

Candidate Name: \_\_\_\_\_

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**MERIDIAN JUNIOR COLLEGE**  
JC2 Preliminary Examinations 2015  
Higher 1

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# H1 BIOLOGY

**8875/01**

Paper 1 Multiple Choice Questions

**23 September 2015****1 hour**Additional Materials: Multiple Choice Answer Sheet

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**READ THESE INSTRUCTIONS FIRST****Do not open this booklet until you are told to do so.**

Write in soft pencils.

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

Write your name, civics group and index number on the Multiple Choice Answer Sheet provided.

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

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

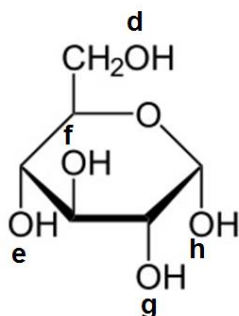
The use of an approved scientific calculator is expected, where appropriate.

You may keep this booklet after the examination.

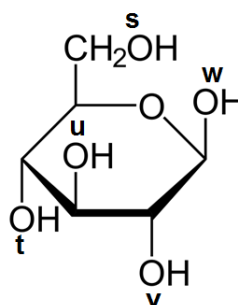
### Question 1

The diagram shows two isomers of a hexose labelled I and II.

Four possible bonding positions are labelled **d**, **e**, **f**, **g** and **h** on one isomer, and **s**, **t**, **u**, **v** and **w** on another isomer.



**Isomer I**



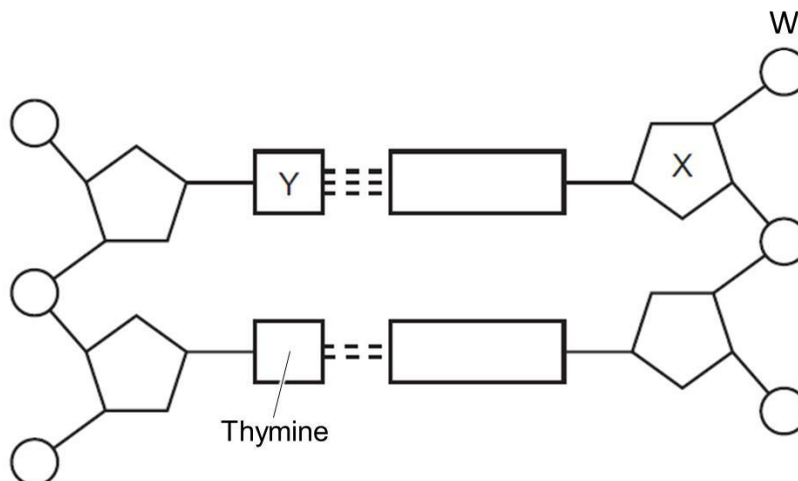
**Isomer II**

Which isomer and bonding positions are involved in the formation of glycogen?

|    | Repeating units | Bonding position |
|----|-----------------|------------------|
| A. | Isomer I        | d-g and d-h      |
| B. | Isomer I        | e-h and d-h      |
| C. | Isomer II       | s-v and s-w      |
| D. | Isomer II       | t-w and s-w      |

### Question 2

The diagram below shows the structure of a biological molecule.

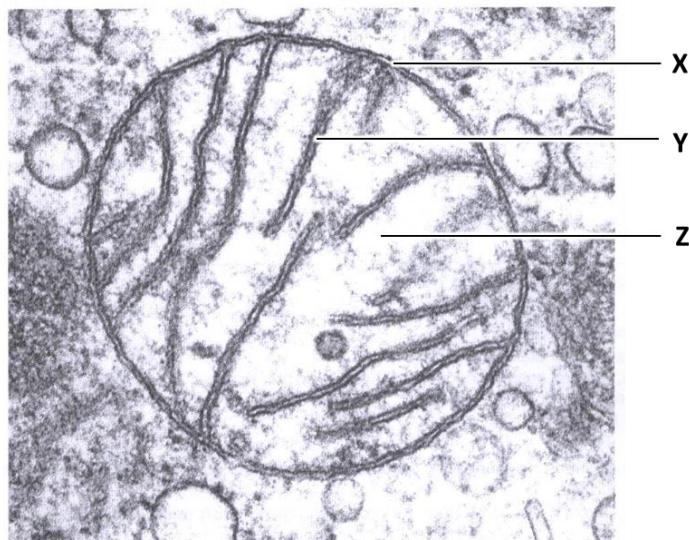


Identify the correct rows for **W**, **X** and **Y**.

|    | W      | Structure X | Structure Y |
|----|--------|-------------|-------------|
| A. | 3' end | deoxyribose | cytosine    |
| B. | 3' end | ribose      | guanine     |
| C. | 5' end | deoxyribose | cytosine    |
| D. | 5' end | ribose      | guanine     |

### Question 3

The electron micrograph below shows an organelle.



