Ecosystem

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 rate of biomass production per unit area over a period is called:

(a) biomass **(b)** decomposition **(c)** standing crop **(d)** productivity

2. Producers in an ecosystem fix 20,000 kJ of energy. By the 10 per cent law, how much energy reaches the fourth trophic level?

(a) 20 kJ **(b)** 2 kJ **(c)** 200 kJ **(d)** 666.667 kJ

3. The gross primary productivity of a grassland is 5,800 kJ m^{-2} yr^{-1}, and respiration uses 2,900 kJ m^{-2} yr^{-1}. The net primary productivity is:

(a) 8,700 kJ m^{-2} yr^{-1} **(b)** 5,800 kJ m^{-2} yr^{-1}

(c) 2,900 kJ m^{-2} yr^{-1} **(d)** 580 kJ m^{-2} yr^{-1}

4. In the food chain phytoplankton → zooplankton → small fish → large fish, the phytoplankton is at:

(a) the fourth trophic level (tertiary consumer)

(b) the second trophic level (primary consumer)

(c) the first trophic level (producer)

(d) the third trophic level (secondary consumer)

5. The step of decomposition in which detritivores such as earthworms break detritus into smaller particles is:

(a) fragmentation **(b)** humification **(c)** catabolism **(d)** mineralisation

6. In an aquatic ecosystem, the major conduit for energy flow is the:

(a) parasitic chain **(b)** grazing food chain

(c) detritus food chain **(d)** decomposer chain

7. Of 12,000 J of sunlight falling on a leaf, 40% is photosynthetically active radiation (PAR), and the plant captures 10% of the PAR. The energy captured is:

(a) 480 J **(b)** 720 J **(c)** 1,200 J **(d)** 4,800 J

8. Assertion (A): The pyramid of biomass in the sea is inverted (fish outweigh phytoplankton).
Reason (R): Energy flow in an ecosystem is cyclic, so energy returns to the producers.

(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 gross and net primary productivity.

10. In the food chain grass → grasshopper → frog → snake → hawk, the producers fix 5,000,000 J. How much energy reaches each of the other organisms, by the 10 per cent law?

11. A forest has a gross primary productivity of 5,600 kJ m^{-2} yr^{-1}, and 40% of it is used in respiration. Find the respiration loss and the net primary productivity. What is secondary productivity?

12. In the food chain plants → rabbit → fox → eagle, at which trophic level are the plants and the rabbit? Is this a grazing or a detritus food chain?

13. Explain mineralisation and humification in decomposition.

14. What is the shape of (i) the pyramid of energy of any ecosystem and (ii) the pyramid of numbers for a single tree with insects and birds?

15. Herbivores in a grassland take in 5,550 kJ of the 37,000 kJ stored by the grasses. What percentage of energy is transferred? Is this close to the 10 per cent law?

16. Sunlight of 30,000 J falls on a crop. If 50% is PAR and the crop captures 5% of the PAR, how much energy is captured? Why is so little captured?

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

17. Describe the process of decomposition.

18. Draw a pyramid of energy for the food chain plants → rabbit → fox → eagle if the producers fix 5,000,000 J. Give the energy at each level, and explain why a pyramid of energy is always upright.

19. Define gross and net primary productivity. A lake has a GPP of 7,300 kJ m^{-2} yr^{-1} and loses 50% of it in respiration: find the NPP. What factors affect primary productivity?

20. Describe the steps of decomposition, explaining mineralisation in particular. Why is decomposition slow in a cold, dry place or for woody litter?

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Answer key

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Q	Answer	Working
1	**(d) productivity**	—
2	**(a) 20 kJ**	20,000 × $(1/10)^3$
3	**(c) 2,900 kJ m^{-2} yr^{-1}**	NPP = GPP − R
4	**(c) the first trophic level (producer)**	count from the producer
5	**(a) fragmentation**	—
6	**(b) grazing food chain**	—
7	**(a) 480 J**	12,000 × 40% × 10%
8	**(c) A is true, but R is false.**	A is true: the pyramid of biomass in the sea is inverted (fish outweigh phytoplankton). R is false.
9	**GPP is the rate of production of organic matter during photosynthesis. NPP is GPP minus the energy used in respiration (R); it is the biomass available to heterotrophs.**	—
10	**grasshopper: 500,000 J; frog: 50,000 J; snake: 5,000 J; hawk: 500 J**	only about 10% passes to the next level
11	**R = 2,240, NPP = 3,360 kJ m^{-2} yr^{-1}; the rate at which consumers form new organic matter**	NPP = GPP − R
12	**plants: the first trophic level (producer); rabbit: the second trophic level (primary consumer); a grazing food chain**	it starts from living producers
13	**Mineralisation: humus is further broken down by microbes, releasing inorganic nutrients; humification: a dark, amorphous, nutrient-rich layer of humus builds up**	—
14	**(i) Always upright; (ii) inverted or spindle-shaped**	—
15	**15%; no, it differs from the usual 10%**	5,550 ÷ 37,000 × 100
16	**750 J; plants can use only PAR, and much of it is reflected, transmitted or lost as heat**	30,000 × 50% × 5%
17	**Decomposers break down complex organic matter into inorganic substances such as CO_2, water and nutrients. Fragmentation: detritivores such as earthworms break detritus into small pieces. Leaching: water-**	—

Q	Answer	Working
	soluble nutrients go down into the soil and are precipitated as salts. Catabolism: bacterial and fungal enzymes degrade detritus into simpler inorganic substances. Humification produces humus, and mineralisation breaks humus down further, releasing inorganic nutrients.	
18	**plants: 5,000,000 J; rabbit: 500,000 J; fox: 50,000 J; eagle: 5,000 J. At each transfer only about 10% of the energy passes on; the rest is used in respiration and lost as heat, so each level has less energy than the one below and the pyramid can never be inverted**	10 per cent law
19	**GPP is the rate of production of organic matter in photosynthesis; NPP = GPP − R, the biomass available to consumers. NPP = 3,650 kJ m^{-2} yr^{-1}. Factors: the plant species, sunlight, temperature, moisture, nutrients and the photosynthetic efficiency of the plants**	NPP = GPP − R
20	**Fragmentation by detritivores, leaching of soluble nutrients, catabolism by bacterial and fungal enzymes, humification and mineralisation. Mineralisation: humus is further broken down by microbes, releasing inorganic nutrients. Decomposition is fast when detritus is rich in nitrogen and sugars and conditions are warm, moist and aerobic; it is slow when detritus is rich in lignin and chitin and conditions are cold, dry or anaerobic**	—