How population Change in size

Biology

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How population change in size: (Old Info)

- One pair of plants after 750 years = 19 million descendants (*Charles Darwin*)
- A group pf elephants do not exceed the limits of their environments

What is a population?

- All the members of a species live in the same place such as:
  - Certain kind of fish in a lake
  - Certain crop in an Ohio field
  - horses in Maryland

Population is a reproductive group.

The word population refers to:

1- The group in general

2- Size of population

3- The number of individuals

Properties of a population:

1- It may be described in terms of size, density or dispersion

2- ***Density*** is the number of individual per unit area or volume

3- ***Dispersion*** the relative distribution or arrangement of individuals within a given amount of space, It may be even, clumped or random

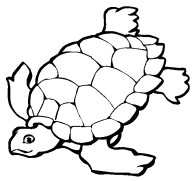
4- Knowing the previous info about a population enables us to predict changes within it.

How does a population change?

$$\text{Growth rate} = \text{births} - \text{deaths}.$$

- Growth rates can be negative, positive or even zero

How fast can a population grow?



Female sea turtle can lay 2000 eggs in its life time

If all of them survived the number of turtles will rapidly increase ***but they do not*** because only some of them survive.

Reproduction Potential:

Biotic potential *of a species: It is the fastest rate at which its population can grow. (It is limited by the reproductive potential).*

Reproductive potential *The maximum number of offspring that each member of the population can produce.*

According to Darwin: pair of elephants $\xrightarrow{750..years}$ *19 million descendants .*

A single bacterium $\xrightarrow{days}$ *19 million descendants*

Factors that effect reproductive potential:

1- *Some species reproduce more than others at the same time*
2- *Some species reproduce more often*
3- *Some species reproduce earlier than others*

Generation time: *the average time it takes a member of a population to reach the age of reproduction.*

- *Bacteria and some small organisms can reproduce in an age of few hours or days*
- *Large organisms such as elephants and humans have a long generation time (about 20 years in case of humans)*

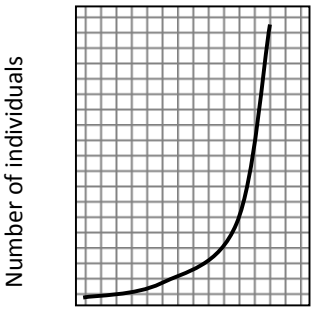
Exponential growth:

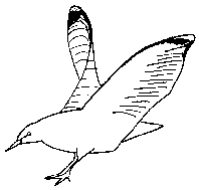
Exponential growth *Populations sometimes grow faster and faster*

2 dogs $\longrightarrow$ *6 dogs* $\longrightarrow$ *18 dogs* $\longrightarrow$ *54 dogs and so on like the graph bellow.*

Properties of Exponential growth

1- *It increases a larger No each succeeding time*
2- *Occurs in nature only if a population have a plenty of food and space*
3- *Examples: European dandelions and starlings when they were brought to USA.*
4- *Also bacteria and mold make a population explosion when they grow on a new source of food*





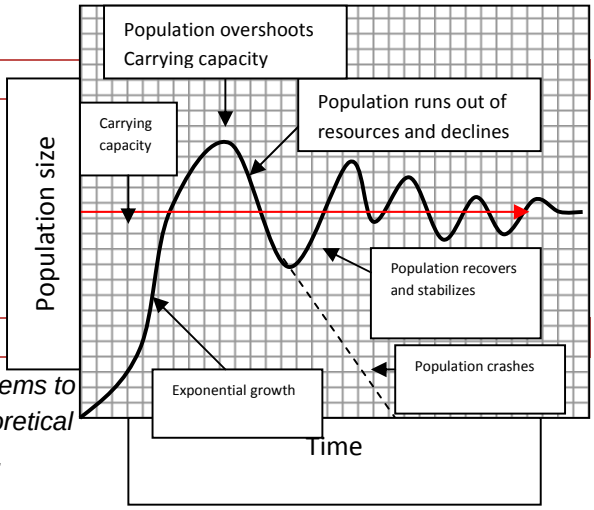
Starling

Dandelion

Bacteria

What limits population growth:

1- *Resources are used up*
2- *Environment changes*
3- *Death increases*
4- *Birth decreases*
5- *Natural selection*



Carrying capacity:

The curved line in the figure represents a population that seems to be limited to a particular size , the arrow represents the theoretical limits of that population and it is called the carrying capacity.

