

APOLLO

Natural selection

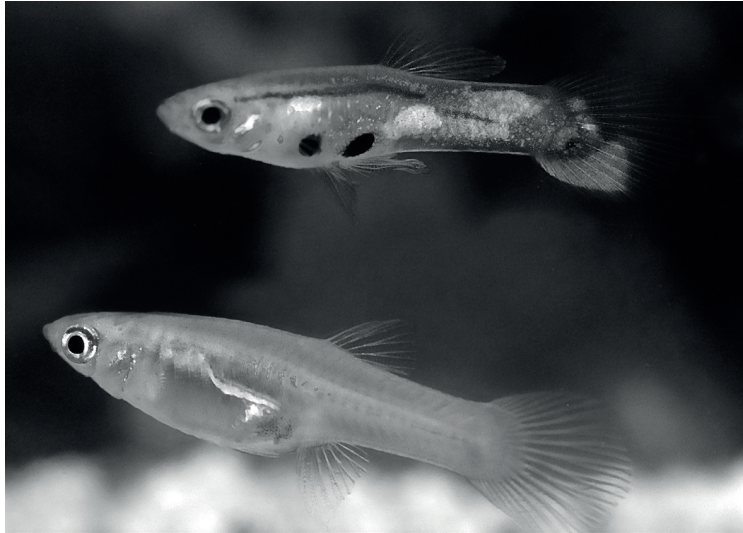
HL

Biology

First assessment 2025

9 questions | questions

38. John Endler's experiments modelled sexual and natural selection in Trinidadian guppies (*Poecilia reticulata*) by controlling selection pressures.



What did the experiments of John Endler demonstrate?

- A. Guppies have no predators in their natural habitat.
- B. Male guppies prefer dull-coloured females for mating.
- C. Predation influences the colour of guppies in different environments.
- D. Guppies are not affected by the presence of other fish species.

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

37. John Endler experimented on populations of guppies (*Poecilia reticulata*) with different colouration. A male guppy fish is shown with large spots, which makes the fish more attractive to females, but more visible to predators.



The table shows the male colouration of guppy fish and number of predators in three different ponds.

	Predator X	Predator Y	Male guppy colouration
Pond 1	12	0	Large colourful spots
Pond 2	15	0	Medium colourful spots
Pond 3	5	17	None/very small drab spots

What can be concluded from the data?

- A. There is a positive correlation between numbers of predator X and size of spots.
- B. Predator Y has least influence on colouration.
- C. There is a negative correlation between number of predators and size of spots.
- D. There is no sexual selection.

38. What is an outcome of selection?

- A. Directional selection increases the size of the gene pool.
- B. Stabilizing selection increases allele frequencies of phenotypic extremes.
- C. Disruptive selection increases genetic variance in a population.
- D. Sexual selection leads to allopatric speciation.

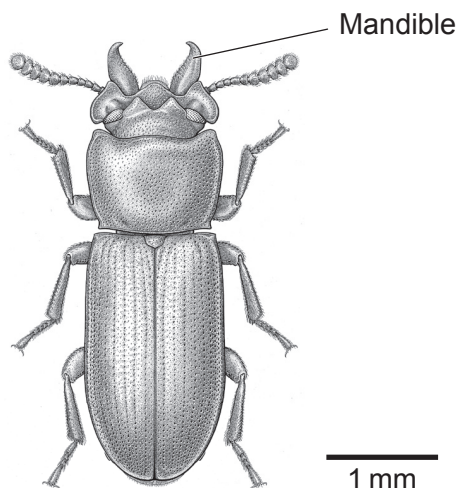
- 38.** The Hardy–Weinberg equation, used to calculate expected genotype frequencies in a population in genetic equilibrium, is:

$$p^2 + 2pq + q^2 = 1$$

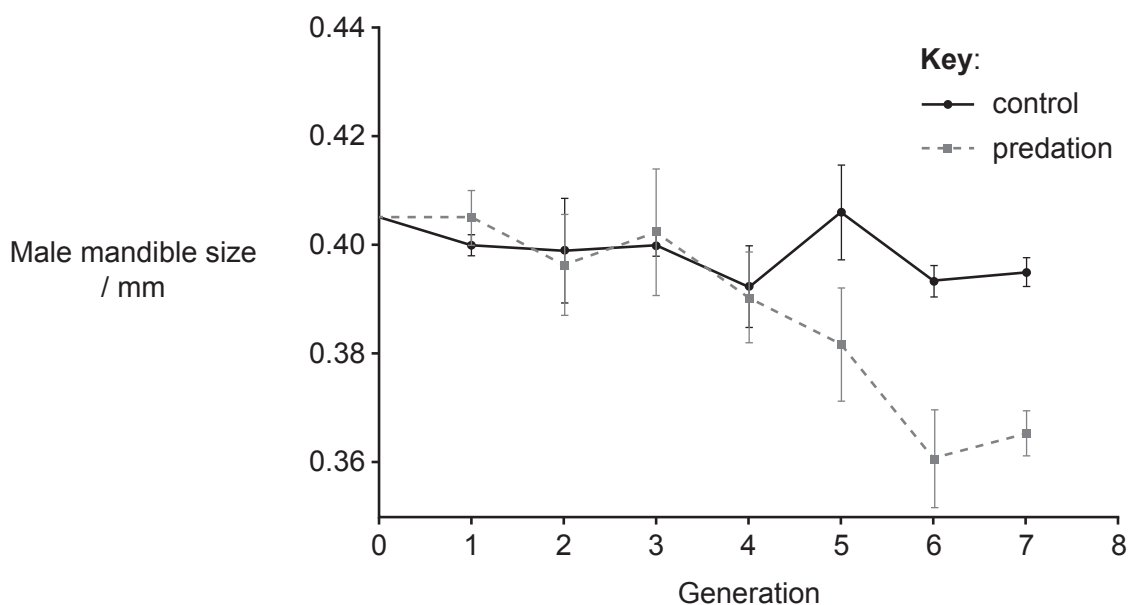
The length of the mouthparts in an insect population is controlled by a gene with two alleles: long mouthparts (dominant) and short mouthparts (recessive). The frequency of the allele for long mouthparts is 0.72. What is the expected genotype frequency of individuals with short mouthparts?

- A. 0.52
- B. 0.40
- C. 0.28
- D. 0.08

4. Mandible (mouthpart) size is variable in the male broadhorned flour beetle (*Gnatocerus cornutus*).



In a laboratory experiment, scientists investigated how natural selection by predation on flour beetles by the larger assassin bug (*Amphibolus venator*) affected male mandible size. The graph shows the mean and standard deviation (SD) male mandible size over seven generations in three replicate experiments. Control populations were not subjected to predation.



- (a) (i) State the reason that a ruler is not a suitable piece of equipment for precisely measuring the length of the mandible.

[1]

(This question continues on the following page)



(Question 4 continued)

(ii) Suggest how the mandible size of the flour beetles could have been measured in this experiment. [1]

(b) List **two** variables that need to be kept constant in this experiment. [2]

(c) Describe the trend for male mandible size with predation. [2]

(d) Explain how natural selection by predation affects male mandible size in flour beetles. [4]



Disclaimer:

Content used in IB assessments is taken from authentic, third-party sources. The views expressed within them belong to their individual authors and/or publishers and do not necessarily reflect the views of the IB. Any trademarks™ or registered® trademarks included are used for illustrative purposes only, and use does not imply any affiliation with or endorsement by the International Baccalaureate.