Which of the following statements about the labelled structures are correct?

1. X serves to compartmentalise the organelle from the extracellular environment.
2. X is made up of a phospholipid bilayer and it is selectively permeable to substances.
3. Y has embedded photosystems that are involved in the absorption of light.
4. Y has embedded ATP synthase that synthesizes ATP.
5. Z contains DNA that has histones that help to package DNA present in the organelle.
6. Z contains glycolytic enzymes that oxidises glucose to pyruvate.

**A. 2 and 4**

B. 5 and 6

C. 1, 2 and 4

D. 1, 3 and 6

### Question 4

Which of the following statements about the Golgi apparatus are correct?

1. It may assist in the aerobic oxidation of glucose, especially in actively respiring tissues like muscles.
2. It forms lysosomes, which are involved in cell autolysis.
3. It is made of membrane-bound sacs called cisternae
4. It is involved lipid synthesis and the packaging of proteins prior to their secretion from the cell.
5. It is commonly found in animal cells, especially those with a secretory function, but it is never found in plant cells.
6. It forms vesicles that migrate along microtubules and fuse to become a cell plate in plant cells.

A. 1, 3 and 4

**B. 2, 3 and 6**

C. 2, 4 and 5

D. 1, 5 and 6

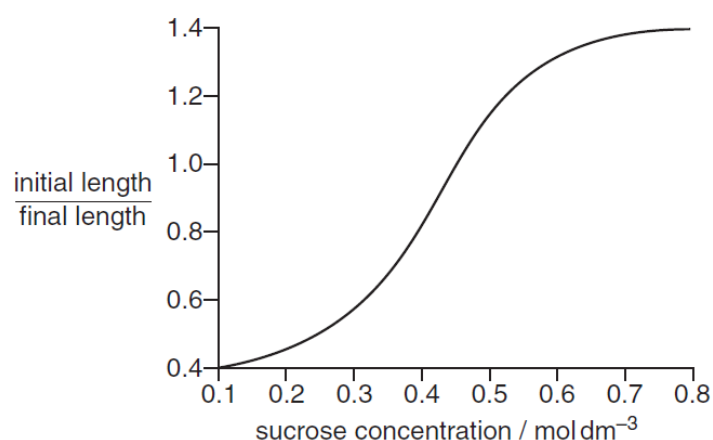
### Question 5

When **not** involved in protein synthesis, ribosomes exist as two separate structures. Identify the site of assembly and components of these structures.

|    | Site of assembly      | Components       |
|----|-----------------------|------------------|
| A. | nucleus and cytoplasm | mRNA and protein |
| B. | nucleolus             | rRNA and protein |
| C. | nucleolus             | rRNA             |
| D. | nucleus and cytoplasm | rRNA and protein |

### Question 6

Strips of plant tissue were immersed in a range of sucrose solutions of different concentrations. Their lengths were measured before immersion and after 30 minutes in the different solutions. The graph shows the ratio of initial length to final length.



Which of the following statements is true?

- A. The change in length of plant tissue strips is due to diffusion of sucrose across the plasma membrane
- B. At 0.8 mol dm<sup>-3</sup> of sucrose, the limiting factor is the number of sucrose transport proteins in the cell membrane.
- C. ATP is required to produce a change in length of the plant tissue strips.
- D. The water potential of the plant cell sap is the same as that of the sucrose solution at 0.45 mol dm<sup>-3</sup> of sucrose.

### Question 7

A solution of amylase is saturated with starch at pH6.5 at 30°C. The best method to obtain a faster yield of products would be to

- A. reduce the amount of substrate so that there are more free proteases to catalyse the reaction
- B. increase the pH so that the proteases are more active
- C. double the temperature to double the rate of reaction
- D. double the concentration of amylase to double the rate of reaction

### Question 8

Which of the following statements about enzymes are false?

