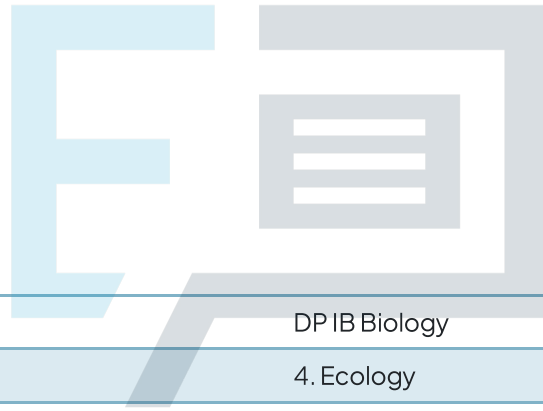


4.1 Species, Communities, Ecosystems & Energy Flow

Mark Schemes



Course	DPIB Biology
Section	4. Ecology
Topic	4.1 Species, Communities, Ecosystems & Energy Flow
Difficulty	Medium

To be used by all students preparing for DP IB Biology SL
Students of other boards may also find this useful

1a

Label F..

- The energy lost in faeces / during egestion / due to incomplete digestion; [1 mark]

[Total: 1 mark]

Energy is lost from the sheep during respiration (energy is lost to the environment as heat), excretion of urine, and egestion of faeces. Energy is lost during egestion because not all food eaten by the sheep is fully digested; chemical energy stored in undigested food is lost from the body in faeces.

1b

The value of P is...

- $78 \text{ (kJ} \times 10^6 \text{ year}^{-1})$; [1 mark]

[Total: 1 mark]

Of the energy consumed, $31.27 \text{ kJ} \times 10^6 \text{ year}^{-1}$ is absorbed (A) from the gut, and of this absorbed energy, some is lost in respiration (R), some goes towards production of new tissues (P), and some is lost in urine (U). P can therefore be calculated by subtracting R and U from A.

$$P = A - (R + U)$$

$$P = 31.27 - (27.49 + 0.04)$$

$$P = 31.27 - 27.49$$

$$P = 3.78 \text{ [1 mark]}$$

1c

Two methods that could be used by the farmer to increase the energy input into tissue production could be. . .

Any **two** of the following:

- Reduce sheep movement by keeping them in enclosed spaces/indoors/in barns; [1 mark]
- Keep sheep in a heated enclosure/barn; [1 mark]
- Provide more digestible food; [1 mark]
- Put antibiotics in feed; [1 mark]

[Total: 2 marks]

Anything that increases energy absorption from food or that reduces the amount of energy lost through respiration will increase the energy that can go towards tissue production. Reducing movement and providing heating will reduce energy losses from respiration, as will adding antibiotics to feed (sheep won't have to expend energy fighting infection), while providing more digestible food will increase the amount of energy absorbed and reduce energy lost in faeces.

Exam Papers Practice

1d

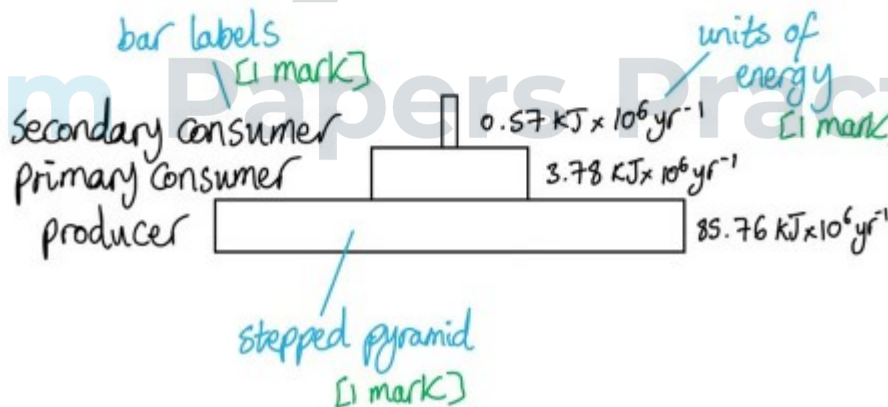
A pyramid of energy that represents the food chain: grass → sheep → human should have the following features...

- Three stepped bars stacked on top of each other **AND** with the largest at the base and the smallest at the top; [1 mark]
- The bars labelled beginning at the base with producer, primary consumer, secondary consumer; [1 mark]
- The bars labelled with the appropriate units of energy, beginning at the base:
 $76 \text{ kJ} \times 10^6 \text{ year}^{-1}$, $3.78 \text{ kJ} \times 10^6 \text{ year}^{-1}$, and $0.57 \text{ kJ} \times 10^6 \text{ year}^{-1}$; [1 mark]

Ignore scale as no graph paper has been provided, ignore any labels of 'grass' etc.

