Version A

AP* Biology: Ecology

Directions: Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case and enter the appropriate letter in the corresponding space on the answer sheet.

1. All of the following statements about the food web diagram above are correct EXCEPT:

   A) All organisms, except grass are consumers.
   B) The death of the snake would cause a collapse in the food web.
   C) The mouse and grasshopper are at the same trophic level.
   D) The grass is a producer.

2. A species of malaria-carrying mosquito lives in a forest in which two species of monkeys, A and B, coexist. Species A is immune to malaria but species B is not. The malaria-carrying mosquito is the chief food for a particular kind of bird in the forest. If all of these birds are eliminated suddenly by hunters, which of the following would be the immediate observable consequence?

   A) Increased mortality in monkey species A
   B) Increased mortality in monkey species B
   C) Emergence of malaria-resistant strains in monkey species B
   D) Emergence of malaria-sensitive strains in monkey species A

3. A study of the metabolic rate in a terrestrial community shows that the energy released by respiration exceeds the energy captured in photosynthesis. Which of the following situations is occurring?

   A) Community biomass is decreasing.
   B) The producer biomass is increasing.
   C) A climax community has been reached.
   D) The first law of thermodynamics is not in effect.

4. Traveling southward from the Arctic regions of Canada to the tropics of Panama, one passes through several biomes: tundra, coniferous forest, temperate deciduous forest, and tropical rain forest. This pattern of change in vegetation is primarily the result of

   A) primary and secondary succession
   B) the invasion of exotic species
   C) the periodic fires that increase in traveling southward
   D) an increase in both mean annual temperature and mean annual precipitation
5. The graph shown illustrates how seed production in a plant species varied with population density in a whole habitat (site A) and in a fragmented habitat (site B). Which of the following conclusions is best supported by the data?

A) There is no relationship between seed production and habitat fragmentation.
B) Seed production is higher in dense populations.
C) Seed production is lower in dense populations.
D) Habitat fragmentation has more effect on seed production than does population density.
6. In the graphs shown, the solid lines represent the original population of sheep from the years 1820-1940. Which graph has a dotted line that best represents the sheep population resulting from a sustained increase in the primary productivity of the environment?
7. The chart above compares the daily water use per person to the price of water in selected countries. Which of the following conclusions can be correctly drawn using only the data in the chart?

A) Water use and water price are directly proportional.
B) Increased water use causes water prices to decline.
C) Increased prices cause water use to decline.
D) Increased water use is generally correlated with lower water prices.

8. Living organisms must acquire energy from their environment. Examples of adaptations that help organisms acquire this energy include which of the following?

   I. The dark, heat-absorbing coloration of a reptile
   II. The fangs and claws of a lion
   III. The light coloration of a peppered moth

A) I only
B) II only
C) I and II only
D) II and III only
Questions 9-11

The graph shows the concentration of carbon dioxide from 1958 to 1992 in ppm.

9. According to the graph, the increase in CO₂ concentration, in parts per million, between 1970 and 1990 is closest to

A) 5 ppm  
B) 25 ppm  
C) 50 ppm  
D) 340 ppm

10. The increases in carbon dioxide levels can be attributed to

A) an increase in photosynthesis.  
B) a decrease in anaerobic respiration.  
C) an increase in the burning of fossil fuels.  
D) a decrease in cellular respiration.
11. Predict which of the graphs below best represents the global mean annual temperature on Earth from 1950-2000.

A)  

B)  

C)  

D)
12. Which lettered portion of the graph most closely corresponds to the carrying capacity of the ecosystem?

A) A  
B) B and E  
C) C or D  
D) E

Questions 13 and 14

The data shown below were collected in a laboratory experiment in which the effect of pH on the survival of water fleas (Daphnia Pulex) was examined. In each trial, 40 live water fleas were added to a solution with the pH as indicated. After two hours, observations were made to determine the number of fleas remaining alive in the sample. Results are presented in the table and in graphical form below.

<table>
<thead>
<tr>
<th>pH</th>
<th>Daphnia Remaining After Two Hours</th>
<th>Fraction of Daphnia Remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3.2</td>
<td>24</td>
<td>0.6</td>
</tr>
<tr>
<td>5.5</td>
<td>32</td>
<td>0.8</td>
</tr>
<tr>
<td>7.4</td>
<td>28</td>
<td>0.7</td>
</tr>
<tr>
<td>8.5</td>
<td>28</td>
<td>0.7</td>
</tr>
</tbody>
</table>

13. The pH at which 50 percent of the Daphnia survive after 2 hours of exposure can be predicted from the data. This pH is closest to

A) 2.5  
B) 3.5  
C) 4.5  
D) 7.5

14. On the basis of the data, the best prediction of the pH of the water in which Daphnia normally are found in the wild

A) 3.0  
B) 5.0  
C) 7.0  
D) 9.0
15. The land on a 100-acre farm is equally suited for grazing cattle and growing corn. Of the following ways of distributing land use, which would produce the greatest number of calories for human consumption?

<table>
<thead>
<tr>
<th>Acres for Grazing Cattle</th>
<th>Acres for Growing Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

A) Cattle: 100  Corn: 0
B) Cattle: 80  Corn: 20
C) Cattle: 50  Corn: 50
D) Cattle: 0  Corn: 100

16. Density independent population controls include all of the following EXCEPT

A) resource competition
B) drought
C) fire
D) climate change

17. Ramsey Island and Brady Island are equidistant from the US mainland. Ramsey Island is three times larger than Brady Island. Given this information, all of the following statements could be true EXCEPT

I. Brady Island can support larger populations than Ramsey Island.
II. Brady Island has more competition than Ramsey Island.
III. Brady Island is more likely to have greater habitat variation than Ramsey Island.

