Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Standard level
Paper 2

9 November 2023

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

1 hour 15 minutes

Candidate session number

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 one question.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[50 marks]**.

Section A

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

1. There were widespread and intense wildfires in Southeast Australia during the summer season from November 2019 to January 2020. Estimates have been made of carbon dioxide emissions from these fires based on satellite monitoring data. The bar chart shows estimates made by five different research programmes: GFED, GFAS, QFED, FEER and FINN.
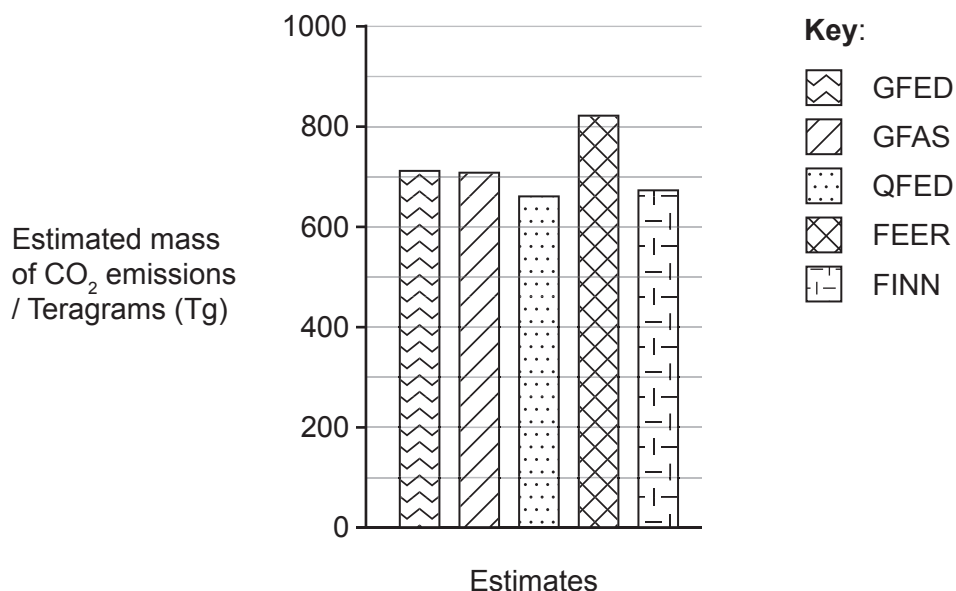
The table shows other statistics for comparison.

Mean emissions of CO_2 from wildfires and fossil fuels		CO_2 / Tg
	Mean annual emissions from wildfires in Australia	410
	Mean annual emissions from combustion of fossil fuels in Australia	402
	Mean Nov to Jan emissions in previous years from wildfires in SE Australia	9
	Mean of the five estimates for Nov 2019 to Jan 2020 emissions from wildfires in SE Australia	715

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(Question 1 continued)

(a) The highest estimate of CO_2 emitted from wildfires in Southeast Australia between November 2019 and January 2020 is 820 Tg, from the FEER research programme. State the lowest estimate. [1]

Programme: ....

Estimate: .... Tg

(b) Using the data in the table, comment on the magnitude of the wildfires in Southeast Australia from November 2019 to January 2020. [3]

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Answers written on this page
will not be marked.

(Question 1 continued)

In addition to carbon dioxide, carbon monoxide and other gases, the wildfires emitted smoke. Smoke is an aerosol of solid particles and liquid droplets suspended in air. The complex mixture of chemicals in this aerosol includes black carbon (soot) and compounds of nitrogen, phosphorus and iron. This aerosol absorbs light, allowing its optical density and movement to be assessed by satellite monitoring.