1. All enzymes are globular proteins.
2. Enzymes catalyse reactions by decreasing the activation energy.
3. A prosthetic group is tightly bound to the enzyme, while a coenzyme is a loosely bound to the enzyme.
4. The effect of competitive inhibitors can be reduced by increasing substrate concentration.
5. An allosteric binding site refers to the active site that has undergone an induced fit.

A. 1 and 3

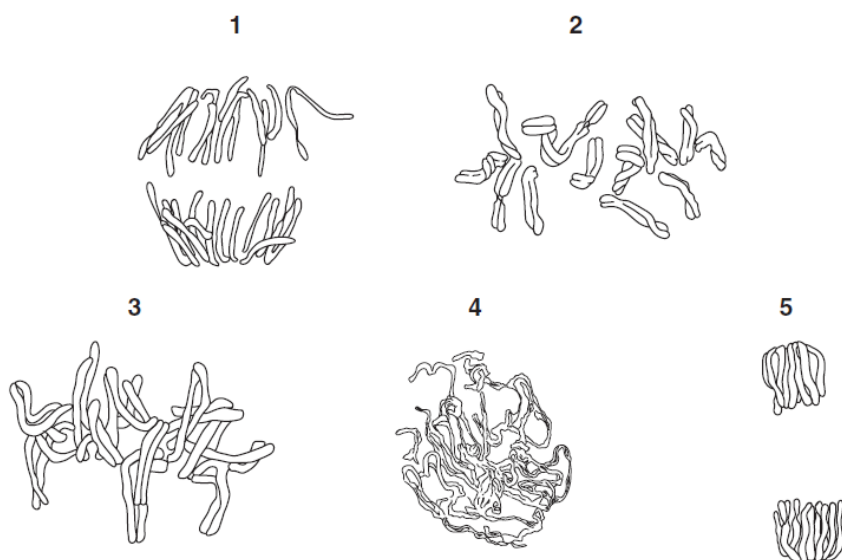
B. 1 and 5

C. 2 and 4

D. 3 and 5

### Question 9

The drawing below shows stages in mitosis.



In which order do the stages occur?

A.  $2 \rightarrow 1 \rightarrow 3 \rightarrow 5 \rightarrow 4$

B.  $2 \rightarrow 4 \rightarrow 1 \rightarrow 5 \rightarrow 3$

C.  $4 \rightarrow 2 \rightarrow 1 \rightarrow 3 \rightarrow 5$

D.  $4 \rightarrow 2 \rightarrow 3 \rightarrow 1 \rightarrow 5$

### Question 10

What would be the ploidy of the gametes generated if non-disjunction occurs at first meiotic division?

A. both  $(n+1)$  and  $n$

B. both  $(n+1)$  and  $(n-1)$

C. either  $(n+1)$  or  $(n-1)$

D.  $(n+1)$ ,  $n$ , and  $(n-1)$

### Question 11

In a laboratory of Molecular Biology, the amino acids sequence of an armadillo intestine protein has been partially determined. The tRNA molecules used in the synthesis have the following anticodons:

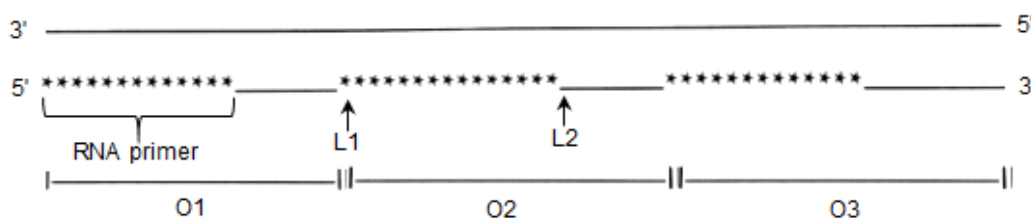
3' UAC 5'    3' CGA 5'    3' GGA 5'    3' GCU 5'    3' UUU 5'    3' GGA 5'

What is the DNA nucleotide sequence of the non-template DNA strand?

- A. 5' ATG-GCT-GGT-CGA-AAA-CCT 3'
- B. 5' ATG-GCT-CCT-CGA-AAA-CCT 3'**
- C. 5' ATG-GCT-GCT-CGA-AAA-GCT 3'
- D. 5' ATG-GGT-CCT-CGA-AAA-CGT 3'

### Question 12

The diagram shows a DNA template with the lagging strand prior to the removal of the RNA primers.

