VIC P	VICTORIA JUNIOR COLLEGE PRELIMINARY EXAMINATION HIGHER 2	
	Answers – last page	
CIGROUP		
BIOLOGY		9744/01
Paper 1		25 September 2023
Additional Materials: Multiple	1 hour	

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid. Write your name and class on the Answer Sheet in the spaces provided. WRITE and SHADE your EXAM NUMBER on the Answer Sheet in the spaces 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 separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

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. **1** The electron micrograph shows two organelles (not to the same scale) present in a plant cell.



Organelle P

Organelle Q

Which of the following options is **false** of the organelles P and Q?

- **A** Only organelle P contains enzymes.
- **B** Vesicles can be pinched off from both organelles.
- **C** Both organelles can fuse with vesicles coming from another organelle in the cell.
- **D** Organelle P is involved in synthesis of phospholipids while Q is involved in synthesis of glycoprotein.
- **2** How many rows in the table show correctly the chemical processes that occur in the organelles found in an animal cell?

Nucleus	Mitochondrion	Rough ER
polymerisation	phosphorylation	glycosylation
replication	reduction	polymerisation
translation	transcription	phosphorylation
transcription	oxidation	translation

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

3 The chart shows the concentration of some substances outside the cell surface membrane, in the cytoplasm, in two organelles 1 and 2 of a plant cell.



Which statement about the direction of movement of these substances and the process by which they are moving is correct?

- **A** Phosphate and ATP are entering the organelles 1 and 2 by active transport.
- **B** ATP is leaving organelle 1 by facilitated diffusion, water is leaving the plant cell by osmosis.
- **C** Phosphate and ATP are leaving organelle 2 by facilitated diffusion, water is leaving the plant cell by osmosis.
- Phosphate is entering the organelle 1 by facilitated diffusion, water is entering organelle
 1 by osmosis
- 4 Which row matches correctly each molecule to a type of bond that is present?

	ester bond	hydrogen bond	disulfide bond
Α	amylase	Haemoglobin	catalase
В	glycerol	glycogen	collagen
С	lipid	amylose	haemoglobin
D	Phospholipid	cellulose	antibody

5 Approximately half of the total protein in a pea seed consists of the storage protein vicilin.

Below are statements describing vicilin:

- Each molecule of vicilin is made up of three identical polypeptides.
- Each polypeptide is made up of two β-pleated sheet regions with linking α-helix regions, folded into a specific shape.
- This allows the three polypeptides to pack together into a compact, flat storage molecule, as shown below.



Based on the information provided, which of the following can be deduced about vicilin?

- **A** The primary structure of the polypeptides has repeating amino acid sequences.
- **B** The most significant level of organisation in vicilin is the secondary structure.
- **C** The β -pleated sheet and α -helix regions are formed by interchain hydrogen bonds at regular intervals between adjacent polypeptide chains.
- **D** Vicilin is coded by three genes, forming a major component of the protein content within the seed.

6 A student investigated the effect of urea on the activity of the enzyme urease. Urease catalyses the following reaction:

urea + water → ammonium carbonate

To find out the rate of the reaction by measuring the amount of ammonium carbonate produced in 10 minutes in different urea concentrations, the student carried out titrations using dilute sulfuric acid and recorded down the volumes of acid needed to neutralise the ammonium carbonate. The results were used to produce the graph below.



Which statements are correct?

- 1. At P, the rate of reaction is limited by the concentration of urease.
- 2. At Q, all the urease active sites are occupied by urea molecules.
- 3. R represents the affinity of the urease for the urea molecules.
- 4. At S, not all the urea molecules are occupying the active sites of urease.
- A 1 and 4 only
- **B** 2 and 3 only
- **C** 1, 2 and 4
- **D** 1, 3 and 4

7 Differentiating stem cells may be used to replace damaged tissues in mice. For example, neural precursor cells derived from embryonic stem cells can give rise to different types of functional nerve cells (neurons and dendrocytes) in the brains of mice.

One risk associated with this treatment is that small numbers of embryonic stem cells remain within cultures of neural precursor cells. When introduced to mice, embryonic stem cells can form tumours known as teratomas. Formation of teratomas in the heart or brain is fatal.

