

Ecology

2017 Mentor Invitational

Team Members:

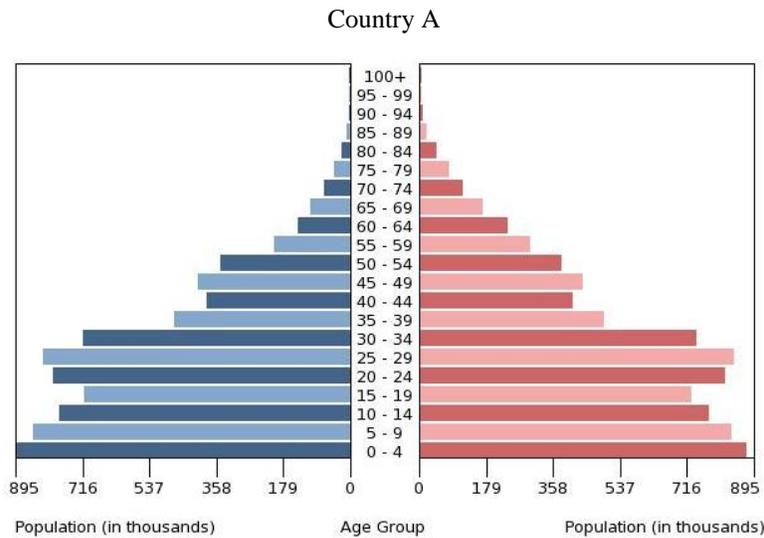
School:

Team Number:

Please read the following instructions carefully:

This test consists of a combination of multiple-choice, true/false, fill in the blank, and short answer responses. There is no answer sheet, so please write directly on the test (circle either “True” or “False” for those types of questions). If your answer is not clear, it will get marked as incorrect. Most multiple-choice questions will have only one correct response, but a “few” of them will have multiple correct answers. “Some” of these “few” questions will be phrased in a way that seeks more than one answer and others will not. In order to receive any credit, you must choose all of the correct choices. If a question is worth more than one point, the point value will be stated in parentheses. Tiebreakers will be predetermined questions. On the unlikely chance that there is a really large tie that goes beyond these indicated questions, the longest consecutive streak *insert fire emoji* from the first question onward will determine the winner. The first tiebreaker is to draw a fire emoji next to your school name so I will know if you’re lit or not. Please make wiser decisions (on this test and in life) than I did, sleeping at 5am the day I’m writing this 😊 and I hope you have more fun taking this test than I had writing it (aka none 😊).

Analyze the following age structure for questions 1-4:



1. How would you characterize Country A's rate of growth?
 - a. Extremely little to no growth
 - b. Slow growth
 - c. Moderate growth
 - d. Rapid growth
 - e. Exponential growth

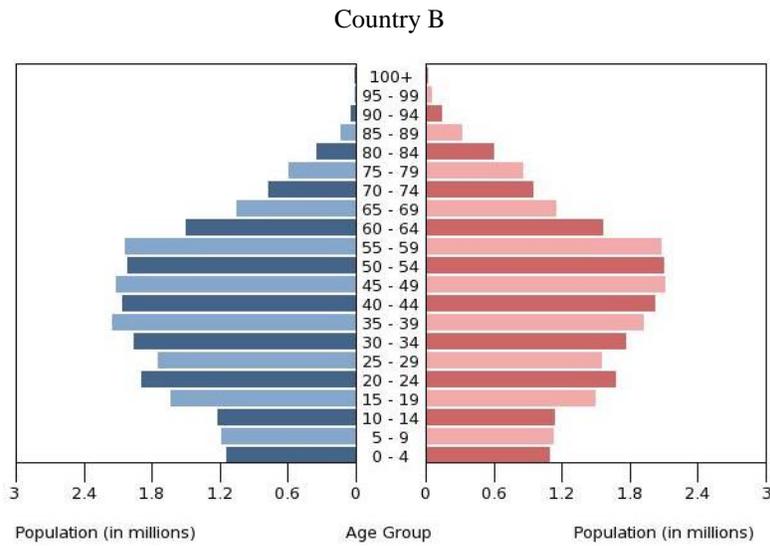
2. True or False: The birth rate of Country A is lower than the death rate.

3. Of the following countries in Asia, which is most likely to be Country A?
 - a. Thailand
 - b. South Korea
 - c. India
 - d. China
 - e. Cambodia

Note that the age structure of India has the same shape, but the scale of the population axis indicates that this country has a population much smaller than that of India.

