

NANYANG JUNIOR COLLEGE
PRELIMINARY EXAMINATIONS
Higher 2

CANDIDATE
NAME

CLASS

BIOLOGY

9744/01

Paper 1 Multiple Choice

24 September 2025

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name and CT on the Answer Sheet in the spaces provided unless this has been done for you.

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.

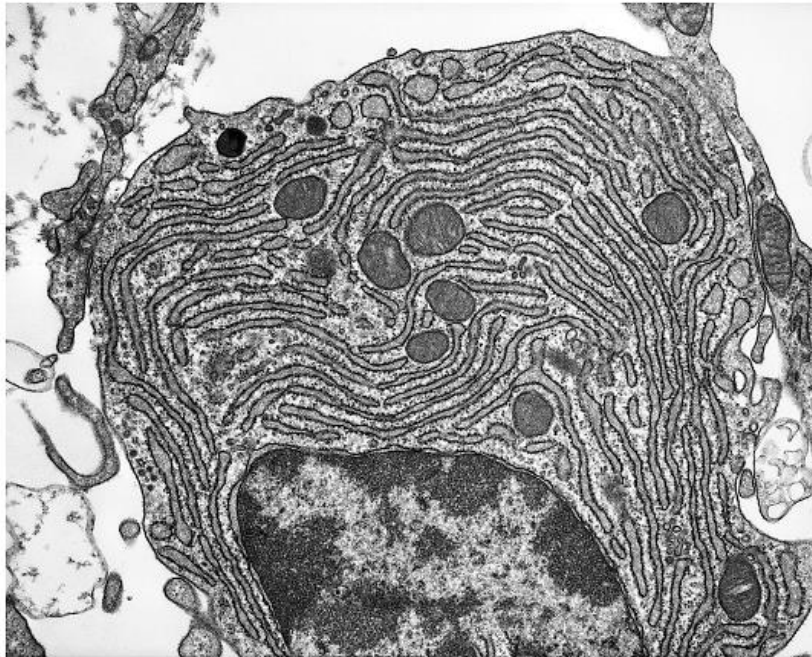
Read the instructions on the Answer Sheet very carefully.

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.

Calculators may be used.

- 1 A cell is shown in the micrograph.



Which statement explains how it is possible to identify the type of microscope used to produce the micrograph?

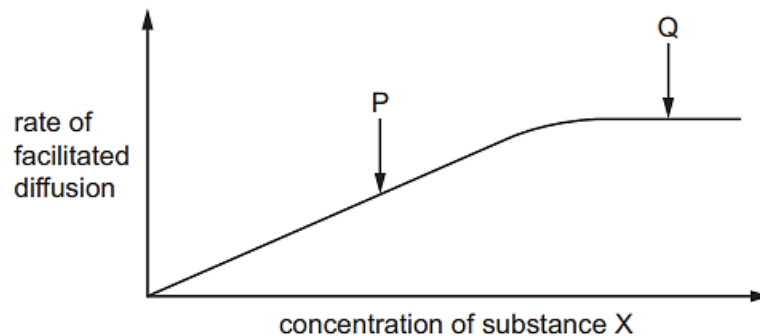
- A The nucleus is visible, so an electron microscope was used.
 - B The endoplasmic reticulum is **not** visible, so a light microscope was used.
 - C Chloroplasts are visible, so a light microscope was used.
 - D Ribosomes are visible, so an electron microscope was used.
- 2 There is a theory that mitochondria and chloroplasts were originally free-living prokaryotes. It is thought that millions of years ago these free-living prokaryotes were taken into larger cells by endocytosis where, instead of being digested, they became functional organelles.

Which features of mitochondria and chloroplasts support this theory?

- 1 Mitochondria and chloroplasts are surrounded by double membranes.
- 2 Mitochondria and chloroplasts have small, circular DNA.
- 3 Mitochondria and chloroplasts synthesise proteins.

- A 1, 2 and 3 B 1 and 2 only C 1 and 3 only D 2 and 3 only

- 3 The graph shows how the rate of facilitated diffusion of substance X across a cell surface membrane changed as the concentration of substance X increased. All conditions, except for the concentration of substance X, were kept constant. Temperature was maintained at 15°C.