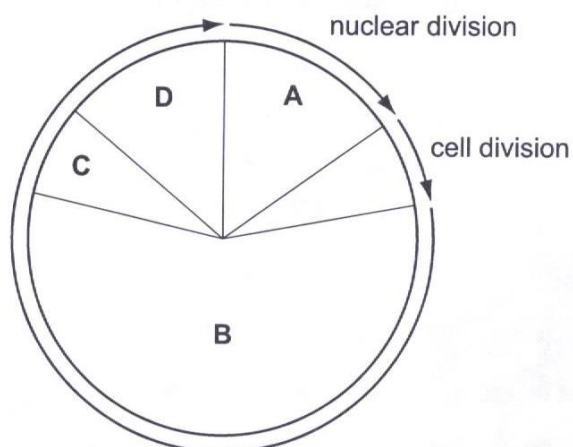


Which row correctly shows the events taking place during the synthesis of the lagging strand?

|           | first Okazaki fragment synthesised | site of phosphodiester bond formation catalysed by DNA ligase |
|-----------|------------------------------------|---|
| <b>A.</b> | O1                                 | L1  |
| <b>B.</b> | O1                                 | L2  |
| <b>C.</b> | O3                                 | L1  |
| <b>D.</b> | <b>O3</b>                          | <b>L2</b>   |

### Question 13

The diagram below shows the mitotic cell cycle. At which stage are gene mutations likely to be introduced ?



**Question 14**

Which of the following mutations is most likely to cause a phenotypic change?

- A. A duplication of all introns
- B. A single nucleotide deletion in an exon coding for an active site
- C. A nucleotide substitution in an exon coding for a transmembrane domain
- D. A frameshift mutation one triplet away from the 3' end of the non-template strand

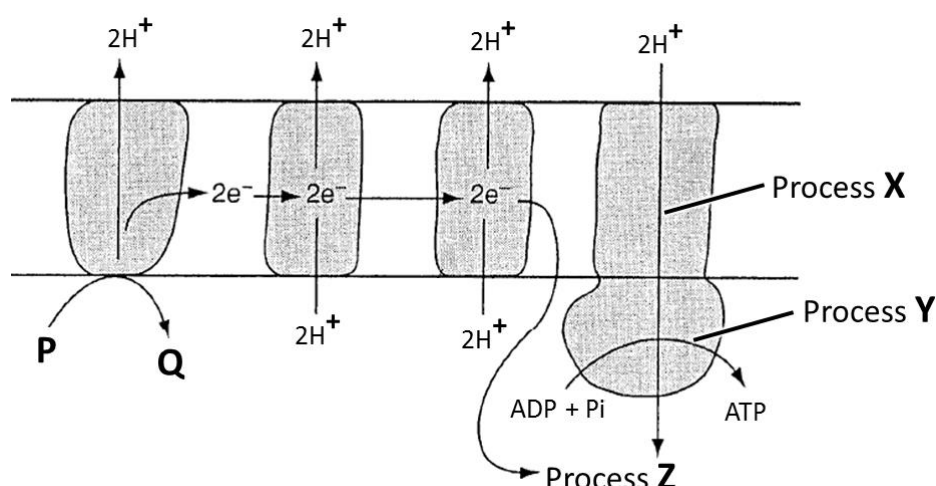
**Question 15**

Which of the following is true about cancer cells?

- A. They exhibit contact inhibition.
- B. Metastasis establishes new tumours distant from the site of the primary tumour.
- C. The number of cancer cells increases with age.
- D. Multiple mutations in different cells are required to give rise to cancer cells.

**Question 16**

The following is a diagrammatic representation of a section through the inner mitochondrial membrane showing the events leading to ATP formation.



Which row correctly identify molecules **P** and **Q**, and processes **X**, **Y** and **Z**?

|           | <b>P</b> | <b>Q</b> | <b>X</b>              | <b>Y</b>                        | <b>Z</b>         |
|-----------|----------|----------|-----------------------|---------------------------------|------------------|
| <b>A.</b> | Water    | Oxygen   | Facilitated diffusion | Photo-phosphorylation           | ATP formation    |
| <b>B.</b> | $FAD^+$  | $FADH_2$ | Chemiosmosis          | Substrate-level phosphorylation | Water formation  |
| <b>C.</b> | NADH     | $NAD^+$  | Active transport      | Substrate-level phosphorylation | Oxygen formation |
| <b>D.</b> | $FADH_2$ | $FAD^+$  | Facilitated diffusion | Oxidative phosphorylation       | Water formation  |

