

VICTORIA JUNIOR COLLEGE JC 2 PRELIMINARY EXAMINATION 2021 HIGHER 2

NAME:

CT CLASS:

BIOLOGY

9744 / 01

Paper 1 Multiple Choice

24/09/2021

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

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 three cell organelles X, Y and Z.



Which of the following statements about organelles X, Y and Z is/are true?

- 1 If a metabolic poison is introduced into the cell, only the function of organelles Y and Z will be disrupted.
- 2 Organelles Y and Z have more than one type of RNA associated with them.
- 3 In the absence of organelle X, the fluidity of the membrane will not be regulated.
- **A** 1, 2 and 3
- B 1 and 3 only
- C 2 and 3 only
- D 2 only

2 The table compares the structure and function of some biomolecules.

	Structure	Function	
	Polymer	Storage	Structural
Starch	1	2	3
Cellulose	4	5	6
Triglyceride	7	8	9
Phospholipid	10	11	12

Which combination of numbers links the four biomolecules to their correct structures and functions?

- **A** 1, 2, 4, 6, 8 and 12
- **B** 1, 3, 5, 8, 10 and 11
- **C** 2, 4, 6, 7, 8 and 11
- **D** 3, 4, 6, 8, 10 and 12
- 3 Which roles of the cell surface membrane result from the properties of the phospholipids?



4 Adult human haemoglobin typically consists of two α chains and two β chains.

Approximately 5% of humans have one amino acid in the β chain that has been changed. This change affects the structure and stability of haemoglobin.

Which levels of protein structure could be affected in the haemoglobin with the changed amino acid?

- A primary only
- **B** primary, secondary and tertiary only
- **C** secondary, tertiary and quaternary only
- **D** primary, secondary, tertiary and quaternary
- **5** The decomposition of hydrogen peroxide to water and oxygen is catalysed by the enzyme catalase.

During an investigation, 2 cm³ of catalase was added to 20 cm³ of hydrogen peroxide and the volume of oxygen released was collected at intervals over a period of time.

Which bar chart shows the result of this investigation?



6 Under normal metabolism, alcohol is broken down in the liver by the enzyme alcohol dehydrogenase to acetaldehyde, which is then converted by the enzyme acetaldehyde dehydrogenase to a harmless acetic acid derivative.

Disulfiram is a drug used to support the treatment of alcoholism. It is a specific enzyme inhibitor of acetaldehyde dehydrogenase. In the presence of disulfiram, the Michaelis-Menten constant (Km) for acetaldehyde dehydrogenase increases. In the presence of disulfiram, alcohol consumed can only be partly broken down, resulting in nausea and vomiting.

Why is it important that the enzyme inhibitor disulfiram is specific?

- 1 It cannot disrupt other metabolic pathways.
- 2 It prevents alcohol from binding to the active site.
- 3 It is unlikely to cause unwanted side effects.
- 4 It binds to an allosteric site of acetaldehyde dehydrogenase.
- **A** 1, 2, 3 and 4
- **B** 1, 2 and 3 only
- C 1 and 3 only
- **D** 2 and 4 only

7 The diagram shows the relationship between the different potency of stem cells.



Which of the following options describes the potency of stem cells found in 1 - 3?

	1	2	3
Α	differentiate into any cell type to form the whole organism	differentiate into limited range of cells and tissues appropriate to their location	differentiate into almost any cell type to form any organ or type of cell
В	differentiate into limited	differentiate into almost any	differentiate into any cell
	range of cells and tissues	cell type to form any organ	type to form the whole
	appropriate to their location	or type of cell	organism
С	differentiate into any cell	differentiate into almost any	differentiate into limited
	type to form the whole	cell type to form any organ	range of cells and tissues
	organism	or type of cell	appropriate to their location
D	differentiate into almost any	differentiate into any cell	differentiate into limited
	cell type to form any organ	type to form the whole	range of cells and tissues
	or type of cell	organism	appropriate to their location

8 Bacteria were cultured in a medium containing heavy nitrogen (¹⁵N) until all the DNA was labelled. These bacteria (generation 1) were then grown in a medium containing only normal nitrogen (¹⁴N) for two generations (generation 2 and 3). The percentage of cells containing ¹⁵N in each generation was estimated.