Much of the smoke from the wildfires in Southeast Australia in 2019–2020 was carried eastwards across the South Pacific Ocean. The study area shown in the map was affected by the smoke.
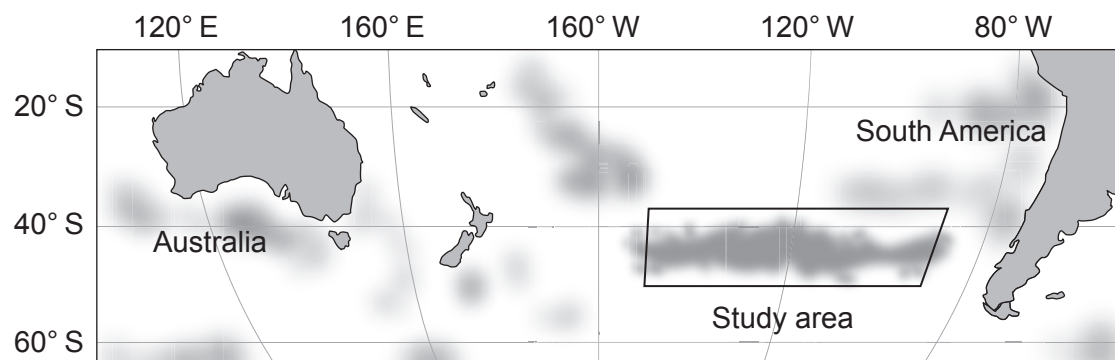
[Source: adapted from Tang, W, Llort, J, Weis, J et al, 2021. Widespread phytoplankton blooms triggered by 2019–2020 Australian wildfires. *Nature* (597), pp. 370–375. https://doi.org/10.1038/s41586-021-03805-8.]

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(Question 1 continued)

The graph shows the optical density of the air and the chlorophyll concentrations of the water in this study area. The concentration of chlorophyll is proportional to the density of phytoplankton (photosynthetic bacteria and algae) in the water.

Key:

Daily measures of aerosol optical density (AOD)

8-day mean chlorophyll concentration in 2019–2020

8-day mean chlorophyll concentration in previous years

[Source: adapted from Tang, W, Llort, J, Weis, J et al, 2021. Widespread phytoplankton blooms triggered by 2019–2020 Australian wildfires. *Nature* (597), pp. 370–375. https://doi.org/10.1038/s41586-021-03805-8.]

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(Question 1 continued)

(c) Identify **two** differences between aerosol optical density (AOD) in the months before the wildfires and during the period of wildfires. [2]

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(d) Using the data in the graph, distinguish between phytoplankton populations in 2019–2020 and in previous years. [3]

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(Question 1 continued)

Samples of air carrying the aerosol from the wildfires were filtered at Mount Wellington on Tasmania, and the amounts of iron and levoglucosan on the filters were measured. Levoglucosan is produced by combustion of carbohydrates such as starch and cellulose, so is used as a chemical tracer for biomass burning.

