Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Higher level
Paper 1B

12 May 2025

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

Candidate session number

2 hours [Paper 1A and Paper 1B]

Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for paper 1B is **[35 marks]**.
- The maximum mark for paper 1A and paper 1B is **[75 marks]**.

2225 – 6020

Answer **all** questions. Answers must be written within the answer boxes provided.

1. The table shows the number of amino acids that are different in the sequences of the protein FOXP2 from a human compared with four other primate species.

Primate species	Number of amino acid differences compared to human
Pan paniscus	2
Pan troglodytes	2
Gorilla gorilla	2
Pongo pygmaeus	3

(a) Identify the total number of different genera named in the table. [1]

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(b) Deduce whether it is possible to conclude that *Pan paniscus* and *Gorilla gorilla* are more closely related to each other than to humans. [2]

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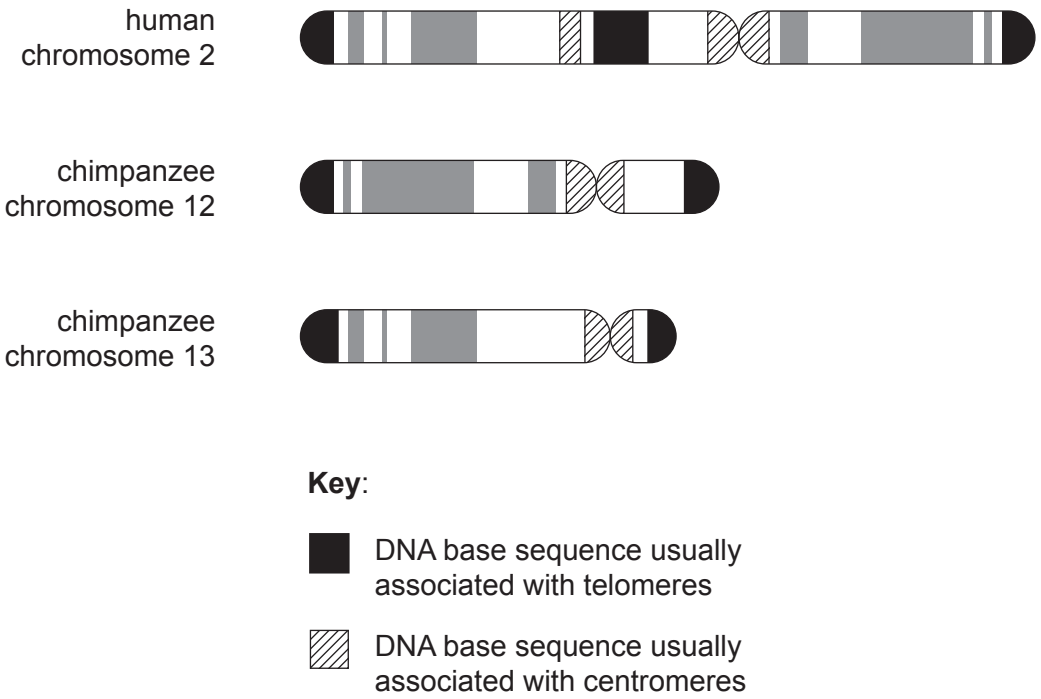
(Question 1 continued)

Humans have 46 chromosomes. However, each of the four other primates in the table have 48 chromosomes.

Scientists analysed chromosome 2 in humans and chromosomes 12 and 13 in chimpanzees (*Pan troglodytes*). The diagrams show a summary of their findings.



(c) Using evidence from the diagrams, justify the hypothesis that chromosome 2 in humans arose from the fusion of chromosomes 12 and 13 with a shared primate ancestor. [4]

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(Question 1 continued)

(d) Some infectious diseases in humans are caused by viruses that originated in other primates.

(i) State **one** structural feature of a virus. [1]

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(ii) State the term used for an infectious disease that can transfer from other species to humans. [1]