What will be the percentage of cells containing ¹⁵N in generations 2 and 3?

	Percentage of cells containing ¹⁵ N			
	Generation 2 Generation 3			
Α	100	100		
В	100	50		
С	50	50		
D	50	25		

9 The diagram below shows some of the molecules involved in translation. They are not drawn to scale.



diagram not drawn to scale

Which of the following statements is true?

- A Molecule 1 may contain the elements carbon, hydrogen, nitrogen, oxygen and phosphorus.
- **B** The amino acids in the active site of molecule 2 lowers the activation energy by increasing the reactivity of the groups involved in peptide bond formation.
- **C** Molecule 3 will allow the addition of water molecule to hydrolyse the peptide bonds in the polypeptide.
- **D** Bond 4 is formed from the carboxyl group of His with the amino group of Arg.

A polypeptide has the amino acid sequence glycine – arginine – lysine – serine.
The table gives possible tRNA anticodons for each amino acid.

amino acid	tRNA anticodons
arginine	UCC GCG
glycine	CCA CCU
lysine	υυς υυυ
serine	AGG UCG

Which sequence of bases on DNA would code for the polypeptide?

- A CCACGCAAGAGC
- B CCTTCCTTCTCG
- **C** GGAAGGAAAAGC
- **D** GGTTGGTTGTGC
- 11 DNA-RNA hybrids are formed by using the mature mRNA for a given gene that is expressed in both the pituitary gland and adrenal gland. The molecular weight of the proteins translated from the mature mRNA from both glands differ by 20%.

It was observed that certain regions of the DNA remained as single stranded while others form double stranded with the mRNA.

Based on the information provided, which of the following statements is true?

- A The number of single stranded DNA regions formed in DNA-RNA hybrid for pituitary gland is the same as that for the DNA-RNA hybrid for the adrenal gland.
- **B** The number of double stranded regions formed in DNA-RNA hybrid for pituitary gland is the same as that for the DNA-RNA hybrid for the adrenal gland.
- **C** The double stranded DNA-RNA regions formed can be made up of both exons and introns.
- **D** The single stranded DNA regions formed in DNA-RNA hybrid may contain exons.

- **12** Which of the following statements is not an advantage of the lysogenic cycle to the lambda phage virus?
 - **A** A stable mode of continued perpetuation of viral DNA is guaranteed.
 - **B** Viral DNA is replicated whenever the bacteria undergo binary fission.
 - **C** Many copies of the phage DNA are replicated within the same host cell.
 - **D** High numbers of prophage can be obtained as bacteria reproduce rapidly.
- 13 The electron micrograph below shows *Escherichia coli* undergoing a certain process.



Which of the following is important for the process shown?

- A pass G1/S checkpoint
- **B** presence of plasmids
- **C** growth of bacterium
- **D** genetic variation

14 Which statement describes the role of cyclic AMP in gene expression of prokaryotic and eukaryotic cells?

	Prokaryotic cell	Eukaryotic cell
Α	It prevents the regulator protein from binding to the <i>lac</i> operator when glucose concentration is low.	It serves to amplify the glucagon signal when glucose concentration is low leading to cellular responses in liver cells.
В	It enhances the expression of the <i>lac</i> operon when glucose concentration is low.	It amplifies glucagon signal when glucose concentration is low leading to nuclear responses to help bring blood glucose up.
С	It activates the repressor protein to prevent RNA polymerase from accessing the <i>lac</i> structural genes.	It activates protein kinase A, triggering a phosphorylation cascade to inhibit an activator to downregulate gene expression.
D	It activates a regulator protein so RNA polymerase binds more effectively to the <i>lac</i> promoter.	It activates protein kinase A which phosphorylates other kinases, leading to transcriptional regulation of various genes.

