

# Ecology Test



November 16-24, 2024

## Instructions:

- You will have **50 minutes** to complete your exam. At the end of this time period, you must stop working. Partial credit will be awarded, so attempt as many questions as you can!
- Each team is allowed one 8.5" x 11" note sheet with information on both sides; however, it must be printed and laminated or in a sheet protector.
- Any multiple choice questions have exactly one answer unless explicitly marked otherwise.
- You will not be penalized for not showing work, but you may get partial credit for correct work if your answer is incorrect.
- **Ties will be broken in accordance with the national Science Olympiad rules in this order:**
  - Tiebreaker questions (#15, #79, #109, #120)
  - Score on Section 1
  - Score on Section 2

School/Team Name: \_\_\_\_\_

Team Number

Written by Kyle Yan (William Mason HS '26), Krish Shah (Seven Lakes HS '25)

Questions? Comments? Email us here:

[kyle.yan75@masonohioschools.com](mailto:kyle.yan75@masonohioschools.com) — [krishshah676@gmail.com](mailto:krishshah676@gmail.com)

## Section A: General Principles of Ecology [46 pts]

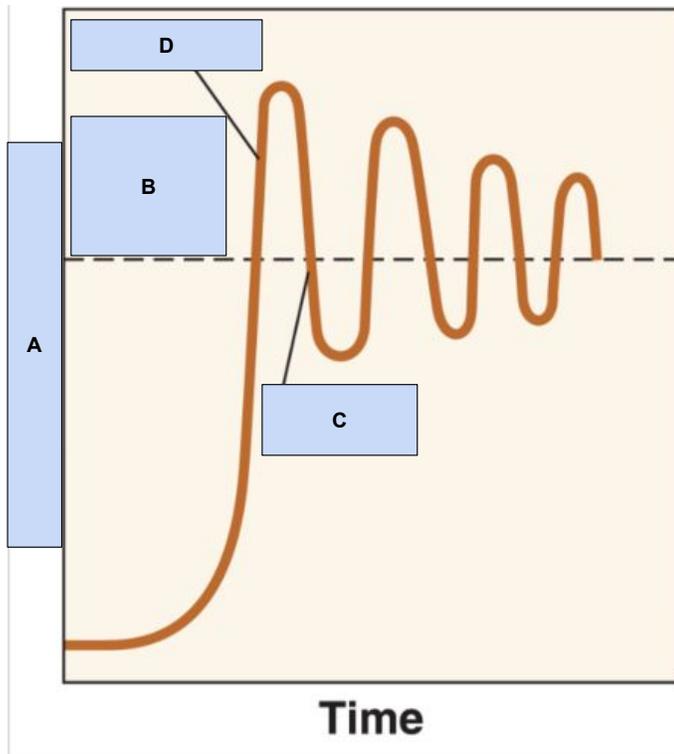
1. The majority of plants are best categorized as which of the following terms? [1]
  - (a) Photoautotrophs
  - (b) Chemoautotrophs
  - (c) Photoheterotrophs
  - (d) Chemoheterotrophs
2. Which subsystem of the Earth includes soil and sediment found at the bottom of bodies of water? [1]
  - (a) Hydrosphere
  - (b) Lithosphere
  - (c) Biosphere
  - (d) Troposphere
3. What type of natural selection favors individuals at both extremes of their trait distribution? [1]
  - (a) Stabilizing
  - (b) Artificial
  - (c) Directional
  - (d) Disruptive
4. In what way does natural selection favor certain individuals within a population? [1]
  - (a) By randomly eliminating weak members, regardless of their traits.
  - (b) By selecting individuals that are best adapted to the current environmental conditions.
  - (c) By ensuring that all individuals reproduce equally in stable environments.
  - (d) By allowing only the strongest individuals to survive, regardless of their environment.
5. A population experiencing zero population growth is characterized by which of the following? [1]
  - (a) Equal birth rate to death rate.
  - (b) High natality and low mortality.
  - (c) Exponential growth curve.
  - (d) A stable carrying capacity.
6. A plant with seeds that rely on wind for dispersal would most likely have... [1]
  - (a) Heavy, water-resistant seeds
  - (b) Seeds with appendages to allow for floating
  - (c) Light seeds with hairy growths
  - (d) Seeds encased in a fruit
7. In what way does sexual selection shape the evolution of species? [1]
  - (a) It decreases genetic variation by favoring only one type of trait.
  - (b) It increases reproductive success by allowing individuals with desirable traits to mate more frequently.
  - (c) It leads to random mating, regardless of traits.
  - (d) It eliminates traits that are not advantageous for survival.

