Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Higher level
Paper 1A

12 May 2025

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

2 hours [Paper 1A and Paper 1B]

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A calculator is required for this paper.
- The maximum mark for paper 1A is **[40 marks]**.
- The maximum mark for paper 1A and paper 1B is **[75 marks]**.

2225 – 6013

1. What property of water leads to aquatic environments having low fluctuations of temperature throughout the year?

A. High specific heat capacity because covalent bonding restricts molecular motion

B. Low specific heat capacity because covalent bonding restricts molecular motion

C. Low specific heat capacity because hydrogen bonding restricts molecular motion

D. High specific heat capacity because hydrogen bonding restricts molecular motion

2. What is a nucleosome?

A. DNA wrapped around histone proteins in a eukaryotic cell

B. RNA bound to ribosomes in a eukaryotic cell

C. A region of the nucleus in a eukaryotic cell

D. Genetic material within a viral capsule

3. What is the function of cellulose in plant cells?

A. It increases the strength of cell walls.

B. It is a source of energy for plants.

C. It maintains the structure of the vacuole.

D. It increases the permeability of the cell membranes.

4. Myoglobin is a globular protein in which nearly all the non-polar R-groups point towards the inside of the molecule. The outside surface contains all the polar R-groups. What can be deduced from this?

A. Disulfide bonds occur on the inside.

B. Hydrogen bonds form with water on the outside.

C. Ionic bonds form with water on the outside.

D. Covalent bonds occur on the inside.

5. Which process is an example of catabolism?

A. Protein synthesis

B. Photosynthesis

C. Oxidation of substrates in respiration

D. Glycogen formation

6. Bromothymol blue is an indicator that is initially blue and turns yellow when CO_2 is present. Tests were carried out varying the presence of a plant (*Elodea canadensis*) and a snail (*Marisa cornuarietis*) in an aquatic environment. What condition would produce a blue colour after sampling the water?

A. Plant kept in the dark without snail

B. Plant and snail kept in the dark

C. Plant kept in the light without snail

D. Snail with no plant

7. What occurs during photosynthesis?

A. Water is oxidized by releasing two electrons to NADPH.

B. Glycerate-3-phosphate (GP) is oxidized by releasing two electrons to photosystem II.

C. NAD is reduced by accepting two electrons from ATP.

D. NADP is reduced by accepting two electrons from photosystem I.

8. The Calvin cycle continues throughout the life of a plant. In this cycle, triose phosphate is produced, which is used to form glucose. In total, how many RuBP molecules are regenerated in the process of creating one glucose molecule?

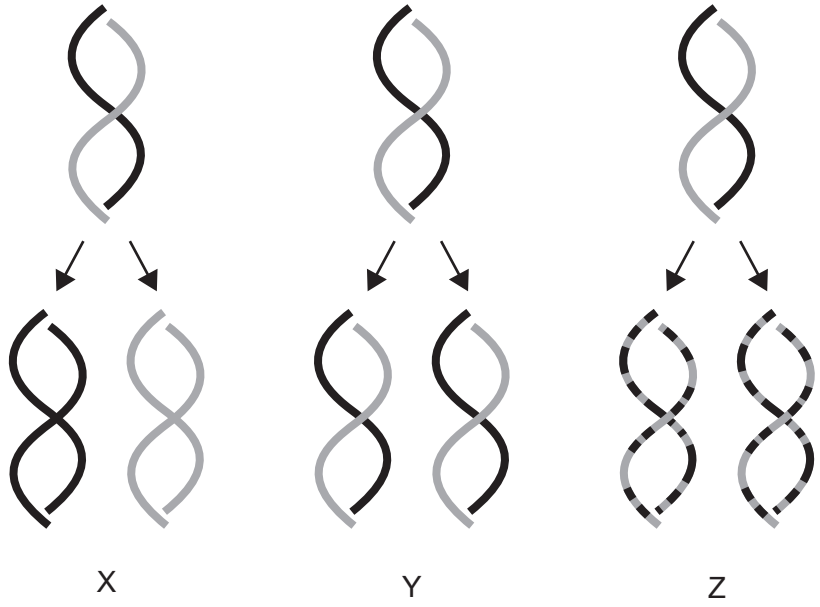
A. 2

B. 6

C. 10

D. 14

9. Which diagram(s) illustrate(s) semi-conservative replication of DNA?



A. X only

B. Y only

C. Z only

D. X and Y only

10. Which sequence of mRNA bases and amino acids could be produced by transcription and translation of the DNA molecule shown?

