AP® Environmental Science
2001 Sample Student Responses

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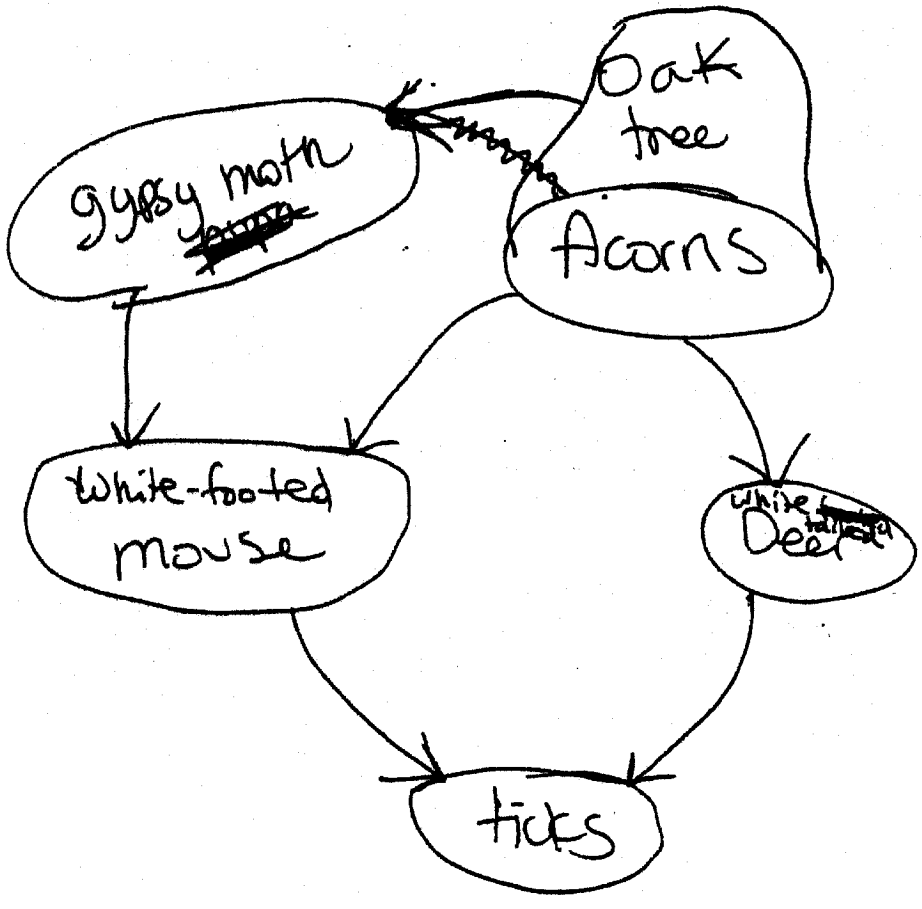
2. After reading the following excerpt from an article about the interrelationships among organisms in an oak forest, answer parts (a), (b), and (c), which follow.

Chain Reactions Linking Acorns to Gypsy Moth Outbreaks and Lyme Disease Risk

Oak trees (*Quercus* spp.) produce large autumnal acorn crops every two to five years, and produce few or no acorns during intervening years. Acorns are a critical food for white-footed mice (*Peromyscus leucopus*). Mice are important predators of the pupal stage of the gypsy moth (*Lymantria dispar*). This introduced insect periodically undergoes outbreaks that defoliate millions of hectares of oak forests, decreasing tree growth, survival, and acorn crop production. An abundance of acorns provides food for white-tailed deer (*Odocoileus virginianus*). Mice and deer are the primary hosts of the black-legged tick (*Ixodes scapularis*), which carries Lyme disease.

(a) In the space provided below, diagram a food web based on the interrelationships of the organisms identified in the excerpt.



(b) Design a controlled experiment that tests the relationship between acorn production and gypsy moth population. Include the hypothesis that the experiment tests.

(c) Briefly describe a strategy that uses integrated pest management for the control of the black-legged tick population.

(B) The hypothesis of the experiment would be that in years of low acorn production, the gypsy moth population would grow. To carry out this experiment, 100 acres of oak forest where this web occurs would be monitored. Every ~~foot~~ square foot would be staked off, and ~~the~~ an inventory would be taken of the type and number of each organism found, including, ~~# of acorn~~ oak trees, white-footed mice, and gypsy moths. This inventory would be done in the fall and the spring on a specified date every year for twenty years. The number of ~~of~~ acorns would be correlated with the number of white-footed mice, which would be correlated with the number of gypsy moths. This would show whether the number of acorns produced would have any effect on the number of mice, which would in turn have an effect on the number of gypsy moths, and then back to the oak trees/acorns.

© As both deer and mice are hosts to the tick, the integrated pest management system would have to affect both populations. One solution is to combine a pesticide that would kill the tick, with new predators to the hosts. This could be a longer deer hunting season, or the introduction of a carnivore such as the ~~fox~~ or coyote that could kill the mice, deer, or both, which would in turn limit the number of

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hosts for the ticks. If the ticks have nowhere to live or eat, they will die, which helps solve the problem. The pesticide would contribute by killing the ticks themselves, which would also help control the population.

