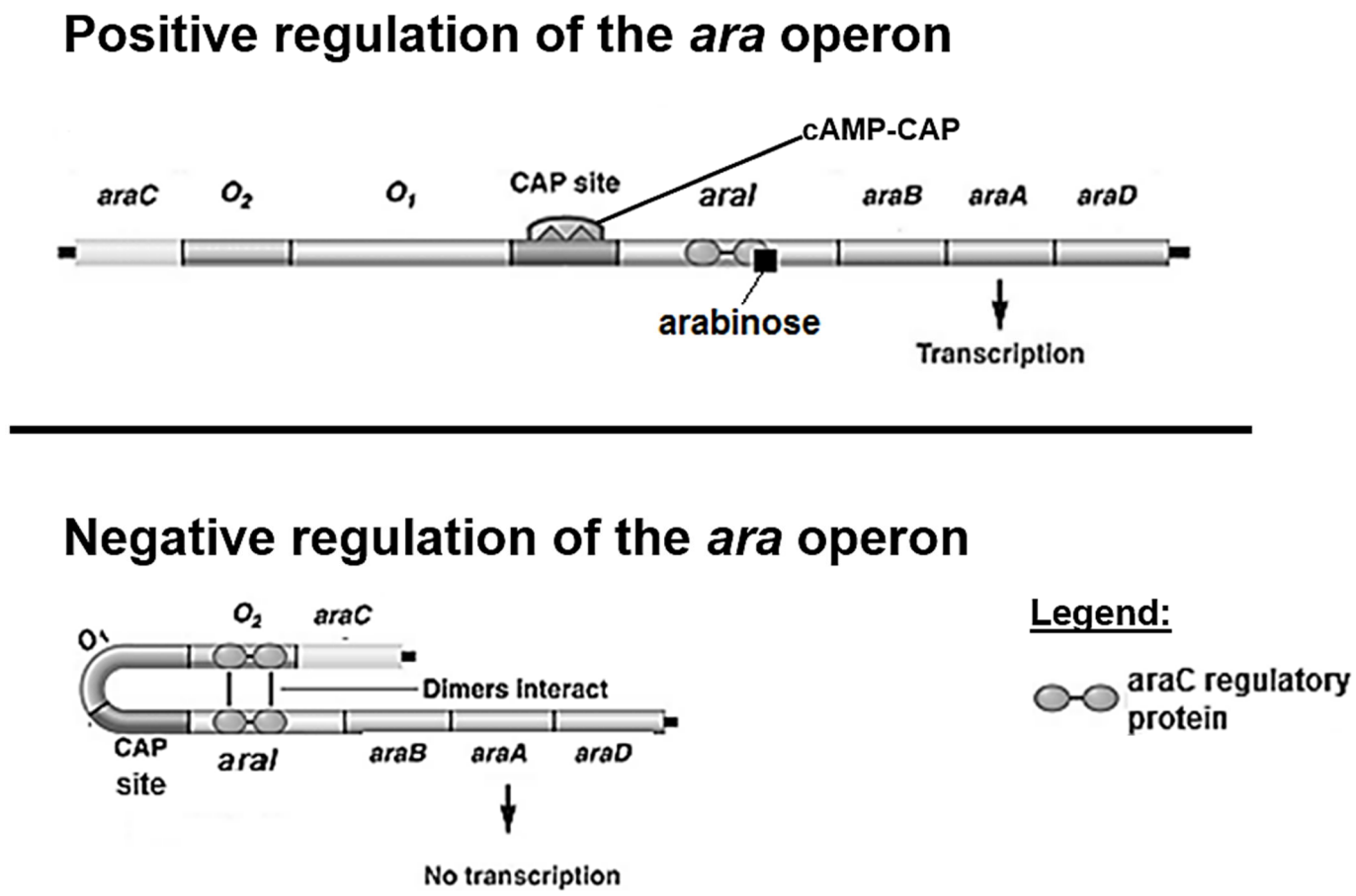

Fig. 7.2

With reference to Fig. 7.2,

(c) Describe and explain the **positive** regulation of the *ara* operon.