Which statement about the rate of facilitated diffusion is correct?

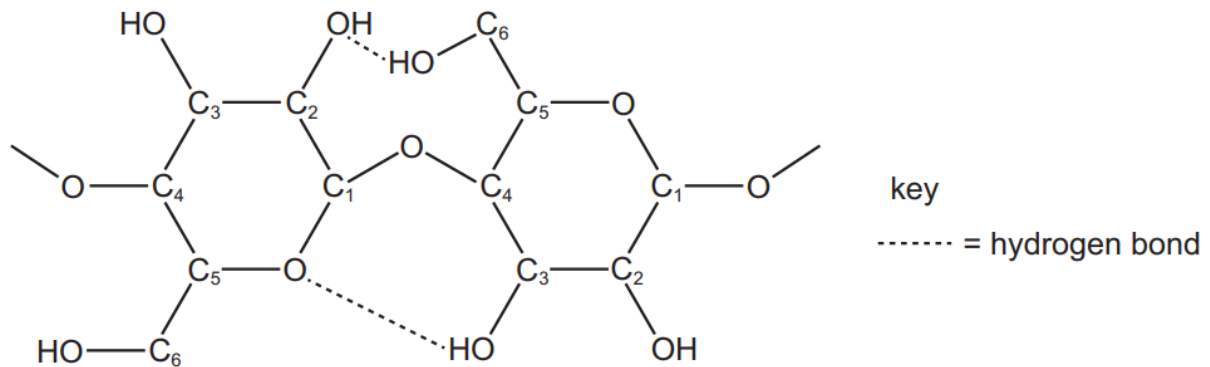
- A The rate of facilitated diffusion of substance X at Q will increase if the temperature is increased to 20 °C.
 - B The rate of facilitated diffusion of substance X at P will increase if the concentration of ATP is increased.
 - C The rate of facilitated diffusion of substance X at Q will increase if the concentration of substance X is increased.
 - D The rate of facilitated diffusion of substance X at P will increase if the length of time over which the rate is measured is increased.
- 4 A naturally occurring polysaccharide synthesised in a plant is a branched chain of α -glucose.

The straight parts of the molecule are linked by α -1,6 glycosidic bonds with only a small number of branches which are linked by either an α -1,3 glycosidic bond or an α -1,4 glycosidic bond.

Which polysaccharide has a structure most similar to that described?

- A amylopectin
- B amylose
- C cellulose
- D glycogen

- 5 The diagram shows how the alternating nature of β -glucose monomers along a chain allows hydrogen bonds to form between consecutive monomers.



Hydrogen bonds in cellulose affect the tensile strength (the ability to withstand pulling forces without breaking).

How do the hydrogen bonds shown in the diagram help cellulose function as a suitable material for a cell wall?