Bars on the graph show amounts of levoglucosan, and datapoints show amounts of iron.
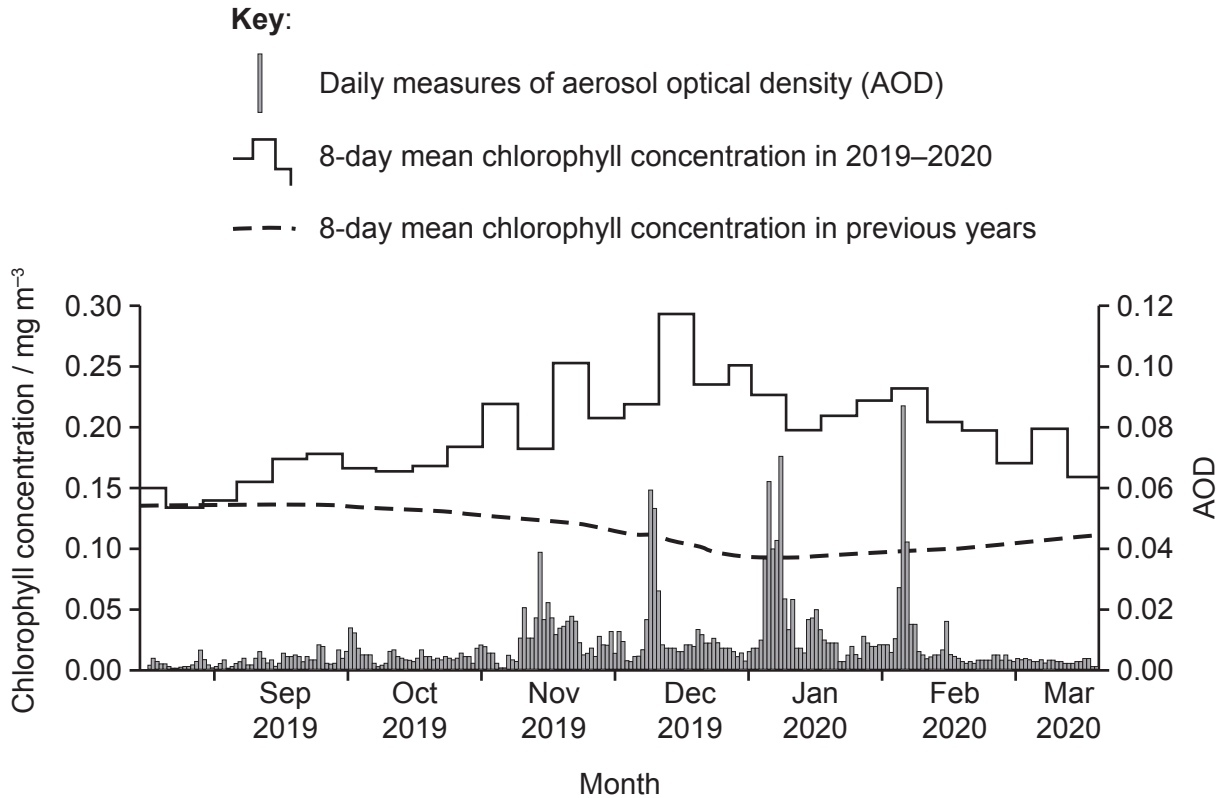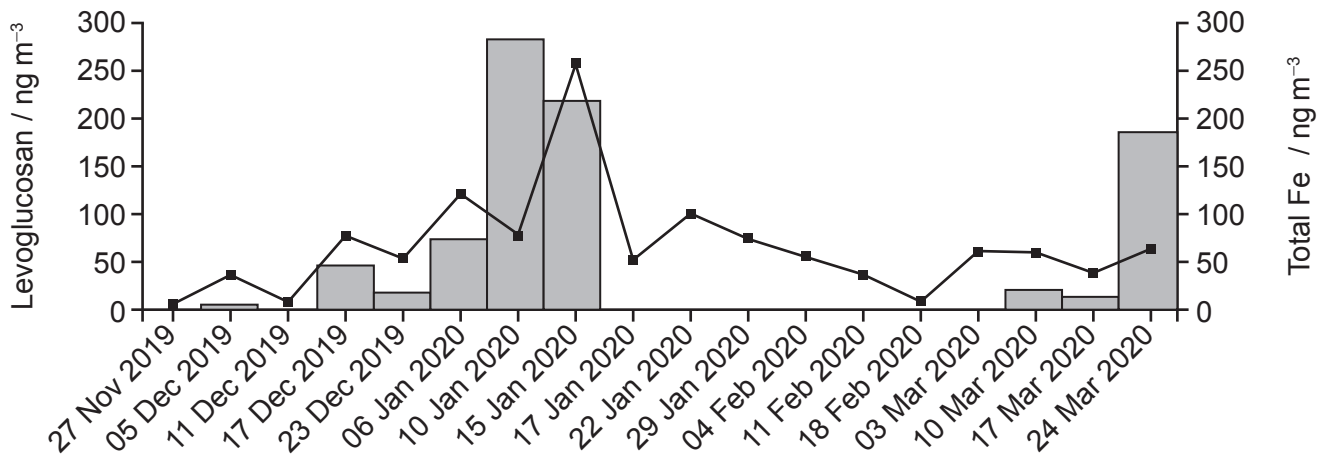

[Source: adapted from Tang, W., Llort, J., Weis, J. *et al.*, 2021. Widespread phytoplankton blooms triggered by 2019–2020 Australian wildfires. *Nature* (597), pp.370–375. https://doi.org/10.1038/s41586-021-03805-8]

(e)   Explain the conclusions that can be drawn from the data in the graph.   [2]

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(f)   In the South Pacific Ocean, chlorophyll production and growth of phytoplankton are usually limited by a low concentration of iron in the water. Suggest a hypothesis for the cause of the unusual pattern of phytoplankton growth during the summer of 2019–2020.   [2]

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2. Hormones are used for cell-to-cell communication in the human body.