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…… [3]

1. **CAP-cAMP** binds to the **CAP site** (Accept CAP-binding site).
2. Together with the binding of **arabinose-bound araC regulatory protein** at the ***araI* site/ inducer site**.
3. This **facilitates efficient positioning of RNA Polymerase at the promoter / prevents araC protein / dimer interaction / looping of DNA** which **allow access of RNA polymerase to structural genes**, (leading to high rate of transcription of structural genes);

(d) Contrast the **negative** regulation of the *ara* operon with that of the *lac* operon.

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…… [2]

***ara* operon**	***lac* operon**
1. In the absence of arabinose, **AraC regulatory protein** (unbound by arabinose) recognized and bind to **both *araI* & O_2 sites**.	In the absence of lactose, (active) **lac repressor** recognizes and binds to **operator**,
2. resulting in a **DNA loop / araC protein/dimer** interaction that **prevents RNA polymerase from binding to promoter / transcribing the structural genes**.	**Block / overlaps with the promoter**; **prevents RNA polymerase from binding to promoter / transcribing the structural genes**.

(e) A deletion occurred at the beginning of the ***araA*** gene.
Predict the effect of this deletion on the gene product of the downstream structural gene, ***araD***.
Explain your answer.

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…… [2]

1. [Predict] **Gene product of *araD*** remains **functiona**l / **no change in tertiary structure**.
2. [Explain] **Gene sequence of *araD* codes for its own start and stop codons** (and is thus, not affected by the deletion of the upstream *araA* gene)

[Total: 12]

8 Fig. 8.1 shows a classic experiment used to show that physical contact between bacterial cell is necessary for conjugation to happen.

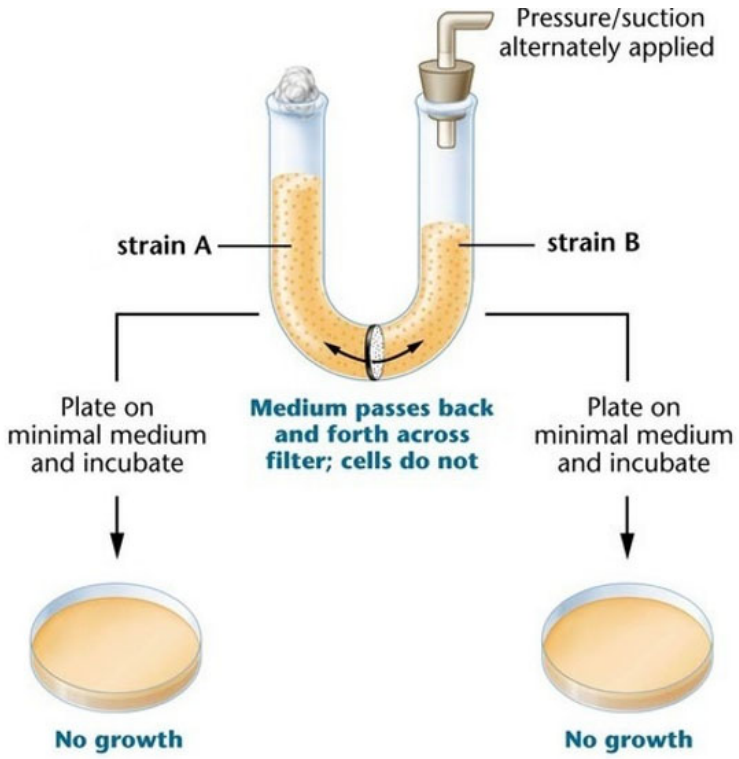

Fig. 8.1

A student tried to replicate the experiment but did not get the result shown in Fig. 8.1.

Instead, he observed a few bacterial colonies which are hybrids of strains A and B. Afterwards, he realised that he forgot to add in DNase when carrying out the experiment.

(a) Briefly describe the role of DNase in this experiment.

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…… [1]

1. Digest naked DNA fragments.

(b) How does the lack of DNase in the experiment result in the growth of the hybrid bacterial colonies?

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…… [2]

1. Without the DNase, the naked **DNA fragments** from **bacteria which have died** may be **taken up** by the other strain via t**ransformation**.
2. **DNA fragment** will be **small enough** to **cross over the filter**.

