Growers of fruit trees have always had problems with insects. Insects can cause visible damage to fruits, making them less appealing to consumers. As a result of this damage, much of the fruit cannot be sold. Insecticides have been useful for controlling these insects, but, in recent years, some insecticides have been much less effective. In some cases, insecticides do nothing to stop the insect attacks.

Provide a biological explanation for this loss of effectiveness of the insecticides. In your answer, be sure to:

1. Identify the original event that resulted in the evolution of insecticide resistance in some insects.
2. Explain why the percentage of resistant insects in the population has increased.
3. Describe one alternative form of insect control, other than using a different insecticide, that fruit growers could use to protect their crops from insect attack.

The three great lakes in Africa (Victoria, Tanganyika, and Malawi) contain a greater number of fish species than any other lakes in the world. Lake Malawi alone has 200 species of cichlid fish. The diversity of cichlid species in these African lakes could have been caused by changes in water level over thousands of years.

According to one hypothesis, at one time the three lakes were connected as one large lake and all the cichlids could interbreed. When the water level fell, groups of cichlids were isolated in smaller lakes as shown in the diagram. Over time, the groups of cichlids developed genetic differences. When the water levels rose again, the isolated populations were brought back into contact. Due to significant genetic differences, these populations were unable to interbreed. Variations in water level over thousands of years resulted in today's diversity of cichlid species.

According to the information given, as the water level of the lakes changed, many species of cichlids survived while others became extinct. State why some species survived while others became extinct.

Questions 37 and 38 refer to the following:

Evolutionary changes have been observed in beak size in a population of medium ground finches in the Galapagos Islands. Given a choice of small and large seeds, the medium ground finch eats mostly small seeds, which are easier to crush. However, during dry years, all seeds are in short supply. Small seeds are quickly consumed, so the birds are left with a diet of large seeds. Studies have shown that this change in diet may be related to an increase in the average size of the beak of the medium ground finch.

37) The most likely explanation for the increase in average beak size of the medium ground finch described in the reading passage is that the

A) birds acquired larger beaks due to the added exercise of feeding on large seeds
B) lack of small seeds caused a mutation which resulted in a larger beak
C) birds interbred with a larger-beaked species and passed on the trait
D) trait is inherited and birds with larger beaks have greater reproductive success

38) In exceptionally dry years, what most likely happens in the population of medium ground finches mentioned in the reading passage?

A) There is increased competition for a limited number of small seeds.
B) The finches develop parasitic relationships with mammals.
C) Birds with large beaks prey on birds with small beaks.
D) There is increased cooperation between the birds.
39) The dichotomous key shown below can be used to identify birds W, X, Y, and Z.

```
<table>
<thead>
<tr>
<th>Bird W</th>
<th>Bird X</th>
<th>Bird Y</th>
<th>Bird Z</th>
</tr>
</thead>
</table>

**Dichotomous Key to Representative Birds**

1. a. The beak is relatively long and slender.................. *Certhidea*
b. The beak is relatively stout and heavy.......................... go to 2
2. a. The bottom surface of the lower beak is flat and straight ...... *Geospiza*
b. The bottom surface of the lower beak is curved.................. go to 3
3. a. The lower edge of the upper beak has a distinct bend .......... *Camarhynchus*
b. The lower edge of the upper beak is mostly flat .................. *Platyspiza*
```

Assuming that bird W's beak, in the dichotomous key shown, is classified as "stout and heavy", other characteristics of this bird's beak would lead you to believe that it is

A) *Certhidea*  B) *Geospiza*  C) *Platyspiza*  D) *Camarhynchus*

40) When Charles Darwin traveled to the Galapagos Islands, he observed 14 distinct varieties of finches on the islands. Darwin also observed that each finch variety ate a different type of food and lived in a slightly different habitat from the other finches. Darwin concluded that the finches all shared a common ancestor, but had developed different beak structures.

