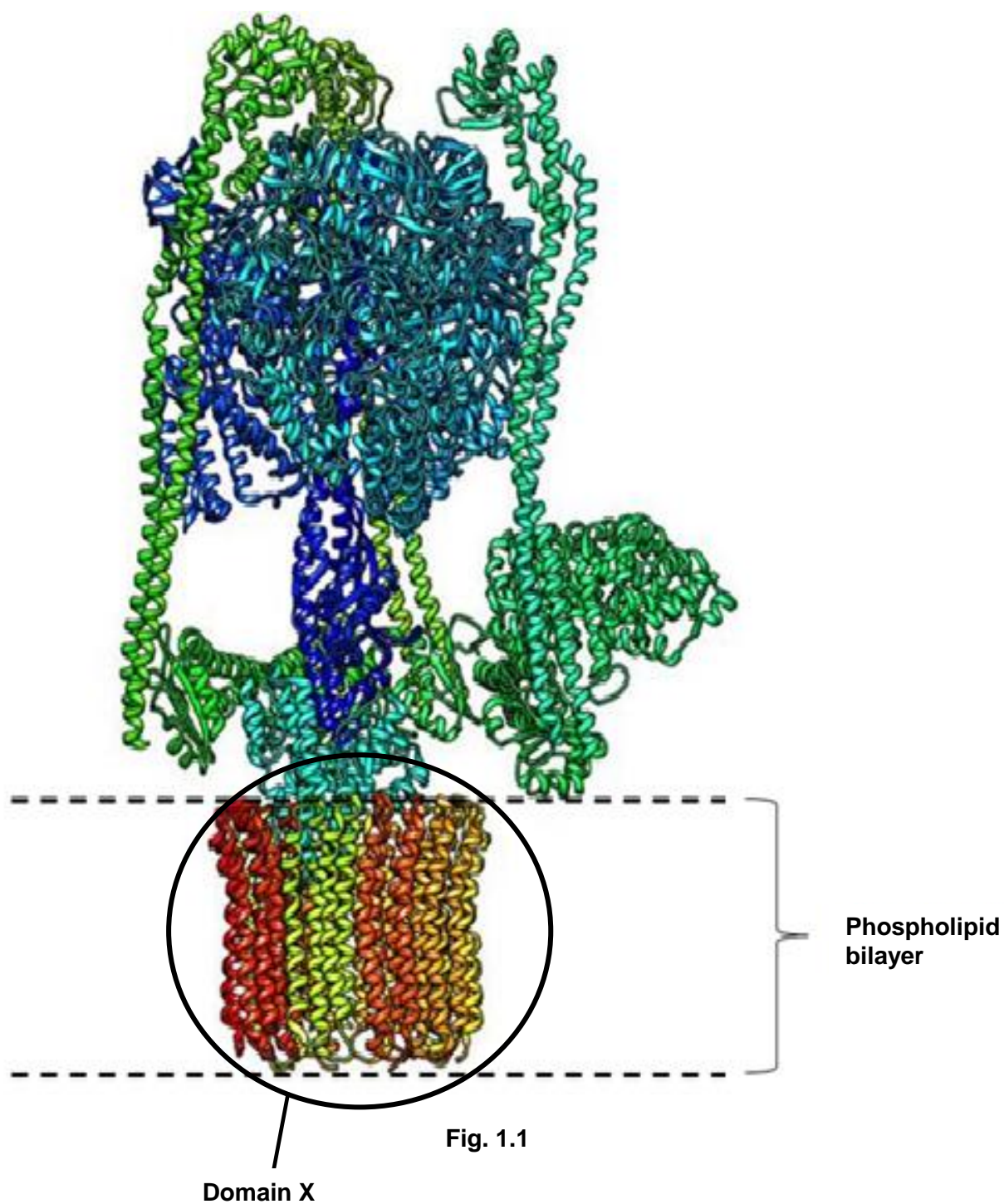


SECTION A

Answer **all** questions.

Question 1

Transport proteins are embedded within the membranes of various organelles. **Fig. 1.1** shows the structure of one such transport protein. The protein is known to contain multiple polypeptide chains.



(a) With reference to **Fig. 1.1**, describe how the structure of Domain X is maintained. [2]

1. primary structure/polypeptide chain folds into secondary structures which are maintained by hydrogen bonds formed between C=O and NH groups;
2. Several α -helices arranged such that they are parallel to each other;
3. further folding into a unique 3D conformation maintained by hydrogen bonds, ionic bonds, disulfide bonds and hydrophobic interactions between R-groups of amino acid residues;

Max 2

A researcher intends to study the transport of substances carried out by the transport protein. The researcher begins by creating artificial vesicles containing only the transport protein embedded within the membrane. The artificial vesicles were then placed in 5 different solutions, each containing a different substance with a concentration of 10 arbitrary units.