The student above repeated the experiment, this time with DNase added. However, he continued to observe a few bacterial colonies which are hybrids of strains A and B.

The student confirmed that the filter was undamaged and there was no cross contamination between bacterial strain A and B.

(c) Suggest how bacterial colonies which are hybrids of strains A and B could have been obtained in the repeated experiment. Explain your answer.

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…… [2]

1. **Transduction.**
2. **Bacteriophages** are **smaller than bacteria**; they **can pass through the filter**.

Bacteria reproduce asexually via binary fission to produce genetically identical daughter bacterial cells. Nevertheless, binary fission is considered one of the processes contributing to the extensive genetic variation in bacteria.

(d) Explain how binary fission contributes to the extensive genetic variation in bacteria.

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…… [2]

1. **Mutation**,
2. the **short generation time/ high rate of bacteria reproduction** allows any mutated DNA sequence to be **propagated and accumulated quickly** in a population.

[Total: 7]

9 In a recent scientific expedition to study a vulnerable species of the cat family (*Felidae*), it was found that this species seemed to be heading for extinction. This species once spanned the globe, but its range is now limited to a few pockets in Africa. It was suggested that the species had somehow lost its genetic variation.

(a) Explain what is meant by a "species".

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…… [2]

1. Mentioning of any 1 of the species concept used
2. The elaboration of the concept

(b) Explain the impact that low genetic variability in a population of this species has on its survival.

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…… [2]

1. the individuals within the population are **very similar genetically/small gene pool**, often resulting from a small population size or inbreeding.
2. Reduced ability to adapt to **changing** environments/ makes a population more vulnerable to random catastrophic events
3. A lack of genetic diversity means that unique and beneficial traits may be lost over time.

(c) It was shown that different species of the cat family no longer interbreed.

Suggest and explain two reasons why interbreeding was not possible.

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…… [3]

1. different species within the cat family have **accumulated genetic differences** due to various factors such as mutation, natural selection, and genetic drift. [Compulsory point]

Two possible reasons:

2. Differing geographical location/barrier leading to no opportunity for interaction.

3. have specific mating behaviors and courtship rituals that are essential for successful reproduction. When these behaviors differ significantly between species

4. physical differences in reproductive organs can prevent successful mating between different species

5. Temporal isolation occurs when different species have different mating seasons or times.

6. These genetic differences can lead to incompatibility between the DNA of different species, making it impossible for their gametes (sperm and eggs) to successfully combine and create viable embryos.

Another species that is often found together with the cats is the zebra (*Equus grevyi*). The ancestors of zebra were known to be small black horses that thrived in thick forest vegetation.

In Africa, the presence of the Tsetse flies was a threat to the animal population, causing conditions like the African sleeping disease.

(d) Explain how the presence of the Tsetse flies affected the evolution of zebra.

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…… [3]

1. Variation in appearance (Striped patten) due to mutation, provide some level of protection against fly bites and reduce the risk of diseases transmitted by these insects.

Either

2. the striped pattern deter biting flies, as these insects have difficulty landing on striped surfaces due to visual confusion OWTTE

OR

2. Flies are more attracted to warm-bodied animals, and zebras have a unique cooling mechanism due to their striped coat.

3. Able to survival till sexual maturity; reproduction success and pass down the **striped encoding** alleles to the subsequent generations.

[Total: 10]

10 Helper T cells play a pivotal role in fighting against infection in our body.

Fig. 10.1 illustrates the change in concentration of Helper T cells in an infection.