Ceramide and S1P are molecules that have opposite effects when they bind to protein receptors on stem cells. Binding of ceramide to stem cells promotes cell death, while binding of S1P to stem cells promotes survival by inhibiting cell death.

Adding a combination of ceramide and S1P to cultures of neural precursor cells can eliminate the risk of teratoma formation without making the stem cells less effective at replacing damaged brain tissue.

	Pluripotent stem cells	Multipotent stem cells		
Α	Have receptors for ceramide and S1P	Have receptors for ceramide but not for S1P		
В	Have receptors for ceramide but not for S1P	Have receptors for ceramide and S1P		
С	Do not have receptors for ceramide or for S1P	Have receptors for S1P but not for ceramide		
D	Have receptors for S1P but not for ceramide	Do not have receptors for ceramide or for S1P		

Which row provides a possible explanation for this?

8 The figure below shows the process of DNA replication.



Which of the following statements is/are true about the process?

- 1. Q is located around the origin of replication.
- 2. R is synthesized discontinuously towards the replication fork.
- 3. T is a short DNA primer for DNA polymerase to elongate.
- 4. S is synthesized continuously until the end of the strand.
- A 1 only
- B 2 only
- **C** 1 and 4
- **D** 2 and 3

9 The diagram below shows a codon table.

Second Base III Codoli										
		U	С	А	G					
First Base in Codon	U	UUU UUC UUA UUG	UCU UCC UCA UCG	UAU UAC UAA Stop UAG Stop	UGU UGC UGA Stop UGG Trp	U C A G				
	С	CUU CUC CUA CUG	CCU CCC CCA CCG	CAU CAC His CAA CAA CAG	CGU CGC CGA CGG	U C A G	e in Codon			
	A	AUU AUC AUA AUG Met or Start	$\left. \begin{array}{c} ACU \\ ACC \\ ACA \\ ACG \end{array} \right\} Thr$	AAU AAC AAA AAG Lys	$\left. \begin{array}{c} AGU \\ AGC \end{array} \right\}_{Ser} \\ \left. \begin{array}{c} AGA \\ AGG \end{array} \right\}_{Arg} \end{array}$	U C A G	Third Base			
	G	GUU GUC GUA GUG	GCU GCC GCA GCG	GAU GAC GAA GAA GAG Glu	GGU GGC GGA GGG	U C A G				

Second Base in Codon

Part of the coding strand controlling the production of a polypeptide includes the nucleotide sequence below.

т	Α	т	Α	Α	G	Α	т	G	С	С	т	т	G	G
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
∱ Start Reading														

Using the information provided, which of the following statements shows the effect of the type of mutation on the DNA sequence?

- **A** A substitution mutation at position 10 with adenine can cause the production of a truncated protein.
- **B** A deletion of a nucleotide at position 12 has no effect on the primary structure.
- **C** A substitution mutation at position 9 with adenine would produce no alteration in the polypeptide sequence.
- **D** An insertion of a thymine after position 3 can cause a premature termination of translation.

10 Cyclins are important regulatory proteins that control the cell cycle together with cyclindependent kinases. Their presence at the precise timing will help to ensure proper cell division and maintain genomic stability.

The figure below shows the changes of concentration of different cyclins in the cell cycle.



What can account for the changing concentration of different cyclins?

- 1. Ubiquitylation of cyclins
- 2. DNA methylation
- 3. Repressor binding to operator
- 4. Activator binding to promoter
- 5. Histones acetylation
- A 1 and 5 only
- B 2 and 4 only
- **C** 3 and 4 only
- **D** 1, 2 and 5
- 11 Which of the following statements about splicing is true?
 - A Spliceosome recognises the splice sites of the pre-mRNA.
 - **B** In the process of excising the intron, there is a formation of a RNA loop.
 - **C** Variability in the splice site sequence allows for different combinations of exons.
 - **D** More than one type of mature mRNA can be produced due to different introns being removed.

12 The diagram below shows a telomere loop (T-loop) which is a crucial structure at the end of linear chromosomes. This protective cap consists of telomeric DNA and associated proteins known as the telomeric repeat factors (TRF).