The 14 varieties of finches mentioned in the reading passage are most likely the result of

A) biological evolution  B) lack of competition  C) asexual reproduction  D) absence of biodiversity

41) Even though the finches on the various Galapagos Islands require different biotic and abiotic factors for their survival, these finches would most likely be grouped in the same

A) population, but found in different ecosystems  B) species and found in the same biosphere
C) kingdom, but found in different ecological niches  D) species, but found in different habitats

42) Galapagos finches evolved partly due to

A) variation and competition  B) cloning and recombination
C) mutation and asexual reproduction  D) migration and selective breeding

43) Beak structures differ between individuals of one species of bird. These differences most likely indicate

A) an abundance of predators  B) a large supply of one kind of food
C) a reduced rate of reproduction  D) the presence of a variety of food sources

44) In members of a bird species living on a remote island, the greatest number of beak variations in the population would most likely be found when

A) homeostasis is limited by a severe climate  B) they are prey for a large number of predators
C) there is a high level of competition for limited resources  D) they have a large and varied food supply

45) The different tools used during the "beaks of finches" lab represented

A) nest construction adaptations  B) feeding adaptations in finches
C) variations in ecosystems  D) variations in seed size
46) A hawk has a genetic trait that gives it much better eyesight than other hawks of the same species in the same area. Explain how this could lead to evolutionary change within this species of hawk over a long period of time. In your answer, be sure to include an explanation of:
   (1) competition within the hawk population
   (2) survival of various individuals in the population
   (3) How would the frequency of the better-eyesight trait be expected to change overtime within the population?
   (4) What would most likely happen to the hawks having the better-eyesight trait if they also had unusually weak wing muscles?

Questions 47 through 49 refer to the following:

The finch diversity chart below contains information concerning the finches found on the Galapagos Islands.

47) Identify one trait, other than beak characteristics, that would contribute to the survival of a finch species and state one way this trait contributes to the success of this species.

48) Using information given in the chart, identify two birds that would most likely compete for food in times of food shortage and explain why they would compete.

49) The cactus finch, warbler finch, and woodpecker finch all live on one island. Based on the information in the given chart, which one of these finches is least likely to compete with the other two for food? [Support your answer with an explanation.]
Questions 50 and 51 refer to the following:

In birds, the ability to crush and eat seeds is related to the size, shape, and thickness of the beak. Birds with larger, thicker beaks are better adapted to crush and open seeds that are larger.

One species of bird found in the Galapagos Islands is the medium ground finch. It is easier for most of the medium ground finches to pick up and crack open smaller seeds rather than larger seeds. When food is scarce, some of the birds have been observed eating larger seeds.

50) Based on the reading passage, describe one change in beak characteristics that would most likely occur in the medium ground finch population after many generations when an environmental change results in a permanent shortage of small seeds.

51) Explain the long-term change in beak characteristics of the Galapagos ground finches described due to scarcity of smaller seeds. Use the concepts of:
   • competition
   • survival of the fittest
   • inheritance

52) In order for new species to develop, there must be a change in the
   A) migration patterns within a population
   B) rate of succession in the environment
   C) genetic makeup of a population
   D) temperature of the environment

53) Thousands of years ago, a large flock of hawks was driven from its normal migratory route by a severe storm. The birds scattered and found shelter on two distant islands, as shown on the map below. The environment of island A is very similar to the hawk's original nesting region. The environment of island B is very different from that of island A. The hawks have survived on these islands to the present day with no migration between the populations.

![Map of islands](image)

Which statement most accurately predicts the present-day condition of these island hawk populations?
   A) The hawks that landed on island B have evolved more than those on island A.
   B) The populations on islands A and B have undergone identical mutations.
   C) The hawks that landed on island A have evolved more than those on island B.
   D) The hawks on island A have given rise to many new species.

54) Which population of organisms would be in greatest danger of becoming extinct?
   A) A population of organisms having few variations living in a stable environment.
   B) A population of organisms having many variations living in an unstable environment.
   C) A population of organisms having many variations living in a stable environment.
   D) A population of organisms having few variations living in an unstable environment.
55) Which process is correctly matched with its explanation?

<table>
<thead>
<tr>
<th>Process</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A extinction</td>
<td>adaptive characteristics of a species are not adequate</td>
</tr>
<tr>
<td>B natural selection</td>
<td>the most complex organisms survive</td>
</tr>
<tr>
<td>C gene recombination</td>
<td>genes are copied as a part of mitosis</td>
</tr>
<tr>
<td>D mutation</td>
<td>overproduction of offspring takes place within a certain population</td>
</tr>
</tbody>
</table>

A) A  B) B  C) C  D) D

56) According to most scientists, which sequence best represents the order of biological evolution on Earth?

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
</table>

A) B → A → C  B) B → C → A  C) A → B → C  D) C → A → B

57) Explain why, in a mammal, a mutation in a gamete may contribute to evolution while a mutation in a body cell will not.