A) I only
B) II only
C) I and II only
D) I, II and III
18. A student is asked to design an experiment aimed at determining whether or not the initiation of migratory behavior is largely under genetic control. Of the following options, the best way to proceed is to

A) observe different genetically distinct populations in the field and see if they have different migratory habits
B) perform within-population mating in a laboratory setting with birds from different populations having different migratory habits and determine if offspring display parental migratory behavior
C) bring birds into the laboratory and determine the conditions under which they become restless and attempt to migrate
D) perform within-population mating with birds from different populations that have different migratory habits and subsequently rear the offspring in the absence of their parents and observe offspring migratory behavior

19. In a mature forest of oak, maple, and hickory trees, a disease causes a reduction in the number of acorns produced by oak trees. Which of the following would least likely be a direct result of an increase in diseased acorns?

A) There might be fewer squirrels because they feed on acorns.
B) There might be fewer mice and seed-eating birds because squirrels would eat more seeds and compete with the mice and birds.
C) There might be an increase in the number of hickory trees because the competition between hickory nuts and acorns for germination sites would be reduced or eliminated.
D) There might be a decrease in the number of maple seeds as the disease spreads to other trees in the forest.
Questions 20 and 21 refer to the figure below, which depicts the age structure of three populations.

20. Which population is in the process of decreasing?

A) I only
B) II only
C) III only
D) I and II only

21. Which population appears to be stable?

A) I only
B) II only
C) III only
D) I and II only

22. For most terrestrial ecosystems, pyramids of numbers, biomass, and energy are essentially the same, exhibiting a broad base and a narrow top. The primary reason for this pattern is

A) Secondary consumers and top carnivores require less energy than producers.
B) At each step, energy is lost from the system as a result of keeping the organisms alive.
C) As matter passes through ecosystems, some of it is lost to the environment.
D) Biomagnification of toxic materials limits the secondary consumers and top carnivores.
23. If a fish farmer wanted to harvest his fish so that it recovered at the maximum rate, where should the population be maintained?

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

24. Which of the factors below would best account for the regulation of the population that exhibits the growth pattern illustrated by the graph below.

A) competition for food
B) competition for mates
C) competition for sunlight
D) competition for space after a fire

25. Which mortality curve indicates that the probability of death is equal at any age?

A) I only
B) II only
C) III only
D) II and III only
Questions 26-28

Milkweed is a common field plant that produces a cardiac glycoside which, like digitalis, stimulates heart contractions. The synthesis of this compound ensures the survival of this plant species because the glycoside is toxic to most herbivores with a notable exception – the monarch butterfly.

Female monarchs lay their eggs on milkweed and the resulting larvae (caterpillars) feed on milkweed leaves. An enzyme produced by the caterpillars allows them to ingest and store the toxin without ill effects. After pupation, adult monarchs emerge with a conspicuous bright orange and black banding pattern and retain the toxic glycoside in their systems.

Viceroy butterflies are almost identical to monarchs in possessing the conspicuous banding pattern. However, viceroys cannot metabolize or store the toxic glycoside.

26. Which of the following is the central concept of the situation described above?
   A) Cryptic coloration
   B) Defensive adaptation
   C) Convergent evolution
   D) Polymorphism

27. The conspicuous banding displayed by monarch butterflies is an example of
   A) polygenetic inheritance
   B) warning coloration
   C) divergent evolution
   D) cryptic coloration

28. The banding pattern of viceroy butterflies is an example of
   A) mimicry
   B) homology
   C) mutualism
   D) commensalism
29. Which of the following best represents a logical conclusion based on the data presented in this graph?

![Graph of prey and predator populations over time]

A) The population of the prey is greater than that of predator.
B) There is no lag time between increases in both the predator and prey populations.
C) A decrease in the predator population results in a decrease of the prey population.
D) A decrease in the population of the prey, results in an increase in the population of the predator.

30. Which of the following is more susceptible to damage from some sort of ecological disturbance?

A) a desert
B) a temperate deciduous forest
C) a tropical rainforest
D) a corn field

31. Which of the following is true concerning the drawing?

![Diagram of two communities]

Community 1: A: 25%  B: 25%  C: 25%  D: 25%
Community 2: A: 80%  B: 5%  C: 5%  D: 10%

A) Community 2 has more species diversity than community 1.
B) Community 1 has more species diversity than community 2.
C) Community 2 has more species richness than community 1.
D) Community 1 has more species richness than community 2.
32. The nitrogen cycle is shown below. The nitrogen that is used by primary and secondary consumers comes in the form of

A) nitrogen gas (N₂) that is inhaled
B) ammonium (NH₄⁺) that is found in most fertilizers
C) nitrates found in most cooked meats
D) amino acids found in proteins
### AP Biology Ecology Unit Exam

**Part B Directions:** These three questions require numeric answers. Calculate the correct answer for each question, and enter your answer on the grid following each question. **Examples** of correct entry for the grid-in questions are shown below. The actual questions for this exam begin on the next page.

<table>
<thead>
<tr>
<th>Integer Answer</th>
<th>Integer Answer</th>
<th>Decimal Answer</th>
<th>Fraction Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>502</td>
<td>502</td>
<td>−4.13</td>
<td>−2/10</td>
</tr>
</tbody>
</table>

Examples of correct entry for the grid-in questions are shown below. The actual questions for this exam begin on the next page.
1. The biomass of a deciduous forest is 50% carbon. Additionally, the biomass increases annually at a rate of $2.7 \times 10^5$ kg/hectare. Calculate the mass of carbon accumulated and stored in 1.0 hectare of this forest in one year. Give your answer to the nearest hundred thousand ($10^5$) kilograms.

2. A population of glasswing butterflies exhibits logistic growth. The carrying capacity of the population is 200 butterflies, and $r_{max}$, the maximum per capita growth rate, of the population is 0.10 butterflies/(butterflies • month). Calculate the maximum population growth rate for the population if the maximum growth occurs when $N = k/2$. Give your answer to the nearest tenth.
3. According to atmosphere temperature and CO₂ concentration records derived from Antarctic ice cores, Earth’s climate has undergone significant changes over the past 200,000 years. Two graphs are shown above. The upper graph shows the variation in atmospheric CO₂ concentration, and the lower graph shows the variation in air temperature. Both graphs cover the same time period from approximately 200,000 years ago until 1950. Calculate the mean rate of change in atmospheric CO₂ concentration between 140,000 years ago and 125,000 years ago.
Version B

AP* Biology: Ecology

Directions: Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case and enter the appropriate letter in the corresponding space on the answer sheet.

