

Chapter 1: Introduction: Ecology, Evolution, and the Scientific Method

Ecological systems exist in a hierarchical organization

MULTIPLE CHOICE

1. Topic: studying ecology at different levels of organization

Level: easy

Which ecological level would be of most interest to an ecologist studying adaptations?

- a. ecosystem
- b. population
- c. individual
- d. community
- e. biosphere

Answer: c

2. Topic: populations and species

Level: easy

Which of the following is NOT a property used in the study of populations?

- a. density
- b. change in size
- c. composition
- d. relative abundance

Answer: d

3. Topic: studying ecology at different levels of organization

Level: easy

Which level of ecological hierarchy includes the movement of water and air?

- a. community
- b. population
- c. ecosystem
- d. biosphere

Answer: d

4. Topic: populations and species

Level: easy

A group of organisms that interbreed in nature and produce fertile offspring is called

- a. a population.
- b. a species.
- c. a community.
- d. a prokaryote.

Answer: b

5. Topic: introduction

Level: easy

Who gave the word *ecology* its current broad meaning?

- a. the German zoologist Ernst Haeckel
- b. the English naturalist Charles Darwin
- c. the Swedish botanist Carl Linnaeus
- d. the American ecologist Rachel Carson

Answer: a

6. Topic: ecosystem

Level: easy

The boundaries of communities are

- a. difficult for species to cross.
- b. flexible.
- c. clear and distinct.
- d. never overlapping.

Answer: b

7. Topic: studying ecology at different levels of organization

Level: medium

Which is the correct hierarchy of ecological systems, starting at the most general?

- a. ecosystem, biosphere, community, population, individual
- b. individual, community, population, ecosystem, biosphere
- c. individual, population, ecosystem, biosphere, community
- d. individual, population, community, ecosystem, biosphere
- e. biosphere, community, ecosystem, population, individual

Answer: d

8. Topic: introduction

Level: easy

The word *ecology* is derived from the Greek *oikos*, which means

- a. world.
- b. ocean.
- c. house.
- d. origin.

Answer: c

9. Topic: ecosystems

Level: easy

Which of the following systems is composed of assemblages of organisms together with their physical and chemical environments?

- a. organism
- b. population
- c. community
- d. ecosystem

e. biosphere

Answer: d

10. Topic: studying ecology at different levels of organization

Level: medium

An ecologist who studies populations would most likely be interested in

- a. adaptations that help individual organisms live in their environment.
- b. births and deaths of individuals belonging to a particular species in a particular place.
- c. the number and relative abundances of species living in a particular place.
- d. physical and chemical transformations of energy and materials in the soil, atmosphere, and water.
- e. transport of energy and materials at the global scale.

Answer: b

SHORT ANSWER

11. Topic: communities

Level: medium

Explain how studying a community can provide insight into population changes.

Answer: Many species' interactions play a part in birth and death rates of populations, such as any species that relies on another for food. Understanding these relationships is often essential to understand why a population is growing or shrinking.

12. Topic: populations and species

Level: medium

Explain how the definition of *species* has become more complicated. Give an example.

Answer: Although species were originally considered to be defined as organisms that could interbreed and produce fertile offspring, exceptions continue to be found. For example, prokaryotic organisms can transfer DNA to each other in horizontal gene transfer. This makes it hard to have a clear difference between species, since they can easily share DNA but are varied enough that they cannot be considered one species.

Ecological systems are governed by physical and biological principles

MULTIPLE CHOICE

13. Topic: conservation of matter and energy

Level: easy

The first law of thermodynamics states that

- a. life requires energy to be continually added to Earth.
- b. matter cannot be created or destroyed.

- c. when energy changes form, some energy is lost.
- d. energy cannot be created or destroyed, but only change form.

Answer: d

14. Topic: dynamic steady states

Level: easy

In a dynamic steady state

- a. there are no inputs or outputs to the system.
- b. the second law of thermodynamics does not apply.
- c. there is no net change in the system.
- d. the system will continue to grow.

Answer: c

15. Topic: evolution

Level: medium

In evolution by natural selection, which of the following is true?

- I. Individuals have varied traits.
- II. Some individuals have higher fitness because of their traits.
- III. Some traits cannot be passed on to the offspring.

- a. I only
- b. I and II only
- c. I and III only
- d. II and III only
- e. I, II, and III

Answer: b

16. Topic: evolution

Level: medium

How can species interactions increase the rate at which species evolve?

- a. Interactions reduce the effects of natural selection.
- b. Interactions increase the fitness of all individuals.
- c. Interactions make specialized traits more useful.
- d. Interactions reduce the genetic variety in individuals.

