Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Higher level
Paper 2

14 May 2024

Zone A morning | **Zone B** morning | **Zone C** morning

Candidate session number

2 hours 15 minutes

Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer two questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[72 marks]**.

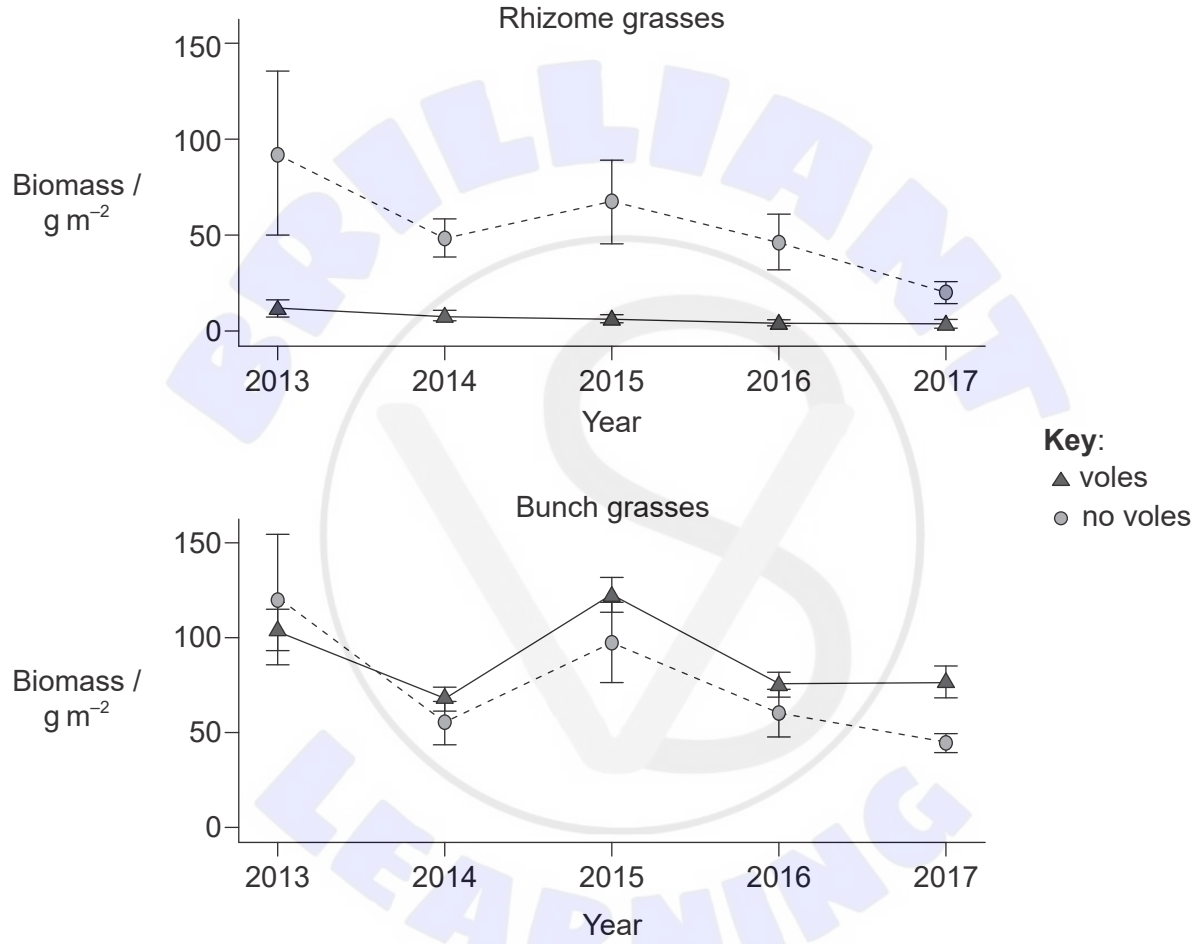
2224 – 6002

20 pages

Section A

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

1. Brandt's voles (*Lasiopodomys brandtii*) are small herbivorous rodents that live in the steppe grassland of Inner Mongolia. These mammals live in large family groups and feed on the roots, stems and leaves of a wide variety of plants that grow near their burrows. Their feeding activities have been found to have a large impact on the grassland vegetation. Researchers investigating the impact of these voles on the vegetation marked out plots of land and recorded how the biomass of two types of grasses, rhizome grasses and bunch grasses, changed in the presence and absence of voles from the years 2013 to 2017.