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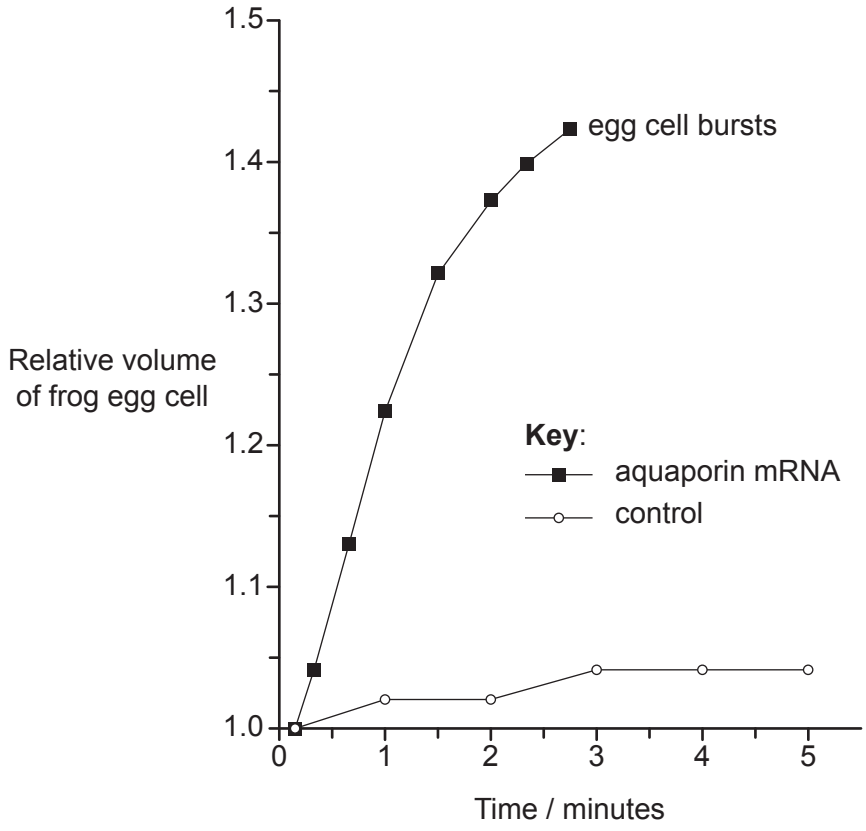
2. In the early 1990s, investigations involving egg cells from the African clawed frog (*Xenopus laevis*) led to the discovery of membrane channel proteins called aquaporins.

In one investigation, scientists injected 10 frog egg cells with a solution containing mRNA encoding for an aquaporin, and another 10 frog egg cells with distilled water (control cells). All the frog egg cells were then incubated in a hypotonic solution. The volume of the frog egg cells was then measured during a period of five minutes.

The graph shows the mean results of the investigation.



(a) State the direction of net movement of water across the plasma membrane of all the frog egg cells between 0 and 3 minutes. [1]

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(Question 2 continued)

(b) (i) Explain the reasons for the different results obtained for the frog egg cells with aquaporin mRNA and the control frog egg cells. [2]

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(ii) Discuss the role of aquaporins in the collecting ducts of a human kidney when the water content of blood is too low. [3]

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(c) Outline the reason that the results are displayed as mean relative volumes rather than mean volumes. [1]

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(d) Comment on the reliability of the results of this investigation. [1]

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(Question 2 continued)

(e) In investigations of this type, scientists usually find that there is a short time delay between the introduction of mRNA into a cell and the effect on the cell.
Explain this observation. [2]

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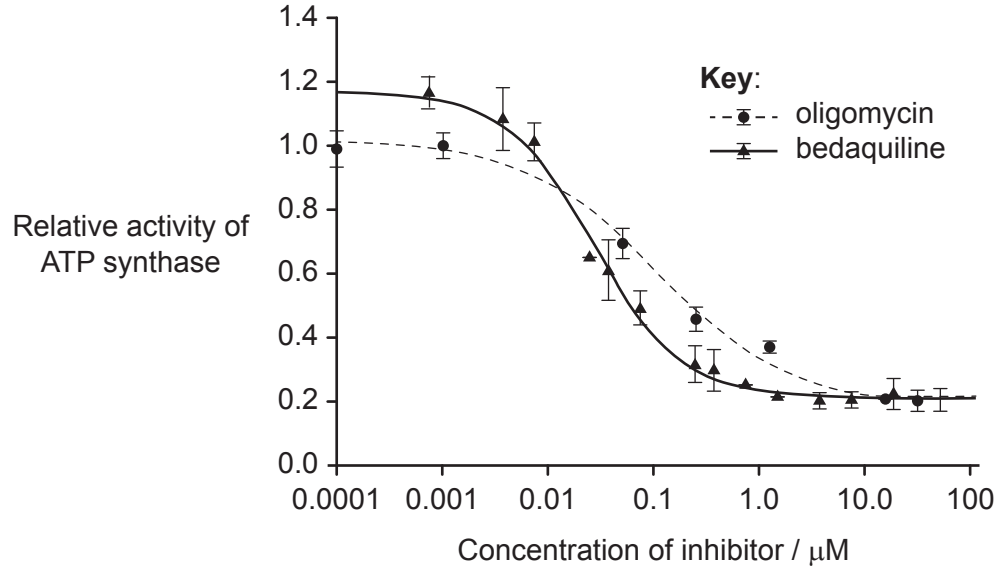
3. Some antibiotics are inhibitors of the enzyme ATP synthase in bacteria.