Carrying capacity:

The maximum population that the ecosystem can support ,
For sure population can increase beyond carrying
Capacity but it can't stay because an ecosystem changes

Example from Australia (Rabbits)

1- *Originally there were no rabbits in Australia*
2- *Rabbits were introduced in 1859*
3- *The Number increase rapidly because of*
   - **a.** *Plenty of food (vegetation)*
   - **b.** *No competition*
   - **c.** *No predators*
4- *Diseases and starvation caused the rabbit population to crash*
5- *Over time the vegetation recovered and rabbits population increased again*
6- *The population continued increase and decrease but less dramatically*

Resources limit:

1- *A species reaches the carrying capacity when it consumes natural resources = the resources produced by an ecosystem*
2- *IN that case we call the natural resources* **Limiting resources**

Examples: *plant growth is limited by:*

1- *water supplies*
2- *Sunlight*
3- *Mineral nutrients*

The supply of the most severely limited resources determines the carrying capacity of an environment for a particular species for a particular time.

Mathematical Environmental science

Given that Δ means change and N means population while t represents time and r is the rate of population growth in the relation $\frac{\Delta N}{\Delta t} = rN$

A- Complete the following table:

Year	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*
Starting pop.	***100***	***105***					
Births	*10*	*20*	*30*	*40*	*50*	*60*	*70*
Deaths	*5*	*10*	*15*	*20*	*25*	*30*	*35*
Ending pop	***105***						
Growth rate	*+5*						
% change	*5%*						

B- Translate the relation $\frac{\Delta N}{\Delta t} = rN$ *. Into English*

Competition within a population:

Example: *mealworm larva in a sac of flour, the 1st generation will lay eggs that will find plenty of food when they hatch while the 2nd generation will have less food due to limited amount of food (they will compete to have that food)* **Another Example;** *instead of direct competition members of a species may compete indirectly for social dominance or for a territory*

Territory *is an area defended by one or more individuals against other individuals.*

Importance of the territory:

1- *Space*
2- *shelter*
3- *food*
4- *breeding sites*

Two types of population regulation

Cause of death in a population may be

1- **Density dependent** (when the density increases the limiting factors such as limited resources, predation and diseases *cause a rate of death more than the abounded space) such as pine trees when they are close to each other they allow beetles to transmit disease.*
2- **Density independent** *a certain proportion of the species may die regardless the density due to sever weather or natural diseases (the winter storm may lead to the freezing of the crops).*
3- **What is the difference between lions in forest & in Zoo?**

In nature they are a part of food web, they feed on zebra, compete with hyena and fed upon by tics and fleas. This interaction is the cause of evolution.

An organism's Niche

Niche: *the unique role of a species in an ecosystem.*

The Niche includes:

1- *Physical home of the species*
2- *The environmental factors needed for survival*
3- *All the species interaction with other organisms*
4- *Function, role or job of a particular species in an ecosystem*

Habitat: *habitat of an organism is its location*

Difference between Niche and habitat: *A niche is an organism's pattern of using its habitat.*

Examples: *Bison occupy American herbivorous niche while Kangaroos do the same to Australian niche.*

Ways in which species interact:

Interaction	***Species A***	***Species B***	***Description***
Competition	***Harmed***	***harmed***	***Each one negatively affects the other***
Predation & parasitism	***benefited***	***harmed***	***A feeds on B***
Mutualism	***benefited***	***benefited***	***A & B help each other***
Commensalism	***benefited***	***Unaffected***	***A benefits B unaffected***

Interaction between species is categorized at the level where one population interacts with another. The five major types of species interactions are ***competition***, ***predation***, ***parasitism***, ***mutualism***, *and* ***commensalisms***..

Competition

1- *Seed-eating birds compete with each other for seed at a bird feeder,*
2- *Weeds compete for space in a sidewalk crack.*

3- *Competition is a relationship in which different individuals or population attempt to use the same limited resources.*
4- *Each individual has less access to the resource and so is harmed by the competition.*
5- *Competition can occur both within and between species.*
6- *Members of the same species must compete with each other because they require the same resources they occupy the same niche. When members of a different species compete, we say that their niches overlap, which means that each species uses some of the same resources in a habitat.*

Indirect competition

Species can compete even if they never come into direct contact with each other. Suppose that one insect species feed on a certain plant during the day and that another species feed on the same plant during the night. Because they use the same food source, the two species are indirect competitors. Similarly, two plant species that flower at the same time may compete for the same pollinators even if the plant do not compete in any other way. Humans rarely interact with the insects that eat our food corps, but those insects are still competing with us for food.