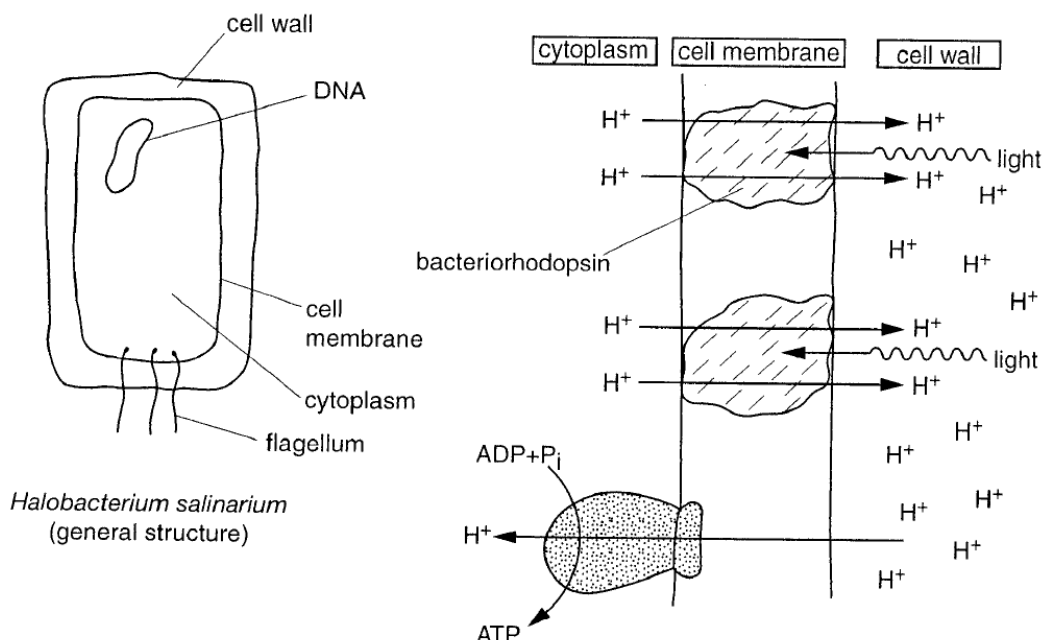
### Question 17

Which of the following best describes the *link reaction* in aerobic respiration?

- A. An oxidative decarboxylation step, where pyruvate loses one carbon and combines with coenzyme A to produce carbon dioxide, NADH and proton.
- B. A dehydrogenation step, where  $\text{NAD}^+$  extracts electrons and protons from coenzyme A to produce carbon dioxide, NADH and proton, catalysed by pyruvate dehydrogenase.
- C. A reductive decarboxylation step, where  $\text{NAD}^+$  extracts electrons and protons from pyruvate and is reduced to NADH, with the production of carbon dioxide and proton.
- D. The transport of pyruvate from the cytosol into the mitochondrial matrix through pyruvate carrier embedded in the inner mitochondrial membrane.

### Question 18

Some bacteria can survive in anaerobic conditions by utilizing light energy to drive the production of ATP in the cell membrane. In such conditions, *Halobacterium salinarium* makes the protein bacteriorhodopsin, which absorbs only green light. This is shown in the diagram below.



Five students made a comparison between ATP synthesis during anaerobic condition in *Halobacterium salinarium* and ATP synthesis in chloroplast of plant cells.

1. In *Halobacterium salinarium*, the proton gradient is generated between the cytoplasm and cell wall. In plant cells, the proton gradient is generated between cytoplasm and stroma.
2. In *Halobacterium salinarium*, the light-harvesting bacteriorhodopsin captures only green light. In plant cells, the light-harvesting photosystem captures largely blue and red light.
3. In *Halobacterium salinarium*, the light-harvesting complex is bacteriorhodopsin embedded in the cell membrane. In plant cells, light-harvesting complex is photosystem embedded in cell membrane.
4. In both *Halobacterium salinarium* and chloroplasts, the bacteriorhodopsin and photosystem, respectively, are both a light-harvesting complex and a proton pump.
5. In *Halobacterium salinarium*, ATP is synthesized in the cytoplasm. In plant cells, ATP is synthesized in the stroma of chloroplast.