The concentrations of the substances in the artificial vesicles were measured before the experiment and after 15 minutes of the experiment. The results obtained by the researcher are shown in **Table 1.2**.

| Solution | Concentration of substances in the artificial vesicles before experiment | Concentration of substances in the artificial vesicles after 15 minutes of the experiment |
|----------|--|---|
| 1 | 0 AU of Na ⁺ ions | 0 AUs of Na ⁺ ions |
| 2 | 0 AUs of Cl ⁻ ions | 0 AUs of Cl ⁻ ions |
| 3 | 1 AUs of H ⁺ ions | 20 AUs of H ⁺ ions |
| 4 | 0 AU of protein insulin | 0 AU of protein insulin |
| 5 | 0 AU of amino acid glutamate | 0 AUs of acidic amino acid glutamate |

Table 1.2

(b) With reference to **Table 1.2**, explain the role of the transport protein in transporting substances across membranes. [2]

1. The concentration of H⁺ ions in the artificial vesicles after 15 minutes is 20AU, which is higher than the initial concentration of 10AU in the solution;
2. Active transport of substances is carried out by carrier protein/ protein pump;
3. Which transports only a specific substance, which is H⁺ ions due to presence of specific binding sites for H⁺ ions;
4. Ref. to against concentration gradient from outside of artificial vesicles to inside artificial vesicles, using energy from ATP hydrolysis;

Another Protein A is a receptor protein. However, unlike the transport protein shown in **Fig. 1.1**, it is made up of only a single polypeptide and is embedded within the cell surface membrane.

- (c) Outline the route taken by Protein A after it is synthesized by the ribosome on the rough endoplasmic reticulum. [3]

1. Protein A inserted/embedded (reject fuse/combine) into the membrane of the rough endoplasmic reticulum;
2. Vesicles with protein embedded in membrane bud off and move to Golgi apparatus;
3. Vesicles bud off from golgi apparatus and fuse with the cell surface membrane;

[Total: 7]

Question 2

Fig. 2.1 shows cultured fibroblasts of the Indian barking deer, *Muntiacus muntjac*, undergoing different stages of the mitotic cell cycle, **J** to **Q**.

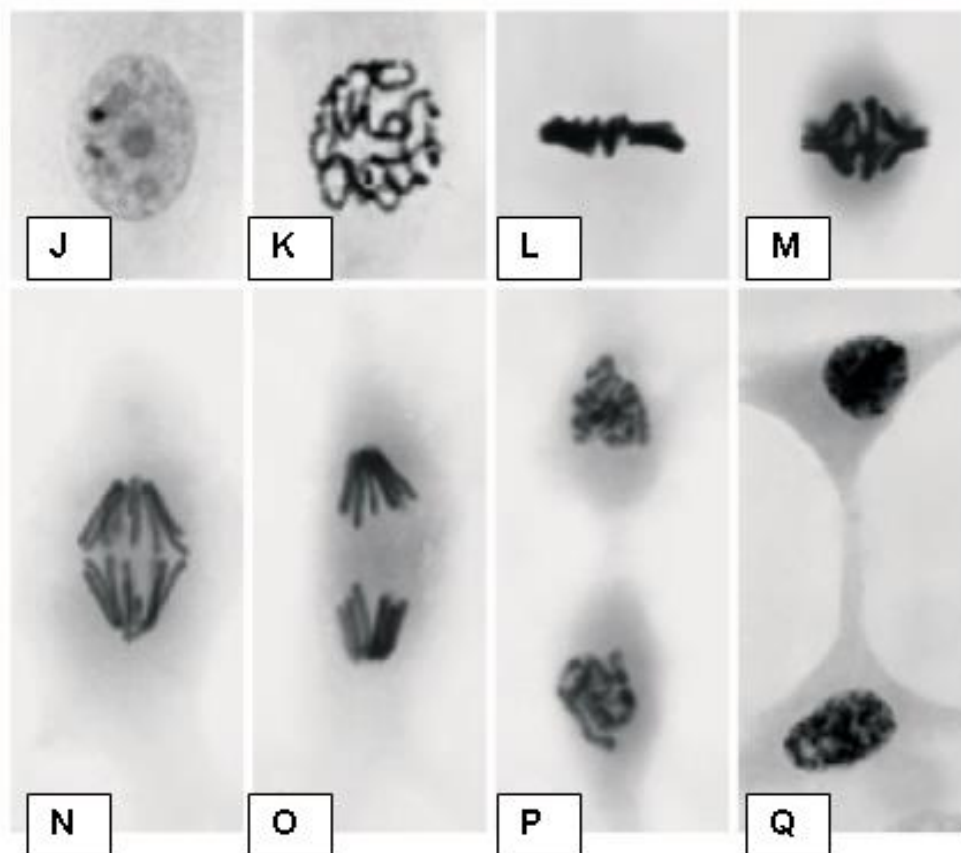


Fig. 2.1

(a) With reference to **Fig. 2.1**, identify stages **K** and **Q**. [1]