Adaptation to competition

When two species with similar niches are placed together in the same ecosystem, we might expect one species to be more successful than the other species. The better-adapted species would be able to use more of the niche. But in the course of evolution, adaptations that decrease competition will also be advantageous for species whose niches overlap.

One way competition can be reduced between species is by dividing up the niche in time or space. Niche restriction is when each species uses less of the niche than they are capable of using. Niche restriction is observed in closely related species that use the same resources within a habitat. For example two similar barnacles species compete for space in the intertidal zone of rocky shorelines. One of the species, cathamalus stellatus, is found only in the upper level of the zone when the other species is present. But when the other species is removed fro the area, C. stellaus is found at deeper levels, In the presence of a competition, the actual niche used by a species may be smaller than the potential niche. Ecologists have observed various other ways of dividing up a niche among groups of similar species.

Predation

An organism that feeds on another organism is called a predator, and the organism that is fed upon is the prey. This kind of interaction is called predation. Examples of predation include snakes eating mice, bats eating insects, or tory bird with its captured prey.

Predation is not as simple to understand as it seems. We may think of predators as meet eating animals, but there can be less obvious kinds of predators. In complex food webs, a predator may also be the prey of another species. Most organisms have evolved some mechanisms to avoid or defend against predators.

Some predators eat only specific types of prey. For example, the Canadian lynx feeds mostly on snowshoe hares during the winter. In this kind of close relationships, the sizes of each population tend to increase and decrease in linked patterns. However, many predators will feed on whichever type f prey is easiest to capture.

Parasitism

An organism that lives in or on another organism and feeds on the other organism is a parasite. The organism the parasite takes its nourishment from is known as the host. The relationship between the parasite and its host is called parasitism. Examples of parasites are tricks, fleas, tapeworms, heartworms, bloodsucking leeches, and mistletoe

Parasites are somewhat like predators. The differences between a parasite and a predator are that a parasite spends some of its life in or on the host, and that parasites do not usually kill their hosts. In fact, the parasite has an evolutionary advantage if it allows its host to live longer. However, the host is often weakened or exposed to disease by the parasite.

Mutualism

Many species depend on another species for survival. In some cases, neither organism can survive alone. A close relationship between two species in which each species provides a benefit to the other is called mutualism. Certain species of

bacteria in your intestines from a mutualistic relationship with you. These bacteria help break down food that you could not otherwise digest or produce vitamins that your body cannot make. In return, you give the bacteria a warm, food rich habitat.

Another case of mutualism happens in the ant acacia trees have spines that protect them against plant-eating animals, but the ant acacias have an additional protection – an ant species that lives only on these trees. The trees provide these ant shelter within hollow thorns as well as food sources in sugary nectar glands and nutrient-rich leaf tips. In turn, the ants defend the tree against herbivores and many other threats.

Commensalism

A relationship in which one species benefits and the other species is neither harmed or helped is called commensalisms. An example is the relationship between sharks and a type of fish called remoras, Remoras attach themselves to sharks and feed on scraps of food left over from the shark's meals. Another example of commensalisms is when birds nest in trees, but only if the birds do not cause any harm to the tree. Even a seemingly harmless activity might have an effect on another species.

Symbiosis and co evolution

A relationship in which two organisms live in close association is called symbiosis. Many types of species interactions are considered symbiotic in some cases. Symbiosis is most often used to describe a relationship in which at least one species benefits.

Over time, species in close relationships may coevolve. These species may evolve adaptations that reduce the harm or improve the benefit of the relationships. Recall that harm and benefit are measured in total effects over time. For example, coevolution can be see in the relationship of flowering plants and their pollinators. Many types of flowers seem to match the feeding habits of certain species of insects or other animals that spread pollen.

Questions

Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question.

____ 1. Thick fur on deer is *not* an example of co-evolution. Why?
a. because thick fur is an adaptation
b. because deer with thick fur live longer
c. because thick fur evolved in response to a cold climate, not in response to other organisms
d. because in the lowlands, where the climate was sunny and warm, deer that did not have thick fur became separated from other deer that did have thick fur

____ 2. An example of a population is
a. all trees in a forest.
b. all maple trees in a forest.
c. all plants in a forest.
d. all animals in a forest.

