Unit 13 · Ecosystem Ecology

ANSWER KEY · FOR TEACHERS

Full marks 39

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. edaphic factors → **d.** the factors of the soil: texture, pH, air and water
2. commensalism → **e.** one partner gains, the other is neither helped nor harmed
3. amensalism → **a.** one partner is harmed, the other is not affected
4. detritus → **b.** dead organic matter and wastes
5. trophic level → **h.** the position an organism occupies in a food chain
6. ecesis → **i.** seeds and spores germinating and growing into adult plants in a bare area
7. climax community → **f.** the final, stable community of a succession
8. ammonification → **g.** the conversion of the nitrogen of dead bodies and wastes into ammonia

Each carries 0.5 mark. **K · 4**

2 Label the diagram

1. fixation
2. ammonium NH_4^+
3. ammonification
4. nitrite NO_2^-
5. denitrification
6. nitrate NO_3^-

Each carries 0.5 mark. **K · 3**

3 Multiple choice

i. **c.** pioneer community **K · 1**

The **pioneer community** (lichens on rock, mosses or grasses on bare soil) comes first; the climax community is the last, stable one.

ii. **b.** *Nitrosomonas* and *Nitrobacter* **K · 1**

That is **nitrification**: *Nitrosomonas* turns ammonium into nitrite and *Nitrobacter* turns nitrite into nitrate. *Rhizobium* and *Azotobacter* fix nitrogen, *Pseudomonas* and *Thiobacillus* denitrify, and *Bacillus ramosus* and *Proteus* carry out ammonification.

iii. **b.** protocooperation **U · 1**

Both gain (the bees get food, the mustard is pollinated), but neither **depends** on the other: the relationship is not obligatory, so it is **protocooperation**. Mutualism, in this scheme, is the obligatory kind, like a lichen's alga and fungus.

iv. **b.** the pyramid of biomass **U · 1**

The **pyramid of biomass** shows the mass present at one moment, so it is inverted here. The phytoplankton grow and divide so fast that, over a year, they still pass on more energy than the zooplankton receive: the pyramid of energy stays upright. (The phytoplankton are also far more numerous than the zooplankton, so the pyramid of number is upright.)

v. **b.** the second (rice) and the fourth (fish) **A · 1**

Rice is a producer, so eating it puts the person at the **second** level. The algae are the first level, the small animals the second, the fish the third, so eating the fish puts the person at the **fourth**. An omnivore feeds at several levels at once.

4 Very short answers

a. **K · 1**

MARKING SCHEME

✓ A. G. Tansley, 1935.

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b. MARKING SCHEME K · 1

✓ Grazing, detritus and parasitic.

c. MARKING SCHEME U · 1

✓ Energy is lost at each step; little reaches the top level.

5 Short answers

a. MARKING SCHEME U · 2

✓ Mutualism: both gain, obligatory, with an example.

✓ Protocooperation: both gain, not obligatory, with an example.

b. MARKING SCHEME U · 2

✓ Energy: lost as heat at each step, one-way flow.

✓ Nutrients: returned by decomposers and reused (biogeochemical cycling).

c. MARKING SCHEME A · 2

✓ Rhizobium in the legume's nodules fixes nitrogen.

✓ The nitrogen is released into the soil when they rot, so the next crop needs less fertilizer.

d. MARKING SCHEME U · 3

✓ Biomass is the standing crop at one moment.

✓ Phytoplankton multiply fast, so a small mass supports a larger one.

✓ Energy is a flow, lost as heat at every step: always upright.

6 Numerical problems

ANSWER A · 4

i. NPP = GPP − R = 30,000 − 12,000 = **18,000 kJ/(m² year)**.

ii. 18,000 ÷ 30,000 × 100 = **60 %**.

iii. Chital: 18,000 × 0.1 = **1,800 kJ/(m² year)**; tiger: 1,800 × 0.1 = **180 kJ/(m² year)**.

iv. Only 180 kJ of the 30,000 kJ the grass made on each square meter reaches the tiger, so one tiger needs the grass of a **very large area**.

MARKING SCHEME

✓ NPP 18,000 kJ/(m² year).

✓ 60 %.

✓ Chital 1,800, tiger 180 kJ/(m² year).

✓ Little energy reaches the top, so a tiger needs a large area.

7 Long answers

a. ANSWER U · 4

Abiotic components: water, dissolved minerals, oxygen and carbon dioxide, the mud at the bottom, and sunlight.

Producers: **phytoplankton** (*Volvox*, *Spirogyra*, *Anabaena*) and **macrophytes** (*Hydrilla*, *Chara*, *Eichhornia*, *Lemna*), which make food by photosynthesis.

Consumers: primary (tadpoles, small fishes, zooplankton such as *Daphnia*); secondary (frogs, big fishes, crabs); tertiary (egrets, kingfishers, water snakes).

Decomposers: bacteria and fungi in the water and mud, which break down dead bodies into simple inorganic substances.

MARKING SCHEME

✓ Abiotic components named.

✓ Producers: phytoplankton and macrophytes, with examples.

✓ Consumers at three levels, with examples.

✓ Decomposers and their work.

b. ANSWER

Nudation: the landslide makes a bare area. **Invasion**: seeds and spores arrive (**migration**), grow (**ecesis**) and multiply into groups (**aggregation**): mosses, grasses and herbs first, from seeds already in the soil.

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Competition and coaction for light, water and nutrients; **reaction**: the plants add humus, hold water and cast shade, so shrubs and then trees replace them.
Stabilization: a stable **climax** forest, in **decades**. This is **secondary succession**.
On glacier rock there is **no soil**: **primary succession** starts with **lichens**, then mosses, which must make the soil first, so it takes **centuries**.

A · 4

MARKING SCHEME

- ✓ Nudation and invasion (migration, ecesis, aggregation), pioneers grasses and mosses.
- ✓ Competition and reaction lead to shrubs and trees.
- ✓ Stabilization: climax forest; secondary succession, decades.
- ✓ Glacier rock: primary succession, lichens first, no soil, centuries.

8 Think

ANSWER

HA · 3

Photosynthesis takes carbon dioxide out of the air; **respiration**, **decomposition** and **burning** put it back, so the cycle stays roughly balanced.
Fossil fuels formed from bodies buried before they decayed, over **millions of years**: that carbon was taken out of the cycle. **Burning** them returns it in a **few centuries**, much faster than photosynthesis can take it back.
Cutting and burning **forests**, which are large stores of carbon, adds more and leaves fewer plants to absorb it.

MARKING SCHEME

- ✓ Photosynthesis removes CO_2; respiration, decomposition and burning return it.
- ✓ Fossil fuels return in centuries carbon stored over millions of years.
- ✓ Cutting forests releases stored carbon and reduces uptake.

9 Activity: A food web near you

(not marked)

WHAT STUDENTS SHOULD FIND

For example: grass → grasshopper → frog → snake; rice → grasshopper → frog → snake → eagle; fallen leaves → earthworm → bird. Plants are the first trophic level, the animals that eat them the second; an animal that eats both plants and animals belongs to more than one level, which is why the chains join into a web.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	11	14	11	3	**39**

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