(a) Identify the year in which the greatest biomass of bunch grasses was recorded in plots with voles present. [1]

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(Question 1 continued)

(b) Compare and contrast the mean biomass of the two types of grass in 2013 in the presence and absence of voles. [2]

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(c) The voles derive nutrition from only one type of the grasses. Deduce with a reason which type. [1]

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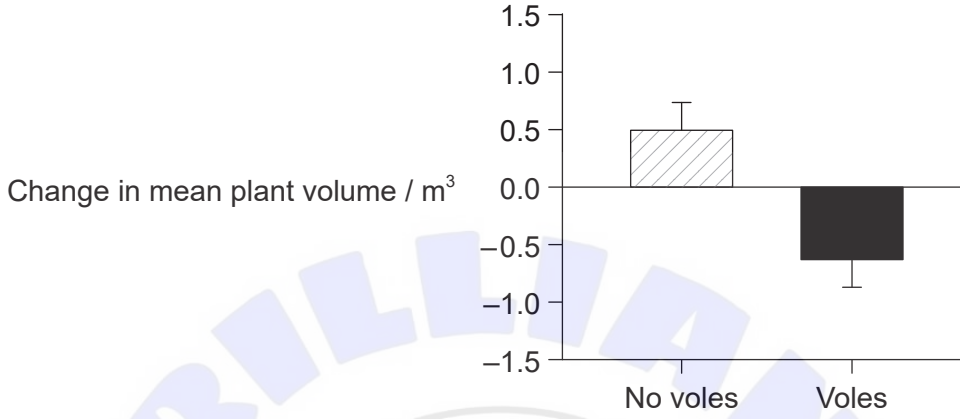
(Question 1 continued)

In a second study carried out from 2019 to 2020, researchers looked at how the presence of voles changed the plant volume of one type of bunch grass, *Achnatherum splendens*, in measured plots of land. This was done by measuring the change in plant volume of *A. splendens* in the plots.



(d) Calculate the mean difference in plant volume in the plots in the presence and absence of voles over the period of study. [1]

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(e) Outline how these results appear to contradict the results of the previous study. [1]

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(f) Suggest **one** advantage of measuring plant volume rather than plant biomass. [1]

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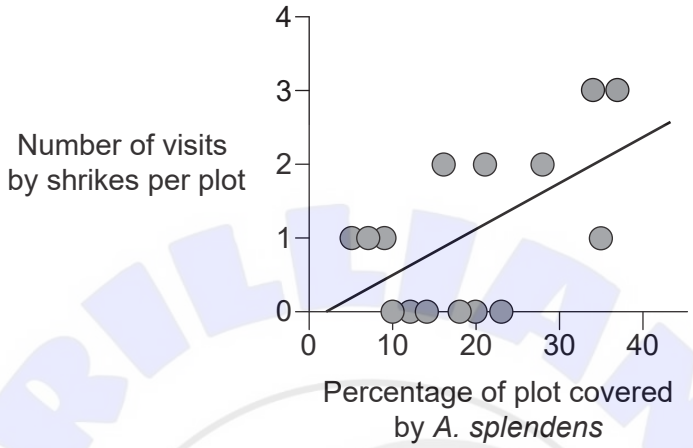
(Question 1 continued)

Shrikes (*Lanius spp.*) are predatory, carnivorous birds that feed on small animals, including voles. Shrikes were seen visiting the marked plots in the second study on plant volume of *A. splendens*, but not in the first study on biomass of two types of grass. The graph shows the number of visits shrikes made to 15 different marked plots of land according to percent coverage by the bunch grass *A. splendens*.