____ 3. The density of a population is
a. the number of individuals born every year.
b. the proportion of males and females.
c. the number of individuals living in cities.
d. the number of individuals per unit area.

____ 4. Each of the following is an example of a parasite *except*
a. a roundworm in a human's intestine.
b. a cow in a pasture.
c. a tick on a cat.
d. mistletoe on a tree.

____ 5. The relationship between a Canadian lynx and a snowshoe hare is an example of
a. parasite and host.
b. predator and prey.
c. competition.
d. mutualism.

____ 6. In which of the following relationships is neither species harmed?
a. predation
b. competition
c. parasitism
d. commensalism

____ 7. Which of the following populations has a random dispersion?
a. flock of flamingoes
b. pine trees in a pine forest
c. herd of bison
d. solitary snakes in a desert

____ 8. Which of the following would most likely cause a large number of density-independent deaths in a population?
a. winter storms
b. disease-carrying insects
c. predators
d. limited resources

____ 9. Which of the following organisms has the highest reproductive potential?
a. dogs
b. elephants
c. bacteria
d. humans

____ 10. A species of plant has exponential growth after it is introduced into an area where it has never lived. Which statement best describes exponential growth?
a. Each individual plant grows much larger than usual.
b. The population immediately decreases.
c. Within a few years the population increases dramatically.
d. The species' reproductive potential declines.

____ 11. The relationship between acacia trees and the ants that live on them is an example of
a. commensalism.
b. mutualism.
c. parasitism.
d. predation.

____ 12. The number of wild horses per square kilometer in a prairie is the horse populations

a. density.
b. dispersion.
c. size.
d. birth rate.

____ 13. A female dog's niche includes all of the following *except*
a. fleas that infest the dog.
b. the number of puppies the dog has.
c. how the dog protects its owners.
d. the neighbor's enclosed yard.

____ 14. If over a long period of time, each pair of adults in a population had only two offspring and the offspring lived to reproduce, the population would
a. grow.
b. shrink.
c. remain the same.
d. disperse randomly.

____ 15. Which of the following has the greatest effect on reproductive potential?
a. producing more offspring at a time
b. reproducing more often
c. having a longer life span
d. reproducing earlier in life

____ 16. A true statement about parasitism is that parasites
a. may cause their hosts to become more vulnerable to predators.
b. do not live on or in their hosts' bodies.
c. are always animals and never plants.
d. immediately kill their hosts.

____ 17. Which of the following is *not* an example of exponential growth?
a. rabbit populations after being introduced to Australia
b. reindeer of the Pribilof Islands after eating most of the lichens
c. a bank account that earns interest
d. mold appearing on bread overnight

____ 18. The carrying capacity of an environment for a particular species at a particular time is determined by the
a. number of individuals in the species.
b. distribution of the population.
c. reproductive potential of the species.
d. supply of the most limited resources.

____ 19. Which of the following statements explains why the growth of orchids on the high branches of tropical trees is an example of commensalism?
a. The orchids draw nourishment from the trees.
b. The trees are neither benefited nor harmed.
c. The orchids keep parasites away.
d. The trees receive nutrients from the orchids.

____ 20. Which of the following statements is *not* correct?
a. Mutualism is a type of symbiosis.
b. Yucca moths and yucca plants have a symbiotic relationship.
c. Symbiosis is a relationship in which two organisms live apart.
d. Coyotes and foxes are competitors because they feed on the same kinds of animals.

____ 21. Which of the following is one of the main properties used to describe a population?
a. number of individuals
b. color of individuals
c. number of species
d. kind of adaptations

____ 22. Which of the following statements is correct?
a. An organism's niche is only the part of its habitat that it eats.
b. An organism's habitat is a location.
c. Habitat and niche are the same thing.
d. An organism's niche is outside its habitat.

____ 23. Competition for food *cannot* occur
a. between two populations.
b. among members of the same population.
c. among populations whose niches overlap.
d. between animals from two different ecosystems.

