Unit: Ecology

- *Biotic/Abiotic*
- *Exchange of matter and energy*
- *Animal Behavior*
- *Interactions between populations, communities, ecosystems*
- *Cooperative interactions*
- *Invasive species*
- *Human Impact*

- KEY EXAMPLES: Life-History strategies, Tropic levels in major biomes, symbiotic examples, invasive species, courtship behaviors
- *KEY MATH SKILLS: Population growth equations, Q10, primary productivity*
- *KEY LABS: Energy Dynamics #10, Fruit Fly Behavior #12*

Enduring understanding 2.A: Growth, reproduction and maintenance of the organization of living systems require free energy and matter.

Essential knowledge 2.A.1: All living systems require constant input of free energy.

a. Life requires a highly ordered system.

1. Order is maintained by constant free energy input into the system.
2. Loss of order or free energy flow results in death.
3. Increased disorder and entropy are offset by biological processes that maintain or increase order.

b. Living systems do not violate the second law of thermodynamics, which states that entropy increases over time.

1. Order is maintained by coupling cellular processes that increase entropy (and so have negative changes in free energy) with those that decrease entropy (and so have positive changes in free energy).

c. Organisms use free energy to maintain organization, grow and reproduce.

3. There is a relationship between metabolic rate per unit body mass and the size of multicellular organisms — generally, the smaller the organism, the higher the metabolic rate.
4. Excess acquired free energy versus required free energy expenditure results in energy storage or growth.
5. Insufficient acquired free energy versus required free energy expenditure results in loss of mass and, ultimately, the death of an organism.

e. Changes in free energy availability can result in changes in population size.

f. Changes in free energy availability can result in disruptions to an ecosystem.

Enduring understanding 2.D: Growth and dynamic homeostasis of a biological system are influenced by changes in the system's environment.

Essential knowledge 2.D.1: All biological systems from cells and organisms to populations, communities and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.

a. Cell activities are affected by interactions with biotic and abiotic factors.

b. Organism activities are affected by interactions with biotic and abiotic factors. [See also **4.A.6**]

c. The stability of populations, communities and ecosystems is affected by interactions with biotic and abiotic factors. [See also **4.A.5, 4.A.6**]

Essential knowledge 2.D.3: Biological systems are affected by disruptions to their dynamic homeostasis.

b. Disruptions to ecosystems impact the dynamic homeostasis or balance of the ecosystem.

Enduring understanding 3.E: Transmission of information results in changes within and between biological systems.

Essential knowledge 3.E.1: Individuals can act on information and communicate it to others.

a. Organisms exchange information with each other in response to internal changes and external cues, which can change behavior.

b. Communication occurs through various mechanisms.

1. Living systems have a variety of signal behaviors or cues that produce changes in the behavior of other organisms and can result in differential reproductive success.
2. Animals use visual, audible, tactile, electrical and chemical signals to indicate dominance, find food, establish territory and ensure reproductive success.

c. Responses to information and communication of information are vital to natural selection and evolution. [See also **1.A.2**]

1. Natural selection favors innate and learned behaviors that increase survival and reproductive fitness.
2. Cooperative behavior tends to increase the fitness of the individual and the survival of the population.

Enduring understanding 4.A: Interactions within biological systems lead to complex properties.

Essential knowledge 4.A.5: Communities are composed of populations of organisms that interact in complex ways.

a. The structure of a community is measured and described in terms of species composition and species diversity.

b. Mathematical or computer models are used to illustrate and investigate population interactions within and environmental impacts on a community. [See also **3.E.1, 3.E.3**]

c. Mathematical models and graphical representations are used to illustrate population growth patterns and interactions.

Essential knowledge 4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.

a. Energy flows, but matter is recycled. [See also **2.A.1**]

b. Changes in regional and global climates and in atmospheric composition influence patterns of primary productivity.

c. Organisms within food webs and food chains interact. [See also **2.D.1**]

d. Food webs and food chains are dependent on primary productivity.

e. Models allow the prediction of the impact of change in biotic and abiotic factors.

- Competition for resources and other factors limits growth and can be described by the logistic model.
- Competition for resources, territoriality, health, predation, accumulation of wastes and other factors contribute to density-dependent population regulation.

f. Human activities impact ecosystems on local, regional and global scales. [See also 2.D.3]

- As human populations have increased in numbers, their impact on habitats for other species have been magnified.
- In turn, this has often reduced the population size of the affected species and resulted in habitat destruction and, in some cases, the extinction of species.

g. Many adaptations of organisms are related to obtaining and using energy and matter in a particular environment. [See also 2.A.1, 2.A.2]

Enduring understanding 4.B: Competition and cooperation are important aspects of biological systems.

Essential knowledge 4.B.3: Interactions between and within populations influence patterns of species distribution and abundance.

a. Interactions between populations affect the distributions and abundance of populations.

- Competition, parasitism, predation, mutualism and commensalism can affect population dynamics.
- Relationships among interacting populations can be characterized by positive and negative effects, and can be modeled mathematically (predator/prey, epidemiological models, invasive species).
- Many complex symbiotic relationships exist in an ecosystem, and feedback control systems play a role in the functioning of these ecosystems.

b. A population of organisms has properties that are different from those of the individuals that make up the population. The cooperation and competition between individuals contributes to these different properties.

c. Species-specific and environmental catastrophes, geological events, the sudden influx/ depletion of abiotic resources or increased human activities affect species distribution and abundance. [See also 1.A.1, 1.A.2]

Essential knowledge 4.B.4: Distribution of local and global ecosystems changes over time.

a. Human impact accelerates change at local and global levels. [See also 1.A.2]

b. Geological and meteorological events impact ecosystem distribution.