(g) Calculate the percentage of plots that had **two** visits by shrikes. [1]

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(h) State the relationship between number of shrike visits to the plots and percentage of plot covered by *A. splendens*. [1]

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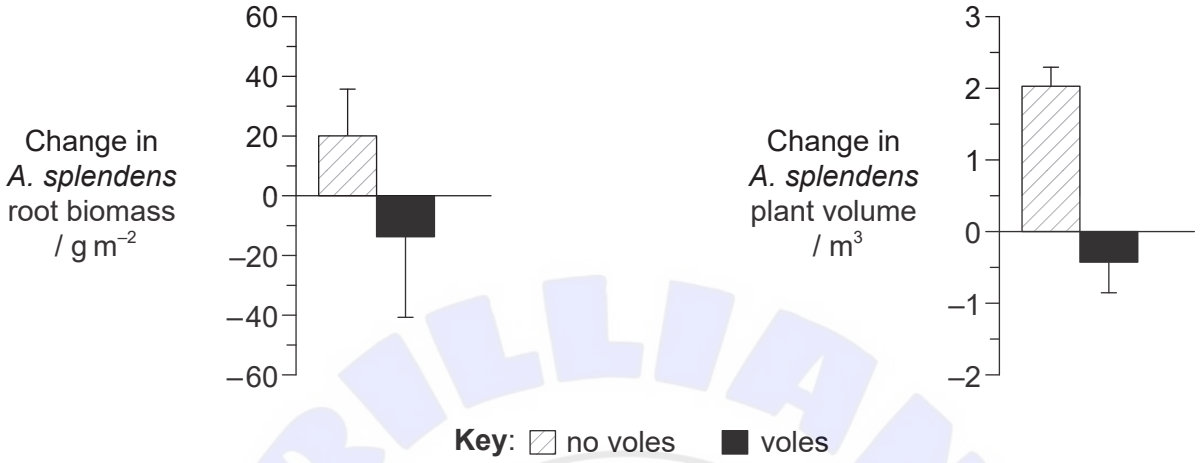
(Question 1 continued)

The researchers prepared plots, some with and some without voles. Shrikes were present in all plots. At the end of one month, the mean changes in root biomass and plant volume of *A. splendens* in the plots were measured.



(i) Suggest a reason for the change in the plant volume of *A. splendens* in the plots over the period of this study. [1]

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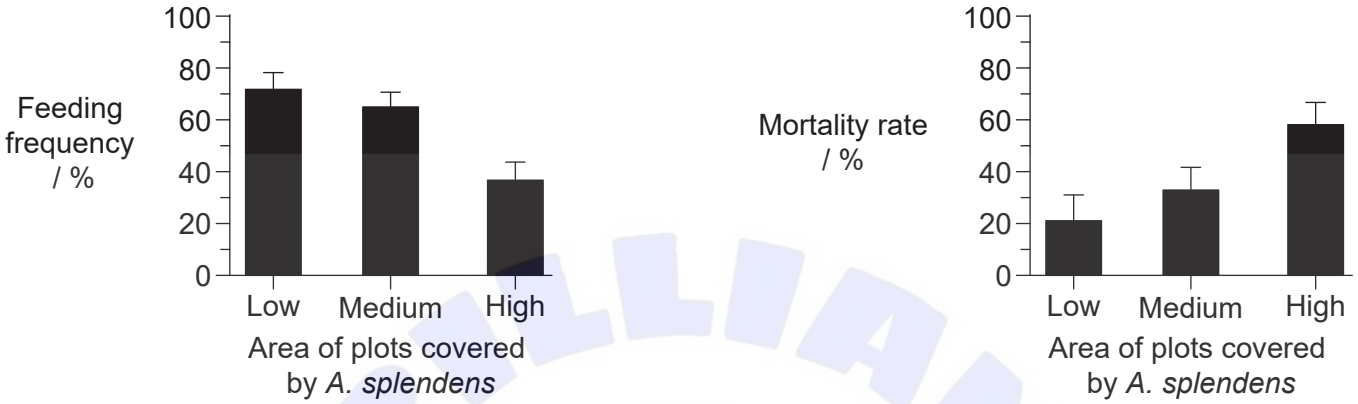
(Question 1 continued)