3′ AAAGTGGCACGTATATTT 5′
5′ TTTCACCGTGCATATAAA 3′

2nd base in codon

1st base in codon	U	C	A	G	3rd base in codon
U	Phe	Ser	Tyr	Cys	**U**
	Phe	Ser	Tyr	Cys	**C**
	Leu	Ser	**STOP**	**STOP**	**A**
	Leu	Ser	**STOP**	Trp	**G**
C	Leu	Pro	His	Arg	**U**
	Leu	Pro	His	Arg	**C**
	Leu	Pro	Gln	Arg	**A**
	Leu	Pro	Gln	Arg	**G**
A	Ile	Thr	Asn	Ser	**U**
	Ile	Thr	Asn	Ser	**C**
	Ile	Thr	Lys	Arg	**A**
	Met	Thr	Lys	Arg	**G**
G	Val	Ala	Asp	Gly	**U**
	Val	Ala	Asp	Gly	**C**
	Val	Ala	Glu	Gly	**A**
	Val	Ala	Glu	Gly	**G**

	Sequence of mRNA bases	Sequence of amino acids
A.	UUU-GAG-GCU-CGA-UAU-UUU	Phe-Glu-Ala-Arg-Tyr-Phe
B.	AAA-CUC-CGA-GCU-AUA-UUU	Lys-Leu-Arg-Ala-Ile-Phe
C.	UUU-CAC-CGU-GCA-UAU-AAA	Phe-His-Arg-Ala-Tyr-Lys
D.	AAA-GUG-GCA-CGU-AUA-UUU	Lys-Val-Ser-Arg-Ile-Phe

11. What is gene knockout used for?

A. Increasing protein production by editing a gene

B. Investigating the function of a gene by replacing it to make it inoperative

C. Identifying the presence of a gene by editing it to produce a different protein

D. Editing a gene to initiate cell death

12. In 2020, Peplow and co-workers obtained an image showing a $GABA_A$ cell membrane protein receptor. The technique they used allowed them to take the image at a particular moment in time by treating the sample so that the protein molecules were firmer and more stable. What technique did they use to obtain this image?

A. Electrophoresis

B. Immunofluorescence

C. Cryogenic electron microscopy

D. Fluorescent dyes

13. What is a difference between the lytic and the lysogenic cycle of the bacteriophage lambda?

A. Only in the lytic cycle is lambda DNA inserted into the host DNA.

B. Only in the lysogenic cycle is the host metabolism used to replicate.

C. Only in the lytic cycle is the host metabolism used to replicate.

D. Only in the lysogenic cycle is lambda DNA inserted into the host DNA.

14. The table shows concentrations of potassium ions and sodium ions maintained inside and outside human cells.

	Concentration of ions / 10^{-3} mol dm^{-3}	
Ions	**Intracellular**	**Extracellular**
Potassium	135	4
Sodium	10	145

What explains these concentrations?

