

There should be 9 pages to this exam - take a moment and count them now. Put your name on the first page of the exam, and on each of the last few pages with short answer questions.

Please fill in your name on the front page of the bubble sheet. FILL IN THE "TEST FORM" bubble in the lower right of the bubble sheet. You have **Test Form A**

The following equations and constants may be helpful:

$$N_t = N_0 e^{rt}$$

$$dN/dt = rN(1-N/K)$$

$$dN_1/dt = r_1N_1(1-N_1/K_1 - a_{12}N_2/K_1)$$

$$dN_2/dt = r_2N_2(1-N_2/K_2 - a_{21}N_1/K_2)$$

$$dN_h/dt = r_hN_h - pN_hN_p$$

$$dN_p/dt = cpN_hN_p - d_pN_p$$

$$PV = nRT$$

$$N_t = \lambda^t N_0$$

$$N = nM/x$$

$$e = 2.72$$

$$\pi = 3.14$$

$$\ln(2) = 0.69$$

$$\ln(1) = 0$$

$$D = 1/\sum p_i^2$$

$$H' = -\sum p_i \ln(p_i)$$

$$\log S = \log c + z \log A$$

Multiple Choice: ____/23 = _____/46

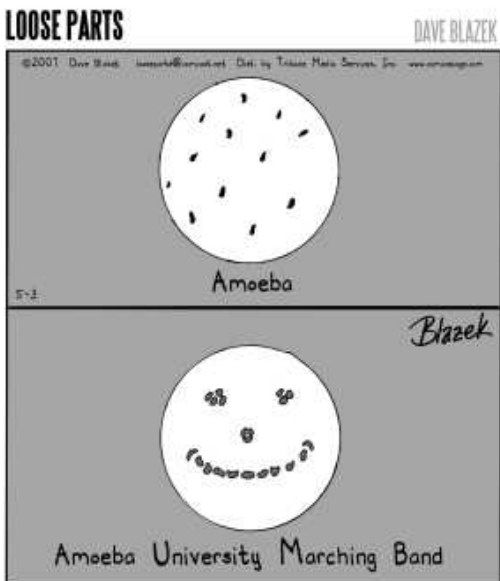
Question 24 _____/ 3

Question 25 _____/ 6

Question 26 _____/ 3

Quest. 27, Prepared essay: _____/ 15

Total _____/69



"Technically, there's nothing wrong with your husband, Mrs. Fungbar. He's just what we call ...all spruced up."

Multiple Choice questions: 2 points each. Please put your answers for this section on the bubble sheet. Feel free to use the question sheet for scratch work. Each question has only one correct answer. You will not be penalized for guessing on this section. Fill in your bubble sheet carefully. Make sure that the number of the question matches the number whose bubble you're filling in!

- 1) According to the intermediate disturbance hypothesis:
 - a) Species diversity is highest at intermediate intensities or frequencies of disturbance
 - b) Species diversity is lowest at intermediate intensities or frequencies of disturbance
 - c) Species diversity is highest in the absence of disturbance
 - d) Species diversity is highest when disturbance is both frequent and intense
 - e) Species diversity is intermediate when disturbance is intermediate

- 2) In the nitrogen cycle, which of the following is the primary means through which useable nitrogen is made available to living things?
 - a) Smelting of copper ore
 - b) Nitrogen fixation through abiotic processes
 - c) Nitrogen fixation through biotic processes
 - d) Internal cycling
 - e) Uplift of sedimentary rocks