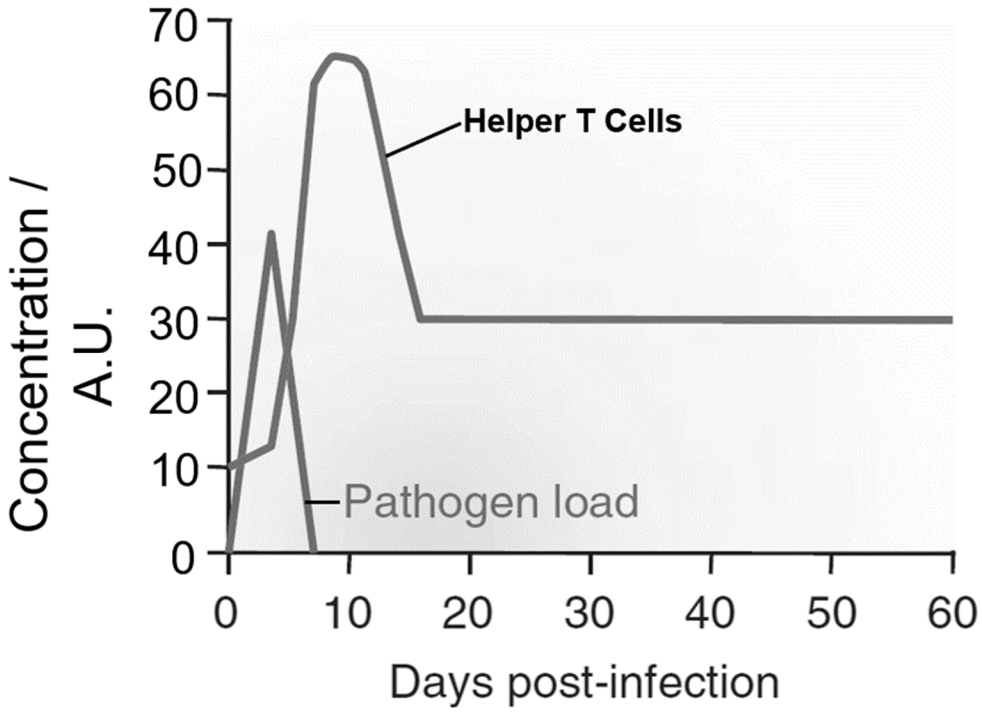

Fig. 10.1

(a) Describe the change in the concentration of Helper T cells from 0 to 20 days post-infection.

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…… [3]

1. As the days of post-infection increases from 0 to 3 days, the concentration of Helper T cell increases gently from 10 A.U. to 12 A.U.
2. As the days of post-infection increases from 3 to 10 days, the concentration of Helper T cell increases rapidly from 12 A.U. to 65 A.U.
3. As the days of post-infection increases from 10 to 20 days, the concentration of Helper T cell decreases rapidly from 65 A.U. to 30 A.U.

(b) Explain how the change in concentration of Helper T cells affect the concentration of pathogen from 3 days post-infection onwards.

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…… [2]

1. As the number of days post-infection increases from 3 to 7 days, there is a rapid increase in the concentration of Helper T cells which lead to rapid decrease of the concentration of pathogen from 42 A.U. to 0 A.U.
2. The presence of high concentration of Helper T cells **activates the humoral immunity and the cell-mediated immunity.**

(c) Based on Fig.10.1, suggest if this is the first time the person is infected with this pathogen. Justify your answer.

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…… [1]

1. No, this is not the first time. The concentration of Helper T cells is not at 0 A.U. before the infection.

[Total: 6]

11 Global warming has changed both the thickness and surface area of sea ice of the Arctic Ocean as well as the Southern Ocean that surrounds Antarctica. Sea ice is highly sensitive to changes in temperature.

Scientists have calculated a long-term mean for the surface area of sea ice in the Arctic Ocean and in the Southern Ocean around Antarctica. This mean value is used as a reference to examine changes in ice extent.

Fig. 11.1 shows the variations from this mean (zero line) over a period of time.