1.

[Diagram of a food web]

All of the following statements about the food web diagram above are correct EXCEPT:

A) All organisms, except grass are consumers.
B) The death of the snake would cause a collapse in the food web.
C) The mouse and grasshopper are at the same trophic level.
D) The grass is a producer.

Questions 2-4

Milkweed is a common field plant that produces a cardiac glycoside which, like digitalis, stimulates heart contractions. The synthesis of this compound ensures the survival of this plant species because the glycoside is toxic to most herbivores with a notable exception – the monarch butterfly.

Female monarchs lay their eggs on milkweed and the resulting larvae (caterpillars) feed on milkweed leaves. An enzyme produced by the caterpillars allows them to ingest and store the toxin without ill effects. After pupation, adult monarchs emerge with a conspicuous bright orange and black banding pattern and retain the toxic glycoside in their systems.

Viceroy butterflies are almost identical to monarchs in possessing the conspicuous banding pattern. However, viceroys cannot metabolize or store the toxic glycoside.

2. The conspicuous banding displayed by monarch butterflies is an example of

A) polygenetic inheritance
B) warning coloration
C) divergent evolution
D) cryptic coloration

3. Which of the following is the central concept of the situation described above?

A) Cryptic coloration
B) Defensive adaptation
C) Convergent evolution
D) Polymorphism
4. The banding pattern of viceroy butterflies is an example of
   A) mimicry
   B) homology
   C) mutualism
   D) commensalism

5. For most terrestrial ecosystems, pyramids of numbers, biomass, and energy are essentially the same, exhibiting a broad base and a narrow top. The primary reason for this pattern is
   A) Secondary consumers and top carnivores require less energy than producers.
   B) At each step, energy is lost from the system as a result of keeping the organisms alive.
   C) As matter passes through ecosystems, some of it is lost to the environment.
   D) Biomagnification of toxic materials limits the secondary consumers and top carnivores.

6. In a mature forest of oak, maple, and hickory trees, a disease causes a reduction in the number of acorns produced by oak trees. Which of the following would least likely be a direct result of an increase in diseased acorns?
   A) There might be fewer squirrels because they feed on acorns.
   B) There might be fewer mice and seed-eating birds because squirrels would eat more seeds and compete with the mice and birds.
   C) There might be an increase in the number of hickory trees because the competition between hickory nuts and acorns for germination sites would be reduced or eliminated.
   D) There might be a decrease in the number of maple seeds as the disease spreads to other trees in the forest.

7. Traveling southward from the Arctic regions of Canada to the tropics of Panama, one passes through several biomes: tundra, coniferous forest, temperate deciduous forest, and tropical rain forest. This pattern of change in vegetation is primarily the result of
   A) primary and secondary succession
   B) the invasion of exotic species
   C) the periodic fires that increase in traveling southward
   D) an increase in both mean annual temperature and mean annual precipitation
Questions 8 and 9

The data shown below were collected in a laboratory experiment in which the effect of pH on the survival of water fleas (*Daphnia Pulex*) was examined. In each trial, 40 live water fleas were added to a solution with the pH as indicated. After two hours, observations were made to determine the number of fleas remaining alive in the sample. Results are presented in the table and in graphical form below.

8. The pH at which 50 percent of the *Daphnia* survive after 2 hours of exposure can be predicted from the data. This pH is closest to

A) 2.5  
B) 3.5  
C) 4.5  
D) 7.5

9. On the basis of the data, the best prediction of the pH of the water in which *Daphnia* normally are found in the wild

A) 3.0  
B) 5.0  
C) 7.0  
D) 9.0
10. The graph shown illustrates how seed production in a plant species varied with population density in a whole habitat (site A) and in a fragmented habitat (site B). Which of the following conclusions is best supported by the data?

A) There is no relationship between seed production and habitat fragmentation.
B) Seed production is higher in dense populations.
C) Seed production is lower in dense populations.
D) Habitat fragmentation has more effect on seed production than does population density.

11. A species of malaria-carrying mosquito lives in a forest in which two species of monkeys, A and B, coexist. Species A is immune to malaria but species B is not. The malaria-carrying mosquito is the chief food for a particular kind of bird in the forest. If all of these birds are eliminated suddenly by hunters, which of the following would be the immediate observable consequence?

A) Increased mortality in monkey species A
B) Increased mortality in monkey species B
C) Emergence of malaria-resistant strains in monkey species B
D) Emergence of malaria-sensitive strains in monkey species A
The chart above compares the daily water use per person to the price of water in selected countries. Which of the following conclusions can be correctly drawn using only the data in the chart?

A) Water use and water price are directly proportional.
B) Increased water use causes water prices to decline.
C) Increased prices cause water use to decline.
D) Increased water use is generally correlated with lower water prices.
Questions 13-15

The graph shows the concentration of carbon dioxide from 1958 to 1992 in ppm.

13. According to the graph, the increase in CO$_2$ concentration, in parts per million, between 1970 and 1990 is closest to

A) 5 ppm  
B) 25 ppm  
C) 50 ppm  
D) 340 ppm

14. The increases in carbon dioxide levels can be attributed to

A) an increase in photosynthesis.  
B) a decrease in anaerobic respiration.  
C) an increase in the burning of fossil fuels.  
D) a decrease in cellular respiration.
15. Predict which of the graphs below best represents the global mean annual temperature on Earth from 1950-2000.
16. Which of the following is more susceptible to damage from some sort of ecological disturbance?

A) a desert  
B) a temperate deciduous forest  
C) a tropical rainforest  
D) a corn field

17. The land on a 100-acre farm is equally suited for grazing cattle and growing corn. Of the following ways of distributing land use, which would produce the greatest number of calories for human consumption?