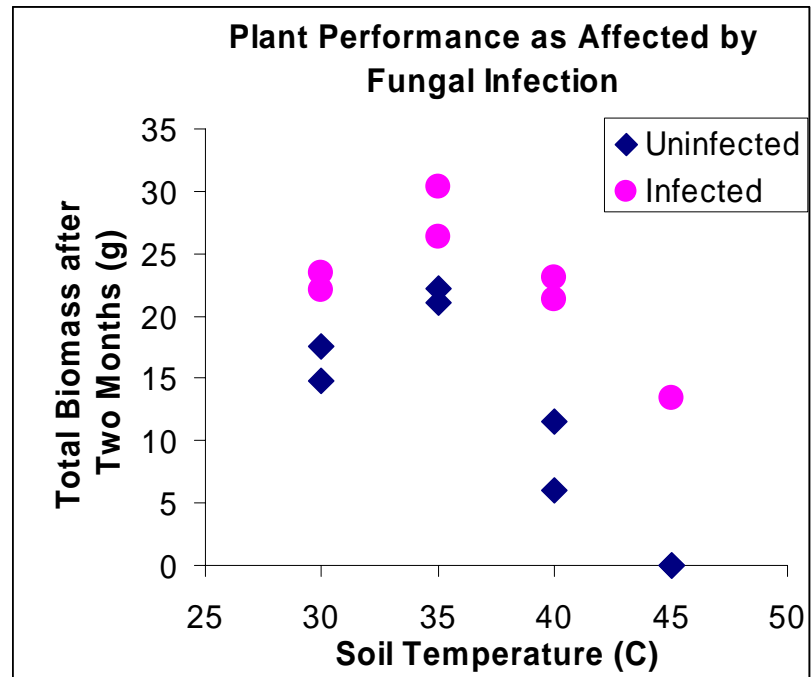
- 3) The following are examples of Mutualism: several species of cleaner fish that remove parasites from other several species of fish in exchange for food scraps, a yucca moth whose eggs that can only grow in the flower of a yucca which can only be pollinated by a yucca moth, and an animal that has in its intestine several types of bacteria necessary for digestion. In the right order, what type of mutualism is each example?
 - a) Facultative, tight, obligatory
 - b) Diffuse obligatory tight
 - c) Diffuse tight, obligatory
 - d) Obligatory, tight, diffuse

- 4) You have been employed to help assess the species diversity of the Plant Communities of the Bath Nature Preserve. Among the data you are to interpret are the following results from equal sized samples of several communities. Based on the best estimator of overall diversity, which of these communities is most diverse?

	Number of Species	Shannon-Weaver Index (H')
a. Disturbed Grassland	10	1.2
b. Disturbed Woods	13	2.2
c. Mature Grassland	98	3.9
d. Mature Woods	85	4.2
e. Wetland Scrub-Shrub	43	3.4

Yellowstone National Park is well known for being geologically active, with many hot springs and geysers. Few plants can grow in these thermally stressful environments, where the soil temperature often exceeds 40C, and goes well over 50C in the summer. Scientists were interested in the hypothesis that mutualistic fungi help plants to survive these conditions. In the November 22 2002 issue of the Journal "Science" (volume 298, page 1581) Regina Redman and her colleagues present a test of this hypothesis for "Hot Springs panicgrass" (*Dicanthelium lanuginosum*). All *D.*

lanuginosum plants growing at their field site were infected by the fungus, and the fungus was not found in the soil around the plants. When they tried to grow the fungus without the plant at 30-45C, none of the fungi survived at any temperature. When they tried to grow the plant (*D. lanuginosum*), without the fungus at 30-45C, after two months of growth they got the results shown by diamonds in the graph above. They also



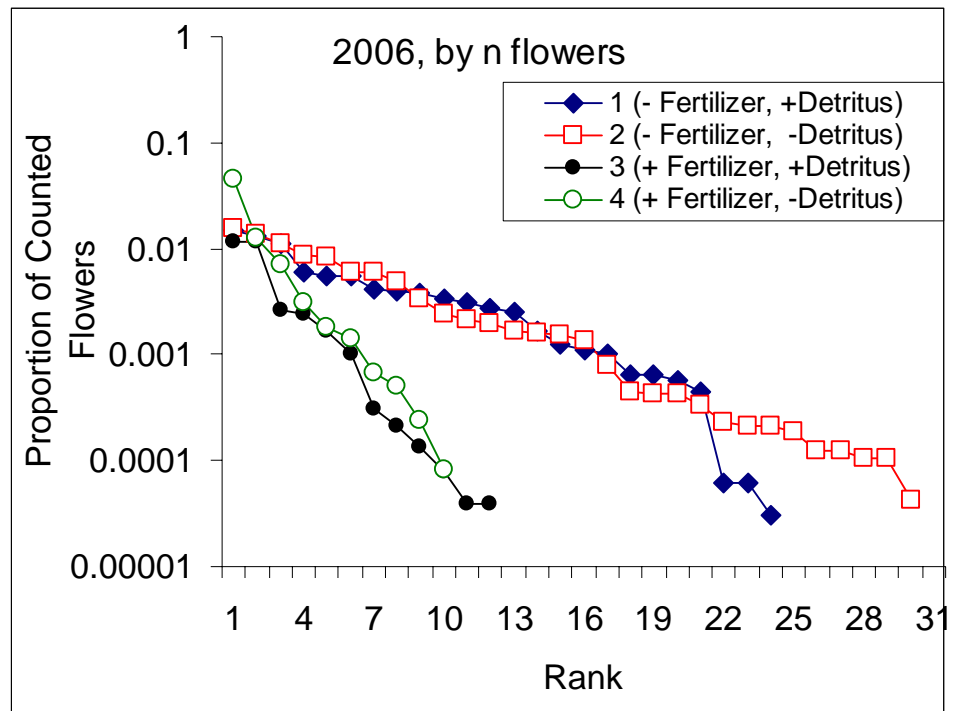
grew some plants that they infected with the fungus in similar pots at 30-45C, and got the results shown in circles above. Microscopic examination of roots confirmed that plants in the uninfected treatment had no fungus on or in them, and those in the infected treatment did..