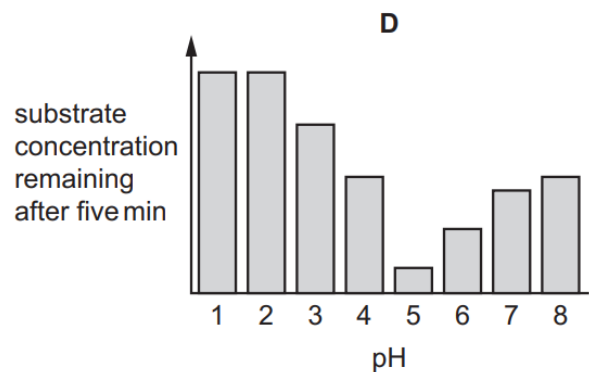
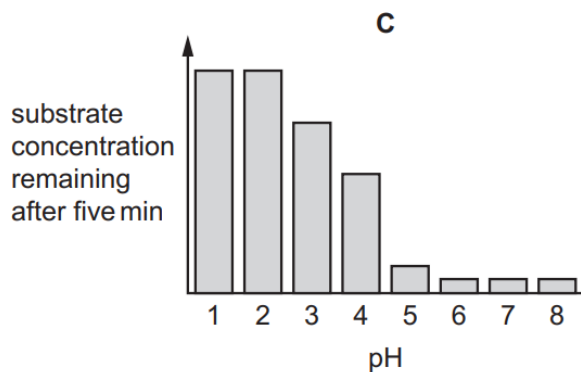
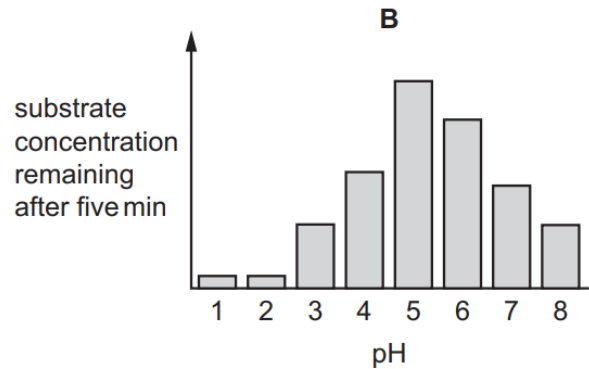
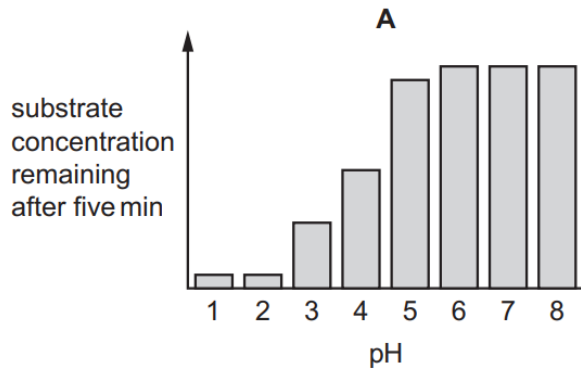
- A** The hydrogen bonds add additional tensile strength along individual cellulose molecules within the cell wall.
- B** The hydrogen bonds create stronger crosslinks between adjacent cellulose molecules, adding to the tensile strength of the cell wall.
- C** Stronger hydrogen bonds form between adjacent cellulose molecules, adding to the tensile strength of the cell wall.
- D** Cellulose molecules within a cellulose microfibril have a stronger link between them, increasing the tensile strength of the cellulose microfibrils.
- 6 Which statement is correct for a non-competitive inhibitor?
- A** The inhibitor binds to the active site of the enzyme and decreases V_{max} .
- B** The inhibitor binds away from the active site and increases the Michaelis–Menten constant.
- C** The inhibitor decreases V_{max} , but the Michaelis–Menten constant does not change.
- D** The inhibitor does not change V_{max} but increases the Michaelis–Menten constant.

- 7 A student carried out investigations at pH 1–8 to look at the effect of pH on an enzyme-catalysed reaction.

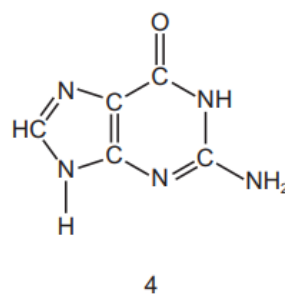
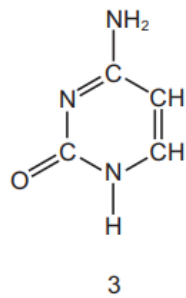
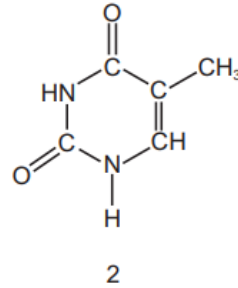
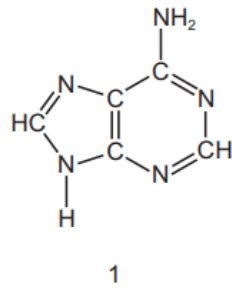
The optimum condition for this enzyme is the acidic environment of the stomach at pH1–2.

The remaining substrate concentration was measured after five minutes at each different pH.

Which graph shows the effect of increasing pH on substrate concentration remaining after five minutes?