(a) Describe the role in the menstrual cycle of one named hormone from the ovary and one from the pituitary gland. [2]

Gland	Hormone	Role in the menstrual cycle
pituitary	. . . .	. . . .
ovary	. . . .	. . . .

(b) Hormones enter and leave the bloodstream through capillaries. Outline **two** adaptations of capillaries for efficient exchange of substances with surrounding tissues. [2]

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Turn over

3. This redwood tree (*Sequoia sempervirens*) was blown over in 1936, but five side branches formed new roots and are now separate trees.

Three of the new trees
formed from side branches
of the original tree

Dead trunk of original tree   Base of original tree
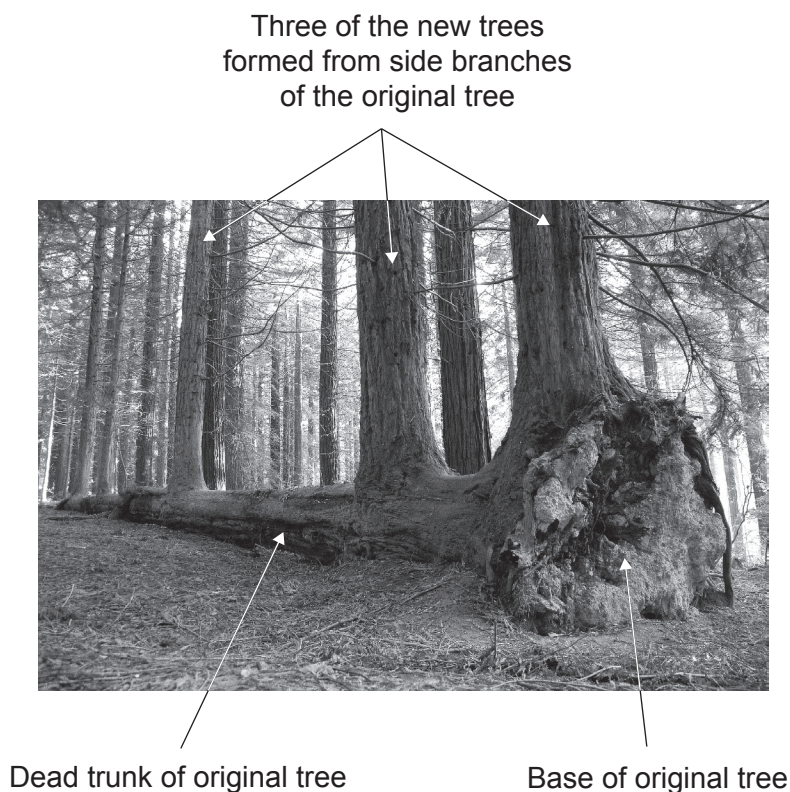
(a) State the molecule that trees such as redwoods use as genetic material. [1]

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(b) If the genomes of the five new trees were sequenced, predict with a reason how similar they would be to each other. [2]

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(Question 3 continued)