- 5) Are the results described above consistent with the idea that there is a mutualistic relationship between this plant and this fungus?
- No, because this is a parasitic relationship
 - No, because both groups of plants did worse at high temperatures than at low temperatures
 - Yes, because the infected plants grew better at high temperatures
 - Yes, because the fungus could not grow at high temperatures without the plant
 - More than one of the above
- 6) When a fat-soluble toxin such as methyl mercury is added to an ecosystem, the pollutant is usually
- Spread equally among the trophic levels
 - Most abundant in the insects
 - Concentrated primarily in the producers, rather than in the consumers
 - Concentrated in the organisms at the highest trophic levels
 - Found equally in the aquatic and terrestrial parts of the community

- 7) Off the coast of California, Oregon, and Washington, sea otters are predators of sea urchins, and urchins eat kelp (an algae that forms undersea “forests”). In the late 1700’s and 1800’s, hunters almost completely wiped out the sea otters, allowing sea urchin populations to grow larger, and decimating (reducing) the kelp forests. Sea otters in this system act as:
- The base of the food web
 - Keystone predators
 - Biomagnifiers
 - Dominant species
 - Primary producers
- 8) In a well-sampled ecological community
- few species are extremely rare.
 - most species are very abundant.
 - few species are moderately abundant.
 - all of the above
 - both (a) and (b)
- 9) Which of the following scenarios involves an oligotrophic lake?
- While hiking in the wilds of Canada, you encounter a beautiful lake with water so clear that you can see to the bottom, with few floating or underwater plants. Its pH is near 7
 - While driving around just south of Akron, you encounter a lake that is filled with algae and other floating plants, and the water is so murky you can see only a few inches under the surface. Its pH is near 7
 - While canoeing in New Hampshire, you encounter a lake that is so clear you can see to the bottom, with few floating or underwater plants. Its pH is near 3
- 10) Which of the following usually occurs during succession?
- Increases in species diversity, and changes in species composition
 - No change in species diversity, and changes in species composition
 - Changes in species diversity, and no change in species composition
 - No change in species diversity, and no change in species composition
- 11) Which of the following statements is False?
- As energy is transferred from one trophic level to another, a lot of energy is lost to limited assimilation and respiration.
 - Annual actual evapotranspiration (AET) is influenced by both temperature and moisture.
 - Highly productive ecosystems can support an unlimited number of trophic levels.
 - Nitrogen-fixation resulting from human activity is much greater than the amount fixed by natural processes
 - In marine ecosystems, areas of highest nutrient input also have highest levels of primary production.

12) In a study At the Bath Nature Preserve, Dr. Mitchell and Dr. Pan are testing the effect of two types of nutrient treatment on the diversity of flowers available to pollinators.

For the first type of nutrient treatment, they added supplemental nitrogen-based fertilizer to some plots and not to others. For the second type of nutrient treatment, each Autumn they removed the dead plants from some plots, and not from others, reducing nutrient availability through nutrient cycling. They counted all flowers in all 6



replicate plots of each of the four treatment combination. The results are shown in the rank abundance plot above. Which treatment has the greatest Species Richness?

- Treatment 1 (- Fertilizer, +Detritus)
- Treatment 2 (- Fertilizer, -Detritus)
- Treatment 3 (+ Fertilizer, +Detritus)
- Treatment 4 (+ Fertilizer, -Detritus)
- They are all equal

13) Still referring to the Mitchell and Pan graph above, which of the following is a reasonable interpretation of their results?