4. Which stage of the Demographic Transition Model is this country most likely to be in?
 - a. Preindustrial
 - b. Industrial
 - c. Transitional
 - d. Post-Industrial

Analyze this age structure from a different country for questions 5-8:



5. How would you characterize Country B's rate of growth?
 - a. Extremely little to no growth
 - b. Slow growth
 - c. Moderate growth
 - d. Rapid growth
 - e. Exponential growth

6. True or False: The birth rate of Country B is lower than the death rate.

7. True or False: Country B is below the replacement fertility rate.

8. Which stage of the Demographic Transition Model is Country B most likely to be in?
 - a. Preindustrial
 - b. Industrial
 - c. Transitional
 - d. Post-Industrial

9. What is a rough estimate of the replacement fertility rate for most countries and why is this an appropriate number? (2 points)

2.1 births per woman: this replaces two parents and adds population to compensate for death. (Accept anything above 2 to 2.5)

10. Which of the following factors can affect the replacement fertility rate in a region?
 - I. Number of births
 - II. Immigration
 - III. Emigration
 - IV. Mortality rates
 - a. IV only
 - b. I & II only

- c. III & IV only
- d. II, III, & IV only
- e. I, II, III, & IV

Now compare the two age structures for questions 11 and 12:

11. True or **False**: The population of infants is greater in Country A than Country B.
12. Describe four factors that could lead to the difference in the age structures between Countries A and B. (4 points)

Four of the following: Country A has *less* gender equality than Country B (fewer women educated/working), Country A has *fewer* sex education/family planning services than Country B, Country A has *fewer* birth control options than Country B (fewer contraceptives), the cost of raising children is *lower* in Country A than in Country B, the infant mortality rate is *higher* in Country A than in Country B, the average age of marriage is *lower* in Country A than in Country B, children are a *more* important part of the labor force in Country A than in Country B, Country A is *more* rural than Country B, Country A has *less* availability of safe abortions than Country B

Note: in order to get credit for each factor, students must get the relationship between the two countries correct

13. Which of the following is not true about the enzyme *nitrogenase*?
 - a. It allows nitrification to occur in the nitrogen cycle
 - b. It splits atmospheric nitrogen and combines the resulting atoms with hydrogen
 - c. It must be used in an oxygen-free environment
 - d. It can be found in cyanobacteria
14. What is the largest natural source of carbon dioxide?
 - a. Ocean-atmosphere exchange
 - b. Plant and animal respiration
 - c. Soil respiration and decomposition
 - d. Volcanic eruptions
15. Which of the following does not eventually contribute to the development of acid rain?
 - a. Hydrogen sulfides in the atmosphere react with water to form sulfur oxides
 - b. Emissions from coal-fired power plants contributes to sulfur oxides
 - c. Emissions from automobiles contributes to sulfur oxides
 - d. Dimethyl sulfide is released by bacteria in the ocean
 - e. Sulfur oxides are released into the atmosphere by volcanoes
16. The reactants for this process are biological nitrogen compounds that have already been incorporated into proteins and nucleic acids:
 - a. Assimilation
 - b. Ammonification
 - c. Denitrification
 - d. Nitrification
17. Identify the relationship between *Rhizobium* the plants they are associated with, and explain each of their roles in this relationship. (3 points)

Mutualistic relationship. Bacteria (rhizobium) receives carbohydrates (organic acids as carbon and energy source) from plant, plant receives nitrogen (in the form of ammonia or amino acids) from bacteria

For questions 13-15, consider a population P of plankton that is experiencing no intraspecific or interspecific competition, growing at an annual rate of r percent per week, with an initial population P_0 of 5000 individuals.

18. Set up an equation that defines the change in the population of plankton over time: (2 points)

$$dP/dt = rP$$

19. Find an equation that gives the population at any time t . (2 points)

$$P(t) = 5000e^{rt}$$

Suppose that the population is found to increase to 5500 individuals after one day.