A. Active transport using a protein pump

B. Facilitated diffusion using a vesicle

C. Simple diffusion using a protein channel

D. Osmosis using an aquaporin

15. What is the role of clathrin molecules in the formation of vesicles?

A. Facilitate transport of sodium and potassium ions

B. Bind together to help the membrane become indented

C. Adhere to the phospholipid bilayer to increase fluidity

D. Create a concentration gradient for uptake of substances into vesicles

16. What results from an unspecialized cell experiencing gradients of signalling chemicals?

A. Cell differentiation

B. Meiosis

C. Saltatory conduction

D. DNA replication

17. What is the action of neonicotinoids on the synapse of an insect?

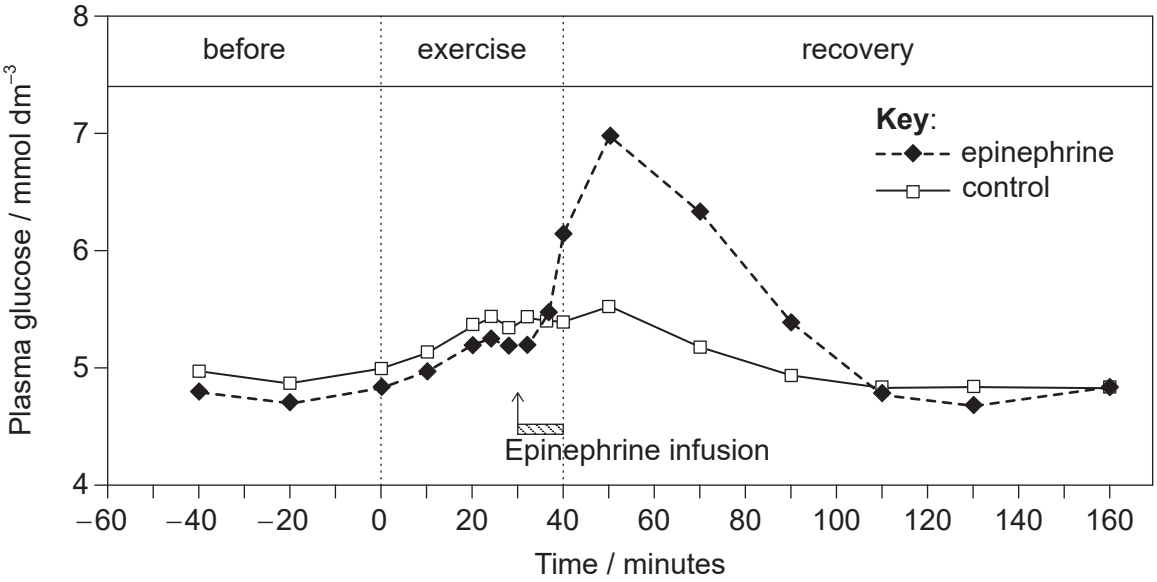
A. They prevent the release of acetylcholine from the presynaptic membrane.

B. They increase the permeability of the presynaptic neuron to sodium ions.

C. They bind to the acetylcholine receptor on the postsynaptic neuron.

D. They block the uptake of acetylcholine in vesicles in the presynaptic neuron.

18. The graph shows changes in blood plasma glucose concentration before exercise, during exercise and during recovery with and without epinephrine (adrenaline) infusion. Epinephrine infusion was started 30 minutes into the exercise routine.



[Source: Kreisman, S.H., Ah Mew, N., Arsenault, M., Marliss, E.B., et al., 2000. *AJP Endocrinology and Metabolism* 278(5): E949–57. https://doi.org/10.1152/ajpendo.2000.278.5.E949. Reference redacted. Source adapted.]

Which action of epinephrine would result in the observed changes to plasma glucose concentration?

A. Second messenger is deactivated.

B. A G protein is activated, and cyclic AMP (cAMP) is produced.

C. Second messenger stimulates the production of ATP.

D. Cyclic AMP (cAMP) deactivates the G protein.

19. What occurs in cell division during both mitosis and meiosis?

A. Condensation of DNA by supercoiling in telophase

B. Movement of microtubules to move chromatids in anaphase

C. Pairing of homologous chromosomes in prophase

D. Crossing over between chromosomes in metaphase

20. Scientists measured methylation levels of amino acids in chromosome 2 in twin studies. The methylation levels of twin 1 were significantly and consistently higher than those of twin 2. What could be proposed to explain this data?

A. Modification to the histone of twin 1

B. Removal of the histone from the chromosome in twin 2

C. The DNA base sequence of twin 1 was altered

D. Cytosines in promoters of twin 2 are more methylated than in twin 1

21. What applies to the process of speciation?

	Mechanism	Change
A.	Reproductive isolation	Populations become more different in their traits
B.	Behavioural isolation	Allele frequency remains constant
C.	Interbreeding	Stabilizing selection occurs
D.	Temporal isolation	Hybrids produced

22. Classification systems can change based on new evidence. What evidence was used to produce the domains of organisms we now recognize?