<table>
<thead>
<tr>
<th>Acres for Grazing Cattle</th>
<th>Acres for Growing Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

A) Cattle: 100  Corn: 0  
B) Cattle: 80  Corn: 20  
C) Cattle: 50  Corn: 50  
D) Cattle: 0  Corn: 100

18. Which of the following best represents a logical conclusion based on the data presented in this graph?

A) The population of the prey is greater than that of predator.  
B) There is no lag time between increases in both the predator and prey populations.  
C) A decrease in the predator population results in a decrease of the prey population.  
D) A decrease in the population of the prey, results in an increase in the population of the predator.
19. Which lettered portion of the graph most closely corresponds to the carrying capacity of the ecosystem?

A) A 
B) B and E 
C) C or D 
D) E 

20. Living organisms must acquire energy from their environment. Examples of adaptations that help organisms acquire this energy include which of the following?

I. The dark, heat-absorbing coloration of a reptile 
II. The fangs and claws of a lion 
III. The light coloration of a peppered moth 

A) I only 
B) II only 
C) I and II only 
D) II and III only 

21. In the graphs shown, the solid lines represent the original population of sheep from the years 1820-1940. Which graph has a dotted line that best represents the sheep population resulting from a sustained increase in the primary productivity of the environment?
22. Ramsey Island and Brady Island are equidistant from the US mainland. Ramsey Island is three times larger than Brady Island. Given this information, all of the following statements could be true EXCEPT

I. Brady Island can support larger populations than Ramsey Island.
II. Brady Island has more competition than Ramsey Island.
III. Brady Island is more likely to have greater habitat variation than Ramsey Island.

A) I only  
B) II only  
C) I and II only  
D) I, II and III

23. If a fish farmer wanted to harvest his fish so that it recovered at the maximum rate, where should the population be maintained?

A) A  
B) B  
C) C  
D) D
24. Which of the factors below would best account for the regulation of the population that exhibits the growth pattern illustrated by the graph below.

A) competition for food
B) competition for mates
C) competition for sunlight
D) competition for space after a fire
Questions 25 and 26 refer to the figure below, which depicts the age structure of three populations.

25. Which population is in the process of decreasing?
   
   A) I only
   B) II only
   C) III only
   D) I and II only

26. Which population appears to be stable?
   
   A) I only
   B) II only
   C) III only
   D) I and II only

27. A study of the metabolic rate in a terrestrial community shows that the energy released by respiration exceeds the energy captured in photosynthesis. Which of the following situations is occurring?
   
   A) Community biomass is decreasing.
   B) The producer biomass is increasing.
   C) A climax community has been reached.
   D) The first law of thermodynamics is not in effect.
28. The nitrogen cycle is shown below. The nitrogen that is used by primary and secondary consumers comes in the form of

A) nitrogen gas (N₂) that is inhaled  
B) ammonium (NH₄⁺) that is found in most fertilizers  
C) nitrates found in most cooked meats  
D) amino acids found in proteins
29. A student is asked to design an experiment aimed at determining whether or not the initiation of migratory behavior is largely under genetic control. Of the following options, the best way to proceed is to

A) observe different genetically distinct populations in the field and see if they have different migratory habits
B) perform within-population mating in a laboratory setting with birds from different populations having different migratory habits and determine if offspring display parental migratory behavior
C) bring birds into the laboratory and determine the conditions under which they become restless and attempt to migrate
D) perform within-population mating with birds from different populations that have different migratory habits and subsequently rear the offspring in the absence of their parents and observe offspring migratory behavior

30. Which mortality curve indicates that the probability of death is equal at any age?

![Mortality curves]

A) I only
B) II only
C) III only
D) II and III only

31. Which of the following is true concerning the drawing?

![Community drawing]

A) Community 2 has more species diversity than community 1.
B) Community 1 has more species diversity than community 2.
C) Community 2 has more species richness than community 1.
D) Community 1 has more species richness than community 2.

32. Density independent population controls include all of the following EXCEPT

A) resource competition
B) drought
C) fire
D) climate change
Part B Directions: These three questions require numeric answers. Calculate the correct answer for each question, and enter your answer on the grid following each question. Examples of correct entry for the grid-in questions are shown below. The actual questions for this exam begin on the next page.
1. The biomass of a deciduous forest is 50% carbon. Additionally, the biomass increases annually at a rate of $2.7 \times 10^5$ kg/hectare. Calculate the mass of carbon accumulated and stored in 1.0 hectare of this forest in one year. Give your answer to the nearest hundred thousand ($10^5$) kilograms.

2. A population of glasswing butterflies exhibits logistic growth. The carrying capacity of the population is 200 butterflies, and $r_{max}$, the maximum per capita growth rate, of the population is 0.10 butterflies/(butterflies • month). Calculate the maximum population growth rate for the population if the maximum growth occurs when $N = k/2$. Give your answer to the nearest tenth.
3. According to atmosphere temperature and CO₂ concentration records derived from Antarctic ice cores, Earth’s climate has undergone significant changes over the past 200,000 years. Two graphs are shown above. The upper graph shows the variation in atmospheric CO₂ concentration, and the lower graph shows the variation in air temperature. Both graphs cover the same time period from approximately 200,000 years ago until 1950. Calculate the mean rate of change in atmospheric CO₂ concentration between 140,000 years ago and 125,000 years ago.
Version C

AP* Biology: Ecology

Directions: Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case and enter the appropriate letter in the corresponding space on the answer sheet.

1. The graph shown illustrates how seed production in a plant species varied with population density in a whole habitat (site A) and in a fragmented habitat (site B). Which of the following conclusions is best supported by the data?

A) There is no relationship between seed production and habitat fragmentation.
B) Seed production is higher in dense populations.
C) Seed production is lower in dense populations.
D) Habitat fragmentation has more effect on seed production than does population density.

The graph shown illustrates how seed production in a plant species varied with population density in a whole habitat (site A) and in a fragmented habitat (site B). Which of the following conclusions is best supported by the data?