- 8 The diagrams show the chemical structure of four bases.



Which diagrams show thymine and cytosine?

- A** 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4
- 9 The diagram shows the nucleotide sequence of a small section of the transcribed strand of a gene.

GCG CGC GGC GCG

The table shows the amino acids coded for by 10 mRNA codons.

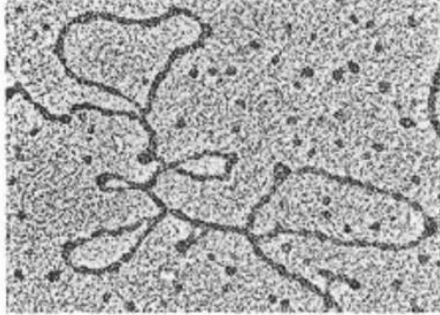
mRNA codon	amino acid
AAG	Lys
ACG	Thr
CGG CGC CGU	Arg
CCG	Pro
GCC GCG	Ala
GGC	Gly
UGC	Cys

What is the sequence of the four amino acids in the polypeptide translated from this small section of a gene?

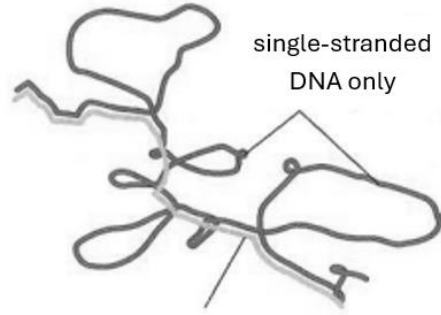
- A** Ala-Ala-Cys-Ala
B Ala-Arg-Gly-Ala
C Arg-Ala-Pro-Arg
D Arg-Arg-Thr-Arg

- 10** In an experiment, scientists hybridised an mRNA to its DNA template and prepared the hybrid molecule for electron microscopy. The resulting hybrid was observed to have different sections of DNA-RNA hybrids as well as single stranded DNA loops as in the diagram.

micrograph of DNA-RNA hybrid



interpretation of micrograph



single-stranded DNA
base-paired with mRNA

Several statements attempting to explain the observations are presented:

- 1 Genes contain unique sequences within them that are not transcribed into mRNA.
- 2 DNA genes are not continuous and are interrupted by non-coding sequences.
- 3 Insertional mutations always disrupt genes and result in additional sequences.
- 4 mRNA undergoes processing to remove some of its sequences.

How many statements correctly explain the findings?

- A** 0 **B** 1 **C** 2 **D** 3

11 Circadian rhythm is the body's internal clock that regulates sleep and wake cycles over a 24-hour period.

It is controlled by numerous proteins which regulate the cyclic nature of the rhythm. The roles of two such proteins are described here:

- Circadian Locomotor Output Cycles Kaput (CLOCK): This protein forms a complex with another protein called Brain and Muscle ARNT-Like 1 (BMAL1) to initiate the transcription of target genes involved in the circadian rhythm.
- Cryptochrome 1 (CRY1): Cryptochrome proteins play a role in the negative feedback regulation of the circadian rhythm. They interact with the CLOCK-BMAL1 complex to inhibit its action.

Which row correctly describes the level at which the proteins regulate expression of genes responsible for circadian rhythm?

	CLOCK	CRY1
A	transcriptional	translational
B	transcriptional	post-translational
C	translational	transcriptional
D	post-transcriptional	post-translational

12 What are the correct roles of mitosis?

	stem cell growth	replacing lost skin cells
A	✓	×
B	✓	✓
C	×	×
D	×	✓

key

✓ = correct

× = **not** correct

13 Which row about the stages of the mitotic cell cycle is correct?

	DNA ligase used in the nucleus	RNA polymerase used in the nucleus
A	G ₁ phase	S phase
B	G ₂ phase	mitosis
C	mitosis	G ₂ phase
D	S phase	G ₁ phase

14 Which statement(s) describes how a gene mutation can lead to the production of a non-functional protein?

- 1 During transcription, an incorrect nucleotide is added to a DNA molecule.
- 2 The mutated gene results in a new codon being transcribed.
- 3 The order of the bases in an anticodon on tRNA is altered during translation.

