

Question 1: Design an Investigation**10 points**

(a) Based on the information in the diagram, **identify** the zone with the lowest level of dissolved oxygen. **1 point**

- Zone C/C

(b) Based on the information in the diagram, **describe** the relationship between biological oxygen demand and dissolved oxygen. **1 point**

Accept one of the following:

- As biological oxygen demand increases, dissolved oxygen decreases.
- As biological oxygen demand decreases, dissolved oxygen increases.
- As dissolved oxygen increases, biological oxygen demand decreases.
- As dissolved oxygen decreases, biological oxygen demand increases.

(c) Based on the information in the diagram, **identify** the zone where there is likely point-source water pollution discharged into the stream. **1 point**

- Zone B/B

(d) **Identify** the dependent variable in the researchers' investigation. **1 point**

Accept one of the following:

- The number of macroinvertebrate species
- Macroinvertebrate diversity
- Macroinvertebrate species richness

(e) **Identify** a testable hypothesis for the researchers' investigation. **1 point**

Accept one of the following:

- As dissolved oxygen levels increase, the number of macroinvertebrate species increases.
- As dissolved oxygen levels decrease, the number of macroinvertebrate species increases.
- There is a direct/inverse relationship between dissolved oxygen levels and the number of macroinvertebrate species.
- There is no relationship between biological oxygen demand and macroinvertebrate biodiversity.

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- (f) **Describe** the reason the researchers selected zone A to serve as the control in the investigation. **1 point**
- Accept one of the following:
- Zone A/A/It is upstream from the source of pollution/organic waste/discharge/change.
 - Zone A/A/It would not be affected by the source of pollution/organic waste/discharge/change.
 - Zone A/A/It has levels of dissolved oxygen that are not impacted by the source of pollution/organic waste/discharge/change.
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- (g) **Explain** how the modification to collect data in the winter months could alter the results of the investigation. **1 point**
- Accept one of the following:
- Cold water will have more dissolved oxygen, which could increase the number of species.
 - Colder water may be below the range of tolerance for some of the organisms, which could decrease the number of species.
 - Lower light levels in the winter decrease plant activity/photosynthesis, which lowers dissolved oxygen levels, which could decrease the number of species.
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- (h) **Describe** the effect that the introduction of raw sewage into the stream could have on the population of bacteria in the stream. **1 point**
- Accept one of the following:
- Raw sewage contains nutrients that could increase the population of bacteria.
 - Raw sewage contains bacteria that could increase the population size.
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- (i) **Identify** an abiotic factor other than dissolved oxygen and organic pollution that could also influence the population size of bacteria in the stream. **1 point**
- Accept one of the following:
- Temperature
 - pH
 - Light/Sunlight
 - Turbidity/Sediment
 - Salinity
 - Nitrate/Phosphate
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- (j) **Explain** how persistent organic pollutants can affect higher trophic levels in an aquatic food web. **1 point**
- Accept one of the following:
- Persistent organic pollutants/Pollutants can bioaccumulate in the tissues of organisms at higher trophic levels because they consume prey that have accumulated the pollutants.
 - Persistent organic pollutants/Pollutants can accumulate/concentrate in the tissues of organisms at higher trophic levels because they consume prey that have accumulated the pollutants.
 - Persistent organic pollutants/Pollutants can bioaccumulate in organisms at higher trophic levels because of higher fat content in their tissues.
 - Organisms at higher trophic levels can experience neurological toxicity because persistent organic pollutants bioaccumulate.
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Total for question 1 10 points

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- (a) (i) **Identify** the area with the greatest nest success rate, based on the information in the diagram. **1 point**

Accept one of the following:

- Area A
- Site/area upstream from the factory

- (ii) **Identify** the dependent variable in the study. **1 point**

- Turtle nesting success

- (iii) Based on the information provided, **identify** a likely scientific question for the study. **1 point**

Accept one of the following:

- Does mercury content in the turtle's habitat affect common snapping turtle nest success?
- Does mercury content in the turtle's habitat affect the location/site of common snapping turtle nests?

- (iv) **Describe** why researchers measured mercury levels in locations upstream from the factory. **1 point**

Accept one of the following:

- The upstream locations acted as a control group in the study.
- The site was used to compare with the high mercury turtle nests downstream.

- (v) There are plans to remove trees and other vegetation along the riverbank. **Explain** how this modification could affect the location and number of successful turtle nests in Area B. **1 point**

Accept one of the following:

- With more open area closer to the river, turtles don't have to travel as far to build nests, leading to exposure to higher levels of mercury near the river, decreasing the number of successful nests.
- With less vegetation to remove the mercury/heavy metals/endocrine disruptors/pesticides, there will be increased concentrations in the soil, decreasing the number of successful nests.
- Soil erosion along the stream would increase, which would make it more difficult for turtles to build nests there and decrease the number of successful nests.
- With less vegetation and reduced shade, the soil temperature will increase/moisture will decrease, decreasing the number of successful nests.

Total for part (a) 5 points

(b) (i) Describe how a persistent pollutant, such as mercury, can negatively affect an organism. **1 point**

Accept one of the following:

- The mercury/persistent pollutant could bioaccumulate in the tissues of organisms because the pollutants do not easily break down and can accumulate over time.
- Mercury is a neurotoxin, which can disrupt an animal's nervous system/neuron functioning.
- The mercury/persistent pollutant disrupts regular functioning of an animal's brain/kidneys/liver/immune system/reproductive system and can lead to death.

(ii) Describe how a persistent pollutant, such as mercury, can negatively affect an ecosystem. **1 point**

Accept one of the following:

- A toxin can biomagnify in the food chain impacting top predators that will have a very high concentration of the pollutant.
- The death of top predators in a food chain leads to a trophic cascade.
- Reproductive success of individual organisms can decrease from exposure to the pollutant, altering the ecosystem's food webs/trophic levels and decreasing its stability/resulting in a decline in biodiversity.

(iii) Researchers measured methylmercury in a location downstream from the factory. Explain how methylmercury could be present in the stream. **1 point**

- Mercury is likely released into the stream by the factory as a waste product. Bacteria/microorganisms in the water/sediments then convert the mercury into methylmercury.

(iv) Researchers claimed that the soil nearest to the river has higher levels of mercury than the field has, and those elevated levels have affected the nesting success for turtles. Explain how the pattern shown in the diagram supports or refutes this claim. **1 point**

Accept one of the following:

- The nests near the river in Area B where there is mercury are not successful, but the nests further away are successful. This supports the claim that the high concentration in the soil negatively affects the nesting success.
- There are fewer total nests/successful nests in Area B closer to the river than in Area A indicating that the mercury in the soil has negatively affected the nesting success. This supports the claim.

Total for part (b) 4 points

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- (c) The turtle study was conducted in an agricultural area. **Describe** how a specific agricultural practice changes the soil in an area. **1 point**

Accept one of the following:

- Tilling/plowing softens/loosens soils and/or removes organic matter or leads to erosion.
- Monocropping removes nutrients and/or moisture from soil.
- Use of synthetic fertilizers disrupts the soil chemistry in areas used for agriculture.
- Irrigation can lead to waterlogging, erosion, and/or salinization of soils.
- Slash and burn removes vegetation and upper organic layers of the soil/adds nutrients to the soil.
- Use of industrialized machinery (harvesters, plows, planters) compacts soil.
- Use of polycultures/cover cropping with nitrogen-fixing plants can add nutrients to soil.
- Use of manure/organic fertilizer can increase moisture content of the soils.

Total for part (c) 1 point

Total for question 1 10 points