8. In which situation would random distribution of a population be most likely to occur? [1]
- (a) When resources are evenly distributed across a habitat.
  - (b) When resources are equally available to all members of a population.
  - (c) When individuals in the population compete fiercely for resources.
  - (d) When populations are influenced by environmental factors like predation and disease.
9. Which type of species thrives in disturbed or unpredictable environments and exhibits high reproduction rates? [1]
- (a) K-selected species
  - (b) Type I species
  - (c) Cosmopolitan species
  - (d) r-selected species
10. How does the age structure of a population influence its future growth? [1]
- (a) A population with many post-reproductive individuals will grow rapidly.
  - (b) The age structure has no effect on population growth.
  - (c) A population with many pre-reproductive individuals is likely to grow more quickly.
  - (d) Populations with a balanced age structure will experience exponential growth.
11. What is the primary difference between Type I and Type III survivorship curves? [1]
- (a) Type I shows constant mortality at all ages, while Type III shows early high mortality with few survivors living long.
  - (b) Type I populations have low mortality early in life, while Type III populations have high mortality in early life stages.
  - (c) Type I has populations that produce many offspring, while Type III has populations that produce few.
  - (d) Type I represents unstable populations, while Type III represents stable populations.
12. A marine ecologist observes that certain fish populations are significantly lower in a coral reef ecosystem that has begun to diminish. Which species interaction most likely explains the decline in fish populations? [1]
- (a) Mutualism, where the fish lost their food source as coral reefs died.
  - (b) Predation, where fish populations decreased due to an increase in predators.
  - (c) Competition, where fish species began competing more intensely for food.
  - (d) Amensalism, where the coral negatively affected the fish by releasing toxins.
13. Which term refers to the maximum number of individuals an environment can support? [1]
- (a) Biotic potential
  - (b) Carrying capacity
  - (c) Population density
  - (d) Reproductive limit
14. Which of the following is true about biomass pyramids? [1]
- (a) They show the flow of energy between trophic levels
  - (b) They compare the number of organisms at each trophic level
  - (c) They compare the dry weight of organic matter at each trophic level
  - (d) They show nutrient cycling within an ecosystem

15. (TB 1) A group of species in a particular forest ecosystem seem to share similar dietary needs, but they coexist without direct competition. Using the idea of niche partitioning, which explanation best describes how they coexist? [1]
- (a) The species have evolved to use different portions of available resources or habitats.
  - (b) The species compete for the same resources, but the strongest species consistently wins.
  - (c) The species use resources that are abundant, eliminating the need for competition.
  - (d) The species have identical fundamental niches but have not realized their full niche potential.
16. In a marine ecosystem, fat-soluble pollutants are introduced into the water. Over time, the concentration of these pollutants is found to be much higher in large predatory fish than in the smaller fish they consume. Which concept explains this accumulation of pollutants in higher trophic levels? [1]
- (a) Bioaccumulation
  - (b) Biomagnification
  - (c) Niche partitioning
  - (d) Competitive exclusion
17. What is resource partitioning? [1]
- (a) Competition for the same resource in different habitats
  - (b) Species using the same resources in different areas to reduce competition
  - (c) The persistence of ecosystem structures after the death of species
  - (d) A complete overlap of resources by competing species
18. Which of the following best defines the term closed community? [1]
- (a) Communities with sharp boundaries
  - (b) Communities without any boundaries
  - (c) Communities with a wide variety of species
  - (d) Communities where all species rely on one another
19. When a certain plant species is removed from a forest, the diversity of the entire ecosystem significantly decreases. Which species type does this plant likely represent, and why? [1]
- (a) Generalist species, because it is adapted to a wide variety of environmental conditions, influencing others
  - (b) Keystone species, because many species relied on it, and its removal caused significant changes.
  - (c) Flagship species, because its removal drew attention to environmental issues.
  - (d) Indicator species, because its removal signaled a decline in the overall health of the ecosystem.
20. Which term describes the relationship where one species is harmed and the other is unaffected? [1]
- (a) Commensalism
  - (b) Parasitism
  - (c) Mutualism
  - (d) Amensalism
21. What does trophic level refer to in an ecosystem? [1]
- (a) The position of an organism in the energy pyramid
  - (b) The niche a species occupies in a community
  - (c) The number of individuals at a specific location
  - (d) The relationship between predators and prey