Answer: c

17. Topic: evolution

Level: easy

A phenotype is

- a. the traits an individual can pass on to its offspring.
- b. the expression of an individual's traits.
- c. an adaptation that increases fitness.
- d. a trait caused by interaction with another species.

Answer: b

18. Topic: dynamic steady state
Level: medium

To maintain a dynamic steady state in a community, which two factors must balance?

- a. new species and species extinctions
- b. immigration and emigration
- c. births and deaths
- d. food consumed and energy expended

Answer: a

19. Topic: evolution
Level: medium

At what ecological level does evolution occur?

- a. individual
- b. population
- c. ecosystem
- d. community
- e. biosphere

Answer: b

SHORT ANSWER

20. Topic: dynamic steady state
Level: medium

How might one hierarchical level that is not in steady state affect the hierarchical level above?

Answer: At the individual level not being in steady state could mean that the organism could not find enough food to meet its energy requirements, reducing its fitness. If this continues across multiple individuals, the birth rate could decrease and the death rate could increase, making the population go out of equilibrium as well.

21. Topic: dynamic steady state
Level: medium

Many warm-blooded organisms must maintain a constant temperature that is commonly warmer than its surroundings. What is the cost associated with maintaining the dynamic steady state, and how is this cost met?

Answer: To maintain a system in disequilibrium with its environment requires expenditure of energy. A warm-blooded animal in cold surroundings must acquire food and use the metabolic energy released from that food to maintain its temperature higher than that of its surroundings.

22. Topic: evolution
Level: difficult

How might the use of pesticides to control insects that feed on wheat affect how the insects evolve?

Answer: If some insects survive the initial application, they are relatively resistant to the chemical. The surviving insects could pass on that trait to the next generation. Over time, the insect species will evolve to be resistant to the pesticide.

23. Topic: conservation of matter and energy
Level: difficult

The law of conservation of matter states that matter cannot be destroyed. Why, then, are we concerned about the depletion of resources?

Answer: Although matter cannot be destroyed, it can be transformed into forms that are not useful or that are difficult to use.

Different organisms play diverse roles in ecological systems

MULTIPLE CHOICE

24. Topic: broad evolutionary patterns
Level: easy

Eukaryotic organisms are distinguished by their

- a. inability to photosynthesize.
- b. chloroplasts.
- c. mitochondria.
- d. single-cell structure.

Answer: c

25. Topic: broad evolutionary patterns
Level: easy

Blue-green algae are

- a. protists.
- b. bacteria.
- c. plants.
- d. fungi.

Answer: b

26. Topic: categorizing species based on sources of energy
Level: easy

Organisms that use photosynthesis or chemosynthesis are

- a. autotrophs.
- b. consumers.
- c. heterotrophs.
- d. herbivores.

Answer: a

27. Topic: types of species interaction

Level: easy

Which interaction is characterized by negative effects for both species?

- a. predation
- b. herbivory
- c. commensalism
- d. competition

Answer: d

28. Topic: types of species interaction

Level: medium

The relationship between a burdock plant and a fox is

- a. competition.
- b. herbivory.
- c. predation.
- d. parasitism.
- e. commensalism.

Answer: e

29. Topic: categorizing species based on sources of energy

Level: easy

A mixotroph is an organism that

- a. consumes dead organic matter.
- b. can be both a parasite and a predator.
- c. survives only because of a symbiotic relationship.
- d. can use multiple methods to obtain energy.

Answer: d

30. Topic: habitat versus niche

Level: easy

The range of biotic and abiotic conditions a species can tolerate is its

- a. community.
- b. habitat.
- c. niche.
- d. ecosystem role.

Answer: c

31. Topic: broad evolutionary patterns

Level: easy

Hyphae are structures found in

- a. plants.
- b. animals.
- c. fungi.
- d. protists.

Answer: c

32. Topic: types of species interactions

Level: easy

Which consumes decomposing organic matter?

- a. detritovore
- b. herbivore
- c. parasite
- d. predator
- e. parasitoid

Answer: a

33. Topic: broad evolutionary patterns

Level: easy

Which evolved first?

- a. plants
- b. fungi
- c. protists
- d. bacteria

Answer: d

34. Topic: types of species interactions

Level: medium

What pair of species would you expect to be commensalistic?

- a. owls and oak trees
- b. fruit bats and herons
- c. rats and foxes
- d. algae and kelp

Answer: a

35. Topic: types of species interaction

Level: easy

There are many examples in nature of cooperation among organisms, such as the bacteria that inhabit the root nodules of leguminous plants. Partnerships between organisms that live in close association are called

- a. networks.
- b. communities.
- c. symbioses.
- d. ecosystems.