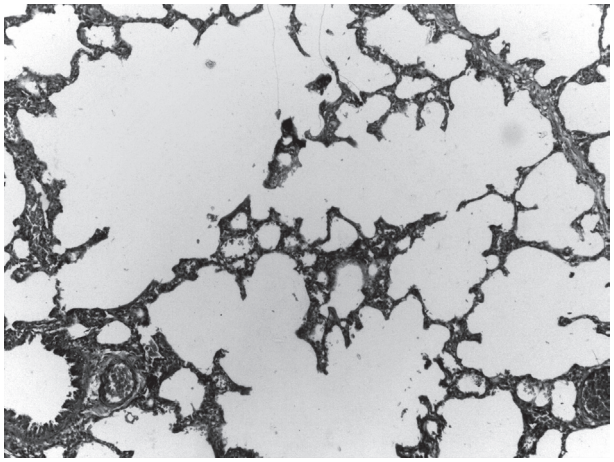
A. mRNA sequence

B. rRNA sequence

C. Amino acid sequence

D. DNA sequence

23. Emphysema is a condition where the alveoli of the lungs are destroyed, resulting in patients feeling out of breath. The micrograph shows air pockets resulting from emphysema.



What is a direct consequence of the destruction of alveoli?

A. Decrease in surface area for gas exchange

B. Increased blood flow to the lungs

C. Increase in pulmonary surfactant production

D. Decrease in ventilation rate

24. Which environmental condition(s) would increase the rate of transpiration in plants?

I. Increased carbon dioxide concentration in the atmosphere

II. Increased temperature of the atmosphere

III. Decreased humidity of the atmosphere relative to the inside of the leaf

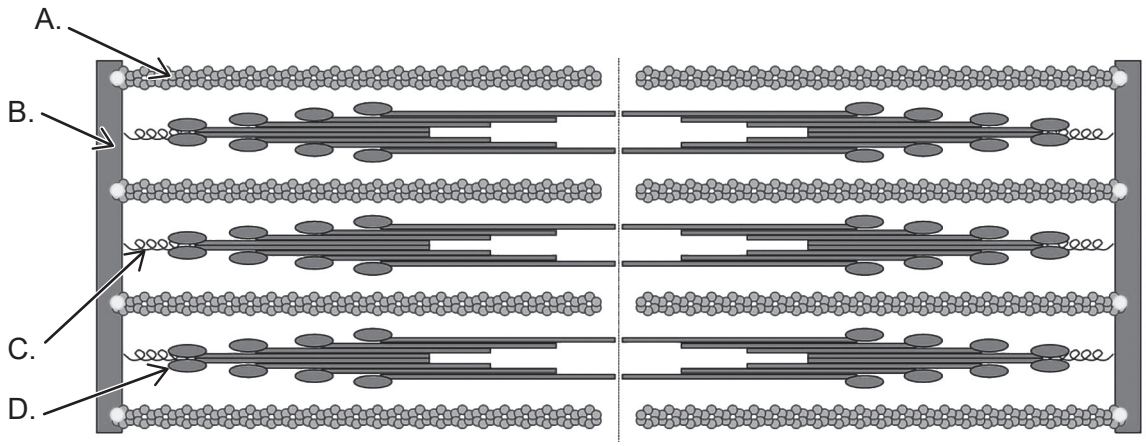
A. I and II only

B. III only

C. II and III only

D. I and III only

25. The diagram shows a contracted sarcomere. Which part will vary in length in response to relaxation of a muscle?



26. What plays a direct role in promoting the ripening of fruit?

A. Oestradiol

B. Auxin

C. Cytokines

D. Ethylene

27. Azithromycin is an antibiotic commonly used to treat pneumonia, an infection of the lungs caused by *Streptococcus pneumoniae*. A patient was diagnosed for the second time with pneumonia, but the same antibiotic was ineffective this time. What biological explanation might there be for this?

A. *S. pneumoniae* had mutated.

B. *S. pneumoniae* had developed antibodies for the antibiotic.

C. The patient was immune to the antibiotic.

D. The patient had antibiotic remaining from the first treatment.

28. Jetlag occurs when the circadian rhythm of a person changing time zones is disrupted. For what reason might they have difficulty sleeping after sunset?