____ 24. Which of the following reproductive situations will limit a population's biotic potential?
a. the minimum number of offspring each pair can produce
b. the maximum number of offspring each individual can produce
c. the number of interactions each individual has
d. the size of offspring each individual can produce

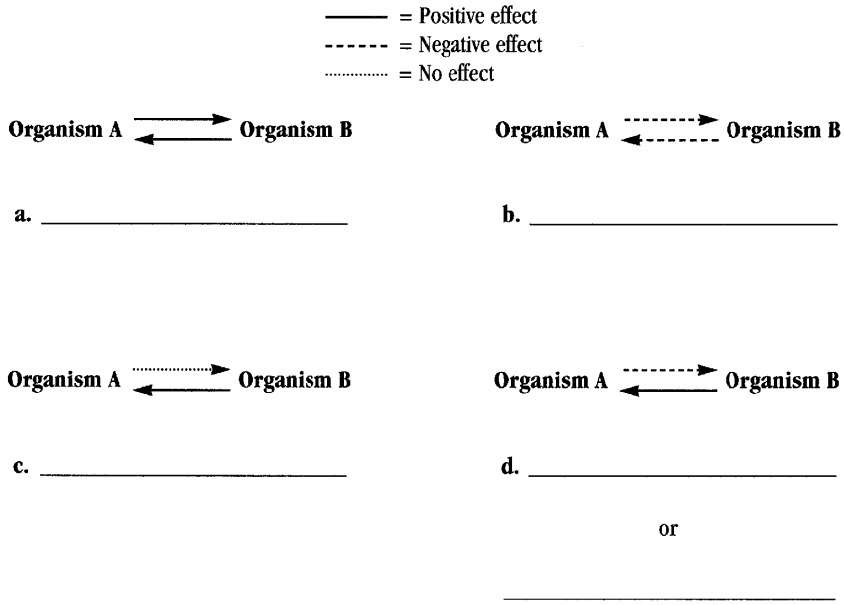
____ 25. The difference between a predator and a parasite is that a predator
a. usually kills and eats its prey.
b. benefits from another organism.
c. lives in or on a host.
d. harms another organism.

Completion
Complete each sentence or statement.

26. A population's _____ is usually described as even, clumped, or random.
27. A robin that does not affect the tree in which it nests is an example of _____.
28. If two species use the same food source at different times, they are _____ competitors.
29. Unlike a predator in relation to its prey, a parasite does not usually _____ its host.
30. The average age at which members of a species reproduce is that species' _____.
31. The maximum number of offspring that each member of a population can produce is the population's _____.
32. The three main properties used to describe a population are _____, _____, and _____.
33. The _____ of an ecosystem for a particular species is the maximum population that the ecosystem can support indefinitely.
34. The amount of food available for wolves in an area determines the ecosystem's carrying capacity for wolves and is a(n) _____ resource for wolves.
35. Members of a species compete indirectly for resources by competing for a(n) _____ and for social dominance.
36. A population's _____ is the number of its members per unit area or per volume.
37. Deaths that are caused by a disease spreading through a population are _____ dependent.
38. A species' _____ includes that species' physical home, the environmental factors necessary for that species' survival, and all its interactions with other organisms.
39. A type of interaction between two species in which both species are harmed is _____.
40. Niche _____ is when each species uses less of the niche than it is capable of using, in order to reduce competition for resources with other species.
41. The organisms in a cow's stomach have a constant source of food; the organisms help the cow break down and use the grass it eats. This type of relationship is an example of _____.
42. A population's growth rate is its _____ rate minus its _____ rate.
43. The type of interaction between cats and mice is _____.
44. A liver fluke is a(n) _____ that harms its host as it obtains food.

45. A(n) _____ usually only weakens its host, while a(n) _____ usually kills its prey.
46. A relationship in which two organisms live in close association, such as mutualism and commensalism, is called _____.
47. If a pair of mice finds a place to live with plenty of food and no predators, the population of mice will probably undergo _____ growth.
48. Over a long period of time, two species can develop adaptations that increase the benefit of their relationship in the process of _____.
49. A population has a(n) _____ growth rate when the death rate is higher than the birth rate.