22. Which term refers to organisms that break down dead or decaying matter, recycling nutrients back into the ecosystem? [1]
- (a) Primary producers
  - (b) Detritivores
  - (c) Decomposers
  - (d) Scavengers
23. Which of the following refers to a species whose absence, presence, or abundance reflects the environmental conditions? [1]
- (a) Indicator species
  - (b) Keystone species
  - (c) Umbrella species
  - (d) Pioneer species
24. In a predator-prey relationship, which of the following would most likely cause a population of prey to increase? [1]
- (a) A decrease in predator population
  - (b) A decrease in prey reproduction rate
  - (c) An increase in competition between prey species
  - (d) An increase in the predator's reproduction rate
25. A species of bird builds its nests in trees, gaining protection from predators. The trees are unaffected by the presence of the birds. What type of interaction does this represent? [1]
- (a) Mutualism
  - (b) Commensalism
  - (c) Parasitism
  - (d) Competitive exclusion
26. Which term indicates the gradual process by which ecosystems change and develop over time, starting from a barren landscape? [1]
- (a) Secondary succession
  - (b) Climax community
  - (c) Ecological succession
  - (d) Primary succession
27. Which community is described as the first organisms to occupy an area? [1]
- (a) Climax community
  - (b) Seral community
  - (c) Pioneer community
  - (d) Transitional community
28. What is the primary process by which water enters the atmosphere? [1]
- (a) Transpiration
  - (b) Precipitation
  - (c) Condensation
  - (d) Infiltration

29. What is the largest natural reservoir of carbon on Earth? [1]
- (a) Atmosphere
  - (b) Ocean
  - (c) Forests
  - (d) Limestone
30. Which of the following is an example of a structural adaptation? [1]
- (a) A bird migrating to find food
  - (b) A camel storing fat in its hump
  - (c) A fish that can change its color
  - (d) An insect avoiding predators by hiding
31. What is the process where nitrogen is converted from ammonia to nitrate? [1]
32. What is the term for an organism's ability to maintain stable internal conditions, despite external environmental changes? [1]
33. In an energy pyramid, which level contains the most energy? [1]
34. Which survivorship curve do humans follow? [1]
35. Rank the three types of population distributions from most common to least common. [1]
36. Assume algae receives 30,000 kcal of energy from the sun. Following the aquatic food web (blue), how many kcal does the sunfish, a tertiary consumer, receive? [1]
37. Imagine a forest ecosystem where a new species of bird has been introduced, competing for the same food resources as a native species. What would happen to the two species? [3]
38. In an environment where oxygen levels fluctuate significantly, being very low at times, how would an anaerobic organism survive compared to an aerobic organism? Which organism would have an advantage? [3]