Answer: c

SHORT ANSWER

36. Topic: habitat versus niche

Level: medium

Why are two species unable to share exactly the same niche?

Answer: If two species have the same niche, they will be competing for the same resources in the same place. While both species might survive for a brief period, eventually the better competitor will force the other species to adapt to a different niche where it can more easily survive and reproduce.

37. Topic: broad evolutionary patterns

Level: difficult

Plants and animals exchange energy and materials with their physical environments. These exchanges occur across surfaces. In animals, surfaces tend to be internal, while in plants, surfaces tend to be external. Discuss the principal reason for this important difference.

Answer: Animals obtain energy from foods they consume. This absorption is best accomplished internally, where foods can be subjected to conditions that release molecules to be taken up across large areas of absorptive structures. Most plants obtain energy from sunlight. They must expose relatively large external absorptive surfaces (typically leaves) to sunlight to obtain this energy, which makes internal absorption impractical.

38. Topic: broad evolutionary patterns

Level: medium

Why are protists suited for symbiotic relationships with other species?

Answer: The small size of most protists makes it easy for them to live inside other larger species. In symbiotic relationships the diverse nature of protists has led to specialized adaptations that can be very useful to other organisms. An example of this is the protists that live in the gut of termites and break down cellulose. In exchange the host organism provides a relatively stable environment for the protists, reducing the energy required to survive.

Scientists use several approaches to studying ecology

MULTIPLE CHOICE

39. Topic: observations, hypotheses, and predictions

Level: easy

An ultimate hypothesis

- a. explains how an organism has adapted its physiology.
- b. addresses an organism's response to the environment.
- c. has been tested and revised.
- d. is a prediction about how an organism might adapt in the future.

Answer: b

40. Topic: testing hypotheses with manipulative experiments

Level: easy

What method is used to increase experimental reliability?

- a. replication
- b. proximate hypotheses
- c. natural experiment
- d. mathematical models

Answer: a

41. Topic: testing hypotheses with manipulative experiments

Level: easy

An experimental control is

- a. an experiment performed on randomly selected samples.
- b. a manipulation without the factor of interest.
- c. a manipulation using natural conditions.
- d. a sample size that is large enough to accurately reflect the variance.

Answer: b

42. Topic: observations, hypotheses, and predictions

Level: easy

Which is the best action if an experiment does not support a hypothesis?

- a. Create a mathematical model.
- b. Revise the hypothesis.
- c. Test the hypothesis again.
- d. Publish your results.

Answer: b

43. Topic: alternative approaches to manipulative experiments

Level: easy

Ecologists using global carbon-balance models were overestimating the rate of increase of atmospheric carbon dioxide. This discovery led these ecologists to

- a. discard their models.
- b. switch to modelling other phenomena.
- c. conclude that increase in atmospheric carbon dioxide is not a serious environmental problem.
- d. search for evidence of other carbon dioxide sinks in the global cycle of carbon.

Answer: d

44. Topic: observations, hypotheses, and predictions

Level: easy

Most scientific investigations begin with a set of facts about nature. These facts are obtained by

- a. observation and description.
- b. development of mathematical models.
- c. development of hypotheses.
- d. experimental testing of hypotheses.

Answer: a

45. Topic: observations, hypotheses, and predictions

Level: easy

The formulation of hypotheses is a critical step in the scientific process. In the simplest terms, what is an hypothesis?

- a. an explanation
- b. an experiment
- c. an observation
- d. a proven fact

Answer: a

46. Topic: testing hypotheses with manipulative experiments

Level: easy

Because it is difficult to experiment on large ecological systems, researchers often replicate the essential features of a system in smaller, simplified laboratory or field settings known as

- a. microcosms.
- b. approximate systems.
- c. natural treatments.
- d. experimental units.

Answer: a

SHORT ANSWER

47. Topic: alternative approaches to manipulative experiments

Level: medium

Explain the potential difficulties of using a natural experiment to test a hypothesis.

Answer: Since a natural experiment relies on existing conditions, it can be difficult to find enough suitable sites to gather sufficient data. The inherent variation in natural systems makes it difficult to isolate the desired variable in the less controlled environment.

48. Topic: testing hypotheses with manipulative experiments

Level: difficult

A scientist hypothesizes that the larvae of a particular species of swallowtail butterfly uses olfaction (the sense of smell) to locate their preferred host plants in the carrot family. To test the hypothesis, the scientist uses extracts from various plants—including some from the carrot family—to moisten small pieces of paper arranged randomly under a wire screen. Swallowtail larvae are released on the wire screen but cannot come into direct physical contact with the pieces of paper. What is the advantage of this experiment compared with simply presenting the larvae with a choice among various plants?