Which of the following statements explain the importance of the T loop?

- **A** Telomeres wind tightly around the TRF to prevent successive DNA replication.
- **B** T loop prevents the shortening of the linear ends of chromosomes after each successive division by hiding the 3' overhang.
- **C** T loop helps to hide the single stranded 3' overhang to prevent aberrant chromosomal fusion.
- **D** The binding of TRF helps to ensure that the telomeric sequences will not be subjected to mutation which can affect the telomerase activity.

13 A gene locus B on human chromosome 2 has two alleles – B and b. Allele b has a single base mutation that results in the loss of a restriction site.

Gene B was isolated from an individual using Polymerase Chain Reaction (PCR). Restriction digestion was carried out on the PCR products and then visualized using Southern blotting.

The diagram below shows the restriction map of the two alleles and the position of radioactive probe.



restriction sites

Which of the lanes best represents the genotype of a heterozygote?



14 Which row shows a comparison that is **incorrect** between a typical prokaryotic cell and a typical eukaryotic plant cell?

	Prokaryotic cell	Eukaryotic plant cell
Α	Circular DNA is found in the nucleoid region.	Linear DNA associated with histone proteins is found in the nucleus.
В	Horizontal gene transfer occurs to give rise to genetic variation.	Genetic variation arises from meiosis and random fusion of gametes.
С	Presence of peptidoglycan cell walls.	Presence of cellulose cell walls.
D	All ribosomes are approximately 20 nm in diameter.	All ribosomes are approximately 22 nm in diameter.

15 The diagram shows the main structural features of the influenza virus, H1N1.



Which option is not a correct statement regarding P, Q, R, S and T?

- **A** The host cell enzymes are not required to form the complementary strand from **P** during viral replication in the host nucleus.
- **B** During entry of the virus into the host cell, fusion of **Q** with the endosomal membrane releases **P** and **R** into the cytoplasm.
- C Genetic reassortment between H1N1 viruses will result in major changes to S and T.
- **D T** has to be embedded in the phospholipid bilayer of the Golgi vesicles to be able to serve as exit points.

16 The graph below shows the DNA content present in diploid cells of an organism undergoing the meiotic cell cycle. Samples W-Z are cells at different phases of the cell cycle.



Which of the following shows correctly the stage of the cells in the various samples?

	Sample W	Sample X	Sample Y	Sample Z
Α	G1 phase	Telophase II	G2 phase	Telophase I
В	G2 phase	Anaphase II	S phase	G1 phase
С	S phase	G1 phase	Fertilisation	Anaphase I
D	Telophase I	G1 phase	S phase	G2 phase

17 A cell has the genotype of AaBb. The two genes are found on different homologous chromosomes.

Which prediction is consistent with events that occur in this cell during meiotic cell cycle?

- A At the end of meiosis I, the cells formed will have a copy of all the alleles.
- **B** At the end of meiosis I, separation of homologous chromosomes will result in cells will either Aa or Bb genotype.
- **C** At the end of meiosis II, cells will contain one copy of each gene, so that the zygote will have two alleles for each gene.
- **D** At the end of meiosis II, cells will half the number of genes are formed so that the original number of genes can be restored upon fertilization.

18 The figure shows the results of the growth of both normal and cancer cells in a culture media in a laboratory over a period of four days.



Which of the following is not an explanation of the results?

- A Cancer cells can proliferate in the absence of serum growth factors because their proliferation does not depend on the interaction between growth factors and their receptors.
- **B** Normal cells growing in the culture exhibit a limited capacity for cell division and their growth levels off when the growth factors become depleted.
- **C** With a constant source of serum growth factors, normal cells will continue to divide due to the signal being transduced into the cells.
- **D** Cancer cells continue to grow regardless of the presence or absence of serum growth factors whereas normal cells are dependent on growth factors for growth.