References:

1. Harp, J.M., Hanson, B.L., Timm, D.E. and Bunick, G.J., 2000. Asymmetries in the nucleosome core particle at 2.5 Å resolution. *Acta Crystallographica Section D Biological Crystallography* 56(12), pp. 1513–1534. <https://doi.org/10.1107/s0907444900011847>. Source adapted.
2. Macionis, V. Reliability of the standard goniometry and diagrammatic recording of finger joint angles: a comparative study with healthy subjects and non-professional raters. *BMC Musculoskelet Disord* 14, 17 (2013). <https://doi.org/10.1186/1471-2474-14-17>.
3. Used with permission of the *Journal of Experimental Biology*, from Giant Nerve Fibre Activity In Intact, Freely Moving Earthworms, by Drewes, C.D, Landa, K.B. and McFall, J.L., *J. Exp. Biol.* 73, pp. 317–227, 1978. Available at: <https://journals.biologists.com/jeb/article-abstract/72/1/217/22476/Giant-Nerve-Fibre-Activity-in-Intact-Freely-Moving?redirectedFrom=fulltext>. Permission conveyed through Copyright Clearance Center, Inc. Source adapted.
4. Diagram: Bousquet Y, et al., 2018. Figure 36; *Gnatocerus* (*Gnatocerus*) *cornutus* (Fabricius, 1798). [image online] Available at: [https://commons.wikimedia.org/wiki/File:Gnatocerus_\(Gnatocerus\)_cornutus_\(10.3897-zookeys.728.20602\)_Figure_36.jpg](https://commons.wikimedia.org/wiki/File:Gnatocerus_(Gnatocerus)_cornutus_(10.3897-zookeys.728.20602)_Figure_36.jpg). Licensed under the Creative Commons Attribution 4.0 International license: <https://creativecommons.org/licenses/by/4.0/deed.en>. [Accessed 30 September 2024]. Source adapted.

Graph: Okada, K., Katsuki, M., Sharma, M.D., et al., 2021. Natural selection increases female fitness by reversing the exaggeration of a male sexually selected trait. *Nat Commun* 12, 3420. <https://doi.org/10.1038/s41467-021-23804-7>. Licensed under a Creative Commons Attribution 4.0 International License: <https://creativecommons.org/licenses/by/4.0/>. Source adapted.

All other texts, graphics and illustrations © International Baccalaureate Organization 2025



Section B

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

10. There is evidence that RNA was used as a genetic material in living organisms before DNA.

- (a) Describe the structure of RNA and the evidence that it was the first genetic material used to store information. [5]
- (b) Describe how analysis of DNA base sequences can be used in the conservation of biodiversity. [3]
- (c) Explain the causes and consequences of changes in the base sequences of DNA in a species over many generations. [7]



Disclaimer:

Content used in IB assessments is taken from authentic, third-party sources. The views expressed within them belong to their individual authors and/or publishers and do not necessarily reflect the views of the IB. Any trademarks™ or registered® trademarks included are used for illustrative purposes only, and use does not imply any affiliation with or endorsement by the International Baccalaureate.

References:

- 1.a Florida Fish and Wildlife Conservation Commission, 2023. *Index Nesting Beach Survey Totals (1989–2023)*. [image online] Available at: <https://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/> [Accessed 25 October 2024]. Source adapted.
- 1.d Foley, A.M., Stacy, B.A., Hardy, R.F., Shea, C.P., Minch, K.E. and Schroeder, B.A. (2019), Characterizing watercraft-related mortality of sea turtles in Florida. *Jour. Wild. Mgmt.*, 83: 1057–1072. <https://doi.org/10.1002/jwmg.21665>.
- 1.f Foley, A.M., Stacy, B.A., Hardy, R.F., Shea, C.P., Minch, K.E. and Schroeder, B.A. (2019), Characterizing watercraft-related mortality of sea turtles in Florida. *Jour. Wild. Mgmt.*, 83: 1057–1072. <https://doi.org/10.1002/jwmg.21665>.
4. Griffin24, 2014. *Germinating bean seed*. [image online] <https://www.gettyimages.co.uk/detail/photo/germinating-bean-seed-royalty-free-image/517816303> [Accessed 4 December 2024]. Source adapted.
5. paveugra, 2015. *Respiratory system*. [image online] Available at: <https://www.gettyimages.co.uk/detail/illustration/respiratory-system-royalty-free-illustration/489734346> [Accessed 6 December 2024]. Source adapted.
- 6.a Řepková, J, Hlaváčová, S., Lízal, P., Kyjovská, Z. and Relichová, J., 2005. *Fig. 2. Genetic map of Arabidopsis thaliana with DNA markers and new mutant loci indicated*. [image online] Available at: <https://ogmb.sci.muni.cz/media/3202562/repkova2005.pdf> [Accessed 29 October 2024]. Source adapted.
7. Used with permission of Oxford University Press -Journals, from *Genome biology and evolution*, Molecular Biology and Evolution Society, volume 8, issue 4, 2016; permission conveyed through Copyright Clearance Center, Inc.