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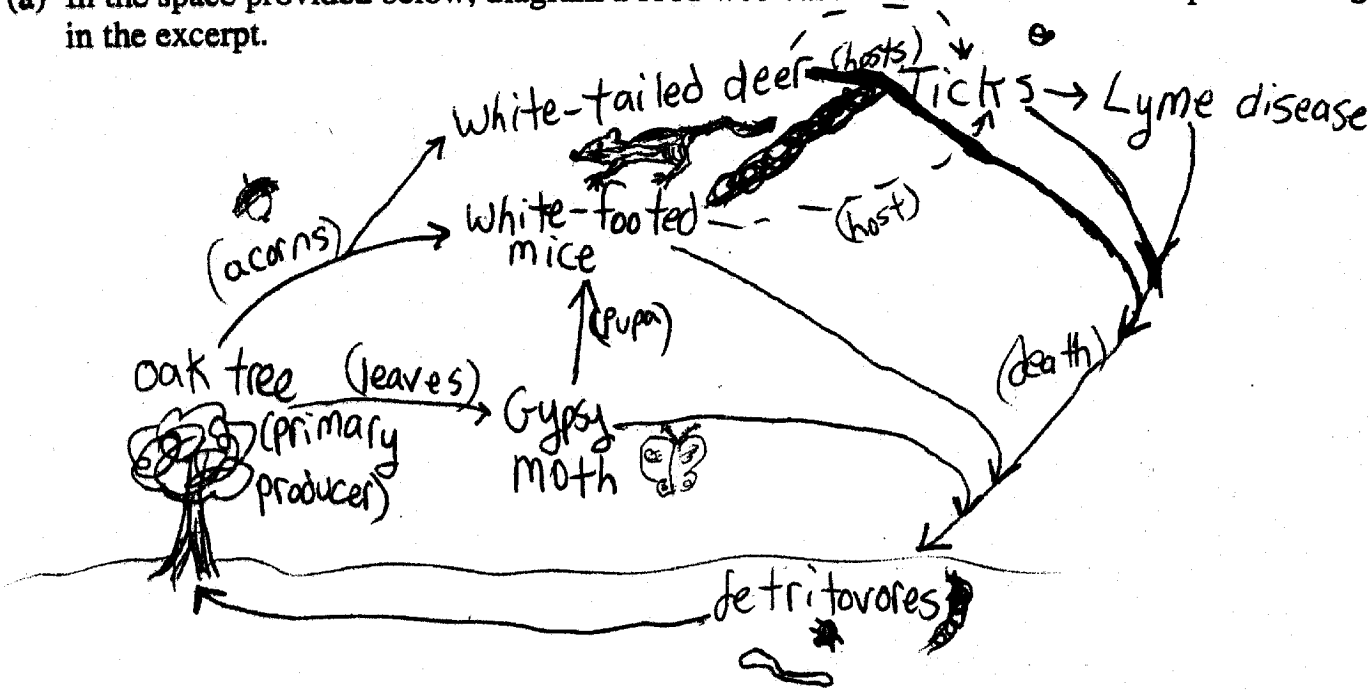

(b) Design a controlled experiment that tests the relationship between acorn production and gypsy moth population. Include the hypothesis that the experiment tests.

(c) Briefly describe a strategy that uses integrated pest management for the control of the black-legged tick population.

b) Hypothesis: If the acorn production decreases, the gypsy moth population will increase.

Procedure: [redacted] Select an isolated section of oak forest and monitor the gypsy moth population over a period of ten years to obtain baseline data. After sufficient data has been gathered, harvest* a significant percent of the oak population and ship it away for commercial use, thus ensuring a drastic reduction in acorn production. Again, monitor the gypsy moth population and observe whether the population has increased or not.

* This experiment may not be feasable due to the long term effect cutting down that many trees could have. Therefore, an alternative would be to [redacted] inject the trees with a chemical that would prevent them from bearing acorns for a period of time. However, I do not know if such a chemical exists and therefore did not include it in my experiment.

c) To manage the tick population pheremones could be sprayed in the affected areas. Pheremones are natural substances and would therefore have minimal consequences on the ecosystem, but would be effective

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in managing the tick population because they would disrupt the mating signals being sent from tick to tick, [redacted] making it difficult for them to mate and produce offspring. Also, by spraying a mild chemical pesticide over the area, the tick population would be reduced because the chemicals would kill the ticks. This part of the strategy is potentially more dangerous because it could disrupt the food web and alter the ecosystem. If the chemical pesticide is too risky for a designated area, sterile male ticks can be bred in laboratories and then released into the wild. Thus, when a wild female tick attempts to bear offspring it will be likely that she won't be able to since her sex-partner was genetically altered to prevent her from doing so. This method would increase the tick population for a brief period of time, but would reduce it in the long run due to low fertility rates. These are just a few ways that the black-legged tick population could be controlled with minimal damage to the ecosystem.