A. The hypothalamus is secreting too much melanin.

B. The pineal gland is not secreting sufficient melatonin.

C. The lack of sunlight inhibits the production of vitamin D.

D. The pituitary gland is secreting too much oxytocin.

29. Cherry trees (*Prunus avium*) have two self-incompatibility alleles. What benefit do self-incompatibility alleles have?

A. They decrease genetic variation.

B. They prevent inbreeding.

C. They decrease the chances of mutations taking place within the gametes.

D. They prevent the plant from releasing pollen at certain times of the year.

30. A cell with 46 chromosomes goes through the process of spermatogenesis. What is the outcome of this process?

A. One cell with 46 chromosomes and 3 polar bodies

B. Four cells with 46 chromosomes each

C. One cell with 23 chromosomes and 3 polar bodies

D. Four cells with 23 chromosomes each

31. Pink flowers arise from the incomplete dominance between red and white flowers in the four o'clock flower (*Mirabilis jalapa*). A pink-flowering variety is crossed with a white-flowering variety.

What could be the possible phenotypes of the offspring?

A. White flowers only

B. Pink and white flowers

C. Red and white flowers

D. Pink flowers only

32. Phenylketonuria is caused by a mutation to a gene. Which genotype would result in the condition and what is the consequence?

	Genotype	Consequence
A.	AA only	Tyrosine is converted to phenylalanine
B.	aa only	Tyrosine is not converted to phenylalanine
C.	AA and Aa	Phenylalanine is converted to tyrosine
D.	aa only	Phenylalanine is not converted to tyrosine

33. What describes analogous structures?

A. They are formed from divergent evolution.

B. They share a common ancestor.

C. They came from different evolutionary origins.

D. They have the same structure but different functions.

34. How are interspecific hybrids formed?

A. Cross-breeding members of different species

B. Selective breeding between individuals of the same species

C. Reproductive isolation between different species

D. Mutations within individuals of a given species

35. Which conditions are characteristics of tundra biomes?

A. Extreme temperature range and high precipitation

B. High temperatures and high precipitation

C. Moderate temperatures with distinct seasonal changes

D. Low temperatures with low precipitation

36. What describes a benefit of the relationship between coral and zooxanthellae?

A. Zooxanthellae receive carbon dioxide from the coral.

B. Zooxanthellae receive glucose from the coral.

C. Coral receives carbon dioxide from the zooxanthellae.

D. Coral receives protection from the zooxanthellae.

37. Studies show that adding iron to the ocean's surface triggers the growth of phytoplankton. What could be a short-term consequence of stimulating phytoplankton growth in this area?

A. Rate of photosynthesis increases, so the ocean becomes the source of carbon.

B. Uptake of carbon dioxide into the ocean decreases, so it becomes a sink of carbon.

C. Rate of respiration increases, increasing the pH of the ocean.

D. Rate of photosynthesis increases, resulting in an increased uptake of carbon dioxide into the ocean.

38. Mutations and sexual reproduction both play a role in generating variation, upon which natural selection acts. What describes how variation is generated?

I. Mutations generate new alleles.

II. Mutations generate new combinations of alleles.

III. Sexual reproduction generates new alleles.

A. I only

B. III only

C. II and III only

D. I and III only

39. Which action will decrease carbon sequestration?

A. Afforestation

B. Primary production

C. Deforestation

D. Rewetting peatlands

40. What is a consequence of ocean water having a very high temperature?

A. Decreased bleaching of coral reefs

B. Increased production of oxygen

C. Increase in energy flow through food chains

D. Reduced nutrient upwelling to the surface

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References:

18. Kreisman, S.H., Ah Mew, N., Arsenault, M., Marliss, E.B., et al., 2000. *AJP Endocrinology and Metabolism* 278(5): E949–57. https://doi.org/10.1152/ajpendo.2000.278.5.E949. Reference redacted. Source adapted.

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31. Buhl, V., 2009. Wunderblume, Four oclock flower, *Mirabilis jalapa*. [image online] Available at: https://commons.wikimedia.org/wiki/File:2009-09-26_(2)_Wunderblume,_Four_oclock_flower,_Mirabilis_jalapa.JPG. [Accessed 18 March 2024]. Source adapted. Licensed under CC Attribution-Share Alike 3.0 Unported license: https://creativecommons.org/licences/by-sa/3.0/deed.en.