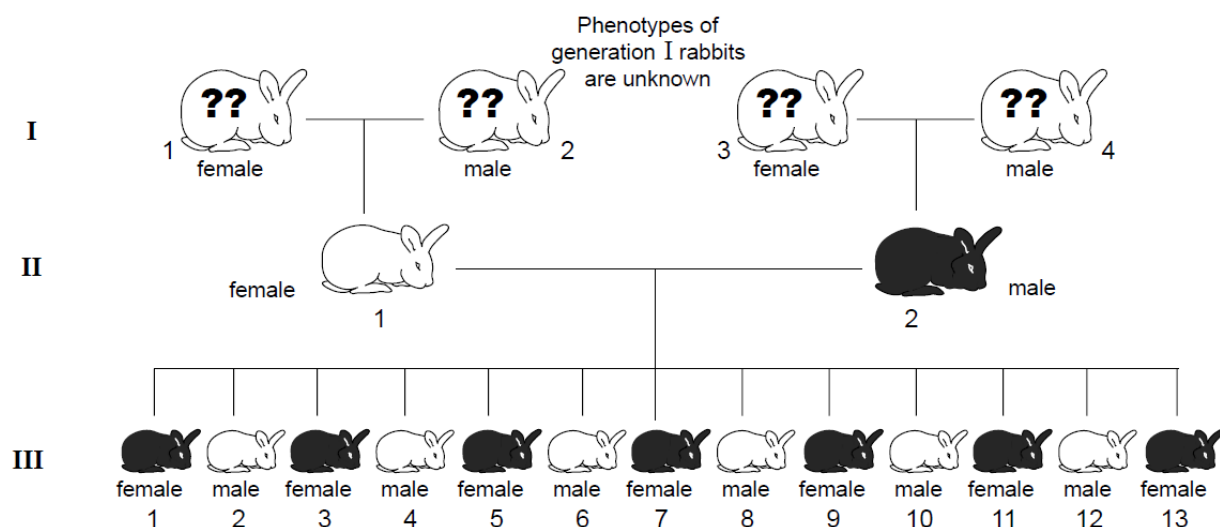
Which students made the correct comparison?

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



### Question 19

The pedigree below represents a family of rabbits. The shaded rabbits have an inherited disease. The phenotypes of I-1, I-2, I-3 and I-4 are not known.



Which correctly shows the possible phenotypes and genotypes of I-1, I-2, I-3 and I-4?

|    | I-1                    | I-2                  | I-3                    | I-4                  |
|----|------------------------|----------------------|------------------------|----------------------|
| A. | Unaffected<br>$X^aX^a$ | Unaffected<br>$X^aY$ | Unaffected<br>$X^aX^a$ | Affected<br>$X^AY$   |
| B. | Affected<br>$Aa$       | Unaffected<br>$aa$   | Affected<br>$Aa$       | Unaffected<br>$aa$   |
| C. | Affected<br>$X^AX^a$   | Unaffected<br>$X^aY$ | Affected<br>$X^AX^a$   | Unaffected<br>$X^aY$ |
| D. | Unaffected<br>$aa$     | Unaffected<br>$aa$   | Affected<br>$AA$       | Affected<br>$AA$     |

### Question 20

Two pure-breeding strains of a garden plant were obtained. One strain had red flowers and the other had white flowers. The two strains were crossed, yielding  $F_1$  plants all with pink flowers. The  $F_1$  plants were then interbred to produce  $F_2$  plants with the following petal colours:

red – 62      pink – 131      white – 67

Which of the following describes the inheritance of flower colour in the garden plants?

- A. The flower colour is controlled by a gene with two alleles and is affected by environmental factors such as acidity of the soil.
- B. The flower colour is controlled by two genes which are co-dominant to each other, resulting in a pink phenotype in  $F_2$  offspring which are heterozygous.
- C. The flower colour is controlled by three genes, each governing one flower colour.
- D. The flower colour is controlled by a gene with two alleles that are co-dominant to each other, resulting in a pink phenotype in  $F_2$  offspring which are heterozygous.