A) There is no relationship between seed production and habitat fragmentation.
B) Seed production is higher in dense populations.
C) Seed production is lower in dense populations.
D) Habitat fragmentation has more effect on seed production than does population density.
Milkweed is a common field plant that produces a cardiac glycoside which, like digitalis, stimulates heart contractions. The synthesis of this compound ensures the survival of this plant species because the glycoside is toxic to most herbivores with a notable exception – the monarch butterfly.

Female monarchs lay their eggs on milkweed and the resulting larvae (caterpillars) feed on milkweed leaves. An enzyme produced by the caterpillars allows them to ingest and store the toxin without ill effects. After pupation, adult monarchs emerge with a conspicuous bright orange and black banding pattern and retain the toxic glycoside in their systems.

Viceroy butterflies are almost identical to monarchs in possessing the conspicuous banding pattern. However, viceroys cannot metabolize or store the toxic glycoside.

2. Which of the following is the central concept of the situation described above?
   
   A) Cryptic coloration  
   B) Defensive adaptation  
   C) Convergent evolution  
   D) Polymorphism

3. The conspicuous banding displayed by monarch butterflies is an example of
   
   A) polygenetic inheritance  
   B) warning coloration  
   C) divergent evolution  
   D) cryptic coloration

4. The banding pattern of viceroy butterflies is an example of
   
   A) mimicry  
   B) homology  
   C) mutualism  
   D) commensalism

5. In a mature forest of oak, maple, and hickory trees, a disease causes a reduction in the number of acorns produced by oak trees. Which of the following would least likely be a direct result of an increase in diseased acorns?
   
   A) There might be fewer squirrels because they feed on acorns.  
   B) There might be fewer mice and seed-eating birds because squirrels would eat more seeds and compete with the mice and birds.  
   C) There might be an increase in the number of hickory trees because the competition between hickory nuts and acorns for germination sites would be reduced or eliminated.  
   D) There might be a decrease in the number of maple seeds as the disease spreads to other trees in the forest.
6. Living organisms must acquire energy from their environment. Examples of adaptations that help organisms acquire this energy include which of the following?

I. The dark, heat-absorbing coloration of a reptile
II. The fangs and claws of a lion
III. The light coloration of a peppered moth

A) I only  
B) II only  
C) I and II only  
D) II and III only

7. In the graphs shown, the solid lines represent the original population of sheep from the years 1820-1940. Which graph has a dotted line that best represents the sheep population resulting from a sustained increase in the primary productivity of the environment?

A)  
B)  
C)  
D)
8. Traveling southward from the Arctic regions of Canada to the tropics of Panama, one passes through several biomes: tundra, coniferous forest, temperate deciduous forest, and tropical rain forest. This pattern of change in vegetation is primarily the result of

A) primary and secondary succession  
B) the invasion of exotic species  
C) the periodic fires that increase in traveling southward  
D) an increase in both mean annual temperature and mean annual precipitation

9. All of the following statements about the food web diagram above are correct EXCEPT:

A) All organisms, except grass are consumers.  
B) The death of the snake would cause a collapse in the food web.  
C) The mouse and grasshopper are at the same trophic level.  
D) The grass is a producer.
Questions 10 and 11

The data shown below were collected in a laboratory experiment in which the effect of pH on the survival of water fleas (*Daphnia Pulex*) was examined. In each trial, 40 live water fleas were added to a solution with the pH as indicated. After two hours, observations were made to determine the number of fleas remaining alive in the sample. Results are presented in the table and in graphical form below.

<table>
<thead>
<tr>
<th>pH</th>
<th>Daphnia Remaining After Two Hours</th>
<th>Fraction of Daphnia Remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3.2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.5</td>
<td>24</td>
<td>0.6</td>
</tr>
<tr>
<td>7.4</td>
<td>32</td>
<td>0.8</td>
</tr>
<tr>
<td>8.5</td>
<td>28</td>
<td>0.7</td>
</tr>
</tbody>
</table>

10. The pH at which 50 percent of the *Daphnia* survive after 2 hours of exposure can be predicted from the data. This pH is closest to

A) 2.5  
B) 3.5  
C) 4.5  
D) 7.5

11. On the basis of the data, the best prediction of the pH of the water in which *Daphnia* normally are found in the wild

A) 3.0  
B) 5.0  
C) 7.0  
D) 9.0
Questions 12-14

The graph shows the concentration of carbon dioxide from 1958 to 1992 in ppm.

12. According to the graph, the increase in CO$_2$ concentration, in parts per million, between 1970 and 1990 is closest to
   
   A) 5 ppm  
   B) 25 ppm  
   C) 50 ppm  
   D) 340 ppm

13. The increases in carbon dioxide levels can be attributed to

   A) an increase in photosynthesis.  
   B) a decrease in anaerobic respiration.  
   C) an increase in the burning of fossil fuels.  
   D) a decrease in cellular respiration.
14. Predict which of the graphs below best represents the global mean annual temperature on Earth from 1950-2000.

A) 

B) 

C) 

D)
15. Which of the following best represents a logical conclusion based on the data presented in this graph?

A) The population of the prey is greater than that of predator.
B) There is no lag time between increases in both the predator and prey populations.
C) A decrease in the predator population results in a decrease of the prey population.
D) A decrease in the population of the prey results in an increase in the population of the predator.

16. For most terrestrial ecosystems, pyramids of numbers, biomass, and energy are essentially the same, exhibiting a broad base and a narrow top. The primary reason for this pattern is

A) Secondary consumers and top carnivores require less energy than producers.
B) At each step, energy is lost from the system as a result of keeping the organisms alive.
C) As matter passes through ecosystems, some of it is lost to the environment.
D) Biomagnification of toxic materials limits the secondary consumers and top carnivores.
The chart above compares the daily water use per person to the price of water in selected countries. Which of the following conclusions can be correctly drawn using only the data in the chart?

A) Water use and water price are directly proportional.
B) Increased water use causes water prices to decline.
C) Increased prices cause water use to decline.
D) Increased water use is generally correlated with lower water prices.
Questions 18 and 19 refer to the figure below, which depicts the age structure of three populations.