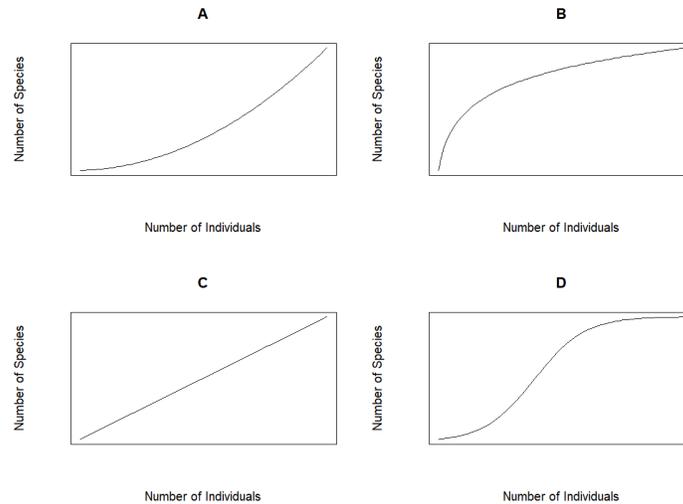


39. In the chart above, what term does A represent? [1]
40. In the chart above, what term does B (the dashed line) represent? [1]
41. In the chart above, what term does C represent? [1]
42. In the chart above, what term does D represent? [1]

## Section B: Terrestrial Ecosystems [64 pts]

43. The Great Plains are best described as which of the following? [1]
- (a) Prairie
  - (b) Savanna
  - (c) Tropical desert
  - (d) Tundra
44. Which of the following is not an alternative name for a temperate grassland? [1]
- (a) Pampas
  - (b) Prairie
  - (c) Savanna
  - (d) Steppe
  - (e) Veld
45. Which of the following organisms would not be found in a typical grassland? (select all that apply) [1]
- (a) Bison
  - (b) Meadowlarks
  - (c) Oaks
  - (d) Sedges
46. What is the process of capturing and storing carbon dioxide known as? [1]
- (a) Carbon Sequestration
  - (b) Carbon blocking
  - (c) Oxystorage
  - (d) Oxide capture
47. What biome would you expect to find a xerocole in? What general group of organisms does it refer to? [1]
- (a) Desert, animal
  - (b) Desert, plant
  - (c) Grassland, animal
  - (d) Grassland, plant
  - (e) None of the above
48. What season do animals aestivate (also spelled estivate) in? [1]
- (a) Spring
  - (b) Summer
  - (c) Autumn
  - (d) Winter
49. Which of the following are characteristics of aestivation? (select all that apply) [1]
- (a) Occur during warm months
  - (b) Occur during rainy seasons
  - (c) Low metabolic rates
  - (d) Unable to be interrupted (hard to wake up)
  - (e) Only occurs in organisms with cryptic coloration

50. Which of the following best describes Group A of the Köppen climate classification? [1]
- (a) Arid
  - (b) Polar
  - (c) Temperate
  - (d) Tropical
51. Which of the following types of soil would be found in a temperate grassland? [1]
- (a) Aridisol
  - (b) Entisol
  - (c) Gelisol
  - (d) Mollisol
52. What is the difference between deflation, abraision, and attrition in the context of erosion by winds [3].
53. What is the name for the number of different species in an ecosystem (one word)? This word can also be seen with the word "species" in front of it, but for the sake of this question, only enter the second word. [2]
54. In one sentence, identify the difference in tissue origin for prickles, spines, and thorns. [3]
55. Which of the following best describes the protective structures most commonly found on cacti? [1]
- (a) Prickles
  - (b) Spines
  - (c) Thorns
  - (d) None of these
56. In the past, Native Americans used the pelts of bison to create clothing items. This is an example of which type of ecosystem service? [1]
- (a) Cultural
  - (b) Provisioning
  - (c) Regulating
  - (d) Supporting
57. Which of the following are typically found in lichens? (select all that apply) [2]
- (a) Algae
  - (b) Archaea
  - (c) Bryophytes
  - (d) Cyanobacteria
  - (e) Fungi
58. The Mojave desert would best be described as which of the following Köppen climate classifications? [1]
- (a) Af
  - (b) Bwh
  - (c) Csb
  - (d) Dwb
  - (e) EF



