External assessment 2023

Multiple choice question book

Biology

Paper 1

General instruction

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Section 1

Instruction

- Respond to these questions in the question and response book.

Question 1

The biological species concept defines *species* as a group of organisms

(A) with a common set of alleles.

(B) descended from a common ancestor.

(C) occupying the same niche or adaptive zone.

(D) that can interbreed to produce fertile offspring.

Question 2

Species classified as K-strategists

(A) often live in unstable habitats.

(B) exhibit an exponential rate of reproduction.

(C) reach sexual maturity later than r-strategists.

(D) are first to colonise a new environment created by a disturbance.

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Question 3

The table provides population data for a species of fairy-wren.

Year	2022
Population on 1st January	15 200
Births	7600
Deaths	4310
Immigration	790
Emigration	24

The population growth rate in 2022 was closest to

(A) 17%

(B) 27%

(C) 55%

(D) 73%

Question 4

Populations with reduced genetic diversity face an increased risk of extinction because they

(A) have fewer chromosomes.

(B) have difficulty finding mates for reproduction.

(C) are less likely to adapt to changing environments.

(D) contain a larger proportion of heterozygous individuals.

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Question 5

Which statement is true for DNA replication?

(A) Adenine pairs with guanine.

(B) The process occurs during metaphase I.

(C) DNA polymerase unwinds the double helix.

(D) New strands are synthesised in the 5′ to 3′ direction.

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Question 6

The phylogenetic tree on the next page shows evolutionary relationships between seven species of Himalayan songbird and the elevations they inhabit.

The data shows that

(A) the most closely related species occupy different elevations.

(B) the most closely related species diverged 14 million years ago.

(C) species at low elevation are more closely related than species at high elevation.

(D) species at middle elevation are less closely related than species at other elevations.

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Question 7

The distributions of phenotypes before and after a selection pressure acted on a population are shown on the next page.

Which graph shows disruptive selection?