- **15** The following are characteristics of eukaryote transcription.
 - Promoters are activated by transcription factors that recognise specific DNA sequences and other sequences that are very similar.
 - Within a promoter, there may be recognition sites for more than one transcription factor.
 - Similar specific sequences can be recognised by more than one transcription factor.
 - Each transcription factor may be capable of recognising a number of promoter recognition sites.

What explains the different levels of expression of a eukaryotic gene?

- A Competition between recognition sites present in the promoter for transcription factors.
- **B** Competition between transcription factors that recognise the same sites of a promoter.
- **C** The number of transcription factors that recognise the same sites of a promoter.
- **D** The number of types of different transcription factors.

16 The four photographs show cells in a flowering plant (2n=24) undergoing meiosis.

Which of the following statements is true?

- **A** At stage I, the homologous chromosomes are arranged across the equator.
- **B** The correct sequence of events is $|| \rightarrow | \rightarrow ||| \rightarrow |V|$.
- **C** The total number of chromosomes in stage III is 48.
- **D** Each group of chromosomes in stage IV only has one copy of the allele for every gene.



17 The figure below shows some of the stages in the development of cancer.

Which of the following identifies correctly the possible processes that occur in 1-4?

	1	2	3	4
Α	cell escapes apoptosis	cells lost contact inhibition	Loss of cell-cell adhesion	metastasis
В	rate of cell division exceeds rate of cell death	angiogenesis	loss of cell-cell adhesion	metastasis
С	cell acquires ability to halt cell cycle	cells undergo structural changes	angiogenesis	metastasis
D	cell acquires a growth advantage	cells lost contact inhibition	angiogenesis	loss of cell-cell adhesion

- **18** In the pea plant (*Pisum sativum*), the timing of flowering is controlled by multiple alleles. Investigators have found evidence for four different alleles at this gene locus that can exert temporal control of flowering:
 - **F**^v very early flowering
 - **F^E** early flowering
 - **F^M** mid flowering
 - **F^L** late flowering

Another **A/a** gene locus on a different chromosome codes for the colour of the flower which is either purple or white.

The table below shows the results of crosses between a mid flowering plant with purple flowers with three other different plants:

Cross	Parents	Offspring
1	mid flowering, purple flowers x early flowering, purple flowers	50% mid flowering, 25% early flowering, 25% very early flowering; All purple flowers
2	mid flowering, purple flowers x mid flowering, white flowers	75% mid flowering, 25% early flowering; 50% purple flowers, 50% white flowers
3	mid flowering, purple flowers x late flowering, purple flowers	50% late flowering, 25% mid flowering, 25% early flowering; 75% purple flowers, 25% white flowers

Which of the following options match the genotypes correctly to their phenotypes?

	Early flowering plant with purple flowers	Mid flowering plant with white flowers	Late flowering plant with purple flowers
Α	F ^E F ^L Aa	F ^M F ^E aa	F ^L F ^L Aa
в	F ^E F ^v Aa	F ^M F ^L aa	F [∟] F [∨] AA
с	F ^E F ^M AA	F ^M F ^M Aa	F [⊥] F ^M AA
D	F ^E F [∨] AA	F ^M F ^E aa	F ^L F ^E Aa

19 A naturally occurring mutant tomato plant with yellow fruit was crossed with the red wild type.

The first generation plants were self-pollinated and were also backcrossed with both parents.

The results are below:

- The first generation plants all produced red coloured fruits.
- The second generation plants produced fruits in a ratio of 3 red : 1 yellow.
- Plants from a backcross with red wild type all produced red fruits.
- Plants from a backcross with the yellow mutant produced fruits in a ratio of 1 red : 1 yellow.
- The mutant yellow fruit had a higher rate of chlorophyll breakdown during fruit ripening.
- The red fruit from the first generation showed lower rates of chlorophyll breakdown, as similarly observed in red wild type fruits.

