7.2 Ecosystems and material cycles

Name: _____ Class: _____ Date: _____ **Total: 20 marks**

KEY WORDS quadrat • transect • decomposer

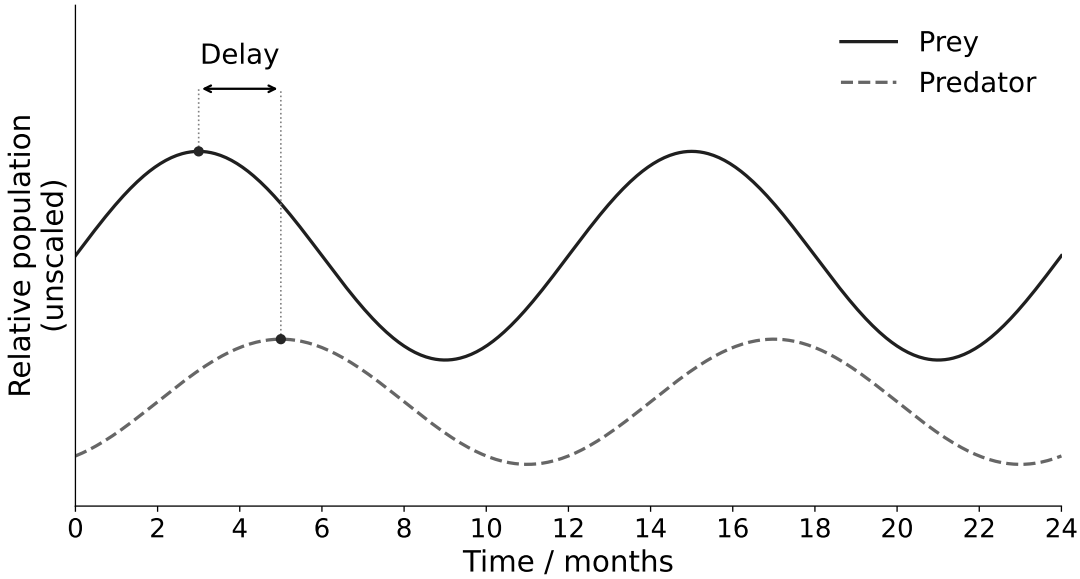
Objective

Use food chains, predator-prey cycles, RP9 sampling, the carbon and water cycles, and decay. Original questions for spec statement 4.7.2, RP9/RP10.

1 Key knowledge and worked examples

■ Food chains and population cycles

A **producer** (plant/alga) makes glucose by photosynthesis. Teacher chain: grass → rabbit → fox. Arrows transfer food to consumers; rabbit=primary consumer, fox=secondary consumer.



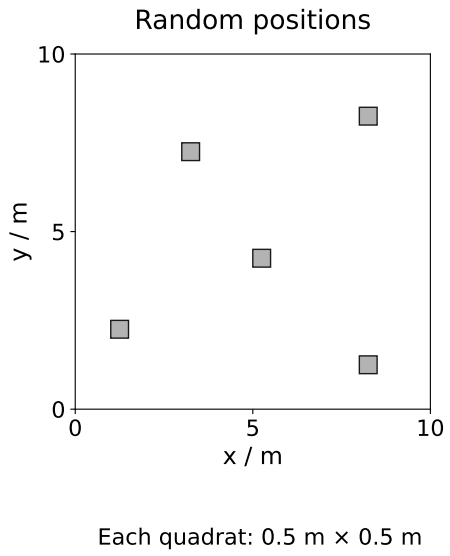
More prey support predator survival/reproduction. Increased predation lowers prey; scarce food lowers predators; fewer predators let prey recover. The response is delayed. Other factors can affect real populations.