1. Biogeographical studies illustrate these changes.

Enduring understanding 4.C: Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

Essential knowledge 4.C.3: The level of variation in a population affects population dynamics.

a. Population ability to respond to changes in the environment is affected by genetic diversity. Species and populations with little genetic diversity are at risk for extinction. [See also 1.A.1, 1.A.2, 1.C.1]

b. Genetic diversity allows individuals in a population to respond differently to the same changes in environmental conditions.

Essential knowledge 4.C.4: The diversity of species within an ecosystem may influence the stability of the ecosystem.

a. Natural and artificial ecosystems with fewer component parts and with little diversity among the parts are often less resilient to changes in the environment. [See also 1.C.1]

b. Keystone species, producers, and essential abiotic and biotic factors contribute to maintaining the diversity of an ecosystem. The effects of keystone species on the ecosystem are disproportionate relative to their abundance in the ecosystem, and when they are removed from the ecosystem, the ecosystem often collapses.

Can You Questions:

1. Explain the effects of abiotic and biotic factors on community structure?
2. Discuss available energy to the producers, primary consumers, secondary consumers and tertiary consumers?
3. Discuss primary and secondary sucession?
4. Describe the following interspecific relationships, interspecific competition, herbivory, predation, commensalism and mutualism?
5. Identify specific tropic levels of a food web and integrate food chains into food webs?
6. Give an example and describe how an invasive species can impact the dynamics of the populations in the ecosystem?
7. Describe the significance of a keystone species to an ecosystem's food web?
8. Predict how species diversity influences stability within an ecosystem?

Ecology

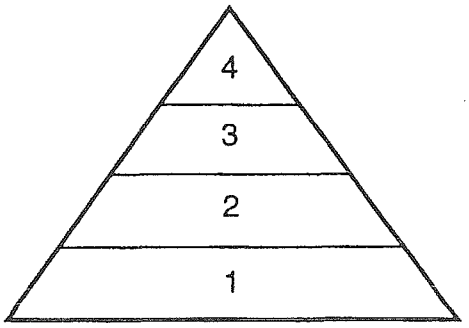
1. Which of the following behaviors involves "reasoning" or problem solving?

   A) Insight
   B) Operant conditioning
   C) Classical conditioning
   D) Habituation
   E) Imprinting

2. Epiphytes grow in the branches of trees to maximize light exposure, with no ill effect on the tree. This is an example of

   A) mutualism B) predation
   C) commensalism D) competition
   E) parasitism

Base your answers to questions **3** and **4** on the drawing below of the pyramid of energy and numbers.



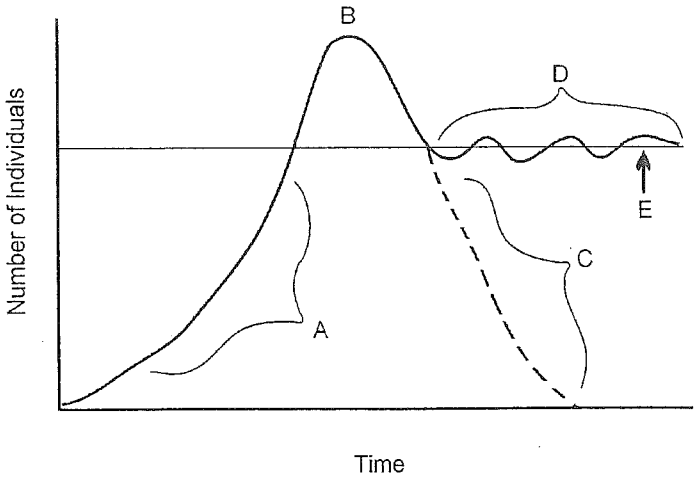
3. Which of the following levels represents the secondary consumer?

   A) 1 B) 2
   C) 3 D) 4
   E) None of the above

4. Which level has the least amount of energy?

   A) Secondary consumer
   B) Decomposer
   C) Primary consumer
   D) Producer
   E) Tertiary consumer

Base your answers to questions **5** through **7** on the graph below that shows the changes in population size over time.



5. A population is struggling because of a major decrease in the food supply

6. The carrying capacity of the environment

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

7. The phase in which a new population would grow exponentially

Base your answers to questions 8 through 15 on the 5 lettered headings listed below. Select the single heading that most directly applies to the subsequent statement. Each heading may be used once, more than once, or not at all within its group.

(A) r-Selected (Opportunistic) Population
(B) k-Selected (Equilibrial) Population
(C) Density-Dependent Factor
(D) Density-Independent Factor
(E) Intrinsic Rate of Increase

8. Characterized by typically low death rates.

9. Characterized by few reproductions per lifetime.

10. Characterized by many offspring per reproductive cycle.

11. Characterized by long lifespans.

12. Their offspring or eggs are generally large in size.

13. Their first reproduction typically takes place late in life.

14. Characterized by short maturation time.

15. Extensive parental care is associated with these populations.

Base your answers to questions 16 and 17 on the components of the nitrogen cycle listed below.

(A) Nitrifying bacteria
(B) Denitrifying bacteria
(C) Decomposing bacteria
(D) Nitrogen-fixing bacteria
(E) Aerobic Fungi

16. Converts ammonium ions (NH_4^+) into nitrite ions (NO_2

17. Converts nitrite ions (NO_2^-) into nitrate ions (NO_3^-)

1. A
2. C
3. C
4. E
5. C
6. E
7. A
8. B
9. B
10. A
11. B
12. B
13. B
14. A
15. B
16. A
17. A