K: prophase (reject interphase) **Q:** cytokinesis (reject telophase)

(b) Describe the events that occur in stage **P**. [2]

1. Individual chromosomes arrive at opposite poles of the cell;
2. Chromosome uncoil/decondense and become thread-like chromatin;
3. A nuclear envelope reforms round the chromosomes at each pole;
4. Nucleoli reappear/reform;
5. Spindle fibres disassemble

Max 2

(c) Outline the role of centromeres. [1]

1. allow sister chromatids to adhere to each other;
2. allow spindle fibres to attach at kinetochores on centromere of sister chromatids;
3. when centromeres divide, this leads to equal separation of sister chromatids to opposite poles during anaphase.

Max 1

(d) Fig. 2.2 shows changes in DNA content at different stages of the animal life cycle.

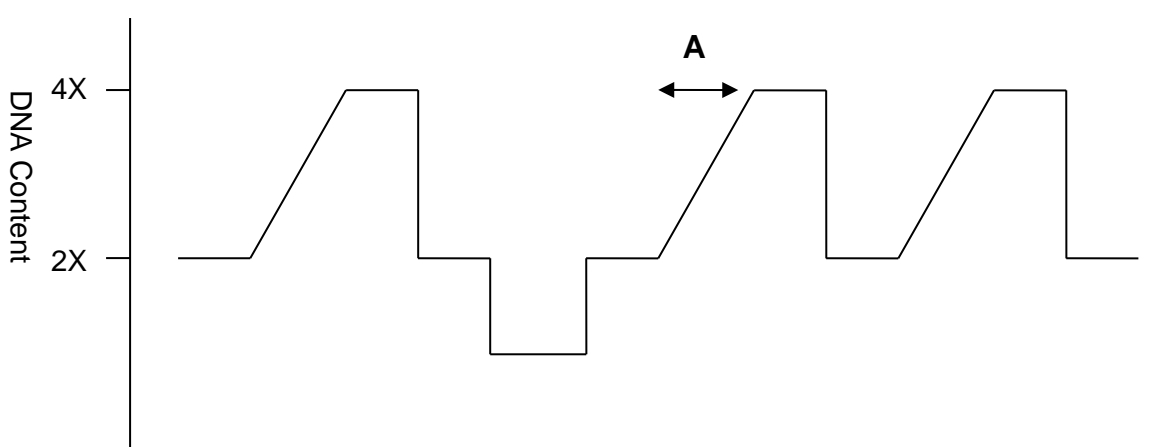


Fig. 2.2

With reference to Fig. 2.2,

(i) identify and describe Stage A. [2]

1. DNA replication during Interphase;
2. Doubling of DNA content from 2X to 4X;
3. Each of 2 parental DNA strands act as templates for synthesis of complementary daughter strands;
4. DNA polymerase elongates new strand formed in 5' to 3' direction

Max 2

(ii) state the significance of Stage A. [1]

1. to produce genetically identical daughter cells

[Total: 7]

Question 3

- (a) Describe how transcription differs from translation in protein synthesis. [2]

| | Transcription | Translation |
|----------------------|---|--|
| Location | <u>nucleus</u> | <u>ribosome</u> ; |
| template | <u>DNA</u> template strand | <u>Messenger RNA</u> ; |
| products | Messenger RNA, Ribosomal RNA, Transfer RNA ® mRNA only | Polypeptide / protein; |
| bonds formed between | <u>phosphodiester bond</u> is formed between | <u>peptide bond</u> is formed between; |
| monomers | free <u>ribonucleotides/ RNA nucleotides</u> ® pentose sugar, phosphate, base ; | <u>amino acids</u> ; |
| Enzyme | <u>RNA polymerase</u> ; | <u>peptidyl transferase</u> in ribosome; |

- (b) Fig. 3.1 represents a polyribosome with several translation sites.

