

2012 AP[®] ENVIRONMENTAL SCIENCE FREE-RESPONSE QUESTIONS

3. The active ingredients in many pesticides are chemical compounds that kill organisms such as insects, molds, and weeds. Proponents claim that the use of pesticides improves crop yields and thus protects land and soil by reducing the conversion of forests and wetlands to cropland. Opponents of pesticide use claim that pesticides degrade water and soil quality and that other modern agricultural techniques and practices are responsible for the improved crop yields in recent years.
- (a) Design a laboratory experiment to determine whether or not a new pesticide (product X) is toxic to minnows, a type of small fish. For the experiment you design, be sure to do all of the following.
 - (i) State the hypothesis.
 - (ii) Describe the method you would use to test your hypothesis.
 - (iii) Identify the control.
 - (iv) Identify the dependent variable.
 - (b) Describe experimental results that would lead you to reject your hypothesis in part (a)(i). (Be specific.)
 - (c) One strategy for dealing with agricultural pests is integrated pest management (IPM).
 - (i) Describe IPM. As part of your description, include TWO specific pest-control approaches that are part of IPM.
 - (ii) Identify one environmental benefit of using IPM.
 - (d) Describe TWO agricultural practices, other than those involving pest control, that increase crop yields.

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Question 3

The active ingredients in many pesticides are chemical compounds that kill organisms such as insects, molds, and weeds. Proponents claim that the use of pesticides improves crop yields and thus protects land and soil by reducing the conversion of forests and wetlands to cropland. Opponents of pesticide use claim that pesticides degrade water and soil quality and that other modern agricultural techniques and practices are responsible for the improved crop yields in recent years.

(a) Design a laboratory experiment to determine whether or not a new pesticide (product X) is toxic to minnows, a type of small fish. For the experiment you design, be sure to do all of the following.

(i) State the hypothesis.

(1 point)

A correct hypothesis includes the following:

- The hypothesis must predict a relationship between product X and minnow health.
- The prediction must indicate a specific direction of change for each variable, such as:
 - An increase in product X concentration will result in increased minnow mortality.
 - Does decreasing exposure to product X result in increased survivorship of minnows?
- Students may also state a null hypothesis in which they predict no relationship between product X and minnow health, such as:
 - Changing the concentration of product X has no effect on minnow health.
 - Increasing exposure to product X does not change minnow mortality.

(ii) Describe the method you would use to test your hypothesis.

(1 point)

A point is earned for a correct method that indicates the manipulation of the independent variable (product X). *Note:* The method must include a minimum of three experimental groups, one of which is not exposed to product X.

(iii) Identify the control.

(1 point)

A point is earned for the identification of an experimental group without the presence of product X as the control.

(iv) Identify the dependent variable.

(1 point)

A point is earned for the identification of a measure of minnow health as the dependent variable.

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Question 3 (continued)

- (b) Describe experimental results that would lead you to reject your hypothesis in part (a)(i). (Be specific.)**
(1 point)

A point is earned for a correct description of experimental results that include minnow health measurements that contradict the prediction in the hypothesis stated in part (a)(i). *Note:* A point can be earned with an incorrectly stated hypothesis in (a)(i), if the results described correctly contradict the statement in (a)(i).

- (c) One strategy for dealing with agricultural pests is integrated pest management (IPM).**

- (i) Describe IPM. As part of your description, include TWO specific pest-control approaches that are part of IPM.**

(3 points: 1 point for a description of IPM and 1 point each for including two specific pest-control approaches that are part of IPM)

One point can be earned for a description of IPM that demonstrates an understanding of one of the following:

- IPM uses a combination of biological, chemical, and physical (two of the three) means to control pests.
- IPM is used to reduce or eliminate the use of pesticides.
- IPM is used to reduce pest populations to acceptable or tolerable levels.

One point can be earned for each of two specific pest-control approaches that are part of IPM (only the first two approaches mentioned can earn points):

- Introduce, attract, or create habitat for the predators of pests.
- Introduce parasites that feed on pests.
- Introduce diseases or disease-carrying bacteria to kill pests.
- Vacuum pests from crops.
- Rotate crops.
- Plant multiple crops simultaneously (e.g., polyculture, intercropping).
- Adjust the planting times of crops.
- Use pheromones to attract pests to traps.
- Spray crops with hot water to scald pests.
- Introduce sterile males into pest populations to decrease their reproductive success.
- Use narrow-spectrum, or less persistent pesticides.
- Spray crops with soap solutions.
- Use noise to repel pests.
- Cultivate pest-resistant genetically modified crops.
- Use physical barriers to prevent pests from reaching crops.
- Other appropriate examples may also earn points.

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Question 3 (continued)

(ii) Identify one environmental benefit of using IPM.

(1 point: only the first benefit mentioned can earn a point)

Note: The benefit must be environmental; economic and societal benefits are not acceptable:

- Reduces the introduction of pesticides into areas other than farmland (e.g., runoff, overspray).
- Reduces incidental killing of non-targeted organisms (e.g., bees, spiders, ladybugs, birds).
- Reduces soil compaction by pesticide application equipment.
- Reduces CO₂ emissions from pesticide production and application equipment.
- Reduces erosion.
- Reduces bioaccumulation/biomagnification of pesticides.
- Reduces genetic resistance to pesticides.
- Other appropriate examples may also earn points.

(d) Describe TWO agricultural practices, other than those involving pest control, that increase crop yields.

(2 points: 1 point for each correct practice described; only the first two practices mentioned can earn points)

The following are acceptable with a suitable description of the practice or how the results of the practice would increase crop yields:

- Develop and plant high-yielding varieties of crops.
- Plant high-yielding genetically modified varieties of crops.
- Plant monocultures (monocropping).
- Plant polycultures.
- Rotate crops.
- Intercropping (alley cropping).
- Use irrigation systems.
- Apply fertilizers.
- Amend soil with organic material (e.g., compost, manure, mulch).
- Keep land in constant production (multiple cropping).
- Use modern farm equipment (e.g., tractors, harvesters).
- Grow crops in greenhouses.
- Grow crops hydroponically.
- Terracing of slopes.
- Contour plowing.
- Plant windbreaks or shelterbelts.
- Plow or till soil.
- Till soil with lower frequency (low-till or no-till).
- Slash and burn farming practices.
- Plant cover crops.
- Other appropriate examples may also earn points.