Which of the following can be concluded from the results above?

- 1 Parental plants are homozygous for both the genes coding for colour of fruit.
- 2 Yellow phenotype is due to a recessive allele found at the same locus as the red allele.
- 3 Red phenotype is observed when red allele cannot fully mask effects of the yellow allele.
- **4** Recessive allele codes for a non-functional enzyme while dominant allele codes for a functional enzyme.
- **A** 1, 3 and 4
- B 1 and 3 only
- **C** 2 and 4 only
- D 2 only

20 Duchenne muscular dystrophy is a condition characterised by progressive muscle wasting. It is caused by a recessive mutation in the DMD gene, located on the X chromosome. The DMD gene codes for a protein known as dystrophin, which in healthy individuals, prevents damage and weakening of muscle fibres.

Which statement explains why not all affected males inherit the mutation from their mother?

- A Some affected males inherit the mutation from their father, who has inherited the mutation from a carrier mother.
- **B** Some males with mothers who are not carrier of the mutated allele are affected as a result of a new mutation in the DMD gene.
- **C** Crossing over occurred in some affected males to result in recombinant chromosomes containing the defective DMD gene.
- **D** Environmental factors induced the expression of the defective genes found on both chromosomes in the affected males.

21 Two pure-bred lines of two varieties of maize which differed greatly in cob length were crossed. The F_1 were allowed to self-fertilize to produce the F_2 generation.

The length of the cobs produced by the two parental varieties and their offspring were measured to the nearest centimetre. The percentage of plants in each length category was counted and shown in the graph below.



Which of the following options show the correct distribution of plants when a back-cross was conducted using the F1 generation?



22 Amitrole is a weed killer. The bar chart shows the effect of amitrole on oxygen uptake and release by plants.



Which of the following can explain the results shown in the bar chart?

- 1 Amitrole has no effect on the rate of respiration in weeds.
- 2 Untreated plants release oxygen in the light by photosynthesis only.
- 3 Amitrole binds irreversibly to inhibit electron carriers in electron transport chain.
- 4 Amitrole blocks light independent reaction but not light dependent reaction.
- A 1 and 2 only
- B 2 and 3 only
- C 3 and 4 only
- **D** 1, 3 and 4

23 An experiment was conducted on a yeast culture inside a commercial fermenter to monitor the rate of anaerobic respiration taking place over a period of time. The yeast culture was incubated with a fixed concentration of glucose at the beginning of the experiment and various parameters were tracked and recorded as shown below.



Which of the following can be concluded from the experiment?

A High concentration of ethanol exerts toxic effects on yeast.

- **B** Rate of glycolysis in yeast increases as dissolved oxygen level drops.
- **C** Biomass of yeast plateaus off because the number of yeast cells become limiting.
- **D** pH of the yeast culture decreases because CO₂ was released from the decarboxylation of ethanal.

24 Three isolated proteins were investigated for their involvement in cellular activities. The properties of these proteins are listed below.

	Protein Q	Protein P	Protein R
ATPase activity	+	-	-
GTPase activity	-	-	+
Protein binding	-	+	+
Transmembrane domain	+	+	-

Key: (+) present, (-) absent

Which of the following correctly shows the identities of these three proteins?

	Protein Q	Protein P	Protein R
Α	Na⁺ K⁺ pump	Glucagon receptor	Ras protein
в	ATP synthase	Glucose transporter protein	Electron carrier
с	Ras protein	Electron carrier	ATP synthase
D	Glucose transporter protein	Na⁺ K⁺ pump	Glucagon receptor

25 A study was conducted to study the signalling pathway of a newly discovered hormone. A liver cell extract was treated with the hormone. At regular time intervals, samples of cells were lysed and the levels of specific cellular components were measured.