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

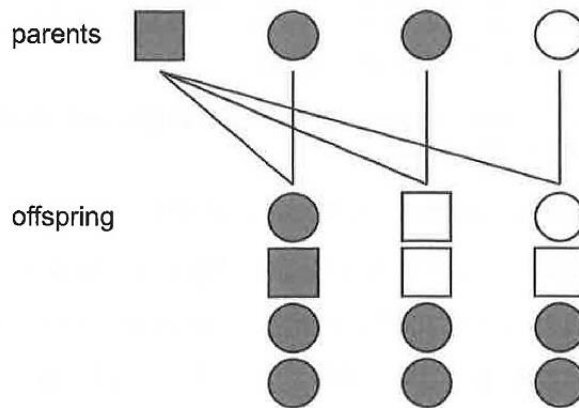
15 The enzyme telomerase prevents loss of telomeres after many mitotic cell cycles.

Which cells need to transcribe telomerase enzyme?

- 1 stem cells
- 2 activated memory B-lymphocytes
- 3 helper T-lymphocytes secreting cytokines

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

- 16 The pedigree diagram shows the results of crosses between a single male mink (square symbol) and three different females (circular symbols). Shaded symbols represent minks with brown fur and unshaded symbols represent minks with white fur.

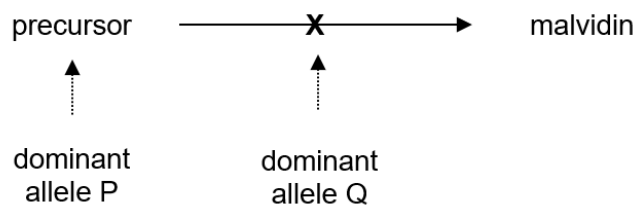


Fur colour in minks is controlled by a single gene with two alleles.

How many of the minks shown in the diagram (parents and offspring) have genotypes for fur colour that can be known with 100% certainty, assuming that no mutation has occurred?

- A 5 B 7 C 9 D 10

- 17 In the *Primula* plant, production of the pigment malvidin creates blue flowers. Synthesis of malvidin is controlled by a dominant allele **P** at the **P/p** gene locus which codes for a colourless precursor substance. However, the conversion of the precursor substance to malvidin can be suppressed by another dominant allele **Q** at the gene locus **Q/q** as shown in the biochemical pathway below. Flowers with the absence of malvidin will appear white.



When two plants with white flowers are crossed, the offspring generation has 44 plants with white flowers and 10 plants with blue flowers.

Which of the following statements is **not** true?

- A The probability of obtaining a pure-breeding offspring at both loci with white flowers is 1 of 9.
 B The deviation from the Mendelian ratio (9:3:3:1) is due to gene interaction in which the expression of gene Q masks the phenotypic expression of gene P.
 C The genotypes of the parents must be PpQq x PpQq.
 D The genotypes PPQQ, PPQq, PpQq and ppQq produce the same phenotype.

- 18** 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.

Results of the measurement are shown in the table below.

Time / s	Levels of Cellular Component / arbitrary units			
	PIP ₂	PKC	IP ₃	Ca ²⁺
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

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

- A** PKC → IP₃ → Ca²⁺ → PIP₂
- B** IP₃ → PKC → Ca²⁺ → PIP₂
- C** PIP₂ → IP₃ → Ca²⁺ → PKC
- D** Ca²⁺ → PIP₂ → IP₃ → PKC

19 Biomolecules that are specific to particular types of cell, including stem cells, are known as cell markers. These markers can be proteins, glycoproteins or glycolipids. Some examples are listed.

- Zygotic stem cells are positive for ZScan4 and OCT4 but negative for CD34 and CD45.
- Embryonic stem cells at the 32-celled stage are positive for OCT4 and negative for ZScan4, CD34 and CD45.
- Blood stem cells that give rise to white blood cells are positive for CD34 and negative for ZScan4 and OCT 4.
- In later developmental stages, some blood stem cells become positive for CD45.
- Differentiated blood cells are negative for ZScan4, OCT4 and CD34 but most types are positive for CD45.

