Unit 2 Review Answers

Student Textbook pages 148–151

Answers to Understanding Concepts Questions

1. A population is a group of individuals from the same species, occupying a defined area, and sharing a common gene pool.
2. Ecology is the study of the interactions of organisms amongst themselves, and with other species. It is also a study that observes how different organisms interact with their physical environments. It is a study of the interdependence and interconnectedness of both the abiotic and biotic factors within ecosystems.
3. If all of the predators were eliminated from an ecosystem, this would cause a population explosion among the prey species until the prey species reached or exceeded the carrying capacities for their environment. Then their reproductive rates would slow down to a sustainable level: or, if they had exceeded the carrying capacity, they would suffer a population crash.
4. Organisms are not randomly or evenly distributed across the planet because for an organism to survive, the biotic and abiotic factors must be present to support its existence. The right combinations of abiotic and biotic factors for different species are isolated in different geographical ranges across the planet. Different regions will support different species because of the differences in abiotic and biotic factors.
5.

Abiotic Factors	Effects on the Pond Ecosystem
Temperature	The deeper regions of the pond will be cooler and will support different plant and animal species than the shallower regions.
Light	Plants will be able to exist within the shallower waters, but as the water becomes deeper, the amount of available light for the plants becomes less and less. This would limit the amount of photosynthesis.
Precipitation	Depending on how the water flows as it enters the pond, some areas may flood over, and others may become silty from the eroded soil entering the water. Not all animals or plants would be able to occupy these areas. This could also change the vertical stratification of the pond water.

Abiotic Factors	Effects on the Pond Ecosystem
Nitrogen and Phosphorous	These elements, when limited in amounts, control the amount of plant growth possible.

6. A scavenger is an animal that feeds upon dead animals or garbage. Biotic factors that would limit the scavenger's population size include prey density for predators and the success of the predators in killing their prey. Another biotic limiting factor would be the number of scavengers competing for the dead organisms within the environment. Too much competition will limit their population sizes. As well, abiotic factors such as drought, floods, and natural disasters could rapidly change the number of dead organisms to be fed upon. The scavengers' populations may crash over time, as the number of animals occupying the ecosystem has rapidly dropped.

7. An example of (a) a biome is the northern boreal forest (taiga). (b) One ecosystem within this biome is a tract of coniferous forest. (c) Within this forest ecosystem, the community includes such animals as deer, bears, elk, wolves, spruce trees, shrubs and many other species.

8. Order is higher on the hierarchy of classification. The lower levels branch out from the higher levels, so two species of the same *family* must also be in the same *order*.

9. (a) An example of an abiotic factor that limits population growth is the availability of sunlight for plants. As the plant density increases within an ecosystem, competition emerges for sunlight, and eventually the ones that cannot compete for their needed amounts of sunlight will die off.

(b) An example of a biotic factor that can limit population growth is a predator/prey relationship. As the number of predators increases within an area, there is a subsequent decrease in the prey population. As the prey population begins to decrease, so does the population of predators.

10. Regular population cycles of mice and squirrels are dependent on both abiotic and biotic factors. Their population cycles could be regulated by biotic factors such as intraspecific and interspecific competition, predation, or parasitism. Abiotic factors that could impact on the population cycles of these animals could be the amount of precipitation, drastic temperature changes, or natural disasters such as a forest fire in the area.

11. The range of a species can be described as the city it lives in. The range is the habitat that the species is able to live in successfully.

12. An example is the Grizzly Bear. Its population growth can be limited by many factors such as the availability of mates, territory, and food. Human activities such as hunting, collisions with vehicles and trains, and continued community development within the bear's natural habitat can also limit the growth the of bear population.

13. Possible student answers include the following: A population of a species in a field could compete for things such as: territory for habitat and mating; access to limited food supplies; limited access to mates; access to water and other abiotic limiting factors such as sunlight and suitable temperature environments.