Time / a	Levels o	Levels of Cellular Component / arbitrary units			
Time / S	PIP ₂	РКС	IP ₃	Ca²+	
15	8.9	0.0	4.8	1.2	
30	6.5	0.0	6.9	1.2	
45	4.3	0.0	8.0	1.2	
60	1.5	0.0	9.5	8.7	
75	0.3	6.9	11.4	12.4	

Results of the measurement are shown in the table below.

Based on the results, which of the following is the correct sequence of cellular components in the signalling pathway?

- **A** PKC \rightarrow IP₃ \rightarrow Ca²⁺ \rightarrow PIP₂
- **B** $IP_3 \rightarrow PKC \rightarrow Ca^{2+} \rightarrow PIP_2$
- **C** $PIP_2 \rightarrow IP_3 \rightarrow Ca^{2+} \rightarrow PKC$
- **D** $Ca^{2+} \rightarrow PIP_2 \rightarrow IP_3 \rightarrow PKC$

26 The graph below shows the frequency of five alleles in a population over 10 generations.

The change in allele frequency is represented as a percentage of the frequency of the five alleles.



Based on the information in the graph, which one of the following is true?

- A Changes in alleles 1 and 5 can be explained by frequency-dependent selection.
- **B** Allele 2 does not confer any advantage or disadvantage to the organism.
- **C** Allele 3 is recessive and changes in allele frequency is due to heterozygote protection.
- **D** Allele 4 is dominant over the other alleles.

27 Modern varieties of wheat have developed from numerous hybridisation events between different species of wild grasses. Fig. 4.1 shows some of the possible steps that are believed to have been involved in the development of bread wheat, *Triticum aestivum*.



Legend: A, B, C different sets of chromosomes

Which of the following statements is true?

- A *Triticum urartu* and *Aegilops speltoides* are expected to produce fertile offspring as they have the same number of chromosomes.
- **B** Doubling of chromosomes allows *Triticum turgidum* to produce viable gametes.
- **C** *Triticum aestivum* is an autopolyploid with 42 chromosomes.
- **D** *Triticum aestivum* is formed as a result of allopatric speciation.

28 The goldenrod gall flies, *Eurosta solidaginis*, lay their eggs individually in developing shoots of the tall goldenrod plant (*Solidago* sp.). The fly larva that hatches from the egg makes a chemical that causes the plant tissue to swell around it, resulting in the formation of a mass of plant tissue called a gall. The gall serves as a home for the larva.

Downy woodpeckers attack large galls and eat the gall fly larva.

Parasitic wasps lay eggs inside small galls and the wasp larvae that hatch from the eggs eat the gall fly larva when it hatches. They are not able to lay eggs in large galls as the wall of the large gall is too thick for the ovipositor of a parasitic wasp to penetrate.



Based on the information given, which of the following conclusions can be drawn?

- A This is an example of stabilising selection where larvae that produce high or low concentration of the chemical will be selected against.
- **B** This is an example of stabilising selection where galls of large and small sizes are selected for as both the woodpeckers and parasitic wasps feed on them.
- **C** This is an example of disruptive selection as the woodpecker and parasitic wasps select for the large and small sized galls respectively.
- **D** This is an example of disruptive selection as larvae that produce high or low concentration of the chemical will be selected for.



The figure below shows the progression of an immune response in a healthy individual.

Which of the following options is correct?

	Р	Q	R	S
Α	Macrophages	B cells	Plasma B cells	T helper cells
в	T helper cells	Cytotoxic T cells	Memory B cells	Macrophages
с	B cells	T helper cells	Memory T cells	Cytotoxic T cells
D	Dendritic cells	T helper cells	Memory B cells	T helper cells

30 A vaccine is available against most common strains of the influenza virus.

Which statement explains why vaccinated people are not immune to a unique strain of influenza virus?

- A Antibodies produced against the virus has already undergone degradation.
- **B** Naïve B cells are unable to recognize the virus through their B cell receptors.
- **C** Memory B cells do not have compatible receptors for the viral glycoproteins.
- **D** Plasma B cells require cytokines from Helper T cells for effective class switching to take place.