Answer: The scientist wants to vary the volatile chemicals presented to the larvae without giving the larvae other cues to the identity of the plants from which these chemicals are extracted. Since all of the pieces of paper look alike, the scientist can eliminate the possibility that the larvae use visual cues to recognize the pieces of paper moistened with extracts from plants in the carrot family. Separating the larvae from the pieces of paper ensures that the larvae cannot use their sense of taste.

49. Topic: observations, hypotheses, and predictions

Level: difficult

Scientists ask questions about how the natural world works. These can usually be classified as how questions or why questions. A scientist observes that an owl species can fly silently. Give an example of a how and a why question that the scientist might study and what the differences would be.

Answer: One possible question is how the owls can fly so quietly, which would mean studying the structure of the wings and feathers and how they differ from those of other birds. Another question would be why it is advantageous for the owls to fly silently; for example, what prey this allows the owl to catch that it might not be able to catch otherwise.

Humans influence ecological systems

MULTIPLE CHOICE

50. Topic: Humans influence ecological systems.

Level: easy

Which of the following has NOT caused increased habitat destruction?

- a. biofuel use
- b. the pet trade
- c. growing populations
- d. cactus harvesting

Answer: b

51. Topic: humans influence ecological systems

Level: medium

If you wanted to understand the impact of an introduced species on existing species in an area, what ecological level should you examine?

- a. population
- b. individual
- c. community
- d. biosphere

Answer: c

SHORT ANSWER

52. Topic: Humans influence ecological systems.

Level: medium

Explain why a species with a very limited niche is particularly susceptible to human influences.

Answer: With a narrow niche a species has small range of conditions in which it can survive and reproduce. As humans continue to destroy habitat and change ecosystems, smaller niches may be eliminated entirely, causing the species to adapt or go extinct.

53. Topic: the role of ecologists
Level: medium

Explain the role of ecology in efforts to reduce the damage humans do to the environment.

Answer: Our ability to manage human impact on global systems depends on understanding the structure and function of ecosystems.

54. Topic: the role of ecologists
Level: medium

Describe one specific successful solution to an environmental problem caused by human activity.

Answer: There are multiple possible answers for this. For example, one might discuss efforts made to save endangered species from extinction, like captive breeding and reintroduction.

Why Do We Calculate Means and Variances?

MULTIPLE CHOICE

55. Topic: means and variances
Level: easy

What is the mean of these data: 22, 19, 34, 24, 27, 20?

- a. 24
- b. 144
- c. 23
- d. 26.5

Answer: a

56. Topic: means and variances
Level: easy

If the number of fruits on 10 strawberry plants is sampled and $E[\chi]$ is found to be 6 and $E[\chi^2]$ is 38, what is the sample variance?

- a. 32
- b. 2
- c. 2.2
- d. 35.5
- e. 6.3

Answer: c

57. Topic: means and variances
Level: medium

Which would be the most informative about the reliability of data gathered in an experiment?

- a. low mean
- b. high mean
- c. low variance
- d. high variance

Answer: c

SHORT ANSWER

58. Topic: mean and variances

Level: medium

Explain why the sample variance is larger than the variance of the mean, especially for small samples.

Answer: The sample variance is larger than the variance of the mean because the smaller the sample, the less reliable the results. Thus for a small sample the sample variance multiplier of $\frac{n}{n-1}$ is larger than for large samples.

Connecting the Concepts: the California Sea Otter

MULTIPLE CHOICE

59. Topic: the California sea otter

Level: easy

Fishermen living along the North Pacific Rim felt threatened by increased populations of sea otters because sea otters consume commercially valuable abalone, sea urchins, and spiny lobster. What beneficial aspect of sea otter ecology did these fishermen ignore?

- a. Sea otters are consumed by killer whales, which would otherwise eat commercially valuable fish.
- b. Sea otters catch and eat trash fish, allowing stocks of commercially valuable fish to increase.
- c. Sea otters catch and eat sea urchins, thereby protecting kelps, which in turn shelter populations of larval fish.
- d. Sea otters have been used in medical research to develop vaccines that protect domestic cats from a variety of diseases.

Answer: c

SHORT ANSWER

60. Topic: the California sea otter

Level: medium

Use the example of the California sea otter to explain why ecologists must study multiple hierarchical levels to understand most environmental problems.

Answer: One part of the sea otter story that illustrates this is the population loss due to killer whales. The food preferences of the whales had to be understood (on the individual level), but so did the community and ecosystem interactions between lower seal and sea lion populations due to low fish populations, which drove killer whales to find new food sources.