14. For evolution to occur, both physical diversity (including adaptive traits) and genetic diversity are necessary. As changes occur in the environment, some individuals will have a selective advantage within a population as compared to the others; this advantage will allow them to reproduce more successfully and allow for the more "fit" adaptations and their supporting genes to be passed on. Without diversity, the population would only be able to survive if it was a static environment.

15.
- Structural adaptations are an organism's physical features, for example, the bills of varying lengths and design on birds or hair on mammals such as bears.
- Physiological adaptations are adaptations of the metabolic processes of an organism. For example, a warm-blooded organism can survive in different environments than a cold-blooded one.
- Behavioural adaptations are behaviours that an organism uses to survive. This could include hibernation or migration.

16. The bat wing and butterfly wing are considered to be analogous structures. They both serve a very similar function but were derived by similar needs in an environment, not from a common ancestor.

17. Individuals in a population cannot change their genetic makeup and do not change even if local environmental conditions change. However, it is unlikely that all of the individuals in a population will be killed or adversely affected by this environmental change. These individuals will pass on the traits (genes) that enabled them to survive the changing conditions, resulting in the population changing over time. An abiotic environmental condition can be said to select for certain characteristics in some individuals and select against different characteristics in other individuals. In this way, the environment exerts selective pressure on a population.

18. A fact is a statement based on collected data. A theory is a collection of ideas and thoughts that explain the collected facts (data) of the world. For example, it is a fact that change over time among species occurs; however, natural selection is a theory that explains the observed facts, such as fossil and biochemical evidence.

19. If two species have similarities within their DNA sequences and patterns, it indicates that these sequences were most likely inherited from a common ancestor. For example, comparing 1 human to another, there would be a 100 percent match of genes (some in different orders),

but comparing human DNA to that of a chimpanzee gives a 98 percent match, suggesting common ancestry.

20. (a) Darwin's experiences on the *Beagle* allowed him to explore the coast and coastal islands of South America, observing the natural history and geographical location of each stop. He noted that the flora and fauna of the regions were very different from those found in Europe.

(b) Lyell was a good friend of Charles Darwin, and his writings and support for the idea of continuous, gradual changes were integral to helping Charles Darwin find the support he needed for his theories of natural selection and evolution occurring over time.

(c) Malthus's essay, "On the Principles of Populations" proposed the idea that populations produced more offspring than could actually survive. This competition would weed out the weaker individuals who did not have adaptive advantages, and this would ensure the strongest and most fit individuals would continue breeding in environments where limited resources promoted competition.

21. (a) Many mutations happen during our lifetimes, and as written in the student's text, about 175 mutational changes occur prior to the birth of a human offspring. Mutations are most often neither beneficial nor harmful. In instances where mutations have a negatively selected influence, the fetus may be aborted, be born sterile, or have adaptive traits that make others within the population not mate with individuals possessing these disadvantaged adaptations.

(b) If a mutation provides a selective advantage, its gene frequency will increase rapidly over successive generations. As it is being selected for, more and more individuals within the population will exhibit this selective advantage.

22. (a) A geographical barrier can be a mountain range or a body of water. A biological barrier can be behaviours such as mating rituals or genetic differences between two populations.

(b) A geographical barrier keeps populations of individuals physically separate. Species separated by a biological barrier can co-exist with overlapping habitats and ranges, but because of behavioural patterns for mating, different courtship songs, and even different attractive pheromones, they will never mate.

23. Evolution explains the gradual changes in organisms as each species cultivates (selects for) traits that improve chances of survival in a wide variety of abiotic conditions. Despite the wide variety of environments on Earth, however, there are still some common elements shared by most environments that relate to oxygen, water, and nutrients. This results in species developing analogous traits to cope with those common elements. Students may also suggest that the commonality of life forms at the cellular level indicates that life originated from a very small number of organisms.

24. A transitional fossil is defined as a fossil that combines features of two taxonomical divisions. It is an intermediate stage that has links to both the prior ancestor and to what the species is becoming. The example of a whale-like aquatic animal with tiny legs is a transitional fossil, as it could show the evolution of an aquatic species to a new terrestrial species.

