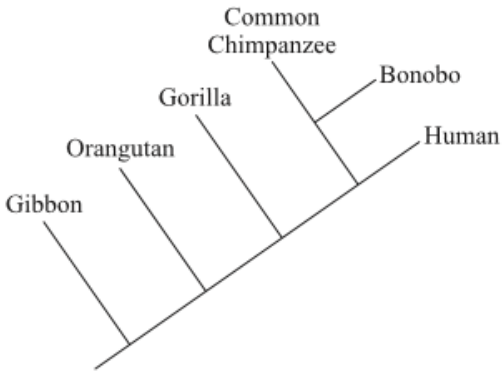
HL Paper 3

Define *gene pool*.

The diagram below is a cladogram.



a. State a function of each of the following parts of the human brain. [2]

(i) Cerebellum

(ii) Hypothalamus

b (i). Identify the **two** most closely related organisms. [1]

b (ii). Identify the species to which the Bonobo is most distantly related. [1]

c. Describe **one** type of barrier that may exist between gene pools. [3]

Cystic fibrosis (CF) is caused by a mutation of a human gene which codes for a chloride channel. The frequency of the CF allele is much higher in Europe than expected for an allele that causes a harmful condition. It has been suggested that individuals who are heterozygous for this allele may be protected against an infectious disease such as cholera or typhoid. This could cause both the CF allele and the normal allele of the chloride channel gene to persist in the population.

a. State the name given to the situation where two alleles of a gene persist indefinitely in a population. [1]

b. CF is a recessive condition that affects approximately 1 in 2500 births in Australia. Calculate the percentage of heterozygous individuals in the population. Show your calculation. [2]

c. Using CF as an example, distinguish between *allele frequency* and *gene pool*. [2]

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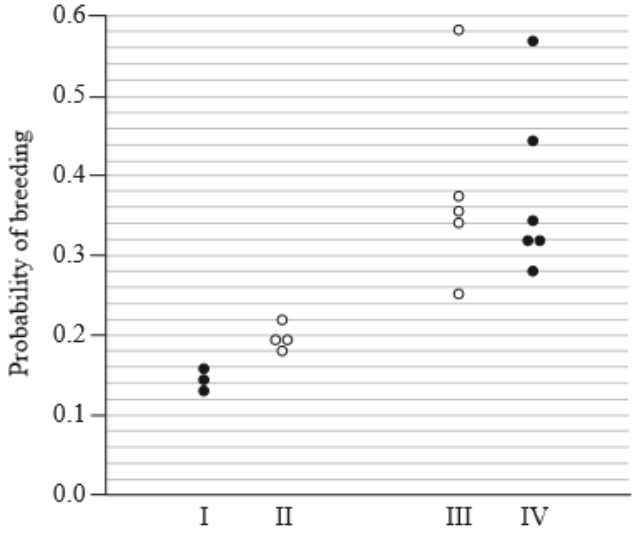
b. Outline the endosymbiotic theory. [2]

c (ii)Define *gene pool*. [1]

Populations of threespine sticklebacks (*Gasterosteus sp*.), a fish living in small freshwater lakes in British Columbia, Canada, are derived from the marine threespine stickleback (*Gasterosteus aculeatus*). In order to investigate the process of speciation in these populations, three small lakes were studied. Each lake contained two varieties of stickleback: a large, bottom-dwelling variety that fed on invertebrates near the shore and a small, plankton-eating variety that lived in the open water. The probability of breeding between pairs of individuals was measured under laboratory conditions in the following breeding combinations:

I different varieties (small × large) from the same lake
II different varieties from different lakes
III same variety (small × small) and (large × large) from different lakes
IV same variety from the same lake.
The data are summarized below.