18. Which population is in the process of decreasing?  
A) I only  
B) II only  
C) III only  
D) I and II only

19. Which population appears to be stable?  
A) I only  
B) II only  
C) III only  
D) I and II only
20. If a fish farmer wanted to harvest his fish so that it recovered at the maximum rate, where should the population be maintained?

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

21. Which of the following is more susceptible to damage from some sort of ecological disturbance?

A) a desert  
B) a temperate deciduous forest  
C) a tropical rainforest  
D) a corn field

22. Density independent population controls include all of the following EXCEPT

A) resource competition  
B) drought  
C) fire  
D) climate change

23. Which lettered portion of the graph most closely corresponds to the carrying capacity of the ecosystem?

A) A  
B) B and E  
C) C or D  
D) E
24. Which of the following is true concerning the drawing?

A) Community 2 has more species diversity than community 1.
B) Community 1 has more species diversity than community 2.
C) Community 2 has more species richness than community 1.
D) Community 1 has more species richness than community 2.

25. The land on a 100-acre farm is equally suited for grazing cattle and growing corn. Of the following ways of distributing land use, which would produce the greatest number of calories for human consumption?

<table>
<thead>
<tr>
<th>Acres for Grazing Cattle</th>
<th>Acres for Growing Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

A) Cattle: 100  Corn: 0
B) Cattle: 80  Corn: 20
C) Cattle: 50  Corn: 50
D) Cattle: 0  Corn: 100
26. Which of the factors below would best account for the regulation of the population that exhibits the growth pattern illustrated by the graph below.

A) competition for food
B) competition for mates
C) competition for sunlight
D) competition for space after a fire

27. A species of malaria-carrying mosquito lives in a forest in which two species of monkeys, A and B, coexist. Species A is immune to malaria but species B is not. The malaria-carrying mosquito is the chief food for a particular kind of bird in the forest. If all of these birds are eliminated suddenly by hunters, which of the following would be the immediate observable consequence?

A) Increased mortality in monkey species A
B) Increased mortality in monkey species B
C) Emergence of malaria-resistant strains in monkey species B
D) Emergence of malaria-sensitive strains in monkey species A

28. Which mortality curve indicates that the probability of death is equal at any age?

A) I only
B) II only
C) III only
D) II and III only
29. The nitrogen cycle is shown below. The nitrogen that is used by primary and secondary consumers comes in the form of

A) nitrogen gas (N₂) that is inhaled
B) ammonium (NH₄⁺) that is found in most fertilizers
C) nitrates found in most cooked meats
D) amino acids found in proteins
30. A student is asked to design an experiment aimed at determining whether or not the initiation of migratory behavior is largely under genetic control. Of the following options, the best way to proceed is to

A) observe different genetically distinct populations in the field and see if they have different migratory habits
B) perform within-population mating in a laboratory setting with birds from different populations having different migratory habits and determine if offspring display parental migratory behavior
C) bring birds into the laboratory and determine the conditions under which they become restless and attempt to migrate
D) perform within-population mating with birds from different populations that have different migratory habits and subsequently rear the offspring in the absence of their parents and observe offspring migratory behavior

31. A study of the metabolic rate in a terrestrial community shows that the energy released by respiration exceeds the energy captured in photosynthesis. Which of the following situations is occurring?

A) Community biomass is decreasing.
B) The producer biomass is increasing.
C) A climax community has been reached.
D) The first law of thermodynamics is not in effect.

32. Ramsey Island and Brady Island are equidistant from the US mainland. Ramsey Island is three times larger than Brady Island. Given this information, all of the following statements could be true EXCEPT

I. Brady Island can support larger populations than Ramsey Island.
   II. Brady Island has more competition than Ramsey Island.
   III. Brady Island is more likely to have greater habitat variation than Ramsey Island.

A) I only
B) II only
C) I and II only
D) I, II and III
**AP Biology Ecology Unit Exam**

**Part B Directions:** These three questions require numeric answers. Calculate the correct answer for each question, and enter your answer on the grid following each question. **Examples** of correct entry for the grid-in questions are shown below. The actual questions for this exam begin on the next page. 

<table>
<thead>
<tr>
<th>Integer Answer</th>
<th>Integer Answer</th>
<th>Decimal Answer</th>
<th>Fraction Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>502</td>
<td>502</td>
<td>−4.13</td>
<td>−2/10</td>
</tr>
</tbody>
</table>

![Grid examples](image)
1. The biomass of a deciduous forest is 50% carbon. Additionally, the biomass increases annually at a rate of $2.7 \times 10^5$ kg/hectare. Calculate the mass of carbon accumulated and stored in 1.0 hectare of this forest in one year. Give your answer to the nearest hundred thousand ($10^5$) kilograms.

2. A population of glasswing butterflies exhibits logistic growth. The carrying capacity of the population is 200 butterflies, and $r_{max}$, the maximum per capita growth rate, of the population is 0.10 butterflies/(butterflies • month). Calculate the maximum population growth rate for the population if the maximum growth occurs when $N = k/2$. Give your answer to the nearest tenth.
3. According to atmosphere temperature and CO₂ concentration records derived from Antarctic ice cores, Earth’s climate has undergone significant changes over the past 200,000 years. Two graphs are shown above. The upper graph shows the variation in atmospheric CO₂ concentration, and the lower graph shows the variation in air temperature. Both graphs cover the same time period from approximately 200,000 years ago until 1950. Calculate the mean rate of change in atmospheric CO₂ concentration between 140,000 years ago and 125,000 years ago.
Version D

AP* Biology: Ecology

Directions: Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case and enter the appropriate letter in the corresponding space on the answer sheet.

1. Which lettered portion of the graph most closely corresponds to the carrying capacity of the ecosystem?
   - A) A
   - B) B and E
   - C) C or D
   - D) E

2. A study of the metabolic rate in a terrestrial community shows that the energy released by respiration exceeds the energy captured in photosynthesis. Which of the following situations is occurring?
   - A) Community biomass is decreasing.
   - B) The producer biomass is increasing.
   - C) A climax community has been reached.
   - D) The first law of thermodynamics is not in effect.