20. Use your equation to calculate the doubling time of this population. Write your answer to the nearest hundredth. Show your work. (6 points)

$$5500 = 5000e^{r/7} \quad r/7 = \ln(1.1) \quad r = 7\ln(1.1) = 0.667$$

$$2 = e^{0.667t} \quad 0.667t = \ln(2) \quad t = \ln(2)/0.667 = 1.04 \text{ weeks}$$

Note: 3 points for r , 3 points for doubling time (must show setup and answer for full credit, -0.5 for incorrect units on final answer), allow for rounding errors

You find another population of plankton that lives in similar conditions to this first population (no competition). You observe this population gain 125 new individuals per 1000 individuals over the course of one week.

21. **Estimate** the doubling time of this new population. Show your work. (3 points)

Rule of 70: $70/r = \text{doubling time where } r \text{ is growth rate as a percentage (12.5\%)}$

$$70/12.5 = 5.6 \text{ weeks}$$

1 point for correct equation, 1 point for correct r , 1 point for correct answer, -0.5 for incorrect units on final answer

For questions 17-19, consider a third population P of plankton with a growth rate of r percent per week and a carrying capacity K of 50000 individuals due to a scarcity of resources.

22. This group of plankton is encountering various limiting factors that put a cap on the growth, abundance, and distribution of the population.

23. If the one plankton competes for resources with other individuals from this same species, it is considered intraspecific competition.

24. Set up an equation that defines the change in this third population of plankton over time: (2 points)

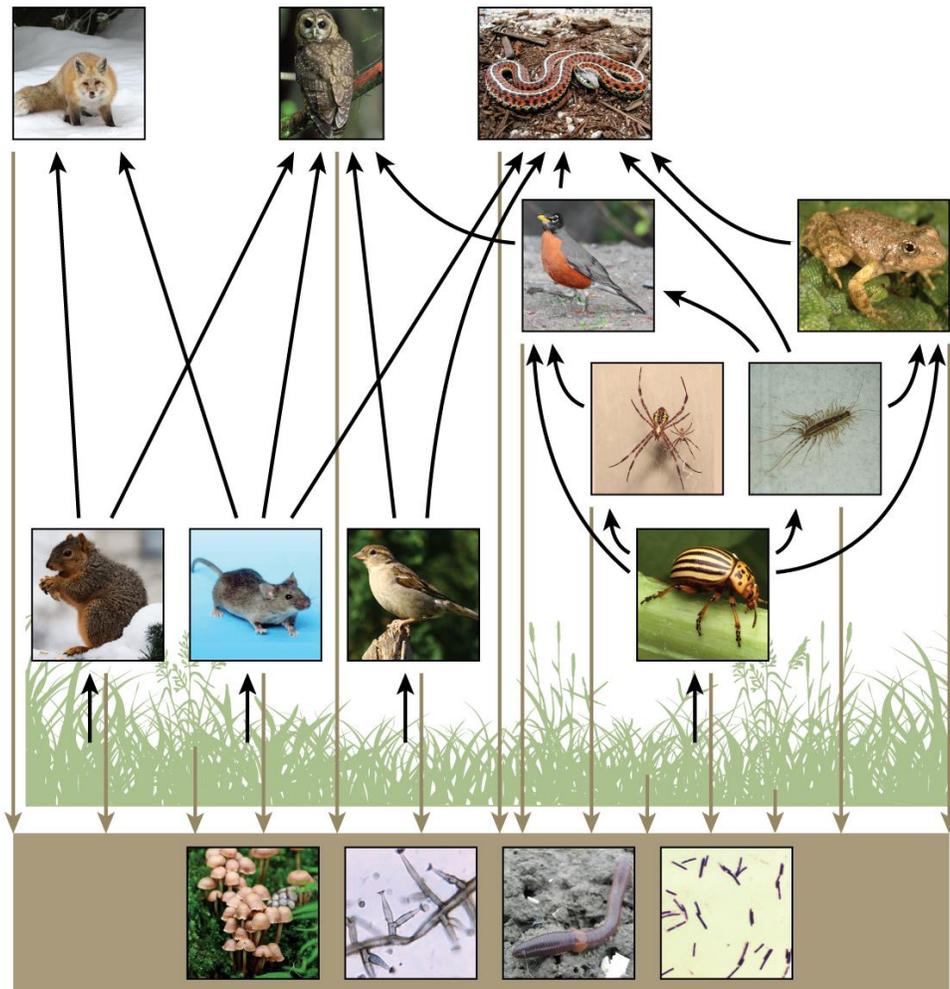
$$dP/dt = rP(1-P/50000) \text{ or } dP = rP(50000-P)/50000$$

25. Given a species whose change in population over time is modeled by the logistic growth equation $dP/dt = -5P(3P-200)$, calculate the carrying capacity. Show your work. (4 points)

$$0 = -5P(3P-200) = 5P(200-3P) \quad 0 = 200-3P \quad P = 200/3 = 66 \text{ or } 67 \text{ individuals}$$

2 points for setting dP/dt equal to 0, 2 points for correct answer, -0.5 for incorrect units (accept individuals, organisms, etc.)