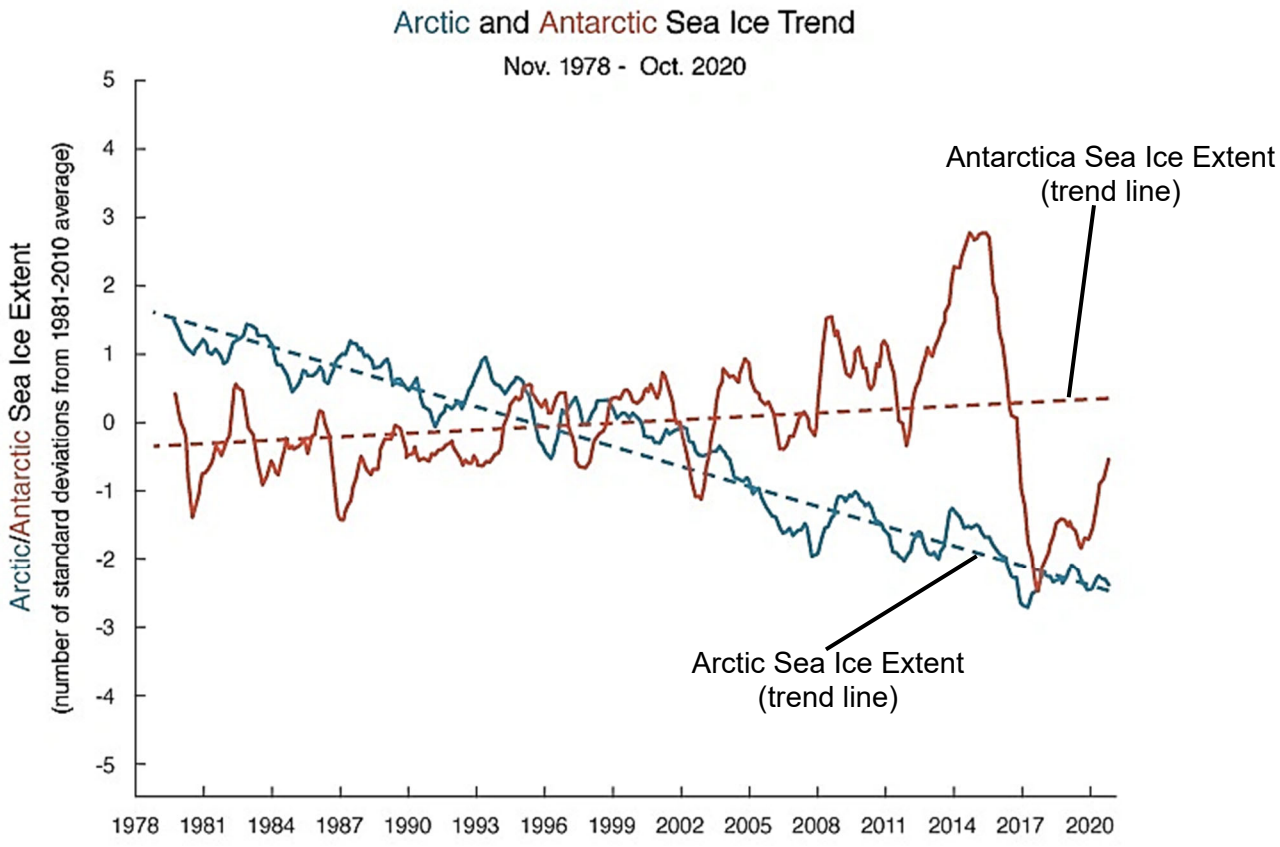

Fig. 11.1

(a) Distinguish between changes in the surface area of sea ice in the Arctic and Antarctica.

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…… [2]

Any two of the following:

1. In the Arctic ocean, the **surface area of sea ice** has declined; in the Antarctica the surface area of sea ice has increased
2. The **rate of change** in the surface area of sea ice is greater for the Arctic Ocean than for the Southern Ocean around the Antarctic
3. There are greater **fluctuations** in the surface area of sea ice in the Southern Ocean around the Antarctica than in the Arctic Ocean

(b) Discuss the data as evidence of global warming.

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…… [3]

Any three of the following:

1. A **decrease in surface area of sea ice** / **melting of sea ice** is expected with global warming - the decrease of sea ice in Arctic provide **supportive** evidence of this effect of global warming

2. A **decrease in surface area of sea ice / melting of sea ice** is expected with global warming - the increase in sea ice in Antarctic is **not supportive** evidence of this effect of global warming;

3. Global warming does not affect all areas in the same way / global warming has complex effects; increase in the sea ice in the Antarctic and decrease in the Artic / **both** changes **may be associated** with **climate change** / caused by **global warming**

4. Data is inconsistent / inconclusive / i.e. data on its own is insufficient to establish, with good certainty, the cause (global warming) and effect (change in surface area of sea ice) / inadequate data / data collection not over a very long / long enough period of time;

[Total: 5]

END OF PAPER