58) When Charles Darwin was developing his theory of evolution, he considered variations in a population important. However, he could not explain how the variations occurred. Name two processes that can result in variation in a population. Explain how these processes actually cause variation.

59) A certain chemical destroys bacteria that have thin cell walls. Bacteria with thick cell walls are not affected. Describe how the introduction of this chemical into a culture containing both types of bacteria could be used to illustrate the theory of natural selection.

60) A European species of rabbit was released on a ranch in Victoria, Australia. The species thrived and reproduced rapidly. The rabbits overgrazed the land, reducing the food supply for the sheep. The Myxoma sp. virus was used to kill the rabbits. The first time this virus was applied, it killed 99.8% of the rabbits. When the rabbits became a problem again, the virus was applied a second time. This time, only 90% of the rabbits were killed. When the rabbits became a problem a third time, the virus was applied once again, and only 50% of the rabbits were killed. Today, this virus has little or no effect on this species of rabbit.

Explain what happened to the species of rabbit as a result of the use of this virus. You must include and circle the following terms in your answer.

- gene
- adaptive value or adaptation or adapted
- variation
- survival of the fittest
61) In the past, a specific antibiotic was effective in killing a certain species of bacteria. Now, most members of this bacterial species are resistant to this antibiotic. Explain how this species of bacteria has become resistant. Your answer must include at least the concepts of:

- overproduction
- variation
- natural selection
- adaptation to the environment

62) Color in peppered moths is controlled by genes. A light-colored variety and a dark-colored variety of a peppered moth species exist in nature. The moths often rest on tree trunks, and several different species of birds are predators of this moth. Before industrialization in England, the light-colored variety was much more abundant than the dark-colored variety and evidence indicates that many tree trunks at that time were covered with light-colored lichens. Later, industrialization developed and brought pollution which killed the lichens leaving the tree trunks covered with dark-colored soot. The results of a study made in England are shown below.

![Graph showing percentage of moth varieties in nonpolluted and polluted environments.]

Based on the given information, state one possible reason that a larger number of the dark-colored variety were present in the polluted environment.
The cartoons below refer to certain concepts of natural selection.

"Of course, long before you mature, most of you will be eaten."

"Listen... I'm fed up with this 'weeding out the sick and the old' business... I want something in its prime."

Choose one cartoon and write its number in the space below. Identify one concept represented in that cartoon, and explain how this concept supports the theory of natural selection. Your answer must:

1. identify one concept represented in the cartoon chosen
2. briefly explain the concept identified
3. explain the relationship between this concept and the process of natural selection
Over the last 30 years, a part of the Hudson River known as Foundry Cove has been the site for many factories that have dumped toxic chemicals into the river. Some of these pollutants have accumulated in the mud at the bottom of the river. The polluted cove water contains many single-celled organisms and simple multi-cellular animals. Curiously, when the same species from nearby regions with non-polluted sediments are moved to the polluted cove water, they die.

Scientists hypothesized that the organisms living in the cove have evolved so that they are able to survive in polluted water. To test this hypothesis, biologists tried to duplicate the history of the cove in the laboratory. They took a large number of one species of simple animal from a cove with unpolluted mud and placed them in a flask that contained polluted mud from Foundry Cove (diagram 1). Most of the animals died, but a few survived (diagram 2). The scientists then bred the survivors with each other for several generations producing offspring that were descendants of the survivors. When placed in Foundry Cove, most of these descendants survived. The diagrams below represent the steps in this investigation.

On the diagram of the flask below, sketch the animals that would be present in flask 3 after several generations of breeding in the laboratory.

State what could happen to a species in a changing environment if the members of that species do not express any genetic variations.
66) The diagram below represents a woolly mammoth, a relative of the modern elephant. Woolly mammoths lived during the Ice Age and eventually became extinct.

State *one* possible reason this species died out.
1) B  2) D  3) B  4) D  5) A  
6) C  7) C  8) A  9) D  10) A  
16) D  17) A  18) B  19) C  20) A  
26) D  27) C  28) B  29) D  30) A  
31) C  32) B  33) C  

34) SAMPLE ANSWER: A and C would probably have the most similar genetic material. A and C have more of the given characteristics in common than any other pair.  