19 When a pure-breeding orchid plant with purple flower and tall stem is crossed with another pure-breeding plant with white flower and short stem, the F₁ generation orchid plants are found to have all purple flower and tall stem. Selfing of the F₁ generation results in the following offspring obtained:

F ₂ generation phenotypes	Number of plants in the F_2 generation
Purple flower and tall stem	140
Purple flower and short stem	20
White flower and tall stem	24
White flower and short stem	16

The chi-squared test was used to compare these results to determine whether the two genes assort independently.

The formula of chi-squared test and probability table are as follows:

$$\chi^2 = \Sigma \frac{(O-E)^2}{E}$$
 whe

ere Σ = 'sum of' O = observed 'value' E = expected 'value'

Degrees of	Probability					
Treedom	0.10	0.05	0.01	0.001		
1	2.71	3.84	6.64	10.83		
2	4.69	5.99	9.21	13.82		
3	6.25	7.82	11.35	16.27		
4	7.78	9.49	13.28	18.47		

Which conclusion correctly explains what the chi-squared test results indicates about the two traits?

- A Since the calculated X² is smaller than that of the X² critical value, there is no significant difference between the observed and expected results. Thus, the inheritance of the two traits is following Mendel's law of independent assortment.
- **B** Since p < 0.001, null hypothesis is rejected and thus the inheritance of the two traits does not follow Mendel's law of independent assortment.
- **C** Since the calculated X² is greater than that of the X² critical value, there is significant difference between the observed and expected results. Thus, the inheritance of the two epistatic traits follows Mendel's law of independent assortment.
- **D** Since p < 0.05, there is no significant difference between the observed and expected results. Thus, the inheritance of the two traits is following Mendel's law of independent assortment.

20 The coat colour of the cat is determined by gene locus B. In all, there are three different coat colour presented in the cat – black, dark brown and cinnamon (light brown).

Different combinations of female and male cats are mated and the results are shown in the table below

Female	Male	F1 generation
Black	Cinnamon	All black
Cinnamon	Black	1 female black: 1 male black: 1 female dark
		brown: 1 male dark brown
Black	Dark Brown	2 female black: 2 male black: 1 female cinnamon:
		1 male cinnamon: 1 female dark brown: 1 male
		dark brown

Which of the following describes the possible mode of inheritance in the coat colour of the cat?

- 1. Incomplete dominance
- 2. Complete dominance
- 3. Multiple alleles
- 4. Sex linkage
- A 1 only
- **B** 3 only
- **C** 2 and 3
- **D** 2 and 4
- 21 The diagram summarises the reactions of photosynthesis in a plant.



Which of the following correctly identifies the substances involved?

	CO ₂	reduced NADP	H₂O	ADP	O ₂
Α	U	W	Y	V	Z
В	U	W	Z	Y	V
С	V	U	Z	W	Y
D	V	U	Y	U	Z

22 Which row matches correctly a product from the different processes Q, R, S and T?



23 The results of increased concentrations of carbon dioxide on soy bean photosynthesis at various leaf temperatures. Carbon dioxide concentration is measured in ppm (parts per million). Light intensity was at an optimum level.

The graph shows the effects of temperature on the rate of photosynthesis in creeping azalea plant at three different light intensities. The effect of temperature on the rate of respiration was also shown.



Which of the following conclusions can be drawn from the graph?

- **A** At leaf temperatures up to 15°C both light intensity and temperatures are limiting.
- **B** At leaf temperatures higher than 30°C, all the proteins in the plant are denatured.
- **C** Increasing light intensity increases the optimum temperature as light provides the kinetic energy for the enzymatic reactions in Calvin cycle.
- **D** As leaf temperature increases, the rate of respiration increases so as to provide more carbon dioxide for photosynthesis.

24 The epinephrine signaling pathway plays a role in regulating glucose homeostasis in muscle cells. The signaling pathway is activated by the binding of the epinephrine to the β -2 adrenergic receptor which is a G protein coupled receptor.

Which of the following steps in the signaling pathway result in signal amplification?