Answers to Applying Concepts Questions

25. (a) Organism A is a damsel fly. Organism B is a dragonfly because wing structure matches 1b.

(b) It can be inferred that dragonflies and damselflies evolved from a common ancestor because both have homologous structures, both are of the class *Insecta*, from the same family (*Odonata*), and have similar life cycles. Note, students do not have to include the Latin names in their answer.

26. (a) Domain – Eukarya
Kingdom – Animalia
Phylum – Chordata
Class – Mammalia
Order – Carnivora
Family – Canidae
Genus – *Canis*
Species – *lupus*

(b) The scientific name of the grey wolf is *Canis lupus*.

27. (a) Grizzly bears will be more likely to become endangered than black bears as the two species come under increased levels of stress (due to habitat loss for example) and as population levels decline. This is due to differences in their habitat requirements and reproductive behaviours. Grizzlies have a more restricted range, niche, and diet than black bears.

(b) Since black bears cannot mate successfully with either grizzly or polar bears, it can be said that black bears are further removed from these other two species of bear. Since grizzly and polar bears can reproduce and have viable offspring, this confirms that they are very close relatives and have a common ancestor more recently in history than that of the common ancestor of the black bear.

28. (a) These data might indicate that leaves in British Columbia and Nova Scotia release more water than leaves in Ontario or Alberta.

(b) The rainfall is higher in provinces whose leaves have more stomata (British Columbia and Nova Scotia).

29. (a) D_p (population density) = $\frac{N}{A}$ where N represents number of organisms and A represents the area where they live.

The mean number of oak tress from the transect data is: $\frac{18.6 \text{ oak trees}}{500 \text{ m}^2}$.

(b) We are now asking the students to convert this to hectares. The conversion is: 1 hectare = 10 000 square metres.

Therefore, 500 square metres / 10 000 square metres = .05 ha (1/20 ha).

Multiply .20 × 18.6 to determine the approximate number of oak trees in one hectare. This results in 372 oak trees.

Multiply this number by 100 (for the total number of hectares) and we get 37 200 oak trees in 100 ha area.

(c) The forester could have used quadrats to obtain similar data.

30. Included within the student response should be a hypothesis that variations will exist within specific traits identified within a population. The procedure needs to offer an effective way to collect, record, and display this information (i.e., measuring the length of the corn cobs, or the average number of kernels per cob).

31. Within a population's gene pool, mutations will introduce new variations in individuals' gene sequences. These new variations can result in new adaptations being produced among individuals within the population. The adaptation will be selected for if it helps the organism to survive and reproduce. As a result, the frequency of the selected gene will increase in the population. As changes occur and new adaptations are selected for, reflecting the principles behind natural selection, the most fit individuals pass on their genes to the next generation to ensure the best adaptive traits for continued existence in that particular environment.

32. This statement accurately describes evolution if we accept the theory of natural selection. Environments continually change over time, just like a continually running motor. For the motor to keep running, it needs to adjust to the changes occurring around it. Evolution is just like tweaking the performance of a machine while it is running to ensure it runs at its best. To ensure that a biosphere works at its best, new adaptations and the adjustments that work (successful adaptations) will be kept (selected for).

33. (a) The first of the pathways comes about as changes accumulate over time. The second pathway occurs when one or more new species arise from a common parent species, and the parent species continues to exist.

(b) An increase in biodiversity will come about through the second pathway, in which one or more new species forms from the original parent species.

34. (a) The distinctive patterns of flashes are like the mating songs of birds—slight changes in the flashes help the different species of fireflies identify their prospective mates and keep them from mating with a different species.

(b) This reproductive barrier ensures no cross-fertilization between the two species of grass. This ensures that they will continue their own species line and not create a new "hybrid" species between the two.