**Question 21**

A particular species of plants has the following genes and alleles.

| Characteristics      | Alleles           |                      |
|----------------------|-------------------|----------------------|
| Leaf shape           | Normal shape (Q)  | Wrinkled shape (q)   |
| Number of seed cases | One seed case (R) | Three seed cases (r) |

A cross between four different pairs of parents produced the following offspring.

| Phenotype                            | Number of offspring |         |         |         |
|--------------------------------------|---------------------|---------|---------|---------|
|                                      | Cross 1             | Cross 2 | Cross 3 | Cross 4 |
| Three seed cases and wrinkled leaves | 32                  | 0       | 0       | 99      |
| One seed case and wrinkled leaves    | 100                 | 0       | 211     | 301     |
| Three seed cases and normal leaves   | 96                  | 0       | 0       | 0       |
| One seed case and normal leaves      | 290                 | 355     | 221     | 0       |

What are the genotypes of the parents in the four crosses?

|           | Cross 1            | Cross 2            | Cross 3            | Cross 4            |
|-----------|--------------------|--------------------|--------------------|--------------------|
| <b>A.</b> | <b>QqRr x QqRr</b> | <b>qqRR x QQrr</b> | <b>QqRR x qqrr</b> | <b>qqRr x qqRr</b> |
| <b>B.</b> | qqRR x QQrr        | <b>QQRR x QQRR</b> | <b>QqRR x qqRR</b> | qqRR x qqrr        |
| <b>C.</b> | qqRR x QQrr        | <b>QQRR x qqrr</b> | QqRR x QqRR        | <b>qqRr x qqRr</b> |
| <b>D.</b> | <b>QqRr x QqRr</b> | qqrr x qqrr        | <b>QqRR x qqrr</b> | QQRr x QQRr        |

**Question 22**

In one of the scientific journals that Charles Darwin published in 1839, he wrote:

*“I have stated, that in the thirteen species of ground-finches [in the Galapagos Islands], a nearly perfect gradation may be traced, from a beak extraordinarily thick, to one so fine, that it may be compared to that of a warbler. I very much suspect that certain members of the series are confined to different islands; therefore, if the collection had been made on any one island, it would not have presented so perfect a gradation. It is clear, that if several islands have each their peculiar species of the same genera, when these are placed together, they will have a wide range of character.”*

What does the quote above illustrate?

- A. Convergent evolution, homologous structures
- B. Convergent evolution, analogous structures
- C. Divergent evolution, analogous structures
- D. Divergent evolution, homologous structures**

**Question 23**

The four-chambered hearts of birds and the four-chambered hearts of mammals evolved independently of each other. If one were unaware of this independence, then one might logically conclude that

- A. the birds were the first to evolve a 4-chambered heart.
- B. birds and mammals are more distantly related than is actually the case.
- C. mammals evolved from birds.
- D. the common ancestor of birds and mammals had a four-chambered heart.**

**Question 24**

An enzyme consists of four domains (A–D), one of which contains the active site. The amino acid sequences of these four domains have been determined and compared in five related species. Which domain probably contains the active site?

| <i>Domain</i> | <i>Percentage of identical amino acids</i> |
|---------------|--|
| <b>A.</b>     | 32%  |
| <b>B.</b>     | 8%   |
| <b>C.</b>     | <b>78%</b>                                 |
| <b>D.</b>     | 50%  |

**Question 25**

Green fluorescent protein (GFP) gene codes for GFP, a small protein that emits bright green fluorescence under UV light.

Genes coding for enzymes that act on substrates to produce fluorescent substances are often preferred over the GFP gene as markers in gene cloning.

Which of the following are the reasons why genes for enzymes that produce fluorescent substances are often preferred over the GFP gene in gene cloning?

1. GFP emits only green fluorescence, while enzymes that act on substrates to produce fluorescent substances can emit different colour fluorescents with different substrates.
2. Because enzymes can be reused, a few molecules of enzyme that produce fluorescent substances can produce a strong fluorescence as compared to the same number of GFP molecules.
3. Low expression of GFP gene may result in weak fluorescence that is difficult to detect, whereas low expression of genes for enzymes that produce fluorescent substances can still result in strong fluorescence by increasing the substrate concentration.

**A. 2 and 3 only**

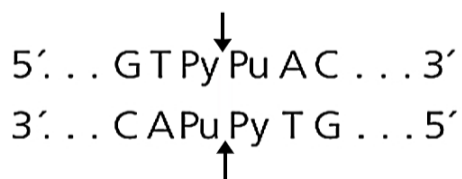
B. 1 and 2 only

C. 1 and 3 only

D. 1, 2 and 3

**Question 26**

The restriction enzyme *Hind*III recognizes and cut at the following sequence:



where Py is any pyrimidine, and Pu is any purine.

What is the number of DNA fragments produced upon subjecting the following short length of linear DNA to *Hind*III digestion?