Short Answer



50. The diagrams above show four different types of interactions between species. An arrow pointing from one organism to another means that the first organism has an effect on the second organism. Label each diagram with the correct type of interaction.
51. The cardon and organ-pipe are flowering cacti that depend on bats for pollination. The bats pollinate the cacti as they eat the nectar in cacti's flowers and spread seeds when they eat the cactus fruit. Studies of the cacti show that they are not producing as much fruit as they could. It was also noted that bats living near these cacti had been driven from their cave homes by local villagers. What is the relationship between the bats and the cacti? How did the reduction in the number of bats affect the cacti?
52. Termites live almost exclusively on wood but cannot actually digest it themselves. Instead, they must depend on certain protozoa (single-celled organisms) that live in their gut to break down the wood into nutrients their body can use. In return, the termites provide an appropriate environment to sustain the protozoa. What is the relationship between the termites and the protozoa? How is this relationship similar to the one between humans and intestinal bacteria?
53. If a population of rabbits experiences exponential growth, what might happen to the population of coyote in the area. Explain your reasoning.

54. Predict what might happen to the population of rabbits and coyote if the rabbits exceed the carrying capacity of the environment. Explain your reasoning.
55. Choose any two species with a close relationship that might have coevolved adaptations and describe how the adaptations benefit both species.
56. Construct a table that compares and contrasts a parasite and a predator.
57. Explain how two species can compete for the same resource even if they never come into contact with each other.
58. Choose two populations and compare them in terms of size, density, and dispersion.
59. List three reproductive behaviors of individual members of a species that affect the reproductive potential of a species. Which one of the three behaviors has the greatest effect on reproductive potential?
60. What are three density-dependent causes of death in a population? What are two density-independent causes of death?
61. Choose an organism and give examples of parts of its niche. What is the difference between its niche and its habitat?
62. Give two examples of species that have the same habitat as hawks but different niches.
63. Aphids obtain the nutrients they need by sucking on the juices of host plants. This will later weaken the plants. What type of relationship do aphids and their host plants have? Explain your answer.

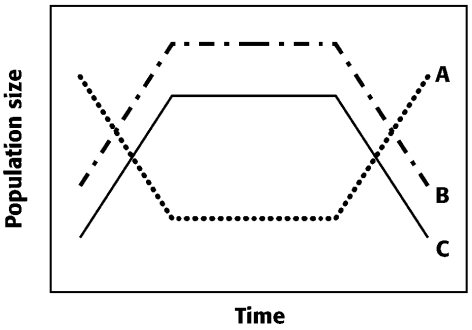
Problem

64. Zebra mussels were accidentally imported to the Great Lakes from Europe in the 1980s. (They were stowaways on cargo ships.) These small mollusks have no natural enemies in the United States. Zebra mussels multiply quickly and attach themselves permanently to anything—fish, boats, rocks, pipes, buoys, or other zebra mussels! Huge water intake pipes for cities have been clogged, channel markers sunk, and marine engines damaged by the mussels. How could zebra mussels be eliminated from the Great Lakes?
65. Viruses are the cause of many infectious diseases, such as common colds, flu, and chickenpox. Viruses can be passed from one person to another in many different ways. Under what conditions do you think viral diseases will spread most rapidly between humans? What can be done to slow the spread of these viruses?

Essay

66. Imagine that one species no longer exists, or becomes extinct, immediately after the extinction of another species. Which relationship did the two species more likely have, competition or commensalism? Explain your reasoning.

Population Size of A, B, and C Over Time



67. Examine the graph above. Each line represents a different species. What type of interaction could be occurring between species A and B? Between B and C? Explain the reasoning behind each of your answers.

ch8
Answer Section

MULTIPLE CHOICE

1. ANS: C
2. ANS: B
3. ANS: D
4. ANS: B
5. ANS: B
6. ANS: D
7. ANS: D
8. ANS: A
9. ANS: C
10. ANS: C
11. ANS: B
12. ANS: A
13. ANS: D
14. ANS: C
15. ANS: D
16. ANS: A
17. ANS: B
18. ANS: D
19. ANS: B
20. ANS: C
21. ANS: A
22. ANS: B
23. ANS: D
24. ANS: B
25. ANS: A

COMPLETION

26. ANS: dispersion
27. ANS: commensalism
28. ANS: indirect
29. ANS: kill and eat
30. ANS: generation time
31. ANS: reproductive potential
32. ANS: size, density, dispersion
33. ANS: carrying capacity
34. ANS: limiting
35. ANS: territory
36. ANS: density
37. ANS: density
38. ANS: niche