(c) Evolution and the limiting factors within the ecosystem will select against the offspring produced by the hybrid. Natural selection will ensure these weaker individuals will not become a new species, as they do not have the adaptive traits needed to compete successfully for the limited resources. As well, the hybrid offspring are infertile and cannot reproduce.

35. Key concepts include: Climate is ultimately determined by average annual temperature and precipitation and is affected by latitude, altitude, and proximity to water bodies. Such abiotic conditions, coupled with parent bedrock material (the geology of an area), will determine soil type. Soils, topography, precipitation, and other abiotic factors will determine the vegetation that an area can support. The types of vegetation will ultimately determine what animals can be supported in that area, as vegetation provides shelter, protection, and food for animals. It is important that in student diagrams, arrows point in both directions, showing an understanding that these relationships are not unidirectional, but rather complex interrelationships. Students should provide examples to show their understanding of this concept.

36. Student answers should include that it is important to respect these restrictions because of the damage these pests cause to ecosystems and the economy. By bringing restricted items into Alberta, people are spreading pests into the area. The affected trees die, resulting in changes to the biotic community as well as the abiotic conditions in the area. For example, areas where trees have died may be more susceptible to soil erosion or to forest fires. In economic terms, infestations of these pests have a direct impact on the forest industry in the province and could also have a detrimental impact on the tourism industry in some locations (tourists are not likely to come into areas with large stands of dead or dying trees).

37. The population remaining constant (2000 for 10 years) showed the carrying capacity for this lake had been reached and maintained. An introduction of the 1000 new fish of the same species will promote intra-specific competition because this large increase will exceed the carrying capacity of the lake's ecosystem for this species. One would expect a population crash as competition increases for the now limited resources. In addition, the new carrying capacity of the lake after the population crash would now exist at a lower level (i.e., 1200 fish) because of the depletion and degradation of the limited resources needed to survive.

38. A forest that has been replanted with a single species (monoculture) has less total species diversity due to the lack of variety of habitats and ecological niches required to support a high biodiversity. On the other hand, a forest that hasn't been logged would have a greater variety of trees which, in turn, results in greater variation of habitats and niches in the area. This variety would allow other species to flourish, resulting in greater biodiversity.

39. The following explains why the examination of proteins in individual organisms can demonstrate relatedness among species.

- In all organisms, the order of amino acids in specific proteins is determined by DNA.
- Since DNA carries genetic information, scientists can determine how closely related two organisms are by comparing their DNA.
- You can infer that if two species have similar proteins, then their DNA must also be similar.
- If two species have similar patterns in portions of their DNA, this similarity indicates that these portions of DNA were most likely inherited from a recent common ancestor.

40. In this situation, the organism's environment is likely changing. Mutations that once were no advantage, or perhaps even a disadvantage, may become favourable in a new environment. In this situation, the mutation provides a selective advantage in the new environment. A mutation that helps individual organisms survive has a good chance of being passed on to subsequent generations. In time, the gene that provided the selective advantage becomes more prevalent in the population.

41. Model "A" supports gradualism, because it visually represents that change occurs within a lineage, slowly and steadily over time. According to this model, big changes (such as the evolution of a new species) occur as a result of many small changes.

Model B shows punctuated equilibrium. This model proposes that evolutionary history consists of long periods of equilibrium where there is little change, "punctuated" or interrupted by periods of speciation. According to the model of punctuated equilibrium, most species undergo most of their morphological changes when they first diverge from the parent species.

42. Students could construct a timeline similar to the one shown below:

300-400 B.C.E.: Aristotle and Plato (life exists in perfect and unchanging form) → 1749: Buffon (*Histoire Naturelle*) → 1790s: Cuvier (*fossil evidence*) → 1809: Lamarck (*inheritance of acquired characteristics*) → 1830: Lyell (*Principles of Geology*) → 1844-1858: Darwin and Wallace (*theory of evolution by natural selection*). A concept map could also be used to display this information.

Answers to Making Connections Questions

43. (a) To help determine if the frogs were of the same species: compare information on the frogs, including mating behaviours, frog calls, time of year that they mate, life cycle stages and lengths, and DNA analysis.