Key

------- Before selection pressure

——— 25 generations later

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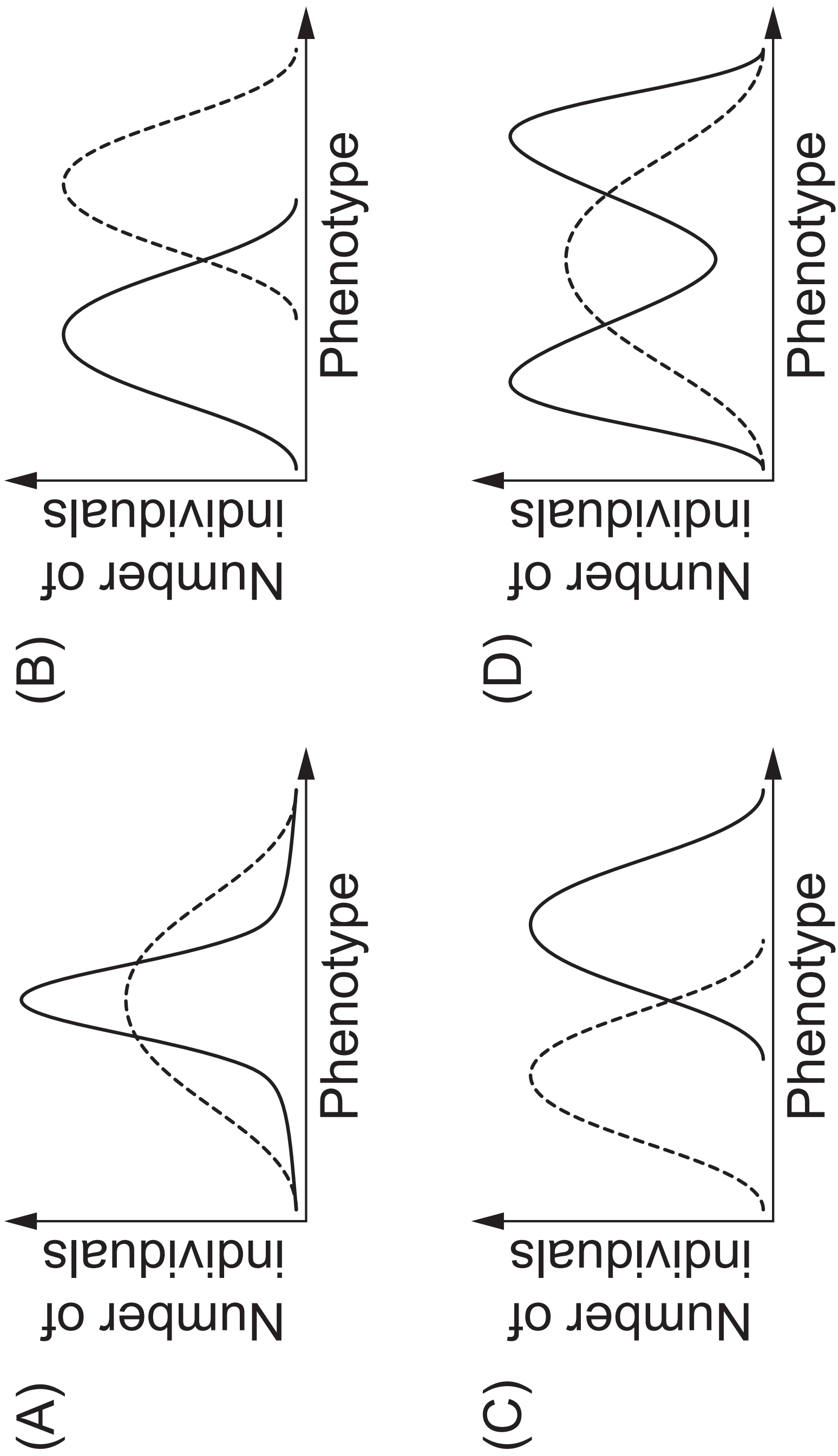
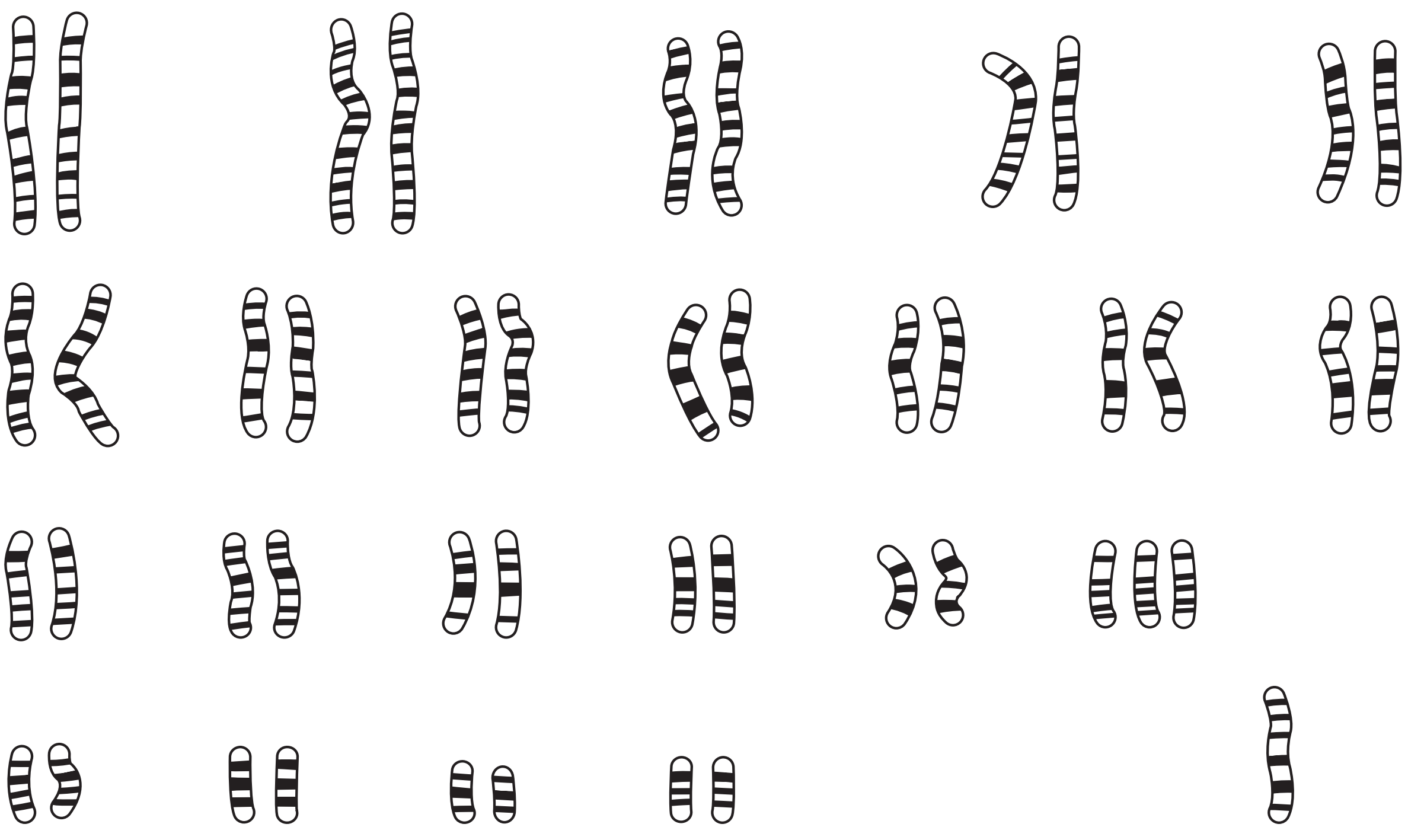