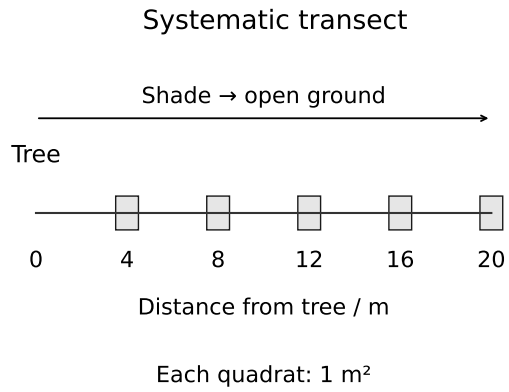
Worked model: corresponding prey/predator peaks occur at months 3/5.

$$\text{peak delay} = t_{\text{predator}} - t_{\text{prey}}$$

$$\text{peak delay} = 5 \text{ months} - 3 \text{ months} = 2 \text{ months}$$

■ RP9: choose a sampling method





Population estimate: random coordinates, consistent quadrats/counting rules, sufficient samples and a mean. **Distribution:** regular shade-to-open transect positions; measure plants/cover and light. Repeat and calculate means; label graph scales/units.

Teacher extension to Practice Q 2.2: counts 4,6,6,8,11 in random 0.25 m^2 quadrats; field 100 m^2. Mode=6; median=6.

$$\text{mean count} = \frac{\text{sum of counts}}{\text{number of quadrats}}$$

$$\text{mean count} = \frac{4+6+6+8+11}{5} = 7 \text{ plants per quadrat}$$

$$\text{density} = \frac{\text{mean count}}{\text{quadrat area}}$$

$$\text{density} = \frac{7 \text{ plants}}{0.25 \text{ m}^2} = 28 \text{ plants m}^{-2}$$

$$\text{estimated population} = \text{density} \times \text{total area}$$

$$\text{estimated population} = 28 \text{ plants m}^{-2} \times 100 \text{ m}^2 = 2800 \text{ plants}$$

Assume representative samples; a chosen gradient is not a random field sample.

■ RP9: interpret original exam evidence

Table 2

	Distance from the tree in metres				
	4	**8**	**12**	**16**	**20**
Mass of fresh soil in grams	250	266	260	248	252
Mass of dried soil in grams	225	234	209	184	181
Mass of water lost from soil in grams	25	32	51	64	71
Percentage of water in soil	10	12	20	26	**X**
Number of daisies per m^2	0	7	15	28	32

2025 Q 02.1–Q 02.4: heat, cool and reweigh to constant mass to remove **all water**. The table excludes container mass. At 20 m, fresh soil=252 g and dry soil=181 g.

$$\text{water mass} = \text{fresh soil mass} - \text{dry soil mass}$$

$$\text{water mass} = 252\text{ g} - 181\text{ g} = 71\text{ g}$$

$$\text{water percentage} = \frac{\text{water mass}}{\text{fresh soil mass}} \times 100$$

$$\text{water percentage} = \frac{71\text{ g}}{252\text{ g}} \times 100 = 28.1746\ldots\% = 28\% \text{ (nearest whole number)}$$

From 4–16 m, water rises 10%→26%; this is not direct proportionality. Repeat/mean at each distance; use more trees/directions or intermediate distances. Other factors may vary: association does not establish cause.

Biology: decay and RP10. Warmth towards the enzyme optimum, moisture and oxygen support aerobic decomposers. Excess heat can denature enzymes; waterlogging can restrict oxygen. Turn compost to aerate it. Anaerobic decay produces methane, collected by biogas generators and then burned as fuel.