[Source: HD Rundle, *et al*., (2000), *Science*, **287**, pages 306–308]
From H. D. Rundle et al. (2000) *Science*, 287, pp. 306–308. Reprinted with permission from AAAS.

a. Identify the highest and lowest probabilities of breeding for individuals of the same variety from different lakes. [1]

Highest probability:

Lowest probability:

b. Identify the breeding combination that results in the lowest probability of breeding. [1]

c. Analyse the probability of breeding between individuals from the same lake. [2]

d. Scientists concluded that speciation is taking place in these populations. Discuss the evidence for speciation provided by the data. [3]

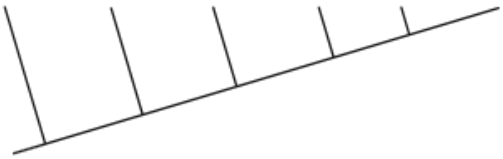
Outline how isolation of a gene pool can lead to evolution.

Discuss evolution by gradualism and punctuated equilibrium.

a. The table shows certain characteristics present (+) or absent (–) in six organisms. [3]

	Segmented	Jaws	Hair	Placenta	Multicellular	Limbs
Amoeba	–	–	–	–	–	–
Cat	+	+	+	+	+	+
Earthworm	+	–	–	–	+	–
Kangaroo	+	+	+	–	+	+
Lizard	+	+	–	–	+	+
Sponge	–	–	–	–	+	–

Using the data, label the cladogram with the names of the organisms.

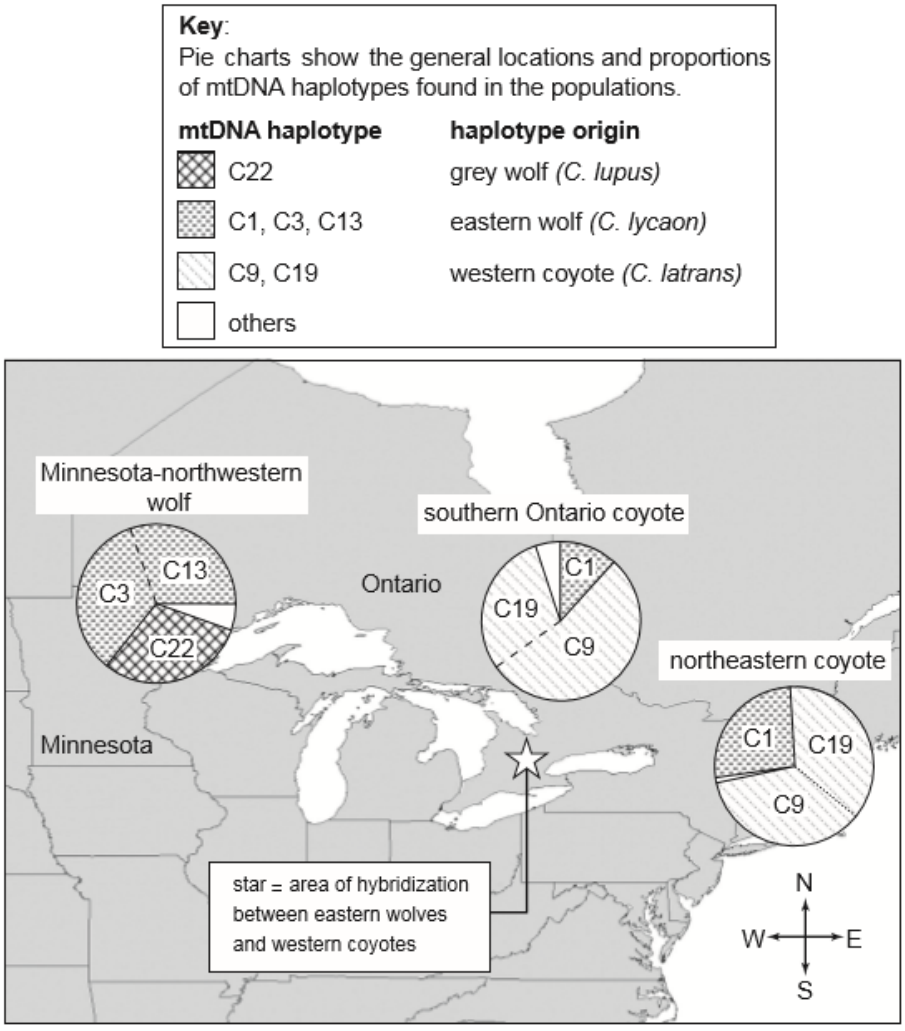


c. A species is often defined as a group of similar individuals that interbreed in nature and produce fertile offspring. Discuss some problems with the use of this definition. [2]

There are many closely related *Canis* species in North America including the grey wolf (*C. lupus*), eastern wolf (*C. lycaon*) and western coyote (*C. latrans*). Hybridization can occur between members of these species.