Question 8

The diagram shows a human karyotype and a list of genetic conditions.



Genetic condition	Common name
Monosomy X	Turner syndrome
Monosomy 5	Cri du chat syndrome
Trisomy 18	Edwards syndrome
Trisomy 21	Down syndrome

Which genetic condition is indicated in the karyotype?

(A) Turner syndrome

(B) Cri du chat syndrome

(C) Edwards syndrome

(D) Down syndrome

Question 9

An *ecological niche* refers to

(A) a group of organisms competing for the same resources.

(B) the role and space that an organism fills in an ecosystem.

(C) all organisms occupying a physical space close enough to interact with each other.

(D) the largest population of a particular species that can be supported by an ecosystem.

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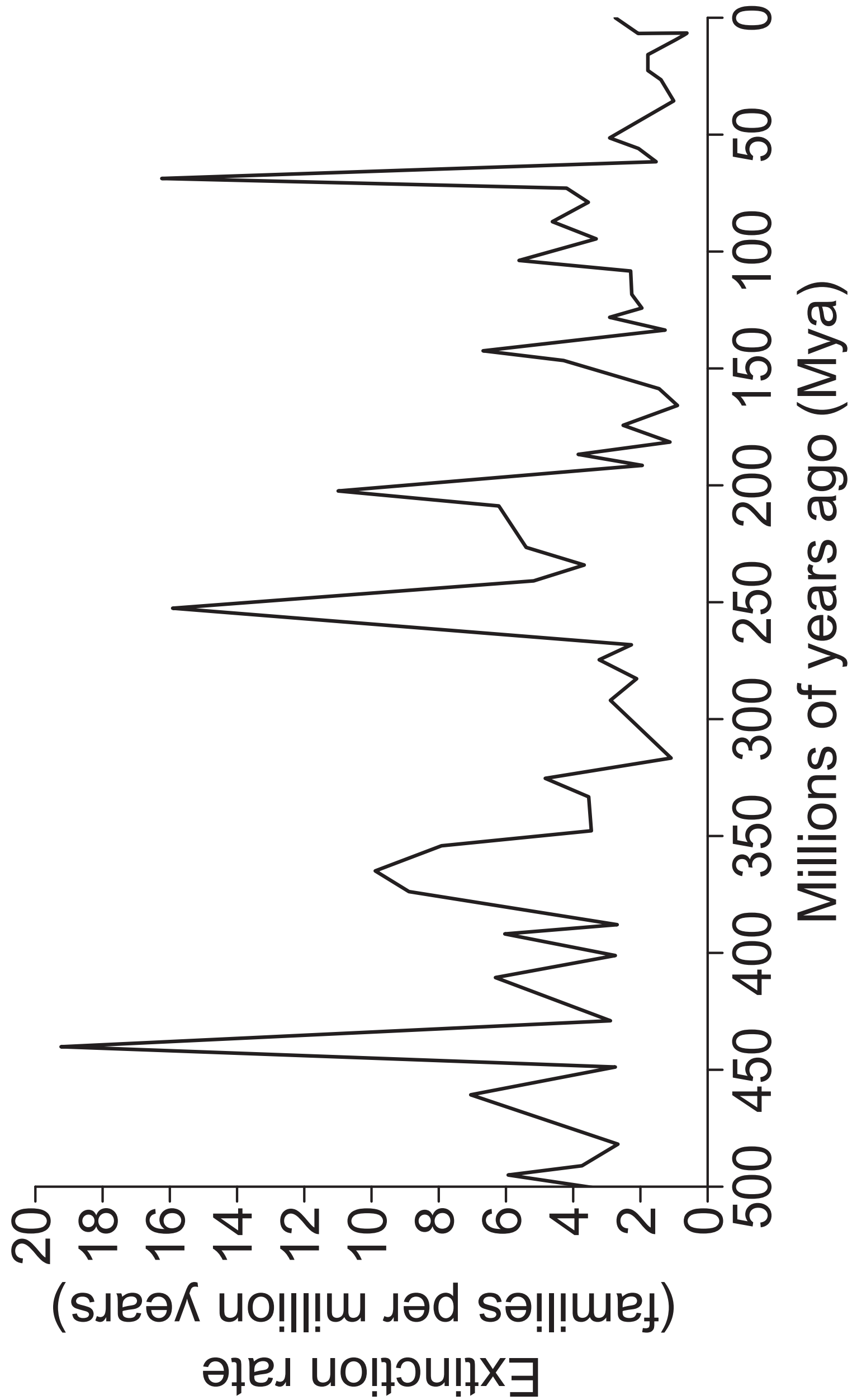
Question 10