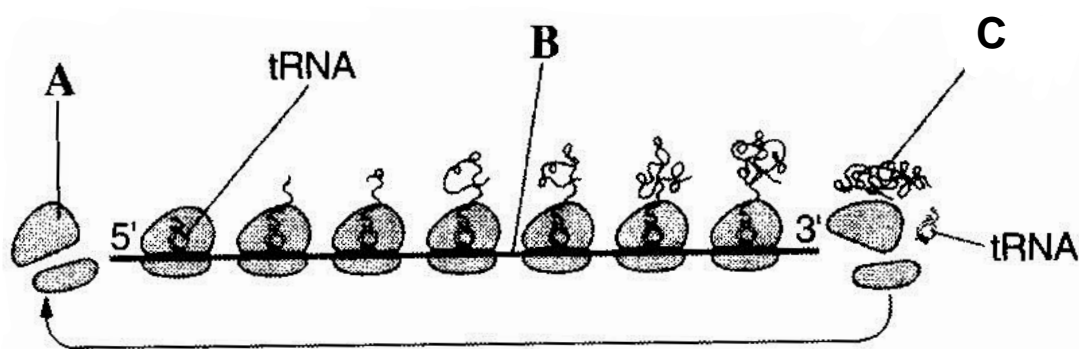


Fig. 3.1

- (i) Name the structures labelled A to C. [3]

A: large subunit of ribosome
 B: messenger RNA ® **mRNA**
 C: polypeptide / protein

- (ii) State **two** molecules, in addition to the molecules shown in **Fig. 3.1**, which are required to complete translation. [1]

1. amino acyl tRNA / activated amino acid;
2. amino acyl tRNA synthetase;
3. ATP / GTP

0.5 marks each

- (iii) Describe **two** structural features which adapt tRNA to its role in translation. [2]

1. Binding site with 3' CCA end that allows specific amino acid molecule to bind to the tRNA;
2. loop with anticodon - complementary to a codon on mRNA;
3. 3D conformation complementary to active site of aminoacyl tRNA synthetase / fitting into E, P and A sites of ribosomes

[Total: 8]

Question 4

The inheritance of a genetic skin disorder in a family is shown in **Fig. 4.1**.

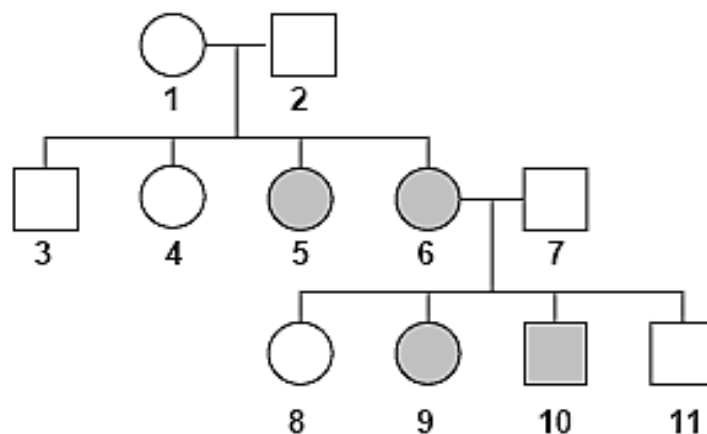


Fig. 4.1

- (a) With reference to **Fig. 4.1**, state the mode of inheritance of this disease. [1]

1. Autosomal recessive;

MARKS SCHEME for 2015 JC2 H1 BIOLOGY PRELIMINARY EXAMINATION PAPER 2

The blood groups of several individuals are listed below:

- Individual 1 – blood group O
- Individual 5 – blood group B
- Individual 6 - blood group A
- Individual 7 - blood group AB

- (b) Using a genetic diagram, illustrate the probability that individuals 6 and 7 will have a child with blood group A, who suffers from the skin disorder. [3]

Legend:

Let D be the dominant allele coding for normal skin

Let d be the recessive allele coding for skin disorder

Let I^A and I^B be the co-dominant alleles coding for blood group A and blood group B respectively