2023 RP10:25 cm^3 milk at 5,15,25°C; record pH daily. Keep milk type/volume consistent; repeat/mean or measure more often. Plot a curved best fit. Draw a tangent at the requested time; use separated points on it. Official 15°C,day 2 example:

$$\text{rate of decrease} = \frac{\text{fall in pH}}{\text{time interval}}$$

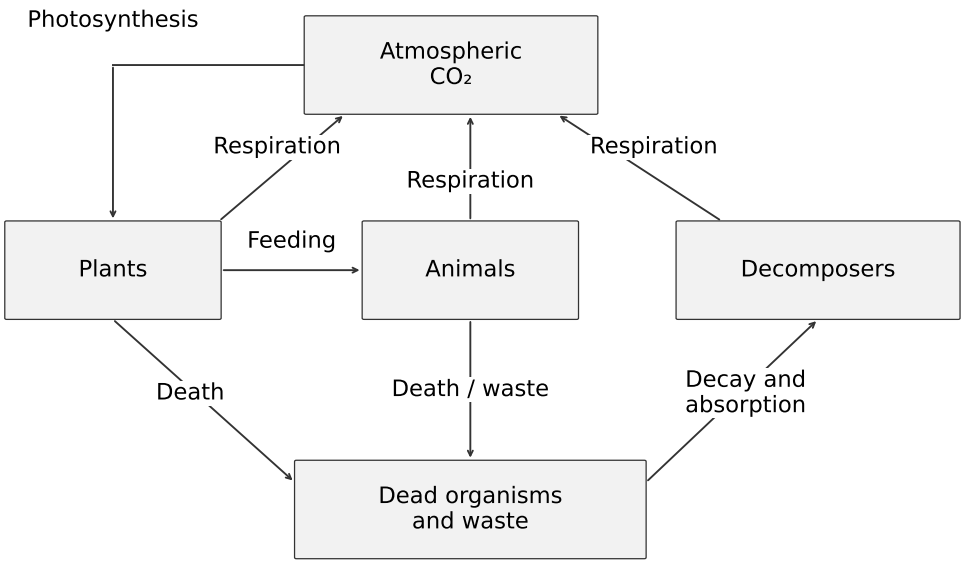
$$\text{rate of decrease} = \frac{6.5 - 4.5}{4 \text{ days}} = 0.5 \text{ pH units per day}$$

$$\text{rate ratio} = \frac{\text{rate at } 15°\text{C}}{\text{rate at } 5°\text{C}}$$

$$\text{rate ratio} = \frac{0.5 \text{ pH units per day}}{0.3 \text{ pH units per day}} \approx 1.67 \text{ (no unit)}$$

In the tested range: greater enzyme activity → faster lipid breakdown → faster fatty-acid production and pH fall. Original data/tangent illustration: topic handout.

■ Carbon, water and mineral recycling



Photosynthesis uses CO_2 to make glucose; feeding transfers carbon. Plants, animals and decomposers respire, releasing CO_2. Microbial enzymes digest dead material; soluble products are absorbed. Combustion also releases CO_2. Mineral recycling is separate; materials recycle, energy dissipates.

Water: evaporation/transpiration → vapour → condensation → precipitation → run-off/drainage → sea. Evaporation leaves salts behind, helping supply fresh water over land.

2023 Q 04.1 [6]: microbes digest leaves. Their respiration releases CO_2; it enters stomata for photosynthesis and glucose production. Recycling releases soil nitrate; roots absorb it by active transport for amino acids/proteins. Explain breakdown and reuse of both elements; detailed nitrogen cycling is not required.

Teacher carbon example [3]: enzymes digest dead material(1); decomposer respiration releases CO_2(1); plants use CO_2 in photosynthesis to make glucose(1).

2 Practice

2.1 Name the organism at the start of every food chain and what it produces. [2]

2.2 In RP9, five quadrats give counts 4, 6, 6, 8, 11. Give the mean, mode and median. [3]

2.3 *(Biology)* Name the gas produced by anaerobic decay and one use. [2]

3 Exam-style questions

3.1 Explain, in sequence, why predator and prey populations cycle out of phase. [4]

3.2 Describe how a student would investigate the effect of light intensity on the distribution of a plant species using a transect. [5]

3.3 *(Biology)* A gardener wants rapid decay of vegetable waste into compost. Explain three conditions he should provide. [4]