59. Imagine that a biologist is walking down a path in a grassland, marking down species every time they see one. Which of the following graphs depicts the most likely relationship between the number of species seen and the total number of individuals seen? [2]
- (a)
  - (b)
  - (c)
  - (d)
60. Using the curves from the previous question (ignore the axis labels), which curve would best represent the population of a rabbit introduced into a new grassland with plentiful resources. [1]
- (a)
  - (b)
  - (c)
  - (d)
61. Deserts that are formed on the leeward side of mountains are said to be in the (two word answer) [1]
62. The relationship between the organisms in lichens is best described as which of the following types of symbiotic relationships? [1]
- (a) Amensalism
  - (b) Comensalism
  - (c) Mutualism
  - (d) Parasitism
  - (e) Predation
63. Which of the following are common animal adaptations to the desert climate? (select all that apply) [2]
- (a) Shortened loops of Henle
  - (b) High surface area to volume ratio
  - (c) Aposematic coloration
  - (d) Nocturnal or crepuscular lifestyle
  - (e) Light coloration

64. Which of the following are plant adaptations to the desert climate? (select all that apply) [3]
- (a) Stomatal crypts
  - (b) Shallow roots
  - (c) Thick cuticles
  - (d) C3 photosynthesis
  - (e) Wide leaves
65. The old man cactus is covered with white trichomes. Which of the following are effects of the trichome covering? (select all that apply) [1]
- (a) Increases temperature
  - (b) Reduced transpiration
  - (c) Frost protection
  - (d) Chemical secretions
66. Which of the following plants exhibits CAM photosynthesis? (select all that apply) [1]
- (a) Agave
  - (b) Barley
  - (c) Corn
  - (d) Palm
  - (e) Wheat
67. Many plants use CAM photosynthesis, but this group consists of species of various ancestors, each of which has independently evolved this trait. This is best described as what type of evolution (one word answer) [1]
68. When are the stomata of a CAM plant typically open? [1]
- (a) Open during the day
  - (b) Open during twilight
  - (c) Open during the night
  - (d) Continuously open
  - (e) Open randomly after rain
69. How many stomachs do ruminants typically have? [1]
70. Ruminants rely on symbiotic bacteria to break down what organic compound from their food that they cannot digest? [1]
- (a) Amylose
  - (b) Cellulose
  - (c) Chitin
  - (d) Glucose
71. The relationship between a ruminant and the bacteria inside of it is best described as what kind of relationship? [1]
- (a) Amensalism
  - (b) Commensalism
  - (c) Mutualism
  - (d) Parasitism
  - (e) Predation

72. A cow trampling grass while walking would best be described as what kind of relationship? [1]
- (a) Amensalism
  - (b) Commensalism
  - (c) Mutualism
  - (d) Parasitism
  - (e) Predation
73. What factors does the Köppen aridity index depend on? (select all that apply) [1]
- (a) Annual precipitation
  - (b) Mean annual temperature
  - (c) Mean length between rainfall
  - (d) Mean annual day length
  - (e) Median temperature
74. If you grow a tree in both a desert and a rainforest, in which environment would you expect to have wider rings, and why? You may assume that the tree is able to survive in both ecosystems. [2]

Prairie chickens are a native species, found exclusively in the Great Plains. During the past century, populations decreased drastically due to habitat loss, pesticide use, and other factors. Since then, their population has recovered significantly, but they still face many challenges.

75. Which of the following best describes prairie chickens? [1]
- (a) Cosmopolitan
  - (b) Endemic
  - (c) Introduced
  - (d) Invasive
76. If 10 prairie chickens were brought to a completely new habitat and reproduced to form a full population, what effect would this have on the genetic diversity of this new population when compared to the original population of the prairie chickens, and why? You should name the effect that describes this relationship, but simply naming it is not justification for the relationship. [3]

Assume that the population is in Hardy-Weinberg equilibrium and that beak color is controlled by a single gene governed by Mendelian genetics. The dominant allele confers a yellow beak, while the recessive allele confers a brown beak, and 31% of the population exhibits brown beaks.