Let I^O be the recessive allele coding for blood group O

| | | | | | | |
|-----------------------------------|--|--|--|--|--|----|
| Parental phenotypes: | Bld grp A w skin disorder x Bld grp AB w normal skin | | | | | 1M |
| Parental genotypes: | $dd I^A I^O \times Dd I^A I^B$ | | | | | |
| Gametes: | <div style="display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin: 0 5px;">$d I^A$</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin: 0 5px;">$d I^O$</div> <div style="margin: 0 10px;">x</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin: 0 5px;">$D I^A$</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin: 0 5px;">$D I^B$</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin: 0 5px;">$d I^A$</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin: 0 5px;">$d I^B$</div> </div> | | | | | |
| Offspring genotype and phenotype: | | <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; text-align: center;">$D I^A$</div> | <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; text-align: center;">$D I^B$</div> | <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; text-align: center;">$d I^A$</div> | <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; text-align: center;">$d I^B$</div> | 1M |
| | <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; text-align: center;">$d I^A$</div> | $Dd I^A I^A$ normal skin, blood group A | $Dd I^A I^B$ normal skin, blood group AB | $dd I^A I^A$ skin disorder, blood group A | $dd I^A I^B$ skin disorder, blood group AB | |
| | <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; text-align: center;">$d I^O$</div> | $Dd I^A I^O$ normal skin, blood group A | $Dd I^B I^O$ normal skin, blood group B | $dd I^A I^O$ skin disorder, blood group A | $dd I^B I^O$ skin disorder, blood group B | |
| Offspring phenotypic ratio: | 2 normal skin, blood group A: 2 skin disorder, blood group A: 1 normal skin, blood group AB: 1 normal skin, blood group B: 1 skin disorder, blood group AB: 1 skin disorder, blood group B | | | | | 1M |
| probability = | <u>0.25</u> | | | | | 1M |

Two populations of a species X living in the wild were studied. One population was found to occupy the lowlands while the other population was found to occupy the highlands. While the organisms in the two populations were very similar, some phenotypic differences were observed to be present.

(c) Explain the presence of phenotypic differences between the organisms in the two populations. [3]

1. The different environmental conditions in (lowlands and highlands) act as different selection pressures;
2. Variations exist within populations;
3. By natural selection, different alleles selected for, allow better adapted individuals which are at selective advantage, survive better till reproductive age and passed on favourable alleles to offspring;
4. leading to increase in frequency of the alleles for the favourable phenotypes

Max 3

A related species Y was discovered. To determine if species X and Y are related, an investigator studied DNA sequences which codes for an important protein that performs the same function in both X and Y.

Sequence D (from species X) and Sequence E (from species Y) were identical except at two points.

(d) Explain how Sequences D and E provide evidence to support the theory of evolution. [2]

1. The two sequences are very similar and show molecular homology/ are homologous sequences;
2. Hence it is most likely that the similarities were inherited from a common ancestor;
3. This is evidence for descent with modification as the two sequences show a modification process from an ancestral sequence via natural selection.

[Total: 9]

Question 5

Fig. 5.1 shows the restriction sites of two different restriction enzymes. The cleavage sites are shown by means of arrows.

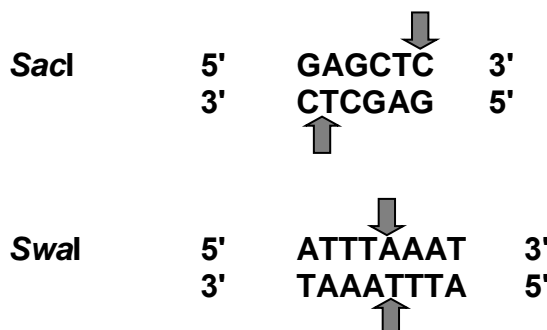


Fig. 5.1

- (a) With reference to **Fig. 5.1**, explain which restriction enzyme is more suitable for use in genetic engineering. [3]

1. **Sac I:**
2. Makes **staggered cuts** to produce fragments with **sticky ends**;
3. Sticky ends between two DNA fragments produced when cut by the **same enzyme** will be **complementary** and will **anneal to each other** via **hydrogen bonds** ;
4. This **holds the 2 fragments in place whilst/ increasing chances for DNA ligase** catalysing **phosphodiester bonds** between fragments to form **recombinant plasmid**;
5. **Does not need additional steps** such as attaching **DNA linkers**, unlike the use of **SmaI** that produce fragments with **blunt ends**.

Max 3

Fig. 5.2 shows pUC19, which is a plasmid that is commonly used in genetic engineering.

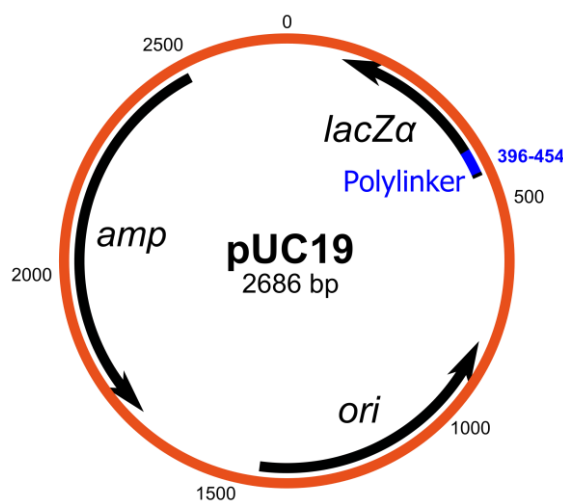


Fig. 5.2

- (b) With reference to **Fig. 5.2**, explain the main features of pUC19 that allows them to be used as DNA cloning vector. [2]