In a final experiment, the researchers prepared plots containing varying levels of cover of *A. splendens*, as well as the plants the voles normally feed on. Shrikes were not excluded from the plots. The amount of time the voles spent feeding and the mortality rate of the voles was recorded over a 3-week period.



(j) Describe, with a reason, the condition that favours survival of the voles. [1]

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(k) The researchers concluded that the voles can modify their ecosystem in order to survive. Discuss this conclusion with reference to all the data in the question. [4]

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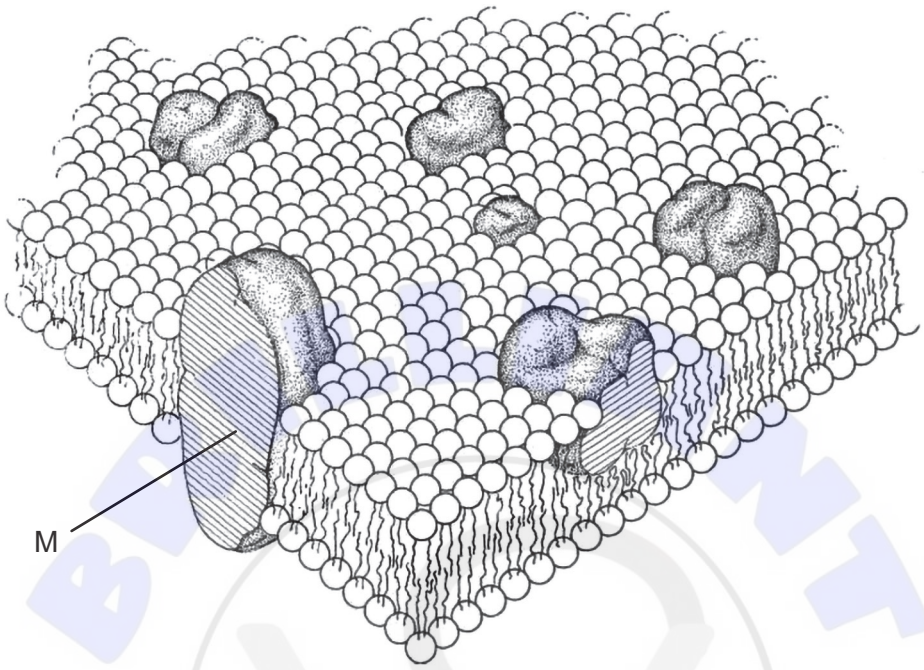
2. The diagram shows the original drawing of the cell membrane made in 1972 by Singer and Nicolson.



(a) Label with the letter H part of a phospholipid molecule that is hydrophilic. [1]

(b) Distinguish between this model of the cell membrane and the Davson–Danielli model. [1]

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(c) Explain the role of molecules such as M in sodium–potassium pumps. [3]

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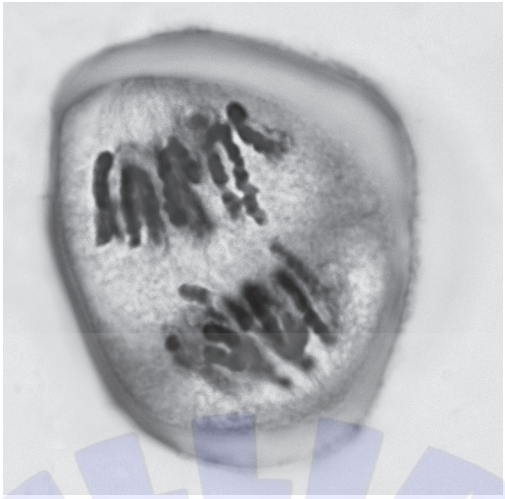
3. The image shows a cell in the anther of a lily (*Lilium sp.*) plant during the first division of meiosis.