Use the food web below to answer questions 21-24:



26. In this meadow ecosystem, there is a grazing food web of photosynthetic organisms at its base, followed by herbivores and various carnivores.
27. The detrital food web shown in brown consists of a base of organisms that feed on decaying organic matter.
28. True or **False**: The fox and the owl occupy the same trophic level.
29. What is the trophic level TL of the toad?
- $TL = 2$
 - $2 < TL < 3$
 - $TL = 3$
 - $3 < TL < 4$**
 - $TL = 4$
 - A and C
 - C and E
30. Not including decomposers, what is the mean chain length of the food web? (3 points)
- 2.875 (accept +/- 0.1 for 1 point)**

31. Beyond the trophic level of the prey/food, which of the following is/are necessary to determine trophic level of a consumer?
- The trophic level of the predator
 - The relative proportions of different species of prey/food in the diet of the consumer
 - The total amount of food/prey consumed by the organism
 - No more information is necessary
32. True or False: The trophic level of an organism must be an integer value.
33. Which of the following organisms marks the end of a food chain?
- Apex predator
 - Scavenger
 - Detritivore
 - Decomposer
 - It's a never-ending cycle!
34. According to fisheries scientist Daniel Pauly, the following organisms have a trophic level of 2:
- Detritivores
 - Decomposers
 - Herbivores
 - Omnivores
 - Tuna
35. What distinguishes detritivores from most decomposers?
- They feed on dead matter and waste products
 - They are important to the fragmentation of dead organic matter
 - They are important to the recycling of nutrients for use by primary producers
 - They are often multicellular animals
36. Which of the following are reasons for the 10% rule of energy transfer?
- The length of food chains is limited (typically a maximum of five trophic levels)
 - Some organic molecules cannot be digested and are excreted rather than used
 - Some organisms in a trophic level die before they are eaten by organisms the next level up
 - Energy is dissipated from organisms as heat during metabolism
 - Only 10% of interactions between trophic levels result in consumption by organisms the next level up
37. Herbivores generally have an abundance of vegetative resources, so their populations are largely controlled or regulated by predators. This is an example of:
- Green world hypothesis
 - Interspecific competition
 - Bottom-up cascade
 - Trophic waterfall
38. The phenomenon by which an organism produces biochemical to influence the germination, growth, and reproduction of other organisms, often characterizing amensalism, is known as:
- Negative feedback
 - Soil sickness
 - Allelopathy
 - Domatium

39. Suppose an elk and a caribou produce an offspring that has a more difficult time finding sufficient resources for survival than either of its parents. This is a phenomenon known as outbreeding depression.
40. The increase in species richness at a(n) ecotone is known as the edge effect.
41. Which of the following correctly depicts an extinction vortex?
- Natural disasters wipe out a population entirely
 - Abiotic and biotic factors work together to lower population
 - The extinction of one species upon which another is dependent causes the extinction of the other species
 - An extinction vortex is a made-up term
42. Which of the following would be considered (an) extant species?
- Human
 - Polar bear
 - Lynx
 - Moose
 - Mammoth
43. This level of species diversity measures the similarity between different habitats in a similar geographical area:
- Alpha
 - Beta
 - Gamma
 - Geographical
44. What is the difference between species diversity and species richness?
- Species diversity differs from species richness in that it takes into account both the *numbers of species* present and the dominance or evenness of species in relation to one another, whereas species richness only accounts for the first (number of species).
45. Which is NOT a characteristic of a measurement of dominance:
- Works well with small samples
 - Does not require all species to be represented
 - Sensitive to species richness
 - Gives probability that any two individuals drawn at random from an infinitely large community belong to different species
46. Migratory birds often seek which biome(s) during non-winter months?
- Rain forest
 - Tundra
 - Taiga
 - Deciduous forest
47. Which of these organisms would you expect to find in a deciduous forest?
- Black bear
 - Woodpecker
 - Oak tree
 - Squirrel
48. Permafrost can be found in which of the following areas?
- Tundra