1. The polylinker contains many restriction sites that allow different restriction enzymes to be used to cut and insert foreign DNA;
2. presence of multiple cloning site or polylinker within lac Z gene allows for insertional inactivation of lac Z gene;
3. allows lac Z gene to be used as a selectable marker for identification/selection of bacteria cells which have taken up the recombinant plasmid, carrying gene of interest / select for recombinant bacteria;
4. Amp resistance gene allows selection of successfully transformed bacterial cells/ or bacteria which have taken up the plasmid from those that have not;
5. Origin of replication allows the plasmid to be able to replicate itself and inserted genes of interest inside bacterial host cells.

Max 2

An anti-thrombin gene was inserted into pUC19. The recombinant plasmid was introduced into *E. coli*.

- (c) Explain how the cells which contain the recombinant plasmids are identified. [3]

1. Grow bacteria on agar medium containing ampicillin and X gal;
2. Bacteria colonies that contain recombinant plasmids with the gene of interest will appear white while those that do not contain recombinant plasmids will appear blue;
3. As anti-thrombin gene is inserted into Lac Z gene, Lac Z gene is disrupted/inactivated, functional β -galactosidase enzyme is not produced to convert/ break down colourless substrate X-gal into a blue compound, thus colonies remain white;
4. Cells with reannealed plasmids will have an intact lac Z gene, functional β -galactosidase enzyme is produced to convert/ break down colourless substrate X-gal into a blue compound/ product, thus colonies are blue.

Max 3

- (d) After the cell containing recombinant plasmid was identified, there was no functional anti-thrombin produced. Suggest how this might have happened. [1]

1. The anti-thrombin gene was inserted in the wrong orientation;
2. RNA polymerases in bacterial cells may not recognize eukaryotic promoter/ A prokaryotic promoter was not used;
3. Bacteria cannot carry out post-translational modification/ lack of enzymes for RNA splicing

[Total: 9]

Question 6

(a) Compare glycogen and collagen. [5]

| | Differences | Collagen | Glycogen |
|---|----------------------|--|---|
| 1 | Subunit/ Monomers | Amino acids | α -glucose |
| 2 | Type of monomers | Different types of amino acids (eg. Glycine, proline etc) | One type of glucose monomer (α -glucose) |
| 3 | Bonds | Peptide bonds | α (1,4) & α (1,6) Glycosidic bonds |
| 4 | Branching | Unbranched | Branched chains |
| 5 | Functions | Main component in connective tissues (cartilage) and in bone formation | Storage molecule |

Similarities:

1. Both are **macromolecules/** made up of many **smaller subunits**
2. Both involve **condensation reactions with the removal of 1 water molecule per bond synthesized.**
3. Both are **insoluble in water.**

(b) Explain the advantages and limitations of the polymerase chain reaction. [6]

Advantages (Max 3)

1. PCR can amplify **large amount** of DNA in a **short** period of time of few hours/ **rapidly**;
2. **High specificity** : PCR **amplifies** only a **specific region** of DNA;
3. **High sensitivity**: PCR only **requires a small amount of template DNA** for amplification;
4. A **cell-free** method of **DNA replication**/ do not need to remove unwanted cellular debris and vector DNA;
5. **Automation** of PCR: use of **thermostable Taq DNA polymerase**, can **withstand high temperatures without being denatured**, allows for the automation of PCR.

Limitations (Max 4)

1. **Limited size** range of DNA sequences (**0.1 – 5 kb**) cloned by PCR, as above this length the polymerase tends to fall off / the typical heating cycle does not leave enough time for polymerisation to complete;
2. **Higher rate of error/mutations**, due to **lack of 3' to 5' proofreading ability by Taq DNA polymerase** / Taq polymerase **lacks a 3' to 5' exonuclease activity**;
3. **Non-specific binding of primers** (leads to non-specific amplification of sequences) due to **sequence duplications / partial primer binding**;
4. **DNA sequences flanking the target gene or sequence must be known** to enable synthesis of **primers to bind to complementary sequences flanking the target sequence**;
5. Possible **contamination** with **non-template DNA**, resulting in inaccurate amplification.