(a) (i) Identify the stage of meiosis shown in the image. [1]

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(ii) State where in the lily flower pollen would be formed. [1]

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(b) Distinguish between plant pollination and fertilization. [2]

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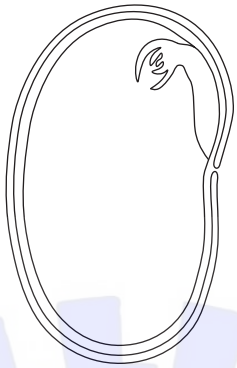
(Question 3 continued)

(c) The diagram shows a cross section through a broad bean (*Vicia faba*) seed.



(i) On the diagram, label the cotyledon. [1]

(ii) Outline the function of the cotyledon. [2]

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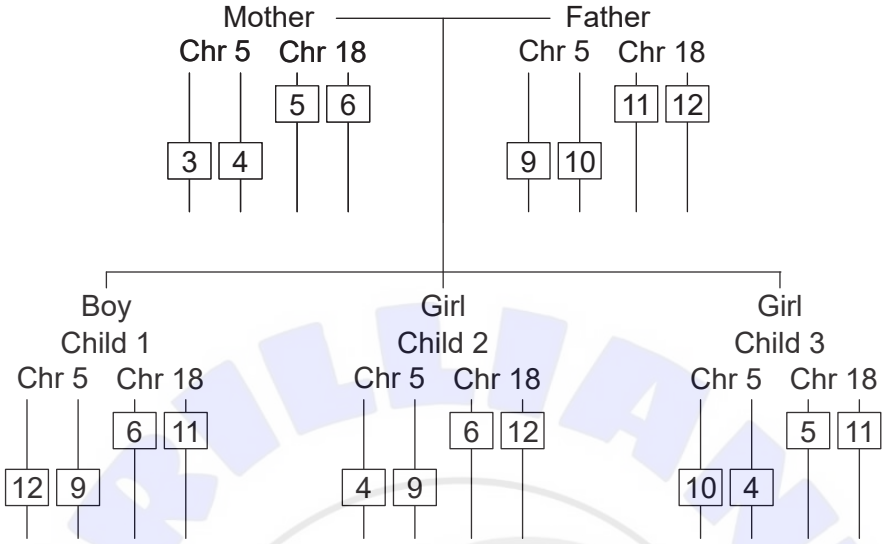
4. The diagram shows the tandem repeats on two different chromosomes for a couple and their children. The number of tandem repeats of the sequence AGAT is shown on chromosome 5 (Chr 5) and the sequence of AGAA on chromosome 18 (Chr 18). One child is adopted.



(a) Outline the use of tandem repeats in DNA profiling. [2]

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(b) Identify the child that is adopted, giving a reason for your answer. [1]

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(c) Explain the function of a promoter in DNA. [2]