The graph shows extinction rates over time.



How many times in the past 500 million years has the extinction rate exceeded 14 families per million years?

(A) 3

(B) 4

(C) 5

(D) 6

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Question 11

Restriction enzymes

(A) join DNA into a single strand.

(B) cut DNA at specific locations.

(C) add nucleotides to a growing DNA strand.

(D) assist in the amplification of recombinant DNA.

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Question 12

The graph on the next page shows the results of a study on the species richness of gut microbes. The data represents the cumulative number of species observed as the number of samples increased.

Based on this data, the minimum number of samples required to obtain valid species richness data is

(A) 2

(B) 6

(C) 12

(D) 16

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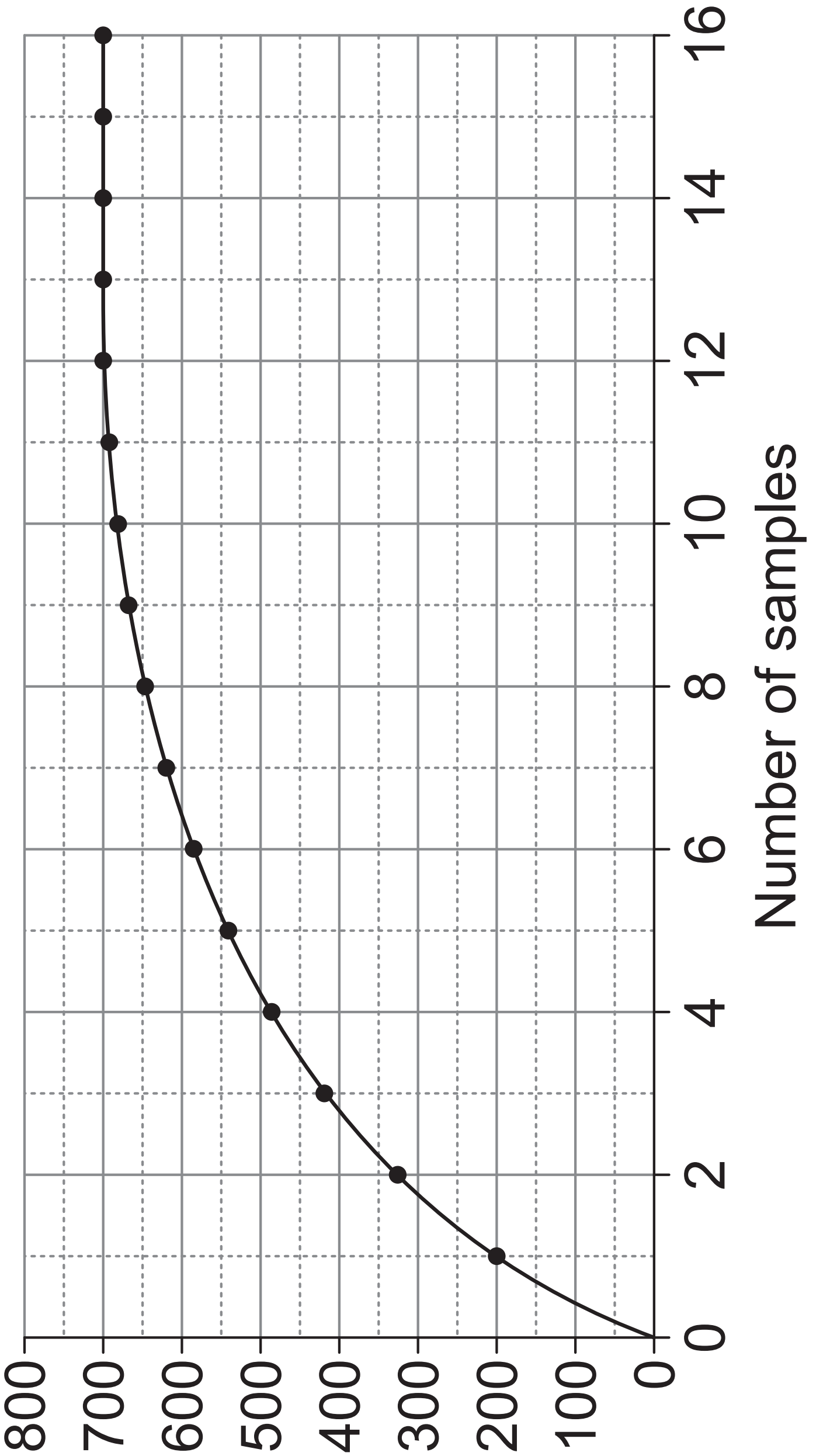