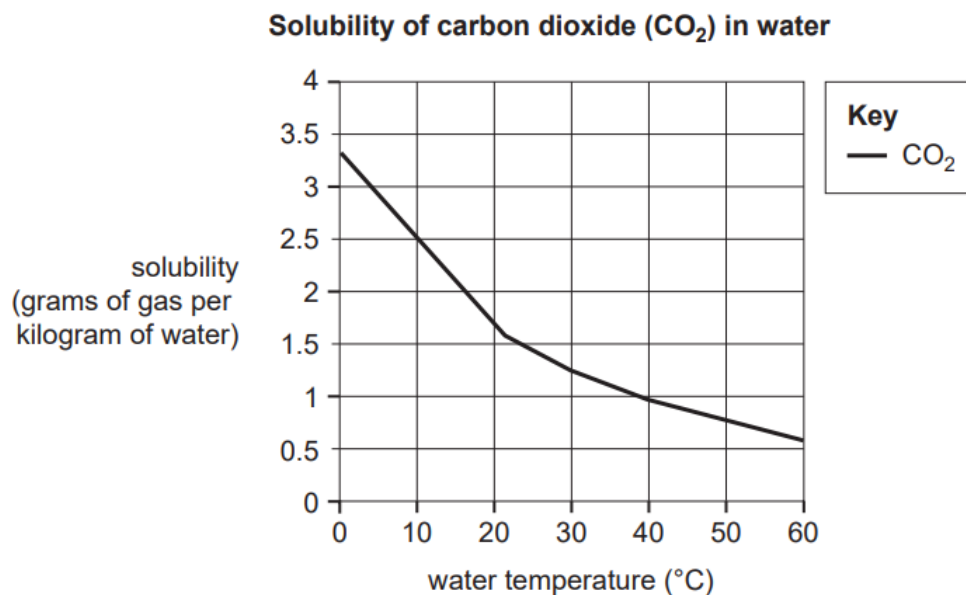
Which statement is consistent with this information?

- A** Cells with the CD34 cell marker are multipotent.
- B** Cells with the CD45 cell marker are multipotent.
- C** Cells with the OCT4 cell marker are totipotent.
- D** Cells with the ZScan4 cell marker are pluripotent.

20 Which one of the following statements about the electron transport chain is correct?

- A** The outputs of the electron transport chain are water, ATP and NADH. The role of water is to donate energy.
- B** The outputs of the electron transport chain are oxygen, ATP and NAD⁺. The role of oxygen is to accept energy from ATP molecules.
- C** The outputs of the electron transport chain are water, ATP and NAD⁺. The role of NADH is to donate electrons and hydrogen ions.
- D** The outputs of the electron transport chain are oxygen, ATP and NADP⁺. The role of NADP⁺ is to accept electrons from the electron transport chain.

- 21** During photosynthesis, carbon dioxide (CO_2) enters chloroplasts. One method CO_2 uses to enter chloroplasts is to dissolve in water. The graph below shows the solubility of CO_2 as temperature increases.



Based on the information provided and your knowledge of photosynthesis, which one of the following statements is correct?

- A** At 30 °C, photosynthesis and photorespiration (where Rubisco binds oxygen instead of CO_2) will be taking place at equal rates.
 - B** Changes in water temperature will only affect the rate of light-independent reactions.
 - C** At a temperature of 40 °C, Rubisco will be fixing carbon at a slower rate than at 20 °C.
 - D** The number of oxygen molecules entering Rubisco's active site will decrease as temperature increases.
- 22** Acyclovir is a molecule that can substitute for the nitrogenous base, guanine. It is used as an antiviral drug.

Four features of acyclovir are listed below.

Which one of these features of acyclovir activity does **not** suggest that it could interfere with, and therefore inhibit, viral DNA replication?