- 1. Binding of epinephrine to the adrenergic receptor resulting in the activation of G protein
- 2. Activation of adenylyl cyclase by subunit of activated G protein
- 3. Production of cAMP by adenylyl cyclase
- 4. Activation of Protein Kinase A by cAMP
- 5. Activation of phosphorylase by Protein Kinase A
- **A** 1, 2 and 4
- **B** 1, 3 and 5
- **C** 2, 3 and 5
- **D** 3, 4 and 5
- 25 The phylogenetic tree below shows the relationship between four species 1-4.



What can be concluded from this tree?

- A Species 3, instead of species 2, is more related to species 4.
- **B** Shared ancestral traits are found in all species.
- **C** Genetic difference between species 2 and 4 is greater than between species 1 and 2.
- **D** The most recent common ancestor of species 3 and 4 is also the ancestor of 1.

26 Two areas of molecular biology that have received considerable attention in evolutionary studies are the genetic code and cytochrome C. Cytochrome C is an essential component of all respiratory electron transport chains.

Which statements lend evidence to the ideas that

- all living organisms are related
- there is a single, rather than a multiple, origin of life?
- 1. The universal nature of the genetic code is a result of evolutionary convergence from multiple lineages.
- 2. The sequence of amino acids in cytochrome C is similar in organisms that are from similar environments or with similar metabolic demands.
- 3. The majority of organisms have the same, or similar, amino acid sequences for cytochrome C.
- 4. When transferred into a very dissimilar organism, a gene coding for cytochrome C will lead to the expression of a protein that will function in the other organism.
- A 1 and 2 only
- B 2 and 3 only
- C 3 and 4 only
- **D** 1, 3 and 4
- **27** T-lymphocytes have a protein, PD-1, on their surface. Some cancer cells have a receptor molecule on their surface which binds with PD-1, inactivating the T-lymphocyte.

A monoclonal antibody, lambrolizumab, has been produced against this receptor.

Trials showed that in 54 of 135 people with advanced skin cancer who were given lambrolizumab, the tumour volume is reduced by more than half. In six of the 57 people who were given the highest dose the tumours disappeared.

What may be correctly concluded from this information?

- 1. Lambrolizumab binds with a receptor on the surface of skin cancer cells.
- 2. Cancer cells to which lambrolizumab is bound cannot inactivate T-lymphocytes.
- 3. Lambrolizumab targets and kills skin cancer cells.
- 4. Lambrolizumab allows a patient's own immune system to kill cancer cells.
- A 1 and 2 only
- **B** 1 and 3 only
- **C** 1, 2 and 4
- **D** 2, 3 and 4

- 28 Which of the following conveys the long-lasting immunity to an infectious agent?
 - 1. Naturally acquired passive immunity
 - 2. Artificially acquired passive immunity
 - 3. Naturally acquired active immunity
 - 4. Artificially acquired active immunity
 - A 1 and 2
 - **B** 1 and 3
 - **C** 2 and 4
 - **D** 3 and 4
- **29** The diagram below shows the coral cover at Great Barrier Reef from 1985 to 2010.



Which of the following statements is a possible explanation for the graph above?

- A The decrease in coral cover in 1985 could be due to a prolonged period of coral bleaching.
- **B** The increase in coral cover in 1990 1995 is a result of bleached coral recovering over years.
- **C** The increase in coral cover in 1990-1995 could be due to increased UV radiation for the zooxanthellae to photosynthesise.
- **D** The decrease in coral cover from 1995-2010 could be due to expulsion of zooxanthellae as they are unable to photosynthesise.

30 The figures below show the temperature range of 2 different insect species. One is a temperate species while the other is a tropical species.



Which of the following statements cannot be concluded based on the data provided?

- **A** Temperate species have a broader thermal tolerance as compared to tropical species.
- **B** Climate change can cause changes in the value of ΔT for both species
- **C** There is little variability in the upper thermal limits of both the temperate and tropical species.
- **D** Global warming will cause an immediate reduction in fitness for both temperate and tropical species.

Answers

Question number	Answer	Question number	Answer
1	A	16	А
2	С	17	С
3	В	18	С
4	D	19	В
5	А	20	С
6	A	21	С
7	В	22	D
8	A	23	А
9	D	24	В
10	D	25	В
11	В	26	С
12	С	27	С
13	В	28	D
14	D	29	А
15	С	30	D