Question 13

Which option best describes the conditions for parapatric speciation?

(A) Geographical barriers limit gene flow between populations.

(B) Gene flow is interrupted in populations occupying the same habitat.

(C) A species occupies such a large geographical area that mate selection is influenced by proximity.

(D) A small group of organisms becomes separated from their parent population by physical barriers.

Question 14

An energy pyramid for an aquatic ecosystem is shown (values are in kJ m^{-2} y^{-1}).

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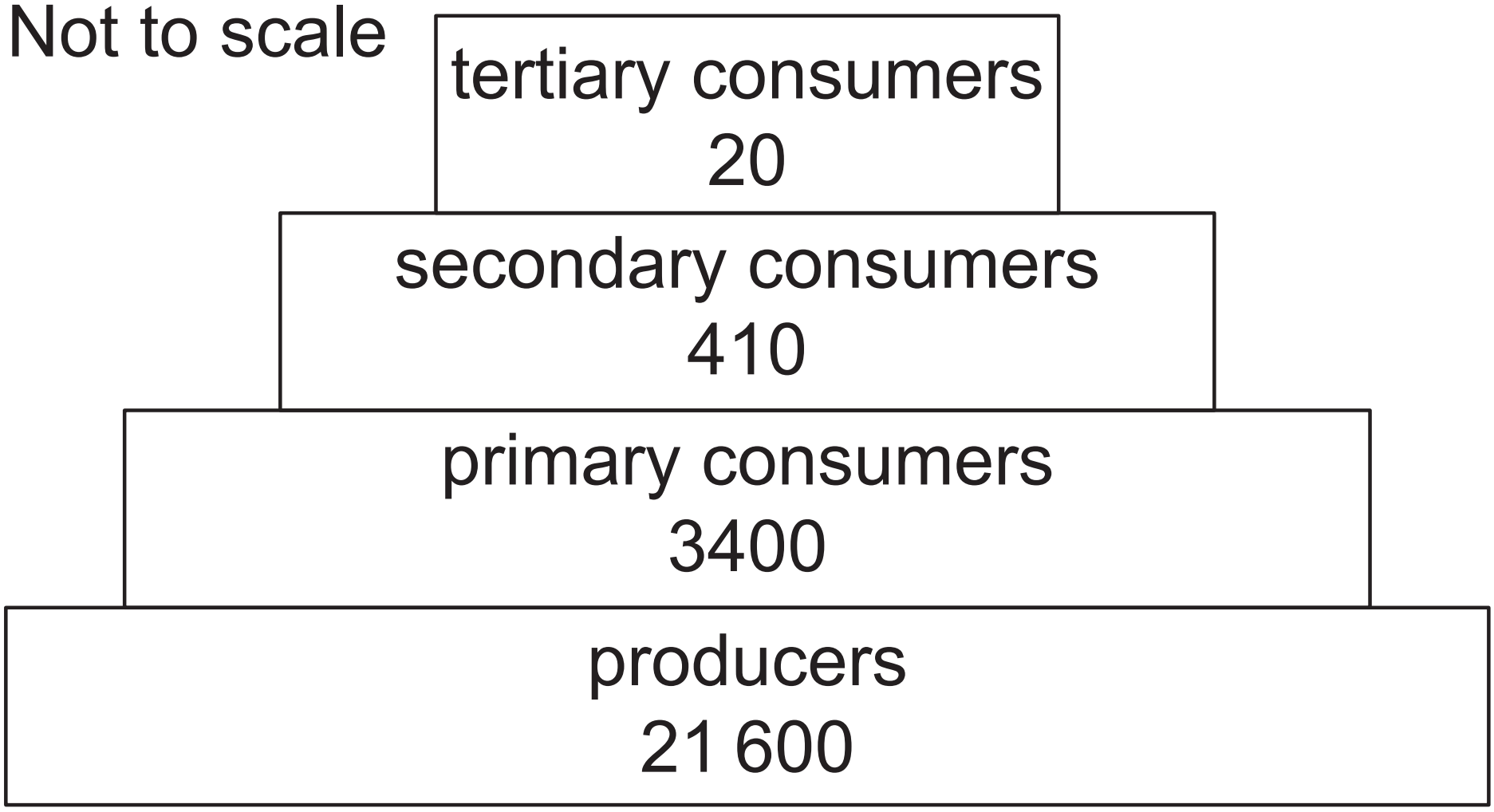

Transfer efficiency between producers and primary consumers is closest to

(A) 5%

(B) 10%

(C) 12%

(D) 16%

Question 15

Allele frequencies are most likely to stay constant in

(A) large populations with low levels of migration.

(B) small populations with low levels of migration.

(C) large populations with high levels of migration.

(D) small populations with high levels of migration.

Question 16

The diagram shows a section of DNA.

Immediately following transcription and RNA splicing, the product would most closely resemble

(A) mRNA: 

(B) tRNA: 

(C) mRNA: 

(D) tRNA: 

Question 17

What is the most likely outcome of a homeobox (HOX) gene mutation?

(A) slower growth rate

(B) body appendages in the incorrect location

(C) failure of sex characteristics to fully develop

(D) impaired ability of red blood cells to carry oxygen

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Question 18

Calcium chloride ($CaCl_2$) is a chemical used in bacterial transformation. An experiment was conducted to determine how the concentration of calcium chloride affects the transformation efficiency of large and small plasmids. Error bars show standard error.

The data on the next page suggests that

(A) the optimal concentration for transforming small plasmids is 0.15 M.

(B) transformation efficiency is highest at concentrations greater than 0.1 M.

(C) large plasmids have higher transformation efficiency than small plasmids.

(D) there is less variation in transformation efficiency of small plasmids when concentration is less than 0.2 M.