- A** It can act as a competitive inhibitor of viral DNA polymerase.
- B** It can act as a non-competitive inhibitor of viral RNA polymerase.
- C** It can be incorporated into the growing viral DNA strand.
- D** It can be phosphorylated to become a nucleoside triphosphate.

23 Which of the following statements can explain how viruses cause disease in animals?

- 1 They inhibit normal host cell DNA, RNA or protein synthesis.
- 2 They disrupt and inactivate the tumor suppressor genes of the host cell causing uncontrolled cell division.
- 3 They disrupt and inactivate the oncogenes of the host cell causing uncontrolled cell division.
- 4 Their viral proteins and glycoproteins on the surface membrane of host cells cause them to be recognized and destroyed by the body's immune system.
- 5 They deplete the host cell of cellular materials essential for metabolic functions.

- A** 1, 2 and 5
B 1, 2, 3 and 5
C 1, 2, 4 and 5
D All of the above

24 Which of the following statements about bacterial genetic transfer are **not** correct?

- 1 In transformation, bacterial cells can only take up the plasmids from the surroundings.
- 2 Homologous recombination is always involved in bacterial genetic transfer.
- 3 After conjugation, the donor and recipient cells contain the same genetic information.
- 4 Binary fission will not contribute to genetic variation in bacterial cells without plasmids.

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

25 Which of the following is / are characteristic(s) of prokaryotic genome and its expression?

- 1 Production of polycistronic mRNA
- 2 DNA associated with histones
- 3 Translation by 80S ribosomes
- 4 Group of structural genes clustered together

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

26 Which of the following explains why a population is the smallest unit that can evolve?

- A Favourable mutations are more common in a population than unfavourable mutations.
- B Interbreeding within a population enables recessive alleles to be masked by dominant alleles.
- C Populations have gene pools that are isolated from the gene pools of other populations.
- D Variation in a population is increased by mutation of the genes that are present.

27 High concentrations of copper ions in soil are toxic to most plants. However, the grass *Holcus lanatus* can be found growing on copper mine sites where the concentration of copper ions in the soil is very high. The grass plants in these populations are said to be copper tolerant.

Seeds from *H. lanatus* at copper mines were collected and tested for copper tolerance by attempting to germinate the seeds in copper sulfate solution. 94% of these seeds germinated successfully.

Seeds from *H. lanatus* from places with normal (low) concentrations of copper ions were also collected and tested for copper tolerance in the same way. 0.16% of these seeds germinated successfully.

What explains the difference in germination of the seeds from the two habitats?

- A Mutations resulting in copper tolerance occur only in *H. lanatus* on mine sites, where they can aid survival.
- B Genetic variation is preserved in natural *H. lanatus* populations by meiosis and sexual reproduction.
- C High concentrations of copper ions cause mutations that make *H. lanatus* on mine sites tolerant to copper ions.
- D The frequency of alleles for copper tolerance increases in *H. lanatus* on mine sites due to natural selection.

28 Which statement about tuberculosis (TB) is **not** correct?

- A TB can be controlled by vaccination.
- B TB is caused by a virus spread by droplet infection.
- C HIV/AIDS increases the risk of developing TB.
- D TB may be transmitted by eating contaminated meat.

29 A vaccine is used to give immunity to the virus that causes the disease influenza.

A new influenza vaccine is needed every year because the virus mutates regularly.

What is the reason for needing a new influenza vaccine every year?

- A** Memory cells become less effective as they age.
- B** The primary immune response does **not** produce enough antibodies.
- C** The secondary immune response does **not** produce enough antibodies.
- D** The virus antigens change and are **not** recognised by the immune system.

30 The temperature in the Arctic is increasing due to global warming. Snow and ice cover are decreasing and soils that were permanently frozen are thawing. As a result, more plants are growing.

Statements that explain how these changes affect global warming are listed.

- 1 More radiant heat is reflected by snow cover than by vegetation.
- 2 More carbon dioxide is absorbed by plants than by snow cover.
- 3 Bacteria break down stored organic matter in soils that have thawed.

Which statements could account for increases in the rate of global warming?

- A** 1 and 2 **B** 1 and 3 **C** 1 only **D** 2 and 3