Unit 20 · Theories of Evolution

ANSWER KEY · FOR TEACHERS

Full marks 34

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. 1809
2. germplasm
3. intraspecific
4. melanism
5. pool
6. mutation
7. drift
8. sterility

K · 4

Each carries 0.5 mark.

2 Label the diagram

1. deletion: C lost
2. duplication: C doubled
3. inversion: B–D turned round
4. translocation: pieces swapped

U · 2

Each carries 0.5 mark.

3 Multiple choice

i. **d.** struggle for existence — K · 1

The **struggle for existence** is one of Darwin's ideas. Lamarck's four postulates are the tendency to increase in size, the direct influence of the environment, use and disuse of organs, and the inheritance of acquired characters.

ii. **b.** Weismann's tailless mice experiment — K · 1

Weismann cut off the tails of mice for five generations; not one of the 901 young was born tailless. (Miller and Urey made organic molecules from gases; Pasteur disproved spontaneous generation.)

iii. **c.** a mutation in a cell that makes sperm — U · 1

Only changes in the **germplasm**, the cells that make eggs and sperm, can be inherited. The others are changes in somatic (body) cells and die with the body.

iv. **c.** leave the most surviving young in their surroundings — U · 1

Fitness in Darwin's sense is **reproductive success**: an animal that lives long but leaves no young has a fitness of zero. Strength and long life count only when they lead to more young.

v. **b.** the bottleneck effect — A · 1

The storm killed the snails **at random**, so the survivors were yellow by **chance**, not because yellow helped them survive. A chance change after a population is cut down to a few is the **bottleneck effect**, a case of genetic drift.

4 Very short answers

a. MARKING SCHEME — K · 1

✓ Herbert Spencer.

b. MARKING SCHEME — K · 1

✓ Crossing over, independent assortment and random fertilization.

c. MARKING SCHEME — U · 1

✓ Its 63 chromosomes can't pair in meiosis.

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5 Short answers

a. MARKING SCHEME — U · 2

- ✓ Tails cut off for five generations; none of the 901 young was born tailless: acquired body changes are not inherited.
- ✓ Continuity of germplasm: only changes in germ cells are inherited, not in somatic cells.

b. MARKING SCHEME — A · 2

- ✓ $2 \times 3^5 = 486$ sparrows.
- ✓ The number stays steady, so most young die: a struggle for existence.

c. MARKING SCHEME — A · 2

- ✓ Both messages written correctly.
- ✓ Insertion does more harm, as it shifts the reading frame for everything after it.

d. MARKING SCHEME — U · 3

- ✓ Bottleneck: a disaster leaves a few survivors with a chance sample of alleles.
- ✓ Founder: a few individuals start a new population elsewhere.
- ✓ One correct example of each (elephant seal or cheetah; the Amish).

6 Long answers

a. ANSWER — U · 4

a. **Tendency to increase in size**: living things and their organs tend to grow larger through an internal vital force. Example: Lamarck pointed to the rise of life from small, simple organisms to large, complex ones.

b. **Direct influence of the environment**: a change in the environment creates new needs, which bring new habits and changes in the organs. Example: the ancestors of ducks took to the water and needed to swim.

c. **Use and disuse of organs**: organs used more develop; organs not used degenerate. Examples: the giraffe's neck lengthened by stretching (use); the snake's legs disappeared through disuse; the human appendix shrank as our diet changed.

d. **Inheritance of acquired characters**: changes acquired in life are passed on, and add up into a new species. Example: the webs between the duck's toes, stretched by paddling, were inherited by its young; over generations, webbed feet became a character of ducks.

MARKING SCHEME

- ✓ Tendency to increase in size, by an internal vital force.
- ✓ Direct influence of the environment: new needs bring new habits (ducks taking to water).
- ✓ Use and disuse of organs, e.g. the giraffe's neck by use, the snake's legs by disuse.
- ✓ Inheritance of acquired characters, adding up into a new species (the duck's webbed feet).

b. ANSWER — U · 4

a. **Enormous fertility**: every species produces far more young than can survive, and would increase in a geometric ratio (an oyster lays up to about 100 million eggs a year).

b. **Struggle for existence**: since food and space are limited, they compete: intraspecific, interspecific and environmental struggle.

c. **Variation and heredity**: no two individuals are alike; some variations are useful, and many are inherited.

d. **Natural selection** (survival of the fittest): those with useful variations survive and leave more young.

e. **Origin of new species**: useful variations build up over many generations, until a population, especially an isolated one, becomes a new species.

MARKING SCHEME

- ✓ Enormous fertility, with an example.
- ✓ Struggle for existence (intraspecific, interspecific, environmental).
- ✓ Variation and heredity, leading to natural selection (survival of the fittest).
- ✓ Useful variations build up over generations into a new species.

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7 Think

ANSWER HA · 3

DDT did not **cause** the resistance; it **selected** it. A few mosquitoes already carried genes that let them survive; DDT killed the rest, and the resistant ones multiplied and passed the genes to their young, so resistance became common: **natural selection**, the Darwinian explanation. A Lamarckian would say each mosquito became resistant by being exposed to DDT and passed this acquired resistance to its young, which is wrong, since acquired changes are not inherited.

MARKING SCHEME

- ✓ The resistant mosquitoes already existed; DDT selected them, it did not cause resistance.
- ✓ Darwinian: the resistant survived, bred and passed on their genes (natural selection).
- ✓ Lamarckian: resistance acquired by exposure and inherited, which doesn't happen.

8 Activity: Weismann's tailless mice

(not marked)

WHAT STUDENTS SHOULD FIND

Weismann cut off the tails of white mice and bred them, for **five generations**, starting with 68 mice. Of the **901** young, **none** was born tailless or with a shorter tail. It tested the **inheritance of acquired characters**: an injury to the body is not inherited. Lamarck might have answered that a tail cut off is not a change by use or disuse, so it is not a perfect test; but no experiment since has shown that changes from use or disuse are inherited either. Weismann explained it by the continuity of germplasm.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	8	18	5	3	**34**

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