Dridi, B., Fardeau, M.-L., Ollivier, B., Raoult, D. and Drancourt, M., 2012. *Methanomassiliicoccus luminyensis* gen. nov., sp. nov., a methanogenic archaeon isolated from human faeces. *International Journal of Systematic and Evolutionary Microbiology*, [online] Available at: <https://www.microbiologyresearch.org/content/journal/ijsem/10.1099/ijss.0.033712-0> [Accessed 6 December 2024]. Source adapted.

All other texts, graphics and illustrations © International Baccalaureate Organization 2025



Please **do not** write on this page.

Answers written on this page
will not be marked.



Please **do not** write on this page.

Answers written on this page
will not be marked.



- 39.** What assumption is made when using the Hardy-Weinberg equation for calculating changes in allele frequencies in a population?
- A. The population size is large.
 - B. Natural selection is taking place.
 - C. Mutations are occurring in the population.
 - D. There is variation among the phenotypes of the population.

- 40.** Domestic dogs (*Canis familiaris*) have evolved from grey wolves (*Canis lupus*). Evidence suggests that the domestication of dogs first occurred around 30 000 years ago. Which best describes the evolution giving rise to the domestic dog?
- A. The wolf produced offspring in large numbers which underwent natural selection.
 - B. Variations in the wolf population that resembled modern dogs favoured wolf survival.
 - C. Wolves showing favourable traits were selected for breeding.
 - D. Dogs were better suited to changes in the natural environment than wolves.
-

Disclaimer:

Content used in IB assessments is taken from authentic, third-party sources. The views expressed within them belong to their individual authors and/or publishers and do not necessarily reflect the views of the IB.

References:

14. Murphy, F. and Whitfield, S., n.d. *Herpes virus image under the microscope*. [image online] Available at: <<https://www.bbvaopenmind.com/en/science/research/virus-inspired-science/>> [Accessed 3 July 2020].
17. University of Delaware, n.d. [Model 2]. [image online] Available at: <<http://www1.udel.edu/chem/white/C527/TransmembraneProteins.pdf>> [Accessed 28 July 2020].
19. Demidenko, R., Daniunaite, K., Bakavicius, D., Sabaliauskaite, R., Skeberdyte, A., Petroska, D., Laurinavicius, A., Jankevicius, F., Lazutka, J.R. and Jarmalaite, S., 2017. Decreased expression of MT1E is a potential biomarker of prostate cancer progression. *Oncotarget*, 8, pp.61709–61718.
23. Hill, M.A., 2020. *Embryology Trisomy 21*. [image online] Available at: <https://embryology.med.unsw.edu.au/embryology/index.php/Trisomy_21> [Accessed 28 July 2020].
24. Gschmeissner, S., n.d. *Centipede underside, SEM*. [image online] Available at: <<https://www.sciencephoto.com/media/374228/view/centipede-underside-sem>> [Accessed 15 July 2020].
32. McGuire, J.A., Witt, C.C., Remsen Jr., J.V., Corl, A., Rabosky, D.L., Altshuler, D.L. and Dudley, R., 2014. Molecular Phylogenetics and the Diversification of Hummingbirds. *Current Biology*, 24(8), pp.910–916.
36. Mepps.com Staff, n.d. *Favored temperature range*. [image online] Available at: <<https://www.mepps.com/mepps-tactics/article/how-water-temperature-and-oxygen-affect-fishing/418>> [Accessed 8 December 2020].