- (c) Using named examples, explain the significance of genetic engineering in solving the **demand for food** in the world and discuss the ethical implications of genetically modified organisms. [9]

Max 4 for any 1 example;

1. **The problem:** Corn is prone to attack by **insect pests**, hence **reducing the amount of corn** being sold/ result in **huge losses**. Nature of the infestation makes it difficult to deal with despite using chemical insecticides and biological control methods.
2. **Bt Corn:** **genetically modified corn with the insertion of a gene from *Bacillus thuringiensis* into the corn.**
3. This gene codes for **Bt delta endotoxin**.
4. **The endotoxin, kills a common pest that destroys corn crops**, called the European Corn Borer (a caterpillar).
5. **Farmers growing Bt corn do not need to spray insecticides on their crops to get rid of the pests.**
6. **Since the crops are not infested with pests, this allows the farmers to increase their yields, productivity, improve their livelihoods and alleviate poverty.**

OR

1. The problem: Atlantic salmon can only grow in summer because their growth hormone gene is switched off in winter.
2. Genetically Modified Salmon/ The Atlantic salmon has been genetically modified with two DNA sequences.
3. They are:
 - A promoter of an anti-freeze gene from an ocean pout.
 - A growth hormone gene from Chinook salmon.
4. These 2 DNA sequences enable the salmon to continue producing growth hormone all year round, even during the winter months.
5. Hence, GM salmon can grow 5 times faster than its wild type counterpart/faster growth rate
6. Because of the **shorter maturation time**, GM salmon raised in tanks can be harvested and sold in a shorter time and thus increasing the profit.

Ethical implications of GMOs (Max 4)

1. Concern about animal rights – GM animals may suffer unnecessarily; E.g., There seems to be *little concern about whether the animals are biologically 'designed' to withstand the additional burden of increased milk or egg or meat production*;
2. Religious implications in food choice, especially when **GM foods are unlabelled**; E.g., incorporation of pig genes into cows – Muslims may find the beef unsuitable for consumption;
3. There is concern about the rights of patenting a genetically modified animal or plant as some people argued that patenting animals is itself unethical as it reduces them to the level of objects;
4. Ownerships issues – unfair for large multinational companies to patent GM crops /animals OR increased dependence of undeveloped countries on rich developed countries;
5. Monopolistic behaviour of biotechnology companies as terminator gene is likely to be inserted into many GMO seeds, causing second generation seeds to be sterile;
6. Labeling of products on sale to indicate that genetic engineering was involved in their production is not mandatory in some countries, thus depriving consumers from making an informed choice based on their religious, medical (allergies), personal (vegetarians) backgrounds

Question 7

- (a) Outline the main features of oxidative phosphorylation and contrast this with photophosphorylation. [9]

Features of oxidative phosphorylation (Max 7)

1. **High energy electrons from NADH and FADH₂** are channelled to the **electron transport chain**;
2. **electrons** are passed along a **series of electron carriers of progressively lower energy levels to oxygen**, the final electron acceptor;
3. **energy released** from electron transfer is used to **actively transport/ pump protons from the matrix into the intermembrane space**;
4. This produces a **high concentration of protons** in the **intermembrane space**, setting up an electrochemical **proton gradient / proton motive force** across **inner mitochondrial membrane**;
5. As **H⁺ ions** **diffuse** from the **intermembrane space into the matrix** of the mitochondrion through **ATP synthase complex**;
6. the **energy released** is utilised by **ATP synthase** to catalyse the **synthesis of ATP** from **phosphorylation of ADP** and inorganic phosphate;
7. **Oxygen**, the **final electron acceptor**, combines with **protons** and electrons, and is reduced to form **water**, catalyzed by **cytochrome oxidase**;
8. **NADH and FADH₂** are **oxidised** to **NAD⁺ and FAD**, respectively/ **NAD⁺ and FAD** are **regenerated** at the end of oxidative phosphorylation