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

**Question 27**

The steps involved in a method of production of human insulin by gene technology are listed below. The steps are not listed in the correct order.

| Steps | Description   |
|-------|---|
| 1     | DNA coding for human insulin inserted into cut plasmid vector |
| 2     | genetically modified bacteria identified                      |
| 3     | mRNA for human insulin is harvested                           |
| 4     | plasmid vector inserted into bacterium                        |
| 5     | genetically modified bacteria cloned                          |
| 6     | DNA for human insulin cloned                                  |
| 7     | cDNA coding for human insulin synthesised                     |

Which of the following shows the correct sequence of steps?

- A. 3 → 7 → 1 → 4 → 6 → 2 → 5**  
 B. 7 → 4 → 1 → 6 → 2 → 5 → 3  
 C. 3 → 1 → 6 → 2 → 5 → 7 → 4  
 D. 7 → 1 → 4 → 6 → 2 → 3 → 5

**Question 28**

Which of the following correctly describe(s) the differentiation of stem cells?

1. Embryonic stem cells taken from the inner cell mass of a blastocyst are able to differentiate into all the cell types of the body to form a whole organism.
2. In the differentiation of haematopoietic stem cells into white blood cells, genes that are not needed are excised from the genome, leaving only genes that are essential for the functions of white blood cells.
3. Induced-pluripotent stem cells (iPSC) are derived from terminally-differentiated somatic cells and have the capacity to differentiate into all cell types, but not those of the extraembryonic membranes.
4. Neural stem cells residing naturally in the neural tissue are only able to differentiate into cells of the nervous system, but are also capable of transdifferentiating into other cell types when artificially induced due to the plasticity nature of adult stem cells.

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

**Question 29**

Despite the potential benefits of using human embryonic stem (ES) cells in the treatment of diseases, the use of human embryos for research has always been high on the ethical and social agenda in many countries.

Which is/are the reason(s) why the ethical and social agenda exist?

1. Embryonic stem cell research poses a moral dilemma. It forces us to choose between two moral principles: the duty to prevent or alleviate suffering, and the duty to respect the value of human life.
2. Because the predominant methods being used to derive human embryonic stem cells require destruction of the embryo, the criteria for 'personhood' are notoriously unclear. Different people define what makes a person in different ways.
3. During in-vitro fertilization procedures, embryos that fail to develop sufficiently to be implanted are sometimes being used for ES cell research without the consent of the egg donor.
4. Offering payment beyond direct expenses would commercialize reproductive material and create a market for human eggs, which could lead to the exploitation of women.

A. 1 and 2 only      B. 3 and 4 only      C. 1, 2 and 4 only      **D. 1, 2, 3 and 4**

**Question 30**

Which row correctly states the goal, benefits and concern arising from the Human Genome Project?

|           | Goal   | Benefit  | Concern   |
|-----------|--|--|---|
| <b>A.</b> | To obtain the sequence of all the DNA nucleotides on all the human chromosomes. This would enable particular sequences to be patented so that advancements could be made in gene therapy.              | Genetic screening for earlier detection of genetic predispositions to disease as increasingly detailed genome maps have aided researchers to seek out genes associated with dozens of genetic conditions.  | Parents choosing embryos for implantation only after ante-natal tests for acceptable genes.                   |
| <b>B.</b> | To allow the various centres sequencing the DNA nucleotides on all the human chromosomes to share results on the databases. This would ensure that data were publicly available.                       | Assessment of risks posed to individuals caused by exposure to toxic agents such as radiation exposure, mutagenic chemicals and cancer causing toxins.   | Genetic archaeologists identifying the earliest forms of genes to show evolutionary relationships.            |
| <b>C.</b> | To develop techniques and technological tools for use in the sequencing project. This would lead to faster sequencing of sections of the human genome and improvements in mapping.                     | A better understanding of the human genome so that genetic counsellors can advise patients on the consequences and nature of the disorder, the probability of developing or transmitting it, and the options open to them in management and family planning. | An insurance company only giving cheap rates to people with genetic predispositions to fewer diseases.        |
| <b>D.</b> | To reduce the gap between the rich and the poor by mapping the positions of all the genes on all the human chromosomes. This would help to identify the location of many genes that can cause disease. | Allows cytologists to develop diagnostic tests for defective genes.  | The possibility of social discrimination that arises due to the knowledge of individual's genetic difference. |

**END OF PAPER 1**