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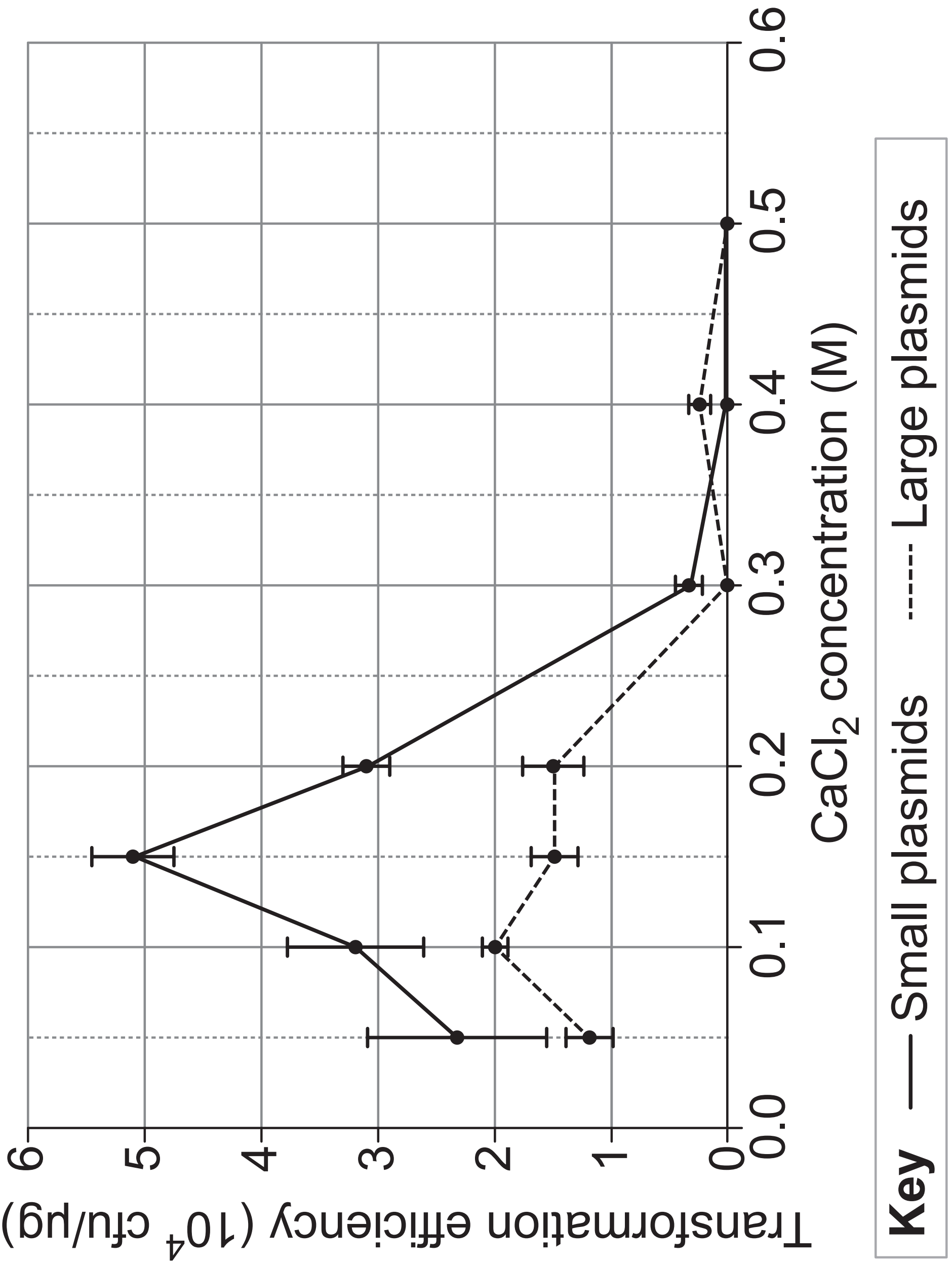

Question 19

Electrophoresis separates DNA fragments based on

(A) size, with larger fragments travelling further through the gel.

(B) size, with smaller fragments travelling further through the gel.

(C) charge, with more positively charged fragments travelling further through the gel.

(D) charge, with more negatively charged fragments travelling further through the gel.

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Question 20

The capture–recapture method and Lincoln index ($N = \frac{M \times n}{m}$) were used to monitor a population of platypuses over a four-year period. Experimental findings are shown.

The table shows data from one year of the study.

Number of individuals captured and marked in first sampling	20
Number of individuals captured in second sampling	18
Number of recaptured individuals marked	17