- b. Taiga
 - c. High altitudes
 - d. Ice shelves
49. Which of the following is/are characteristic of the taiga?
- a. Season-dependent animal camouflage
 - b. Dry summers
 - c. Common forest fires
 - d. Summertime insect breeding grounds
50. In the long run, organisms of any species must prioritize which of the following?
- a. Surviving as long as possible
 - b. Avoiding competitive exclusion
 - c. Resource partitioning
 - d. Reproduction
51. The activity of decomposers is greatest under which of the following soil conditions?
- a. Temperature of 20 degrees Celsius
 - b. Temperature of 30 degrees Celsius
 - c. 50% saturation with water
 - d. 90% saturation with water
52. The greatest biodiversity is typically found in land biomes that
- a. Are near coastlines
 - b. Go four seasons
 - c. Are located near the equator
 - d. Experience a large amount of rainfall
53. What is typically a result of predator-prey interactions in a balanced ecosystem?
- a. The populations of predators and prey continuously cycle, with their peak populations in sync
 - b. The populations of predators and prey continuously cycle, with their peak populations slightly off sync
 - c. The predators must always be looking for new sources of prey as they kill off one species
 - d. The prey must continuously learn to escape predators and predators must continuously learn new hunting methods
54. Which is true of abiotic factors?
- a. They affect all plants but only some animals
 - b. They determine which species can survive
 - c. They include both weather and climate
 - d. They are not important compared to biotic factors
55. Do humans, as a species, exhibit biodiversity?
- a. No, humans are a single species and biodiversity is between different species
 - b. Yes, humans have different internal morphologies
 - c. No, humans are too alike to each other to exhibit biodiversity
 - d. Yes, humans have different genes and appear different from one another
56. Where would you expect to find organisms that reside primarily in the tundra biome?
- a. Northern parts of the Contiguous United States
 - b. Northern Scandinavia
 - c. Southern Argentina

d. Southern Greenland

57. "Drunken trees" are associated with which of the following?

- a. Heavy rain
- b. Melting of ice
- c. Taiga
- d. Deciduous forest

58. True or False: Permafrost can exist at low latitudes.

59. Which of the following does not appropriately match the land biome with its location?

- a. Northern Mixed, North of Great Lakes
- b. Mediterranean Scrub, Coast of Southwestern United States/Northwestern Mexico
- c. Mexican Montane, Central Mexico
- d. Hot Desert, Southwestern United States (away from coast)

60. Acid rain typically has pH values between which two numbers?

- a. 2
- b. 5
- c. 5.6
- d. 6
- e. 7

61. Permafrost covers approximately what percent of the exposed land surface in the Northern Hemisphere?

- a. 6%
- b. 12.5%
- c. 25%
- d. 35%

62. Approximately how many different kinds of plants exist in the tundra?

- a. 500
- b. 1200
- c. 1700
- d. 2500
- e. 5000

63. How much of the global soil bound carbon is found in permafrost?

- a. 10%
- b. 25%
- c. 33%
- d. 45%

64. Explain how concerns of global warming are connected to the tundra. (2 points)

Melting of permafrost releases large amounts of carbon into the atmosphere increasing, carbon dioxide is known to trap heat within the Earth's atmosphere

65. Less desirable and dead trees are harvested. As younger trees mature, they produce seedlings that continue to grow as the now-mature trees are harvested. This method of harvesting trees is known as:

- a. Selective cutting
- b. Shelterwood cutting
- c. Seed tree cutting

- d. Clearcutting
66. **True** or False: the rate of deforestation in boreal forests is greater than that of tropical rain forests.
67. A protected zone that connects isolated unlogged or undeveloped areas is known as:
- Rangeland
 - Wilderness
 - National Park
 - National Wildlife Refuge
 - Wildlife corridor**
68. Explain the difference between translocation and reintroduction. (2 points)
- Translocation moves wild-caught animals from one natural location to another**
- Reintroduction moves captive-born animals into their natural historical range.**
69. Define gasohol.
- 85-90% gas and 10-15 % ethanol**
70. A collector is used to absorb solar radiation and transfer the heat to a fluid that is pumped through the device. This is characteristic of:
- Passive solar power
 - Active solar power**
 - Photovoltaic cells
 - Not solar power