39. ANS: competition
40. ANS: restriction
41. ANS: mutualism
42. ANS: birth, death
43. ANS:
    predation
    predator-prey
44. ANS: parasite
45. ANS: parasite, predator
46. ANS: symbiosis
47. ANS: exponential
48. ANS: coevolution
49. ANS: negative

SHORT ANSWER

50. ANS:
    a. mutualism
    b. competition
    c. commensalism
    d. predation, parasitism
51. ANS:
    The relationship between the bats and cacti is mutualism; the bats eat the nectar in cacti's flowers and spread pollen and seeds. With a decreased bat population, flowers will go unpollinated and fruit will go uneaten, reducing the number of opportunities for the cactus plants to reproduce.
52. ANS:
    The relationship between the termites and protozoa is mutualism—the termites receive nutrients in a usable form and the protozoa gain a hospitable environment. This relationship is similar to the one between humans and intestinal bacteria. Like the protozoa, the bacteria in human intestines break down some types of food that humans would otherwise be unable to digest. In return, humans provide a suitable environment for the bacteria, as do the termites for the protozoa.
53. ANS:
    Answers may vary. Sample answer: The population of coyote might also experience exponential growth. The coyote are predators of rabbits and would have an abundant source of food as the rabbit population grows at an increasingly faster rate. With plenty of food available, more coyotes would survive to reproduce.
54. ANS:
    Answers may vary. Sample answer: As the rabbits exceed the carrying capacity, they will run out of resources. Starvation and possibly diseases will severely reduce the population of the rabbits. The coyote will have less food available and their population will decline unless they find another food source.
55. ANS:
    Answers may vary. Sample answer: A species of plant with red, tubular flowers and a species of hummingbird with long beaks may have coevolved. The hummingbird benefits by being attracted to the flowers where it finds an exclusive source of food. The plant benefits when the hummingbird pollinates the flowers it visits.
56. ANS:
    Tables may vary, but should contain the idea that a parasite and predator are similar in that they benefit by obtaining resources while another species is harmed. They differ in that a parasite has a host that it lives in or on. Parasites may weaken their host but usually do not kill it to get the resource they need. Predators kill their prey to get food.

57. ANS:
Species can compete over time or space without meeting by utilizing the same resource at different times, such as one species of insect feeding on a plant during the day and another species of insect feeding on the same plant at night. Or, two species of plants that flower at the same time may be in competition for pollinators.
58. ANS:
Answers may vary. Sample answer: A population of Canada geese is often made up of a large number of individuals (size) in a small area such as a lake (density), while a population of redheaded woodpeckers is made up of a few individuals in each of several forested areas. The geese have a clumped dispersion and the woodpeckers have an even dispersion based on territories.
59. ANS:
producing more offspring at a time, reproducing more often, reproducing earlier in life. Reproducing earlier in life has the greatest effect.
60. ANS:
limited resources, predation, and disease; severe weather, natural disasters
61. ANS:
Answers may vary. Sample answer: A niche includes a species' physical home, environmental factors for its survival, and its interaction with other organisms. A habitat describes the location where it lives. Parts of a pet dog's niche include its food and water, where it sleeps, other animals it chases, and its role as a family pet. The dog's habitat may be a residential neighborhood, as opposed to a forest.
62. ANS:
Answers may vary. Sample answer: rabbits, snakes
63. ANS:
Parasitism; the aphids feed on the juices without immediately killing the plant.

PROBLEM

64. ANS:
Answers may vary. Sample answer: The European practice of introducing the natural predators of zebra mussels into their habitat could be explored to see if it could be used effectively in the United States.
65. ANS:
Answers may vary. Sample answers: Viruses are density dependent and will spread most rapidly in crowded conditions. The spread of viruses could be slowed by having healthy people avoid crowded conditions and by having people with the viruses stay home.

ESSAY

66. ANS:
Commensalism; if the organisms were competing for resources, then the extinction of one would make more resources available for the other; thus, the other should thrive. If species A derives benefit from species B and species B becomes extinct, then species A might also become extinct.
67. ANS:
The populations of species A and B fluctuate in an opposite (inverse) manner, suggesting competition in which one species monopolizes available resources. Alternatively, species A might prey on B (predation). Thus, as the number of predators (A) diminishes, the number of prey (B) would rise. Then as A increases consumption of B, the population size of A would increase and the size of B would diminish. The population sizes of B and C fluctuate together (in synchrony), which could indicate mutualism, or alternatively, a highly specialized type of parasitism or predation.