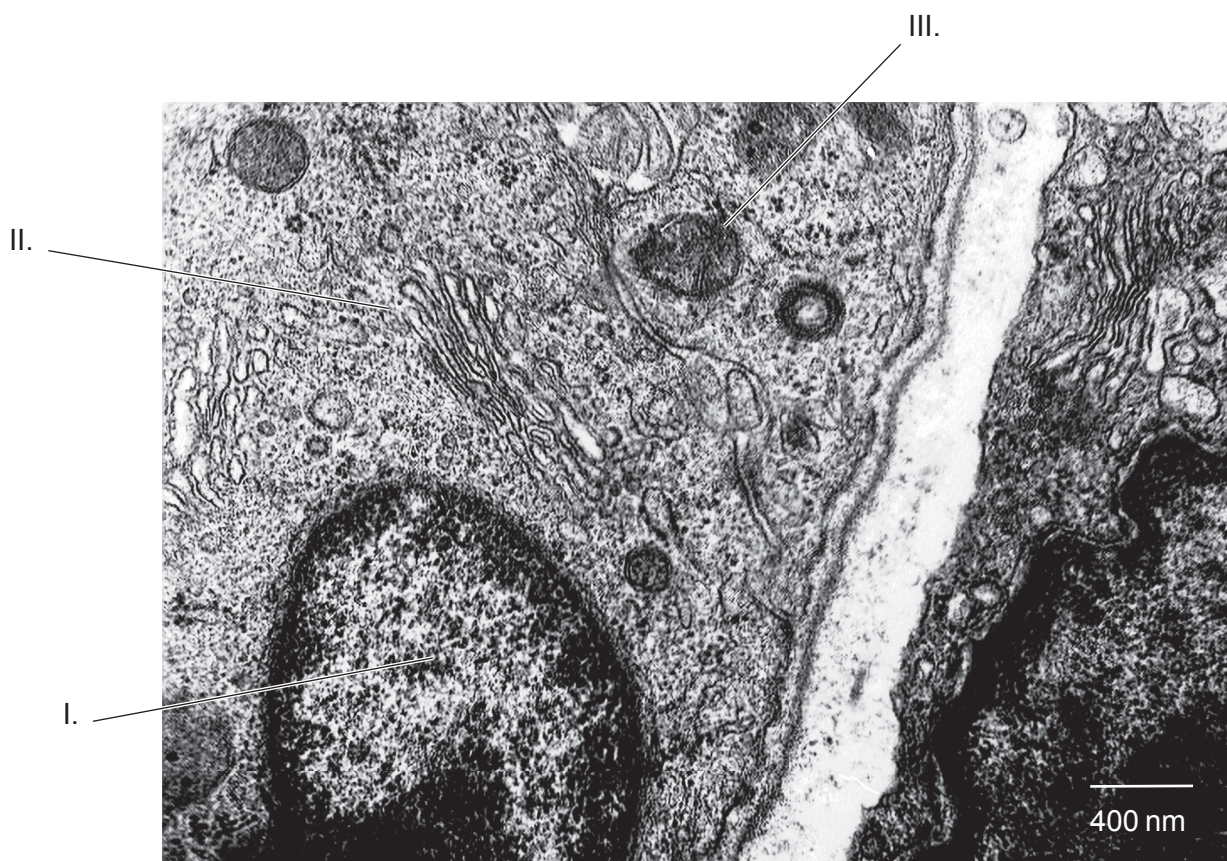   (c)   Outline **one** method that has been used successfully to clone an adult animal.   [3]

Turn over

4. The electron micrograph shows parts of two cells.

(a)   Identify organelles I to III.   [3]

I: . . . .

II: . . . .

III: . . . .

(b)   Using evidence from the micrograph, deduce whether the cells are prokaryotic
or eukaryotic.   [2]

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(Question 4 continued)

(c)   State the function of flagella and ribosomes in prokaryotic cells.   [2]

Flagella: . . . .

Ribosomes: . . . .