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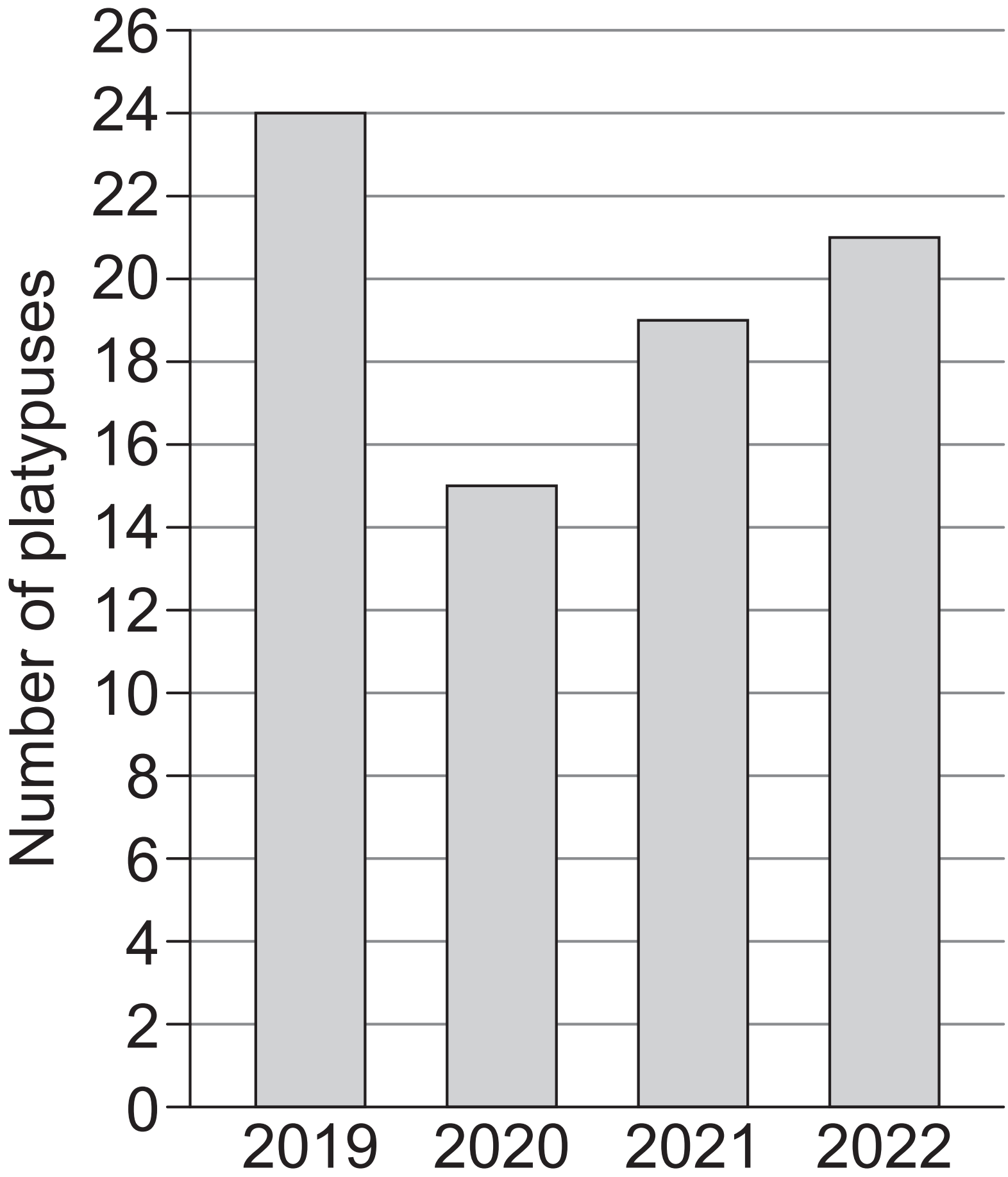

When was the data in the table collected?

(A) 2019

(B) 2020

(C) 2021

(D) 2022

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References

Question 6

Adapted from Mooers, A 2014, Figure 1: *Himalayan songbird assemblage*, 'Supply and demand', Nature, issue 509, pp. 171-172, https://www.nature.com/articles/nature13332.

Question 10

Adapted from Ritchie, H, Roser, M 2021, '*Big Five*' *Mass Extinctions in Earth's History*, 'Biodiversity', OurWorldinData, https://ourworldindata.org/extinctions

Question 18

Adapted from Lim, G, Lum, D, Ng, B & Sam, C 2015, 'Differential transformation efficiencies observed for pUC19 and pBR322 in *e. coli* may be related to calcium chloride concentration'; J*ournal of Experimental Microbiology and Immunology (JEMI)*, https://jemi.microbiology.ubc.ca/sites/default/files/Lim%20et%20al.pdf