(b) If the two species of frogs were different, you could tell how closely they are related by analyzing their DNA, looking for similarities and difference in terms of gene sequencing. A more practical analysis would involve the comparison of the above-mentioned points—to observe the frogs' geographic area and suggest a time when they may have become geographically isolated, or to conduct an investigation attempting to breed the two frogs to see if they produce viable offspring. If the offspring produced were not viable, then they truly would be new biological species. If a viable hybrid could be formed, then it would suggest that their divergence along the phylogenetic tree was relatively recent.

44. This opinion-based question can be answered either way, as long as the student argues with logical points. For example, if a student says it is as important to be concerned about moss, the answer should include the ecological importance of moss, including its role in the cycling of nutrients; water retention for forests; soil protection; and the importance of other organisms that are supported by the moss and the implications of the loss of the moss. Students might also mention the potential medicinal importance of the moss, or question why the moss is threatened. Finally, suggestions should be made as to how either species can be protected to ensure that it does not become extinct.

45. All living things have general requirements for growth. These factors include nutrient availability, habitat (space), light, water availability, and suitable temperature range. Factors that limit growth of populations will be access to these resources, coupled with competition pressures, predation, and potential parasites.

- The population growth of most food-borne bacteria is limited by access to warm temperatures, moisture, and a food source.
- Tree population growth is limited by access to water, light, and nutrients in the soil.
- Deer populations can be limited by access to food, the size of predator populations in their area, as well as infestations of parasites.

46. Many of the endangered species in the world have very specific, or narrow, ecological niches because they often live in highly diverse areas with other organisms, and as such, need a specialized niche in order to survive. Some species exist only in one geographic area and nowhere else in the world (endemic). Both endemic and threatened species can have very restricted ranges because of either natural geographic barriers (such as islands or mountain tops) or human-engineered barriers (such as habitat

fragmentation, destruction, and isolation). Species are further threatened by extinction when they are over-hunted or out-competed by invasive species.

47. Biodiversity needs to be maintained because it keeps the gene pool of many species alive. Within these gene pools, there exist significant differences in genetic adaptations. As the environment continually changes, different adaptations will be selected for as individuals or populations out-compete the other species (inter-specific competition), or their own species (intraspecific competition) for the limited resources.

48. Students may choose to argue that antibiotics should be available without a prescription. However it will be difficult to make a case for this using the principles of natural selection.

Antibiotics work by killing bacteria. However, there will always be some bacteria that may be genetically resistant to the antibiotic due to a mutation that suddenly becomes a selective advantage. While early application of the antibiotic will kill the non-resistant bacteria, it may take a sustained application of the antibiotic to kill the resistant bacteria. If this sustained application does not happen, the resistant bacteria will be able to survive and reproduce, passing the resistant mutation on to their offspring. (This is an example of natural selection for this mutation.) As the numbers of resistant bacteria increase, the antibiotic in question will be less effective and eventually may be unable to have any effect on a population of largely resistant bacteria.

If antibiotics are available by prescription only, it is assumed that a physician will supervise the drug use, ensuring that the whole course of medication is taken in order to kill off all bacteria, and that antibiotics are not used indiscriminately, thus increasing the chances that resistant bacteria will develop.

49. (a) Growth was much faster in the first 30 days.

(b) Access to light, nutrients, and water might influence the growth. As more plants grow, they begin to compete with each other for resources, and the rate of growth slows.

(c) Student answers should show a surge in the organisms feeding on the algae in response to the increased plant growth, with numbers tapering off in response to the slower growth.

50. Some (1 percent) of the insects in this population are resistant to the insecticide. The 1 percent of the organisms that lived passed on this adaptive trait to many of the new offspring that were produced. As a result, a larger percent of subsequent generations of insects were resistant to the insecticide. This is one possible explanation why only 50 percent of the insects (instead of 99 percent) were killed by subsequent applications of the same insecticide.