Evolution

Standard difficulty · 20 questions · 40 marks · Time: 42 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer 8 × 1 = 8 marks

1. The theory of natural selection was put forward by:

(a) de Vries **(b)** Mendel
(c) Lamarck **(d)** Charles Darwin (with Alfred Wallace)

2. In a population in Hardy–Weinberg equilibrium, the frequency of the recessive phenotype (aa) is 0.16. The frequency of heterozygotes (Aa) is:

(a) 0.48 **(b)** 0.4 **(c)** 0.6 **(d)** 0.36

3. The wing of a bat and the arm of a human are:

(a) analogous (convergent evolution) **(b)** vestigial organs
(c) homologous (divergent evolution) **(d)** the result of genetic drift

4. Neanderthal man:

(a) arose in Africa and spread across continents
(b) lived about 2 million years ago in East African grasslands and used stone weapons
(c) lived about 15 million years ago; Ramapithecus was more man-like
(d) had a brain of about 1400 cc, lived in east and central Asia and buried the dead

5. Genes moving with migrating animals is an example of:

(a) gene flow (gene migration) **(b)** convergent evolution
(c) genetic drift **(d)** adaptive radiation

6. A population of 400 has 42 AA, 262 Aa and 96 aa individuals. The frequency of allele A is:

(a) 0.5675 **(b)** 0.105 **(c)** 0.76 **(d)** 0.4325

7. Hardy–Weinberg equilibrium is disturbed when a few individuals start a new island population. This factor is:

(a) genetic drift **(b)** natural selection
(c) mutation **(d)** genetic recombination

8. Assertion (A): If the frequency of allele a is 0.1 in a population in equilibrium, the frequency of aa individuals is 0.01.
Reason (R): In Hardy–Weinberg equilibrium the frequency of aa is 2q.

(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Section B — Short answer — 8 × 2 = 16 marks

9. Distinguish between homologous and analogous organs.

10. In a population of 20,000 in Hardy–Weinberg equilibrium, 36% show the recessive trait. Find p, q, and the numbers of AA, Aa and aa individuals.

11. In a sample of 500 plants, 384 are AA, 103 are Aa and 13 are aa. Find the frequencies of alleles A and a.

12. Write one fact about Neanderthal man and one about Homo sapiens.

13. Are a sweet potato (root) and a potato (stem) homologous or analogous? What kind of evolution do they show?

14. What do Darwin's finches of the Galapagos and sudden large heritable changes show?

15. What is disruptive selection? In a population with q = 0.8, what are p and the expected heterozygote frequency before any selection?

16. A recessive allele has frequency 0.7. If all aa individuals die before reproducing, what is its frequency in the next generation?

Section C — Word problems — 4 × 4 = 16 marks

17. Explain Darwin's theory of natural selection.

18. In a population of 20,000, 81% of people have a recessive genetic disorder. Assuming Hardy–Weinberg equilibrium, find the allele frequencies, the number of carriers, and say which five factors could upset the equilibrium.

19. A lethal recessive allele (aa individuals die young) has frequency 0.7. Find its frequency after one and two generations of selection, and explain why it is never completely removed.

20. Arrange these in the order in which they appeared, and give one fact about each: Neanderthal man, Homo erectus, Dryopithecus and Ramapithecus.

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Answer key

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Q	Answer	Working
1	**(d) Charles Darwin (with Alfred Wallace)**	—
2	**(a) 0.48**	q = √0.16 = 0.4, p = 0.6, 2pq = 0.48
3	**(c) homologous (divergent evolution)**	—
4	**(d) had a brain of about 1400 cc, lived in east and central Asia and buried the dead**	—
5	**(a) gene flow (gene migration)**	—
6	**(d) 0.4325**	p = (2 × 42 + 262) ÷ (2 × 400)
7	**(a) genetic drift**	—
8	**(c) A is true, but R is false.**	A is true: $q^2 = 0.1^2 = 0.01$. R is false.
9	**Homologous organs have the same basic structure and origin but may do different jobs (forelimbs of whale, bat and human): divergent evolution. Analogous organs do the same job but differ in structure and origin (wings of butterfly and bird): convergent evolution.**	—
10	**q = 0.6, p = 0.4; AA 3,200, Aa 9,600, aa 7,200**	q^2 = recessive frequency; p + q = 1
11	**p = 0.871, q = 0.129**	each individual carries two alleles
12	**Neanderthal man: had a brain of about 1400 cc, lived in east and central Asia and buried the dead; Homo sapiens: arose in Africa and spread across continents**	—
13	**Analogous (convergent evolution)**	homologous: same origin, different use; analogous: different origin, same use
14	**adaptive radiation; mutation (saltation, as de Vries said)**	—
15	**Favours both extremes, so the population may split into two forms; p = 0.2, 2pq = 0.32**	—
16	**7/17 ≈ 0.41**	$q_1 = q/(1 + q) = 0.7/1.7$
17	**Organisms produce more offspring than can survive; members of a population vary, and many variations are heritable. Resources are limited, so there is a struggle for existence.**	—

Q	Answer	Working
	Those with variations suited to the environment survive and reproduce more (natural selection). Over many generations, these favourable variations accumulate, giving rise to new species.	
18	**q = 0.9, p = 0.1; carriers 2pq × 20,000 = 3,600; factors: gene migration, genetic drift, mutation, genetic recombination and natural selection**	$p^2 + 2pq + q^2 = 1$
19	**after one generation 7/17; after two 7/24; it keeps hiding in heterozygotes (Aa), which selection cannot see**	$q_{n+1} = q_n/(1 + q_n)$
20	**Dryopithecus and Ramapithecus: lived about 15 million years ago; Ramapithecus was more man-like; Homo erectus: lived about 1.5 million years ago, had a brain of about 900 cc and probably ate meat; Neanderthal man: had a brain of about 1400 cc, lived in east and central Asia and buried the dead**	Dryopithecus → Australopithecus → H. habilis → H. erectus → Neanderthal → H. sapiens