Scientists investigated the effect of varying the concentration of two antibiotics, bedaquiline and oligomycin, on the relative activity of ATP synthase.



(a) In this investigation, there were two independent variables and many controlled variables.

(i) Identify **both** independent variables in this investigation. [1]

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2. . . . . .

(ii) Outline how temperature could be kept constant in this investigation. [1]

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(Question 3 continued)

(iii) Explain the reasons for keeping the enzyme concentration constant. [3]

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(b) (i) State the type of scale shown on the horizontal axis of the graph. [1]

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(ii) Explain the benefit of using this type of scale for the data obtained in this investigation. [1]

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(c) Describe how the reliability of the results obtained in this investigation is indicated on the graph. [1]

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(d) State the precise location of ATP synthase in mitochondria. [1]

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4. Physical therapists used goniometers to obtain range of motion measurements for different joints from a total of 674 healthy, normal subjects aged 2–69 years. The male and female subjects were grouped into four age groups: 2–8, 9–19, 20–44 and 45–69 years.

The table shows mean range of motion values for hip and knee joints.

Joint motion	**Age 2–8**	**Age 9–19**	**Age 20–44**	**Age 45–69**
Females (*N*)	39	56	143	123
Hip extension	26.2 (23.9–28.5)	20.5 (18.6–22.4)	18.1 (17.0–19.2)	16.7 (15.5–17.9)
Hip flexion	140.8 (139.2–142.4)	134.9 (133.0–136.8)	133.8 (132.5–135.1)	130.8 (129.2–132.4)
Knee flexion	152.6 (151.2–154.0)	142.3 (140.8–143.8)	141.9 (140.9–142.9)	137.8 (136.5–139.1)
Knee extension	5.4 (3.9–6.9)	2.4 (1.5–3.3)	1.6 (1.1–2.1)	1.2 (0.7–1.7)
Males (*N*)	55	48	114	96
Hip extension	28.3 (27.2–29.4)	18.2 (16.6–19.8)	17.4 (16.3–18.5)	13.5 (12.5–14.5)
Hip flexion	131.1 (129.4–132.8)	135.2 (133.0–137.4)	130.4 (129.0–131.8)	127.2 (125.7–128.7)
Knee flexion	147.8 (146.6–149.0)	142.2 (140.4–144.0)	137.7 (136.5–138.9)	132.9 (131.6–134.2)
Knee extension	1.6 (0.9–2.3)	1.8 (0.9–2.7)	1.0 (0.6–1.4)	0.5 (0.1–0.9)

(a) (i) State what the numbers in brackets represent. [1]

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(ii) Calculate the percentage decrease in mean range of motion for hip extension in males from the youngest to the oldest group. [1]

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(Question 4 continued)

(b) Describe how to measure the range of motion of a joint. [3]

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(c) Distinguish between the skeletons in arthropods and vertebrates. [2]

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References:

1.a Enard, W., Przeworski, M., Fisher, S.E., Lai, C.S., Wiebe, V., Kitano, T., Monaco, A.P. and Pääbo, S., 2002. Molecular evolution of FOXP2, a gene involved in speech and language. *Nature* 418(6900), pp. 869–72. https://doi.org/10.1038/nature01025. Source adapted.

2. Reproduced from Gregory M. Preston et al., Appearance of Water Channels in Xenopus Oocytes Expressing Red Cell CHIP28 Protein, DOI: 10.1126/science.256.5055.385. 1992, AAAS.

3. Luo, M., Zhou, W., Patel, H. et al. Bedaquiline inhibits the yeast and human mitochondrial ATP synthases. *Commun Biol* 3, 452 (2020). https://doi.org/10.1038/s42003-020-01173-z. https://creativecommons.org/licenses/by/4.0/. Source adapted.

4. Soucie JM, Wang C, Forsyth A, Funk S, Denny M, Roach KE, Boone D; Hemophilia Treatment Center Network. Range of motion measurements: reference values and a database for comparison studies. *Haemophilia*. 2011 May; 17(3):500-7. doi: 10.1111/j.1365-2516.2010.02399.x. Epub 2010 Nov 11. PMID: 21070485.

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