3. Density independent population controls include all of the following EXCEPT
   - A) resource competition
   - B) drought
   - C) fire
   - D) climate change

4. Which mortality curve indicates that the probability of death is equal at any age?
   - A) I only
   - B) II only
   - C) III only
   - D) II and III only

(1) Test Questions are Copyright © 1984-2002 by College Entrance Examination Board, Princeton, NJ. All rights reserved. For face-to-face teaching purposes, classroom teachers are permitted to reproduce the questions. Web or Mass distribution prohibited. (2) AP® is registered trademark of the College Entrance Examination Board. The College Entrance Examination Board was not involved in the production of and does not endorse this product. Permissions granted of individual classroom teachers to reproduce the activity sheets and illustration for their own classroom use. Any other type of reproduction of this material is strictly prohibited.
Questions 5 and 6 refer to the figure below, which depicts the age structure of three populations.

5. Which population is in the process of decreasing?
   A) I only
   B) II only
   C) III only
   D) I and II only

6. Which population appears to be stable?
   A) I only
   B) II only
   C) III only
   D) I and II only
The chart above compares the daily water use per person to the price of water in selected countries. Which of the following conclusions can be correctly drawn using only the data in the chart?

A) Water use and water price are directly proportional.
B) Increased water use causes water prices to decline.
C) Increased prices cause water use to decline.
D) Increased water use is generally correlated with lower water prices.

8. The land on a 100-acre farm is equally suited for grazing cattle and growing corn. Of the following ways of distributing land use, which would produce the greatest number of calories for human consumption?

<table>
<thead>
<tr>
<th>Acres for Grazing Cattle</th>
<th>Acres for Growing Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

A) Cattle: 100    Corn: 0
B) Cattle: 80    Corn: 20
C) Cattle: 50    Corn: 50
D) Cattle: 0    Corn: 100
**Questions 9-11**

Milkweed is a common field plant that produces a cardiac glycoside which, like digitalis, stimulates heart contractions. The synthesis of this compound ensures the survival of this plant species because the glycoside is toxic to most herbivores with a notable exception – the monarch butterfly.

Female monarchs lay their eggs on milkweed and the resulting larvae (caterpillars) feed on milkweed leaves. An enzyme produced by the caterpillars allows them to ingest and store the toxin without ill effects. After pupation, adult monarchs emerge with a conspicuous bright orange and black banding pattern and retain the toxic glycoside in their systems.

Viceroy butterflies are almost identical to monarchs in possessing the conspicuous banding pattern. However, viceroys cannot metabolize or store the toxic glycoside.

9. The conspicuous banding displayed by monarch butterflies is an example of

   A) polygenetic inheritance  
   B) warning coloration  
   C) divergent evolution  
   D) cryptic coloration

10. Which of the following is the central concept of the situation described above?

   A) Cryptic coloration  
   B) Defensive adaptation  
   C) Convergent evolution  
   D) Polymorphism

11. The banding pattern of viceroy butterflies is an example of

   A) mimicry  
   B) homology  
   C) mutualism  
   D) commensalism

12. In a mature forest of oak, maple, and hickory trees, a disease causes a reduction in the number of acorns produced by oak trees. Which of the following would least likely be a direct result of an increase in diseased acorns?

   A) There might be fewer squirrels because they feed on acorns.  
   B) There might be fewer mice and seed-eating birds because squirrels would eat more seeds and compete with the mice and birds.  
   C) There might be an increase in the number of hickory trees because the competition between hickory nuts and acorns for germination sites would be reduced or eliminated.  
   D) There might be a decrease in the number of maple seeds as the disease spreads to other trees in the forest.

13. Traveling southward from the Arctic regions of Canada to the tropics of Panama, one passes through several biomes: tundra, coniferous forest, temperate deciduous forest, and tropical rain forest. This pattern of change in vegetation is primarily the result of

   A) primary and secondary succession  
   B) the invasion of exotic species  
   C) the periodic fires that increase in traveling southward  
   D) an increase in both mean annual temperature and mean annual precipitation
14. Living organisms must acquire energy from their environment. Examples of adaptations that help organisms acquire this energy include which of the following?

   I. The dark, heat-absorbing coloration of a reptile
   II. The fangs and claws of a lion
   III. The light coloration of a peppered moth

   A) I only  
   B) II only  
   C) I and II only  
   D) II and III only

15. The graph shown illustrates how seed production in a plant species varied with population density in a whole habitat (site A) and in a fragmented habitat (site B). Which of the following conclusions is best supported by the data?

   A) There is no relationship between seed production and habitat fragmentation.  
   B) Seed production is higher in dense populations.  
   C) Seed production is lower in dense populations.  
   D) Habitat fragmentation has more effect on seed production than does population density.

The graph shown illustrates how seed production in a plant species varied with population density in a whole habitat (site A) and in a fragmented habitat (site B). Which of the following conclusions is best supported by the data?
16. For most terrestrial ecosystems, pyramids of numbers, biomass, and energy are essentially the same, exhibiting a broad base and a narrow top. The primary reason for this pattern is

A) Secondary consumers and top carnivores require less energy than producers.
B) At each step, energy is lost from the system as a result of keeping the organisms alive.
C) As matter passes through ecosystems, some of it is lost to the environment.
D) Biomagnification of toxic materials limits the secondary consumers and top carnivores.

17. The nitrogen cycle is shown below. The nitrogen that is used by primary and secondary consumers comes in the form of

A) nitrogen gas (N₂) that is inhaled
B) ammonium (NH₄⁺) that is found in most fertilizers
C) nitrates found in most cooked meats
D) amino acids found in proteins
18. Which of the following is more susceptible to damage from some sort of ecological disturbance?

