

## ENVIRONMENTAL SCIENCE

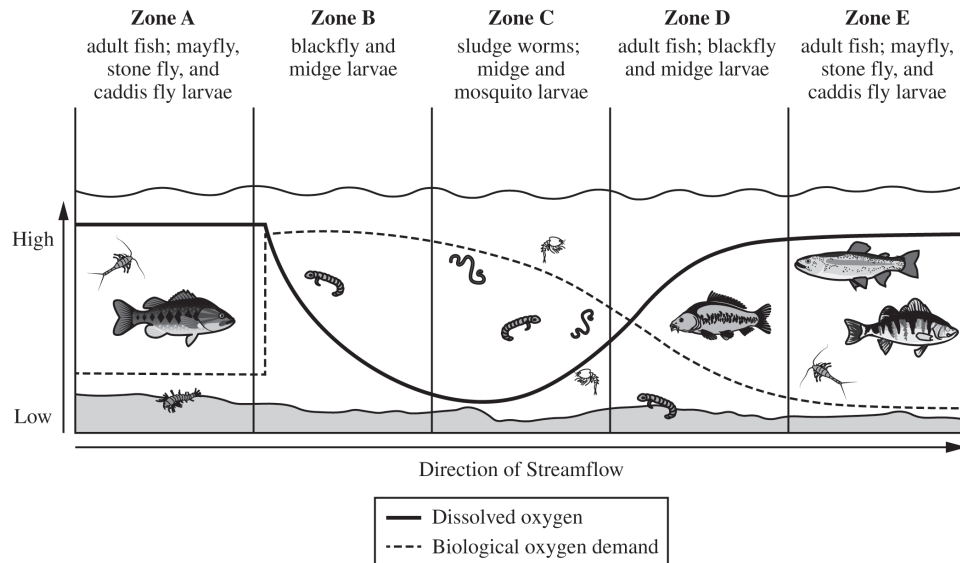
## SECTION II

Time—1 hour and 10 minutes

3 Questions

**Directions:** Answer all three questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers in the Free Response booklet. Where calculations are required, clearly show how you arrived at your answer. Where explanation or discussion is required, support your answers with relevant information and/or specific examples. You may plan your answers in this orange booklet, but no credit will be given for anything written in this booklet. **You will only earn credit for what you write in the separate Free Response booklet.**

1. Researchers are studying the stream ecosystem shown in the following diagram. They have identified five different zones based on the dissolved oxygen levels and biological oxygen demand as the water flows downstream. Biological oxygen demand is the amount of oxygen needed by bacteria and other microorganisms to break down organic material in water. Some of the most common fish and macroinvertebrate species found in each zone are listed in the diagram.

**Dissolved Oxygen and Biological Oxygen Demand in a Stream Ecosystem**

- (a) Based on the information in the diagram, **identify** the zone with the lowest level of dissolved oxygen..
- (b) Based on the information in the diagram, **describe** the relationship between biological oxygen demand and dissolved oxygen.
- (c) Based on the information in the diagram, **identify** the zone where there is most likely point-source water pollution discharged into the stream.

The research team is interested in investigating the relationship between dissolved oxygen levels and macroinvertebrate species richness in the stream. Researchers counted the number of macroinvertebrate species in zones A, B, and C during the summer months. The researchers selected zone A to serve as the control in the investigation.

- (d) **Identify** the dependent variable in the researchers' investigation.
- (e) **Identify** a testable hypothesis for the researchers' investigation.
- (f) **Describe** the reason the researchers selected zone A to serve as the control in the investigation.

The researchers decided to repeat their data collection during the winter months.

- (g) **Explain** how the modification to collect data in the winter months could alter the results of the investigation.

Stream ecosystems are affected by point-source organic pollution in a variety of ways.

- (h) **Describe** the effect that the introduction of raw sewage into the stream could have on the population of bacteria in the stream.
- (i) **Identify** an abiotic factor other than dissolved oxygen and organic pollution that could also influence the population size of bacteria in the stream.
- (j) **Explain** how persistent organic pollutants can affect higher trophic levels in an aquatic food web.

**Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.**

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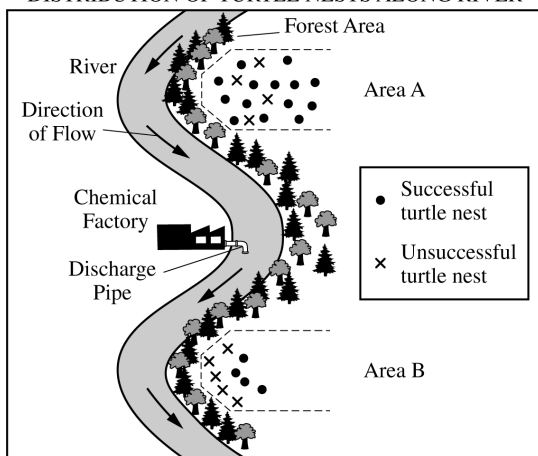
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## 3 Questions

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1. Common snapping turtles, *Chelydra serpentina*, are primarily aquatic, but they lay their eggs on land. Researchers are interested in understanding the impact of pollution on turtle nesting sites. The researchers examined nesting sites at two agricultural areas along the floodplain of a river upstream and downstream from a chemical factory that is a known source of aqueous mercury pollution. Turtle eggs, soil, and vegetation samples taken from areas around turtle nests downstream from the chemical factory showed high levels of mercury in a previous study. Mercury was not detected in samples taken upstream from the chemical factory.

DISTRIBUTION OF TURTLE NESTS ALONG RIVER



- (a) The map shows locations of both successful and unsuccessful turtle nests.
- (i) **Identify** the area with the greatest nest success rate, based on the information in the diagram.
  - (ii) **Identify** the dependent variable in the study.
  - (iii) Based on the information provided, **identify** a likely scientific question for the study.
  - (iv) **Describe** why researchers measured mercury levels in locations upstream from the factory.
  - (v) There are plans to remove trees and other vegetation along the river bank. **Explain** how this modification could affect the location and number of successful turtle nests in Area B.
- (b) Mercury can affect organisms and ecosystems in many ways.
- (i) **Describe** how a persistent pollutant, such as mercury, can negatively affect an organism.
  - (ii) **Describe** how a persistent pollutant, such as mercury, can negatively affect an ecosystem.
  - (iii) Researchers measured methylmercury in a location downstream from the factory. **Explain** how methylmercury could be present in the stream.
  - (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.
- (c) The turtle study was conducted in an agricultural area. **Describe** how a specific agricultural practice changes the soil in an area.

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2. Pesticides have been utilized for many years to increase food production and control pest populations. Pesticide use can be both beneficial and harmful to humans and other organisms.

- (a) Pesticide use has advantages, disadvantages, and unintended consequences on human health. **Describe** one benefit to human health that can result from the use of pesticides.
- (b) **Identify** one way chemical pesticides can enter the human body.

Cotton farmers in the southern United States used a chemical pesticide to control an insect cotton-crop pest over a 40-year period. To study the effectiveness of the pesticide as an insect pest-control strategy, traps were placed in treated cotton fields and the number of pests captured were compared to application rates for the pesticide. The results of the study are shown in the table below.

| Year | Grams of Pesticide Applied per Hectare | Number of Crop Insect Pests Captured |
|------|----------------------------------------|--------------------------------------|
| 1960 | 0                                      | 700                                  |
| 1975 | 500                                    | 2                                    |
| 1980 | 500                                    | 3                                    |
| 1985 | 500                                    | 8                                    |
| 1990 | 550                                    | 14                                   |
| 1995 | 600                                    | 83                                   |
| 2000 | 700                                    | 150                                  |
| 2005 | 800                                    | 405                                  |
| 2010 | 900                                    | 727                                  |
| 2015 | 1,000                                  | 1,100                                |

- (c) Use the data in the table to answer the following questions.
- (i) **Identify** the year when the pesticide was most effective at reducing the size of the pest population.
- (ii) **Describe** the change in the number of crop insect pests in the cotton fields over time.
- (iii) **Explain** how the change in the cotton-crop pesticide effectiveness between the initial application in 1975 and the latest application in 2015 illustrates genetic resistance in pests, based on the data in the table.
- (d) **Describe** TWO effects of pesticide use, other than death, on nontarget wildlife.

- (e) There are many problems associated with the repeated application of chemical pesticides to reduce pest populations.
- (i) Crop rotation is often used to reduce pesticide use. **Describe** the process of crop rotation.
- (ii) **Propose** one reasonable method, other than crop rotation, of reducing the use of pesticides in agricultural practices while still maintaining a high crop yield.
- (iii) **Justify** how the method proposed in (e)(ii) would provide a benefit to humans.

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