Accept error carried forward from part b) for the energy in the primary consumer

[Total: 3 marks]



2a

Abiotic factors the student should have controlled throughout the experiment include...

Any **two** of the following:

- Temperature; [1 mark]
- Light intensity; [1 mark]
- Water pH; [1 mark]
- Oxygen/carbon dioxide concentration in the water; [1 mark]
- Mineral ion/nutrient content of water; [1 mark]

[Total: 2 marks]

Remember that abiotic factors are the nonliving components of an ecosystem.

2b

The difference in biomass between native pondweed grown separately and native pondweed grown in a tank together with *E. canadensis* after 15 days is...

- 310 g; [1 mark]

Units are required for the mark. Accept answers between 305–315.

[Total: 1 mark]

Grown separately = 350 g biomass

Grown with *E. canadensis* = 40 g biomass

$$350 - 40 = 310 \text{ g [1 mark]}$$

mark scheme allows for any value between 35-45g

2c

When both species of pondweed are grown together:

- There is competition / they compete for light/space/nutrients/oxygen/carbon dioxide; [1 mark]
- *Elodea canadensis*/Canadian pondweed is a better competitor / outcompetes native pondweed (causing its population/biomass to decrease); [1 mark]

[Total: 2 marks]

Competition is when organisms compete with each other for the same resources (in the case of plants they often compete for abiotic factors such as light, space to grow, mineral nutrients, and water). If one species is better adapted than the other, the less well-adapted species is likely to be out-competed - it won't be able to exist very well alongside the better-adapted species and its population will **decrease**. Given enough time, the less well-adapted species may disappear altogether - this is what is happening to the native pondweed when it is grown in the same tank as the better adapted, invasive Canadian pondweed.

Exam Papers Practice

2d

Mesocosm experiments are beneficial in understanding interactions between organisms in their natural environment because:

Any **three** of the following:

Supporting arguments:

A maximum of **two** of the following:

- (They make it possible to) investigate interactions between species, e.g. competition / impact of changing abiotic factors, while other variables are controlled; [1 mark]
- Variables other than the variable being tested will not influence the results; [1 mark]
- Mesocosms can be designed to mimic a natural environment as closely as possible; [1 mark]

Negative arguments:

- In natural environments there are other abiotic factors/biotic factors that cannot be controlled **OR** (closed) mesocosms are unrealistic representations of a natural environment; [1 mark]
- The results gained from studying a closed system/mesocosm cannot be directly applied to a natural environment; [1 mark]

[Total: 3 marks]

The experiment in part (a) is not described in very much detail, so it may or may not be a true mesocosm, but it has similarities in set up and purpose, and your knowledge of mesocosms should allow you to answer this question either way.

Note that when a question asks you to evaluate, it is always good to consider both sides of an argument where possible.

3a

The organisms that can make up a population are. . .

- Purple topshell snails/ *Gibbula umbilicalis*; [1 mark]

The reason for this is that. . .

Any **one** of the following:

- A population is a group of organisms of the same species (occupying a particular area at a particular time); [1 mark]
- Barnacles, seaweeds, and lichens are all groups of organisms containing more than one species; [1 mark]

[Total: 2 marks]

Only purple topshells can be considered to be a single population here, as we are told that there are several species of barnacle (and therefore several populations), and the terms 'seaweeds' and 'lichens' are vague, and therefore likely to refer to more than one species of each.

3b

To collect data to determine whether or not there was an association between purple topshells and common rock barnacles, the ecologists would. . .

- Use random sampling e.g. a grid of the rocky shore area with coordinates selected using a random number generator; [1 mark]
- Use quadrats; [1 mark]
- Record the number of quadrats that contain one, both, or neither species / record results in a contingency table; [1 mark]

[Total: 3 marks]

Organisms inside a quadrat can be counted in various ways, including number of individuals and percentage cover, but in this instance it is **association** between two species that is being studied, so all the ecologists need to record is whether one, both, or neither species is present; this data can be recorded in a type of table called a contingency table.

3c

From this analysis it can be concluded that. . .

Any **two** of the following:

- The null hypothesis can be accepted; [1 mark]
- There is no significant association between purple topshells and common rock barnacles; [1 mark]
- There is only a 5 % probability that this result is due to chance; [1 mark]

[Total: 2 marks]

4a

The modes of nutrition used by the organisms are. . .

- (i) Autotrophic; [1 mark]
- (ii) Saprotrophic; [1 mark]
- (iii) Consumers; [1 mark]

Ignore references to heterotrophic nutrition.

[Total: 3 marks]

Remember that organisms feeding on dead matter are either detritivores or saprotrophs; fungi and bacteria digest their food externally and are therefore saprotrophs. Root feeding nematode worms are shown to feed on living plant material, and are therefore classed as consumers. While (ii) and (iii) are both examples of heterotrophic nutrition, this is not considered to be a specific enough answer.