For example, during the last 100 years, hybridization has occurred between western coyotes (*C. latrans*) and eastern wolves (*C. lycaon*) in the area of Ontario shown by a star in the map shown below.

Genetic evidence for hybridization is based on identification of haplotypes (combinations of linked alleles in clusters of similar genes) that exist in mitochondrial DNA (mtDNA) of *Canis* populations. The populations in this study were the Minnesota-northwestern wolf, southern Ontario coyote and northeastern coyote. Assume that all animals in each *Canis* population have the same mtDNA haplotypes.



[Source: T. Wheeldon *et al.* (2010) *Biology Letters*, **6** (2), pages 246–247. Colonization history and ancestry of northeastern coyotes. By permission of the Royal Society.]

a. Outline the genetic evidence that *Canis* populations have hybridized. [2]

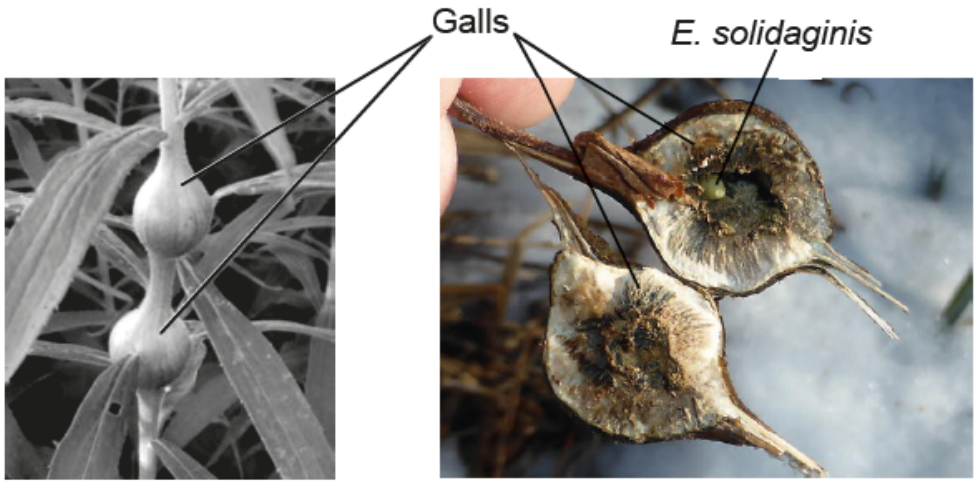
b. Compare the genetic data for southern Ontario coyotes and northeastern coyotes. [2]

c. State with a reason whether the genetic evidence shows that the western coyote and the grey wolf have overlapping ranges. [1]

d. The northeastern coyote has more wolf-like skull features than the southern Ontario coyote. Suggest a reason for this difference. [1]

e. Discuss briefly whether there is genetic evidence to show a common ancestor for the Minnesota-northwestern wolf, the southern Ontario coyote and the northeastern coyote. [2]

The larval stage of the fly *Eurosta solidaginis* develops in the plant *Solidago altissima*. The larva secretes a chemical which causes plant tissue to grow around it forming a swelling called a gall. The gall provides the developing insect with protection from predators.



[Source: https://nhgardensolutions.files.wordpress.com]

[Source: Masumi Palhof]

The *E. solidaginis* fly is preyed upon by the parasitic wasp *Eurytoma gigantea*. The graph shows the relationship between gall diameter and the percentage of flies that avoid predation by *E. gigantea*.

a. In order to form galls, the insects choose a location where cell division occurs at a high rate. State the term for a region of rapid cell division within a plant. [1]

b. Describe the relationship between gall diameter and percentage survival of *E. solidaginis*. [2]

c. Explain the concept of directional selection with respect to this example. [2]