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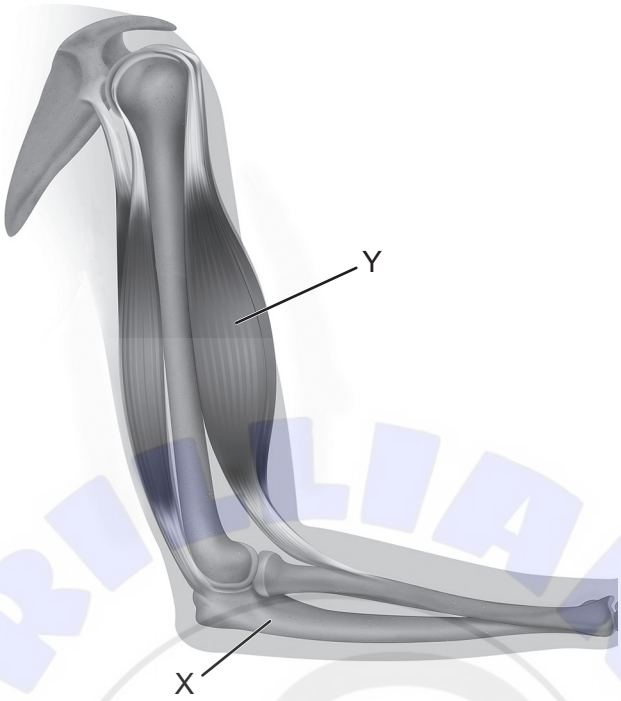
5. The diagram shows the bones and muscles of the human elbow joint.



(a) Identify structures X and Y. [2]

X: . . . . . .

Y: . . . . . .

(b) Outline the antagonistic action of the muscles of the elbow. [2]

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(c) State **one** reason that striated muscle cells are considered atypical. [1]

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(Question 5 continued)

(d) Explain how specialized cardiac muscle cells initiate each heartbeat. [3]

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Section B

Answer **two** questions. Up to one additional mark is available for the construction of your answers for each question. Answers must be written within the answer boxes provided.

6. The chemical and physical properties of water make it an essential medium for life.

(a) Outline how water acts as a coolant when sweating. [3]

(b) Describe how the kidney regulates water when the body is dehydrated. [5]

(c) Explain how water is transported from the soil to the atmosphere in flowering plants. [7]

7. The confirmation of DNA as the genetic material, together with the elucidation of its structure by Crick and Watson, had a profound effect on modern biology.

(a) Outline the reason that DNA replication is described as semi-conservative. [3]

(b) Describe how genetic variation is brought about by sexual reproduction. [5]

(c) Explain how isolation leads to speciation. [7]

8. The element carbon is an essential component of living matter, representing approximately 50 % of all dry biomass, and is present in a wide range of compounds.

(a) Describe how cellulose is formed from monosaccharides. [3]

(b) Outline the reasons that climate change is a threat to coral reefs. [5]

(c) Explain how carbon dioxide is converted to organic molecules during the light-independent reactions of photosynthesis. [7]

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References:

1. (a) Cui, C., Xie, Y., Hua, Y., et al., 2020. Brandt's vole (*Lasiopodomys brandtii*) affects its habitat quality by altering plant community composition. *Biologia* 75, pp.1097–1104. [e-journal] https://doi.org/10.2478/s11756-020-00469-z. Source adapted.

1. (d)(g)(i) Zhong, Z., et al., 2022. A rodent herbivore reduces its predation risk through ecosystem engineering. *Current Biology* 32(8), pp.1869–1874.e4 [e-journal] https://doi.org/10.1016/j.cub.2022.02.074. Source adapted.

2. Martin, L., 2022. *Discovering the Structure of the Plasma Membrane*. [online] Available at: https://archive.org/details/cnx-org-col10470/page/n19/mode/2up [Accessed 13 April 2023]. Source adapted.

3. (a) Reschke, E., n.d. [*Lilium - Lily 400X*.] [image online] Available at: https://www.gettyimages.com.mx [Accessed 13 April 2023]. Source adapted.

4. Angers, A., Kagkli, D., Oliva, L., Petrillo, M. and Raffael, B., 2019. *Study on DNA Profiling Technology for its Implementation in the Central Schengen Information System*. [online] Available at: https://publications.jrc.ec.europa.eu/repository/handle/JRC116742 [Accessed 13 April 2023]. Source adapted.

5. Aldona, n.d. [*Human arm*]. [image online] Available at: https://www.gettyimages.co.uk/detail/illustration/an-example-of-an-anatomical-and-physical-royalty-free-illustration/1291366338 [Accessed 16 May 2023]. Source adapted.