4b

A food chain that includes bacteria could be . . .

- Plants → dead plant matter → bacteria → arthropods → moles/birds;
[1 mark]

OR

Plants → dead plant matter → bacteria → single celled eukaryotes → predatory nematode worms → arthropods → moles/birds; [1 mark]

[Total: 1 mark]

Remember that with the sun as the initial source of energy, food chains must always begin with a producer, so your food chain must include living plants.

4c

It is unusual to see food chains of this length because . . .

- Energy is lost (to the environment) at each trophic level due to incomplete digestion of food / energy lost in faeces/egestion / release of heat during respiration / release of metabolic waste in urine/excretion; [1 mark]
- There is not enough energy available to consumers at higher trophic levels (in long food chains) / predators at the top of a long food chain cannot hunt enough prey to gain energy to survive; [1 mark]

[Total: 2 marks]

Note that this question draws on knowledge of NOS: Use theories to explain natural phenomena; the concept of energy flow explains the limited length of food chains

4d

The soil food web will be affected by a farmer harvesting crop plants from a field in the following way. . .

Any **three** of the following:

- No dead plant matter will be available (due to the harvesting of plants/crops while they are still alive); [1 mark]
- Saprotrophs/decomposers will lose their food source; [1 mark]
- Saprotrophs/decomposers will die/reduce in number/reduce in diversity; [1 mark]
- Less food / a reduced range of food sources will be available to arthropods **OR** arthropods will eat all of the root feeding nematode worms; [1 mark]
- (Inorganic) nutrients are not returned to the soil, reducing plant growth; [1 mark]

[Total: 3 marks]

Soil health is crucial for an ecosystem to be sustainable. The removal of organic matter has direct impacts on consumers higher up the food chain, reducing the availability and variety of food sources, and also prevents the return of inorganic nutrients to the soil, impacting plant growth and eventually removing all food sources from the food web. Scientists and farmers around the world are becoming more aware of the importance of maintaining soil biodiversity for successful crop growth.

5a

The processes by which energy flows through ecosystems includes. . .

Any **seven** of the following:

- Light energy is absorbed by chlorophyll; [1 mark]
- Light energy is converted into chemical energy by plants/producers during photosynthesis; [1 mark]
- Chemical energy is stored in tissues in the form of carbon compounds/correctly named storage compound; [1 mark]
- Energy is passed from one trophic level to the next / producer to primary consumer to secondary consumer in food chains; [1 mark]
- Organism tissues are consumed by consumers/detritivores/saprotrophs, and the carbon compounds/correctly named storage compound in tissues are broken down and absorbed; [1 mark]
- Carbon compounds/correctly named storage compound can be used to fuel respiration / produce ATP; [1 mark]
- Respiration releases heat energy into the environment; [1 mark]
- Energy is lost to the environment (in faeces) when food is not completely digested; [1 mark]
- The amount of energy available to the next trophic level decreases at higher trophic levels; [1 mark]
- Energy that is lost to the environment cannot be regained by organisms in the food chain / cannot be recycled; [1 mark]

[Total: 7 marks]

5b

This mode of plant nutrition is unusual because . . .

Any **three** of the following:

- The parasitic plants gain their organic molecules/carbon compounds from other organisms e.g. plants or fungi; [1 mark]
- Parasitic plants are heterotrophs/heterotrophic; [1 mark]
- Most plants are producers, producing their own organic molecules using energy from sunlight; [1 mark]
- Most plants are autotrophs/autotrophic; [1 mark]

[Total: 3 marks]

Note that this question draws on knowledge of NOS: Looking for patterns, trends and discrepancies; plants and algae are mostly autotrophic but some are not.



Exam Papers Practice

5c

The concept of ecosystem sustainability states that. . .

- When organisms die, the inorganic nutrients in their tissues are broken down by detritivores/saprotrophs/decomposition; [1 mark]
- (During decomposition) inorganic nutrients are released into the soil (more than can be absorbed by the saprotrophs themselves) where they can be taken up/absorbed by producers/plants; [1 mark]
- Producers/plants use inorganic nutrients (from the soil) to build their tissues (e.g. nitrates are needed to build proteins and nucleic acids); [1 mark]
- Inorganic nutrients pass to consumers when producers are eaten/consumed; [1 mark]
- Provided that decomposition occurs, inorganic nutrients will continue to be released into the soil and re-enter the food chain / ecosystems will not run out of inorganic nutrients; [1 mark]

[Total: 5 marks]

Clarity of communication: Answers are logically constructed and concise, with meaning immediately apparent to the reader. Perfect spelling and grammar are not required, but any errors should not interfere with interpretation or lead to inaccurate statements; [1 mark]

[Total: 16 marks]