Max 4 for differences

| | Photophosphorylation | Oxidative phosphorylation |
|---|--|--|
| Location | <u>Thylakoid membrane of chloroplast</u> | <u>Inner membrane of mitochondrion</u> |
| Electron donors | <u>Water</u> - Electron donor in non-cyclic pathway & <u>P700 specialised chlorophyll a</u> - Electron donor in cyclic pathway | Reduced coenzyme , NADH/FADH ₂ |
| Electron acceptors | <u>NADP</u> - Final electron acceptor in non-cyclic pathway & <u>P700 specialised chlorophyll a</u> - Final electron acceptor in cyclic pathway | Molecular <u>Oxygen</u> |
| Establishing proton gradient for the synthesis of ATP | H ⁺ ions are pumped inwards , from <u>stroma</u> across the thylakoid membrane, into the <u>thylakoid space</u> . | H ⁺ ions are pumped outwards , from <u>matrix</u> across the inner mitochondrial membrane, into the <u>intermembrane space</u> . |
| Source of energy for phosphorylation | <u>Light energy</u> from the sun | Oxidation of glucose / NADH / FADH |
| Involvement of light | <u>Light</u> is required for photolysis of water. | Light is not required. |
| Involvement of pigments | <u>Pigments</u> (chlorophylls a and b, carotene and xanthophyll) are used for trapping light energy. | Pigment is not required. |
| Products | <u>ATP, NADPH + H⁺</u> produced, <u>oxygen</u> as a by-product . | <u>ATP</u> and <u>water</u> produced; <u>NAD⁺</u> and <u>FAD</u> are regenerated. |

(b) Compare the Krebs cycle and the Calvin cycle. [5]

Max 4 for differences

| Features | Calvin Cycle | Krebs Cycle |
|-------------------------------|--|---|
| Location | Occurs in <u>stroma</u> of <u>chloroplast</u> . | Occurs in <u>matrix</u> of <u>mitochondrion</u> . |
| Cell type | Occurs in plant cells / algae / blue-green bacteria | Occurs in <u>all aerobically respiring</u> cells |
| Process | Anabolic reaction (formation of triose phosphate or starch) | Catabolic reaction (breakdown of acetyl-coA) |
| Electron or hydrogen carriers | NADP+ (nicotinamide adenine dinucleonucleotide phosphate) | NAD+ and FAD (nicotinamide adenine dinucleonucleotide and flavin adenine dinucleotide) |
| Compound that is regenerated | Ribulose biphosphate is regenerated at the end of cycle. | Oxaloacetate is regenerated at the end of cycle. |
| Carbon dioxide | Carbon dioxide is fixed by ribulose biphosphate , catalysed by ribulose biphosphate carboxylase (Rubisco) . | Carbon dioxide released by oxidative decarboxylation . |
| ATP | ATP is used in the reduction of PGA to PGAL / and the regeneration of RuBP . | ATP is synthesised by substrate level phosphorylation . |
| Redox reactions | <ul style="list-style-type: none"> Reduced NADP are used; To reduce phosphoglyceric acid (PGA) to triose phosphate | <ul style="list-style-type: none"> Reduced NAD and FAD are formed; when NAD and FAD oxidises intermediates of the cycle |
| Role of O ₂ | Does not require O₂ | Occurs only when O₂ is present |
| Requirement of light | Is indirectly dependent on light as requires NADPH and ATP which were produced during the light dependent reactions . | Is not dependent on light |
| Enzymes involved | Carboxylases | Dehydrogenases, decarboxylases |

Similarities of the Krebs Cycle and Calvin Cycle

Max 3 for similarities

1. Both involve **regeneration of the starting compound**, thus they are termed 'cycles' / cyclic processes;
 - In respiration, oxaloacetate is regenerated; in photosynthesis, RuBP is regenerated;
2. Both cycles involve **redox reactions**;
3. Both cycles utilize **electron / hydrogen carriers**;
 - Krebs cycle – NAD^+ & FAD^+ ; Calvin cycle – reduced NADP / NADPH

(c) Explain how gel electrophoresis is used to analyse DNA. [6]

1. DNA **samples** are digested by **restriction enzyme** into **fragments**;
2. **DNA fragments mixed with loading dye** are loaded into **wells** at one end of an **agarose gel**, near the **negatively charged electrode**;
3. A loading dye is added to the DNA samples, which allows the process of electrophoresis to be tracked / helps DNA samples to **sink into the wells** when loaded;
4. Agarose gel is submerged in a **buffer solution** that will conduct electricity;
5. **Electrodes are attached to both ends** of the electrophoresis chamber and **an electric current is applied**;
6. As DNA fragments are **negatively charged** due to the phosphate group, they will migrate towards the **positive end of the gel**;
7. agarose gel forms a **cross-linked matrix** that functions as a 'molecular sieve', so as to **separate DNA fragments by size**;
8. **Smaller size fragments migrate more rapidly/at a faster rate** than large fragments and located **further away from the well** because smaller size fragments have **lower resistance** in moving through the pores of the gel, **thus the DNA is separated into bands**;
9. A ladder containing **fragments of known sizes**/ can be used as a **standard**, thus allowing **sizes of unknown fragments to be estimated by visual comparison of the DNA bands**;
10. The invisible **DNA fragments can be stained/intercalated with ethidium bromide** and **ultra-violet (UV) light** is used to **visualize the DNA bands**.