A) a desert  
B) a temperate deciduous forest  
C) a tropical rainforest  
D) a corn field

19. Which of the following is true concerning the drawing?

A) Community 2 has more species diversity than community 1.  
B) Community 1 has more species diversity than community 2.  
C) Community 2 has more species richness than community 1.  
D) Community 1 has more species richness than community 2.
Questions 20-22

The graph shows the concentration of carbon dioxide from 1958 to 1992 in ppm.

20. The increases in carbon dioxide levels can be attributed to

A) an increase in photosynthesis.
B) a decrease in anaerobic respiration.
C) an increase in the burning of fossil fuels.
D) a decrease in cellular respiration.

21. According to the graph, the increase in CO₂ concentration, in parts per million, between 1970 and 1990 is closest to

A) 5 ppm
B) 25 ppm
C) 50 ppm
D) 340 ppm
22. Predict which of the graphs below best represents the global mean annual temperature on Earth from 1950-2000.
23. A student is asked to design an experiment aimed at determining whether or not the initiation of migratory behavior is largely under genetic control. Of the following options, the best way to proceed is to

A) observe different genetically distinct populations in the field and see if they have different migratory habits
B) perform within-population mating in a laboratory setting with birds from different populations having different migratory habits and determine if offspring display parental migratory behavior
C) bring birds into the laboratory and determine the conditions under which they become restless and attempt to migrate
D) perform within-population mating with birds from different populations that have different migratory habits and subsequently rear the offspring in the absence of their parents and observe offspring migratory behavior

24. If a fish farmer wanted to harvest his fish so that it recovered at the maximum rate, where should the population be maintained?

A) A
B) B
C) C
D) D
All of the following statements about the food web diagram above are correct EXCEPT:

A) All organisms, except grass are consumers.
B) The death of the snake would cause a collapse in the food web.
C) The mouse and grasshopper are at the same trophic level.
D) The grass is a producer.

Questions 10 and 11

The data shown below were collected in a laboratory experiment in which the effect of pH on the survival of water fleas (*Daphnia Pulex*) was examined. In each trial, 40 live water fleas were added to a solution with the pH as indicated. After two hours, observations were made to determine the number of fleas remaining alive in the sample. Results are presented in the table and in graphical form below.

<table>
<thead>
<tr>
<th>pH</th>
<th>Daphnia Remaining After Two Hours</th>
<th>Fraction of Daphnia Remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3.2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.5</td>
<td>24</td>
<td>0.6</td>
</tr>
<tr>
<td>7.4</td>
<td>32</td>
<td>0.8</td>
</tr>
<tr>
<td>8.5</td>
<td>28</td>
<td>0.7</td>
</tr>
</tbody>
</table>

26. The pH at which 50 percent of the *Daphnia* survive after 2 hours of exposure can be predicted from the data. This pH is closest to

A) 2.5  
B) 3.5  
C) 4.5  
D) 7.5

27. On the basis of the data, the best prediction of the pH of the water in which *Daphnia* normally are found in the wild

A) 3.0  
B) 5.0  
C) 7.0  
D) 9.0
28. Which of the following best represents a logical conclusion based on the data presented in this graph?

![Graph showing prey and predator populations over time]

A) The population of the prey is greater than that of predator.
B) There is no lag time between increases in both the predator and prey populations.
C) A decrease in the predator population results in a decrease of the prey population.
D) A decrease in the population of the prey results in an increase in the population of the predator.

29. Which of the factors below would best account for the regulation of the population that exhibits the growth pattern illustrated by the graph below?

![Graph showing population density and carrying capacity over time]

A) competition for food
B) competition for mates
C) competition for sunlight
D) competition for space after a fire

30. A species of malaria-carrying mosquito lives in a forest in which two species of monkeys, A and B, coexist. Species A is immune to malaria but species B is not. The malaria-carrying mosquito is the chief food for a particular kind of bird in the forest. If all of these birds are eliminated suddenly by hunters, which of the following would be the immediate observable consequence?

A) Increased mortality in monkey species A
B) Increased mortality in monkey species B
C) Emergence of malaria-resistant strains in monkey species B
D) Emergence of malaria-sensitive strains in monkey species A
31. Ramsey Island and Brady Island are equidistant from the US mainland. Ramsey Island is three times larger than Brady Island. Given this information, all of the following statements could be true EXCEPT

I. Brady Island can support larger populations than Ramsey Island.
II. Brady Island has more competition than Ramsey Island.
III. Brady Island is more likely to have greater habitat variation than Ramsey Island.

A) I only
B) II only
C) I and II only
D) I, II and III

32. In the graphs shown, the solid lines represent the original population of sheep from the years 1820-1940. Which graph has a dotted line that best represents the sheep population resulting from a sustained increase in the primary productivity of the environment?
Part B Directions: These three questions require numeric answers. Calculate the correct answer for each question, and enter your answer on the grid following each question. Examples of correct entry for the grid-in questions are shown below. The actual questions for this exam begin on the next page.
1. The biomass of a deciduous forest is 50% carbon. Additionally, the biomass increases annually at a rate of $2.7 \times 10^5$ kg/hectare. Calculate the mass of carbon accumulated and stored in 1.0 hectare of this forest in one year. Give your answer to the nearest hundred thousand (10^5) kilograms.

2. A population of glasswing butterflies exhibits logistic growth. The carrying capacity of the population is 200 butterflies, and $r_{max}$, the maximum per capita growth rate, of the population is 0.10 butterflies/(butterflies • month). Calculate the maximum population growth rate for the population if the maximum growth occurs when $N = k/2$. Give your answer to the nearest tenth.
3. According to atmosphere temperature and CO₂ concentration records derived from Antarctic ice cores, Earth’s climate has undergone significant changes over the past 200,000 years. Two graphs are shown above. The upper graph shows the variation in atmospheric CO₂ concentration, and the lower graph shows the variation in air temperature. Both graphs cover the same time period from approximately 200,000 years ago until 1950. Calculate the mean rate of change in atmospheric CO₂ concentration between 140,000 years ago and 125,000 years ago.