Unit 19 · Evidence of Evolution

ANSWER KEY · FOR TEACHERS

Full marks 35

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. organic evolution → **g.** descent with modification of populations over many generations
2. microevolution → **e.** small changes in gene frequencies within a population
3. retrogressive evolution → **j.** a trend from complex to simple, losing structures no longer needed
4. atavism → **a.** the sudden reappearance of a lost ancestral character in one individual
5. paleontology → **i.** the study of fossils
6. pseudofossil → **b.** a mineral pattern that looks like a fossil but is not one
7. index fossil → **f.** a common, widespread, short-lived species that dates a rock layer
8. half-life → **d.** the time in which half of a radioactive atom decays

K · 4

Each carries 0.5 mark.

2 Label the diagram

1. human serum
2. chimp
3. rabbit
4. anti-human serum
5. lemur
6. dog

U · 3

Each carries 0.5 mark.

3 Multiple choice

i. **b.** small-scale changes in gene frequencies — K · 1

Microevolution is the change in the frequencies of genes within a population over a few generations. The formation of new species and larger groups is macroevolution; the trend from simple to complex is progressive evolution.

ii. **b.** petrified fossils — K · 1

Petrified fossils: the hard parts are replaced or filled by minerals and turned to stone.

iii. **b.** convergent evolution — U · 1

Three **unrelated** groups (an insect, and two vertebrates whose ancestors had no wings) evolved wings **independently** for the same job, flying: convergent evolution. Their wings are analogous organs.

iv. **b.** atavism — U · 1

A character lost long ago, **reappearing** in one individual, is **atavism**. The coccyx all of us have is the vestigial organ; the rare tail is the atavism.

v. **a.** older than the leaves — A · 1

By the principle of **superposition**, lower layers are older, so the fish is older. That is relative dating: it gives the order, not the age in years.

4 Very short answers

a. MARKING SCHEME — K · 1

✓ *Peripatus.*

b. MARKING SCHEME — K · 1

✓ 5,730 years, up to about 50,000 years.

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c. MARKING SCHEME U · 1

✓ Quick burial in sediment happens mostly at the bottom of seas, lakes and rivers.

5 Short answers

a. MARKING SCHEME U · 2

✓ Homologous: same structure and origin, different jobs, with an example.

✓ Analogous: same job, different structure and origin, with an example.

b. MARKING SCHEME A · 2

✓ One-sixteenth left means four half-lives.

✓ $4 \times 5{,}730 = 22{,}920$ years.

c. MARKING SCHEME A · 2

✓ a. Carbon-14, as it is under 50,000 years old and was alive.

✓ b. Potassium–argon of the ash, as carbon-14 would be all gone.

d. MARKING SCHEME U · 3

✓ Human serum injected into a rabbit gives anti-human serum (antibodies).

✓ Anti-human serum mixed with other animals' sera forms a precipitate.

✓ More precipitate means a closer relative (apes most, dogs almost none).

6 Long answers

a. ANSWER U · 4

Archaeopteryx is a fossil, about 150 million years old, from the Jurassic limestone of Solnhofen in Germany, about the size of a crow.

Reptilian features: jaws with **teeth** in sockets; **three free, clawed fingers** on each wing; a long, **bony tail** of about 21 vertebrae; no keel on the breastbone; belly ribs; a skull and brain like a small dinosaur's.

Bird features: a body covered with **feathers**, with long flight feathers on the wings and tail; forelimbs made into **wings**; a **wishbone** (fused collarbones); large eye sockets.

Its role: it combines a reptile's skeleton with a bird's feathers and wings, so it is a **transitional form** between reptiles and birds. It shows that birds evolved from reptiles: today we know, from many other feathered fossils, that they evolved from small meat-eating dinosaurs. It was found in 1861, just after Darwin's *Origin of Species* predicted such in-between forms.

MARKING SCHEME

✓ About 150 million years old, Jurassic, from Solnhofen in Germany; links reptiles and birds.

✓ Reptilian features, any two: teeth in sockets, three free clawed fingers, a long bony tail, no keel on the breastbone.

✓ Bird features, any two: feathers, wings, a wishbone (furcula), large eye sockets.

✓ A reptile's skeleton with a bird's feathers: a transitional form showing that birds evolved from reptiles.

b. ANSWER

Hyracotherium (*Eohippus*, the "dawn horse") lived about 55 million years ago, in the early Eocene: it was the size of a fox, about 30 cm high, a browser of soft leaves in forests, with 44 low-crowned teeth, four toes on each front foot and three on each hind foot. Through *Mesohippus*, *Miohippus*, *Parahippus*, *Merychippus* and *Pliohippus*, the line led to *Equus*. The main changes:

a. the **body size increased**;
b. the **neck** became longer and more mobile;
c. the **toes were reduced** from four (front) and three (hind) to **one**: the third toe became large, with a hoof, and the side toes became splint bones;
d. the **front of the skull** (the face) became longer;
e. the **lower parts of the limbs** became longer, raising the wrist and ankle: the horse stands on the tip of one toe and runs fast;
f. the **premolars and molars** became large, high-crowned and ridged, for grinding grass;
g. the **metacarpals and metatarsals** of the third toe became a single long cannon bone (and the forearm and shin bones fused).

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These changes fitted the horses to the open **grasslands** that replaced forests as the climate became drier: running fast from predators over hard ground, and grazing on tough grass. U · 4

MARKING SCHEME

- ✓ *Eohippus* (*Hyracotherium*): about 55 million years ago, fox-sized, four toes in front and three behind; through *Mesohippus*, *Merychippus*, *Pliohippus* to *Equus*.
- ✓ Body larger, neck and face longer.
- ✓ Toes reduced to one (the third, with a hoof; side toes as splints); lower legs longer.
- ✓ Cheek teeth large, high-crowned and ridged for grinding grass, as forests gave way to grasslands.

7 Think

ANSWER HA · 3

The whale evolved from **even-toed hoofed mammals** (artiodactyls); its nearest living relative is the **hippopotamus**. Fossils of walking whales from Pakistan and India and DNA studies have confirmed it. Its streamlined shape is **convergent evolution**: unrelated animals living the same way in water evolve the same shape independently, so the likeness is analogy, not kinship (and the whale's flipper holds the bones of a mammal's forelimb).

MARKING SCHEME

- ✓ Whales came from even-toed hoofed mammals; the hippo is the closest relative.
- ✓ Confirmed by fossils of walking whales (Pakistan, India) and by DNA.
- ✓ The fish-like shape is convergent evolution (analogy), not common ancestry.

8 Activity: Building a fossil record (Activity 7.2)

(not marked)

WHAT STUDENTS SHOULD FIND

The **lowest** pen was buried first: it is the oldest "fossil", and the top pen the youngest. The pile tells the **order**, not the age in years; for that a clock is needed, such as a date written in each book (in rocks, a volcanic ash layer dated by potassium–argon). If the pile is overturned, as rocks can be folded right over in mountain building, the order is reversed, so geologists first check which way up the layers are. The pile shows the **principle of superposition**: younger layers lie above older ones.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	8	19	5	3	**35**

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