5. There are five classes of vertebrates, one of which is birds.

(a) Outline **two** recognition features of birds. [2]
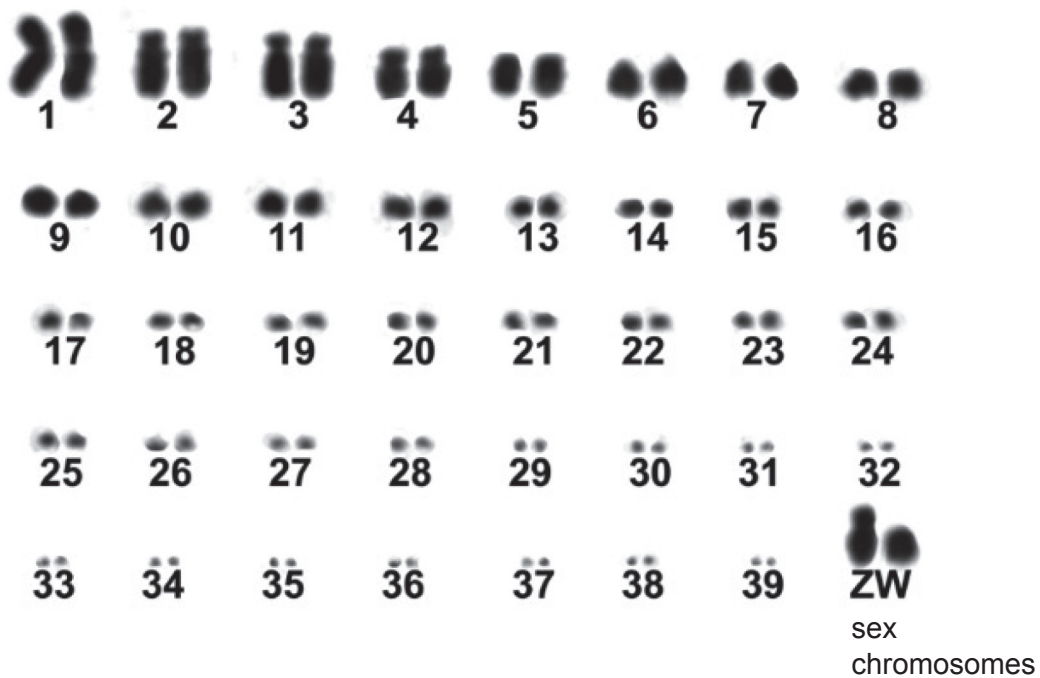
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The karyogram shows the chromosomes of a female saffron finch (*Sicalis flaveola*) bird.

(b) Compare and contrast the chromosomes of the saffron finch and humans. [2]

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Section B

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

6.   Fats are used by mammals and oils are used by plants for energy storage. Both of these types of lipid are triglycerides.

    (a)   Outline how plants make oils using carbon from the atmosphere.   [4]

    (b)   Explain the reasons for oils being insoluble and sugars such as glucose being soluble in water.   [4]

    (c)   Explain how a fat-rich diet might contribute to the development of poor health.   [7]

7.   Living organisms cause change and also respond to change.

    (a)   Describe how increased concentrations of atmospheric carbon dioxide may change coral reef ecosystems.   [4]

    (b)   Explain how a population changes by natural selection.   [7]

    (c)   Explain the changes in lung function of a person with emphysema.   [4]

References:

1.(a) Adapted from van der Velde, IR, van der Werf, GR, Houweling, S et al, 2021. Vast CO_2 release from Australian fires in 2019–2020 constrained by satellite. *Nature* (597), pp. 366–369. https://doi.org/10.1038/s41586-021-03712-y.

1.(c) Adapted from Tang, W, Llort, J, Weis, J et al, 2021. Widespread phytoplankton blooms triggered by 2019–2020 Australian wildfires. *Nature* (597), pp. 370–375. https://doi.org/10.1038/s41586-021-03805-8.

1.(e) Adapted from Tang, W, Llort, J, Weis, J et al, 2021. Widespread phytoplankton blooms triggered by 2019–2020 Australian wildfires. *Nature* (597), pp. 370–375. https://doi.org/10.1038/s41586-021-03805-8.

4. Howard, Louisa. https://commons.wikimedia.org/wiki/File:Pancreatic_cells_-_TEM.jpg. Public domain.

5. Kretschmer, R, et al. (2021). Karyotype Evolution and Genomic Organization of Repetitive DNAs in the Saffron Finch, *Sicalis flaveola* (Passeriformes, Aves). *Animals 11*(5)*, 1456*. [e-journal] http://dx.doi.org/10.3390/ani11051456. Source adapted.