77. What is the frequency of the dominant allele? Round your answer to 3 decimal points, and include a leading 0 if needed (0.5 instead of .5). [2]
78. If there are 8693 individuals in the population, then how many individuals are heterozygous for the beak color gene. Round to the nearest ten. [2]

79. (TB 2) If there are 651 female prairie chickens and 497 male prairie chickens in a population, what is the effective population size to the nearest individual? [3]

Use the following information about a hypothetical grassland ecosystem for the next 5 problems.

Species	Frequency
Grasshoppers	167
Rabbits	134
Mice	101
Hawks	53
Foxes	45

80. Which species has the most individuals? [1]
- (a) Foxes
  - (b) Grasshoppers
  - (c) Hawks
  - (d) Mice
  - (e) Rabbits
81. If there is mercury in the grass of this grassland, which of the following species would you expect to have the highest concentration of mercury? [2]
- (a) Foxes
  - (b) Mice
  - (c) Rabbits
  - (d) Impossible to determine
82. What is the name for the process in the previous question? [2]
83. What is the species richness of this animal community. You may assume that there are no other species than the ones shown. [1]
84. If you could modify the number of individuals for each species while ignoring ecological pressures like energy and food consumption and keeping the total number of individuals constant, how many individuals should each species have to maximize the diversity. In this case, you may assume that diversity means the Shannon Index, but knowledge of the index or how to calculate it is not needed for this question. The total number of individuals in your answer should be the same as the total number of individuals in the community. [3]

## Section C: Human Impact on Environment [54 pts]

85. Which of the following greenhouse gases is the most abundant in Earth's atmosphere? [1]
- (a) Carbon dioxide (CO<sub>2</sub>)
  - (b) Sulfur dioxide (SO<sub>2</sub>)
  - (c) Methane (CH<sub>4</sub>)
  - (d) Nitrous Oxide (N<sub>2</sub>O)
86. A community near a coal power plant reports increased respiratory issues among its residents. Which pollutant from the power plant is likely causing these health problems? [1]
- (a) Carbon dioxide (CO<sub>2</sub>)
  - (b) Sulfur dioxide (SO<sub>2</sub>)
  - (c) Methane (CH<sub>4</sub>)
  - (d) Water vapor (H<sub>2</sub>O)
87. Which pollutants mainly contribute to acid deposition? [1]
- (a) Carbon monoxide and methane
  - (b) Ozone and chlorofluorocarbons (CFCs)
  - (c) Particulate matter and methane
  - (d) Nitrogen oxides and sulfur oxides
88. A(n) \_\_\_\_\_ forest is a type of forest that has never been cut down. [1]
89. The second law of thermodynamics indicates that all processes lead to the \_\_\_\_\_ of the universe increasing. [1]
90. What is the difference between a surface fire and a crown fire? Which one spreads more easily? [3]
91. On average, how many million acres of forest is lost each year in the United States? [1]
- (a) 1 million
  - (b) 2 million
  - (c) 3 million
  - (d) 4 million
92. The earth's albedo has been decreasing for the past few decades. What is the effect of this on global warming? [2]
93. Explain the positive feedback loop of the earth's albedo, adding on to question 92. [2]