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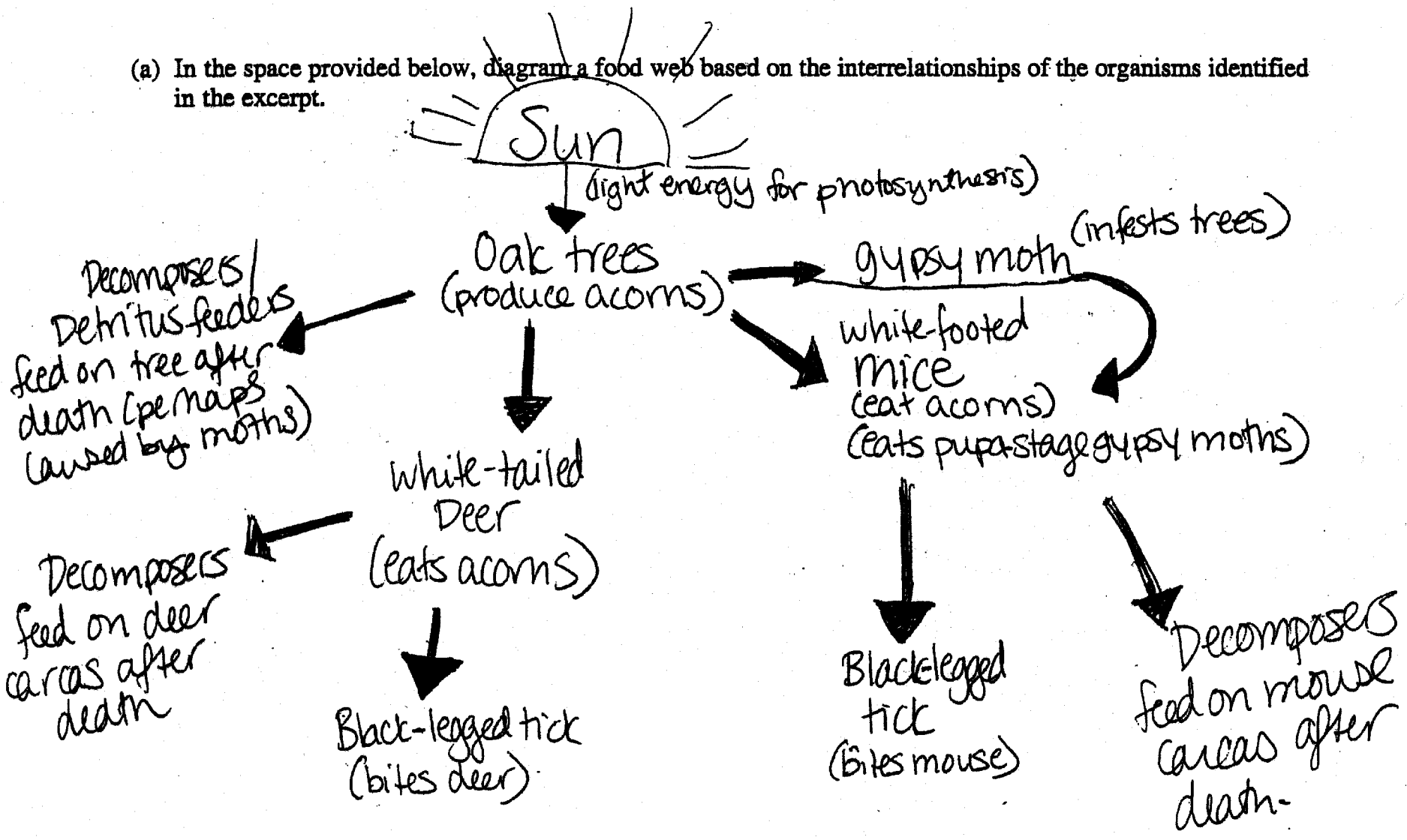

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b) Prob- Does gypsy moth population affect acorn production?
Hypo- The greater the population of gypsy moths, the lesser the production of acorns. The relationship is inversed.
Data- moths infestation and outbreaks defoliate millions of hectares of oak forests, decreasing tree growth, survival and acorn population.
Experiment - Acquire two forested areas containing oak trees. These areas should be identical in biotic and abiotic factors, including temp, percipitation, and soil fertility. The same number of trees should also exist in all areas. There should be at least 5 areas with 25 trees in each.
Release a specific number of gypsy moths into each area, leaving one area free of the insect. Divide areas in this fashion:
Area 1 - no moths
Area 2- 100 moths
Area 3- 500 moths
Area 4 - 1000 moths
Area 5 7000 moths
This should allow for variation in numbers (a wide range of #s)
Each week, monitor the trees, checking bark, leaves and tree for health. This should keep a toll of how many

die. When acorns develop, count the number and their stage of development (ex. size, color). Keep accurate results, and compare them.

c) As in any ecosystem, a creature cannot survive without proper biotic conditions, in this case, food. A tick cannot live without deer and mice (and other prey.) Conversely, it ~~cannot~~ will have too large a population if there are enough deer/mice to support it. By controling population of animals, tick will also be controlled. Also, once the tick reaches the carrying capacity of the environment, it will be naturally controlled.