35) SAMPLE ANSWERS:  
(1) A mutation (or genetic change) probably occurred that led to the resistance to the insecticide.  
(2) The percentage of resistant insects in the population has increased over the years because they survived when the insecticide was used, and were then able to reproduce and pass on the resistance.  
(3) release natural predators of the insects OR the release of large numbers of sterile males of insect species that damage fruits OR provide conditions that help predators of the insects live in the area OR genetically engineer insect-resistant plants  

36) SAMPLE ANSWER: Some species are better adapted to the environment. OR Some species have a greater ability to compete for food or escape predators or breed. OR natural selection  

37) D  38) A  39) B  40) A  41) C  
42) A  43) D  44) D  45) B  

46) SAMPLE ANSWERS:  
(1) The hawk with the better eyesight would compete more successfully. OR The hawks with the better eyesight would have a better chance of obtaining food.;  
(2) Individuals with the better-eyesight trait would have a better chance to survive.;  
(3) The frequency of the better-eyesight trait would increase.;  
(4) If the hawks have better eyesight and weak wings, they will not have the same advantage as those with better eyesight and normal wings.  

47) SAMPLE ANSWERS: Faster or more aggressive birds get to seeds faster. OR Larger or stronger birds compete successfully. OR Coordination helps an individual avoid predators.  

48) SAMPLE ANSWERS: Medium and large ground finches both have crushing bills and eat plants. OR Small tree finches and large tree finches would compete because both eat mainly animals. OR Large ground finches and sharp-billed ground finches have similar beaks and eat mainly plant food.  

49) SAMPLE ANSWER: The cactus finch is least likely to compete with the other two for food because it eats mainly plant food, while the other two eat mainly or all animal food.  

50) SAMPLE ANSWERS: Beaks would be thicker. OR Birds with larger, thicker beaks would become more common in the population than those with the original beak characteristics.  

51) SAMPLE ANSWER: Competition for food would increase as small seeds became scarce. Birds with larger, thicker beaks would have a better chance of surviving when the seeds were larger and tougher to crack. Birds with normal thickness beaks would be less likely to survive. Reproduction of the surviving birds, many with the larger, thicker beaks, would produce more offspring inheriting the better adapted beak type. Over time, this would lead to a large proportion of the population having the thicker beaks.
57) Answers may vary.
SAMPLE ANSWERS: Mutations in a gamete may lead to variation in a population. OR Mutations occurring in body cells are not passed on to offspring. OR Mutations in gametes may be passed on to offspring.

58) Answers may vary.
SAMPLE ANSWERS: Mutations change DNA, resulting in new traits. OR Crossing over during meiosis may produce new gene combinations. OR Fertilization involves union of sex cells from each of two parents, resulting in offspring different from either parent.

59) Answers may vary.
SAMPLE ANSWERS: Through survival of the fittest, only the thick-walled bacteria would survive. OR When the chemical is introduced, only the bacteria with thick cell walls survive. OR The introduction of the chemical causes an environmental change that selectively allows only the thick-walled bacteria to survive.

60) Answers may vary.
SAMPLE ANSWER: Some rabbits had genes that resulted in the production of a variation that made them resistant to the virus. These rabbits were better adapted to survive in the presence of the virus. These rabbits are better fit to survive and will pass on the favorable variation so each succeeding generation will contain more resistant members.

61) Answers may vary.
SAMPLE ANSWER: Due to their rapid rate of reproduction, more bacteria than can possibly survive (overproduction) were produced. Due to genetic differences (variation), some bacteria had genes making them resistant to the antibiotic and so were better adapted to an environment containing the antibiotic. They were the ones most likely to survive and produce the next generation (natural selection). Over several generations, a greater percentage of the population was resistant (adaptation to the environment).

62) Answers may vary.
SAMPLE ANSWERS: Dark-colored moths were better camouflaged from predators in the polluted environment. OR Dark-colored moths were better adapted for survival on the darker tree bark.

63) Answers may vary.
SAMPLE ANSWERS: CARTOON 1: (1) overproduction; (2) More organisms are produced than can survive; (3) The organisms that are best adapted will survive; OR CARTOON 2: (1) struggle for survival (or survival of the fittest); (2) Those organisms best adapted will survive; (3) Those that survive will pass these traits on to their offspring.

64)

65) Answers may vary.
SAMPLE ANSWERS: The species could become extinct. OR The species does not evolve. OR The species remains the same.

66) Answers may vary.
SAMPLE ANSWERS: The environment changed and the wooly mammoth could no longer adapt. OR The number of herbivores increased 10,000 years ago and there was more competition for food. OR Increase in predators OR overhunting by humans.