- Adding fertilizer increased the diversity of flowers available to pollinators
- Removing detritus decreased the diversity of flowers available to pollinators
- Diversity is greatest in low productivity plots
- Removing detritus affects diversity more than does adding fertilizer
- Plots with detritus left in place and receiving fertilizer have more species of flowers than any other treatment

14) Paine found that removal of the starfish *Pisaster* from areas of the rocky intertidal zone of the Washington coast resulted in:

- Biomagnification
- More mutualism
- Greater species diversity
- Lower species diversity
- No change in species diversity

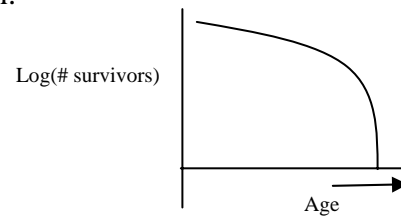
- 15) Which of the following statements is true?
- a) Two communities with the same number of species must have equal species evenness
 - b) Highly productive ecosystems can support an unlimited number of trophic levels
 - c) The amount of energy available to consumers in an ecosystem decreases at higher trophic levels
 - d) In terrestrial environments, the climax community is always forest
 - e) A community that has been carefully sampled often yields a normal distribution curve for species abundance on a linear scale
- 16) As discussed in class, an important difference between how energy and nutrients behave in an ecosystem is that:
- a) Energy moves among different compartments of an ecosystem with few losses, while nutrients are constantly lost to detritivores and recycling activities
 - b) Energy does not follow the laws of thermodynamics, while nutrients follow the laws of thermodynamics
 - c) Energy is not regenerated and retained within an ecosystem, while nutrients are regenerated and retained within an ecosystem
 - d) Energy moves through food chains, while nutrients do not move through food chains.
 - e) Energy can undergo 'biomagnification', while nutrients cannot undergo 'biomagnification'
- 17) Which of the following is the most correct answer to this question: How does the carbon dioxide content of the Earth's atmosphere now compare to that billions of years ago?
- a) It is much higher now, because of human activities that liberate carbon dioxide
 - b) It is much higher now, the earth's crust has gradually released more and more carbon dioxide through natural processes.
 - c) It is much lower now – photosynthetic organisms long ago removed the great majority of atmospheric carbon dioxide
 - d) It is unchanged – the biosphere has natural homeostatic mechanisms that maintain a very stable atmospheric composition of gases
 - e) It is much lower now, because solar radiation breaks the carbon dioxide down into hydrogen and oxygen.
- 18) Dominant species have strong impacts on community structure but are not considered 'keystone species' because:
- a) Dominant species can only be invasive
 - b) Keystone species must have impacts that are disproportionately large compared to their biomass
 - c) Dominant species are not important in community structure
 - d) Keystone species require intermediate levels of disturbance
 - e) Dominant species tend to decrease community evenness
- 19) In class, we discussed the mutualistic relationship between oxpecker birds and ungulates. This relationship would BEST be described as:
- a) Facultative and diffuse

- b) Obligatory and diffuse
- c) Facultative and tight
- d) Obligatory and tight

- 20) A scientist ecologist who studies ecology at the community level would most likely study which of the following?
- a) physiological tolerances to the abiotic environment
 - b) changes in numbers, resulting from 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) transport of energy and materials at the global scale
 - e) behavior of animals feeding at widely dispersed food sources
- 21) Which of the following areas is most likely to have the MOST species diversity?
- a) Arctic tundra
 - b) Temperate grassland
 - c) Temperate forest
 - d) Desert
 - e) Tropical forest

- 22) This survivorship curve is most likely to be found in:

- a) House Sparrows
- b) House Flies
- c) House Cats
- d) House Mice
- e) House Plants



- 23) Which of these values is closest to the current size of the human population on Earth?
- a) 0.65 billion
 - b) 6.5 billion
 - c) 65 billion
 - d) 650 billion
 - e) 6500 billion

24) **(3 points)** Why is decomposition essential for communities and ecosystems?

25) Your book suggests that diversity is related to habitat heterogeneity in a predictable way.

a) **(3 points)** Please construct a properly labeled graph demonstrating that relationship

b) **(3 points)** Now briefly explain one potential cause for this pattern

26) **(3 points)** Choose one concept you learned in this course that might be applicable to someone pursuing a career in medicine or human health. Briefly explain that concept AND how it is applicable to medicine or human health. Please use this as an opportunity to BRIEFLY demonstrate your mastery of the material.

27) **15 points.** YOUR REVIEW SHEET HAD 3 QUESTIONS YOU WERE TO PREPARE FOR. OF THOSE, THIS IS THE ONE YOU MUST ANSWER. REMEMBER: your answer should be well reasoned and well written -- outline format is not acceptable (though you may outline the answer for your own benefit on the back of another page)

Recent estimates indicate that mutualism is one of the most common of species interactions. If this new estimate is correct, how would this affect our understanding of how loss of biodiversity through extinction, habitat destruction, and other means may affect natural communities? Explain your answer.