94. Which of the following ecosystems would have the highest albedo effect? [1]
- (a) Dark desert soil
  - (b) Ocean water surface
  - (c) Forest canopy
  - (d) Snow-covered ice caps
95. The \_\_\_\_\_ curve shows that the concentration of CO<sub>2</sub> in the atmosphere rises each year. [1]
96. \_\_\_\_\_ occurs when excess night lighting around urban areas is added, impacting life cycles and organisms. [1]
97. Acid rain typically has a pH value of: [1]
- (a) 7.0
  - (b) 5.0 to 5.8
  - (c) 4.2 to 4.4
  - (d) 2.0 to 3.5
98. Which of the following are examples of TEK? (select all that apply) [2]
- (a) Asking a tribal elder for advice on growing native crops
  - (b) Consulting an American farmer on growing wheat
  - (c) Conduct prescribed burns in the way the indigenous people did
  - (d) Hunting animals using advice from a local hunter
99. Which of the following are toxic gases that a typical three way catalytic converter of a car would transform into harmless gases? (select all that apply) [1]
- (a) NO<sub>2</sub>
  - (b) SO<sub>2</sub>
  - (c) CO
  - (d) CO<sub>2</sub>
100. What element is commonly found in high concentrations in highly acidic soils and is generally toxic to plants? Answer with the full name of the element, not the atomic symbol. [1]
101. In one sentence, why is the element from the previous question only toxic in acidic soils? [1]
102. What is the GWP of a gas? Your response should include both what the acronym stands for and the definition of the unit. [3]
103. What is the most abundant greenhouse gas in Earth's atmosphere? Enter in your answer as a chemical formula (ex. H<sub>2</sub>O, O<sub>2</sub>). [1]
104. What is the unit of thickness of the ozone layer? Why is it not just meters or kilometers? [3]

105. What does ODS stand for in the context of the ozone layer. Enter in the plural form of the phrase with each word in a different blank. Do not separate words with a hyphen. If there is a hyphen, replace the hyphen with a space and treat the words connected by a hyphen as different words. [1]
106. Which of the following are ODSs? (select all that apply) [1]
- (a) CFCs
  - (b)  $\text{CF}_4$
  - (c)  $\text{NO}_2$
  - (d)  $\text{SO}_2$
- John marks 100 birds with a special tag and releases them back into the wild. No other birds in the population have this tag. After a year, where the birds perfectly mixed back into their population, which experiences no immigration and emigration, he collects another sample of 100 birds. In this sample, there are 15 marked birds.
107. In which of the following scenarios would the method described above be most useful? [1]
- (a) Measuring the population size of a small, local population
  - (b) Measuring the population size of a critically endangered species
  - (c) Measuring the population size of a large, dispersed population
  - (d) None of these are suitable for this method
108. What is the approximate population size using the Lincoln-Petersen method? Round to the nearest whole number. [2]
109. (TB 3) What is the approximate population size using the Chapman estimator? This will always result in a whole number, so enter that in as your answer. [3]
110. Are horizontal axis or vertical axis wind turbines more efficient? Why? [2]
111. Which of the following are disadvantages of solar power? (select all that apply) [1]
- (a) High greenhouse gas emissions
  - (b) High initial cost
  - (c) High maintenance
  - (d) Inconsistent output
112. In one sentence or less, briefly describe how binary cycle geothermal plants are different from other forms of geothermal power. [2]
113. What are the first three stages of the invasion curve? Enter each answer in its own blank in order (the first stage should be in the first blank, second in the second, and third in the third) [3]
114. Would you expect an invasive species to more often be r-selected or K-selected? [1]
- (a) r-selected
  - (b) K-selected
  - (c) Too little information
  - (d) Both

115. How does the competitive exclusion principle relate to invasive species and their typical effects on native ecosystems? [2]
116. In one sentence, what is extirpation? [1]
117. In one sentence, what is the difference between sourcing individuals *in situ* and *ex situ* in the context of reintroducing species to a region? [2]
118. In one sentence, explain how flagship species are used in conservation biology. [1]
119. What is the difference between bioaugmentation and biostimulation? [2]
120. (TB 4) Why was wind power so popular? Because they had so many \_\_\_\_\_! [0]

Thanks for taking our test! We hope you enjoyed it :)

This test was written by Kyle Yan (William Mason HS '26) and Krish Shah (Seven Lakes HS '25)

Feel free to reach out to us here:

[kyle.yan75@masonohioschools.com/kk.xy\\_](mailto:kyle.yan75@masonohioschools.com/kk.xy_) (Sections A & C)

[krishshah676@gmail.com/a\\_mallard](mailto:krishshah676@gmail.com/a_mallard) (Sections B & C)