There should be 7 pages in this exam - take a moment and count them now. Put your name on the first page of the exam, and on each of the pages with short answer questions. Please fill in the first character or two of the sections on the front of the Bubble sheet, including SS #, name, and course information (3100-217-001).

    The following equations and constants may be helpful:

$\lambda = N_{t+1} / N_t$

$R_o = \Sigma\, l_x\, m_x$

$N_t = N_o\, \lambda^t$

$N_t = N_o\, e^{rt}$

$T = \Sigma x\, l_x\, m_x / R_o$

$dN/dt = rN$

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

$dN_1/dt = r_1 N_1(1-N_1/K_1 - a_{12}N_2/K_1)$

$dN_2/dt = r_2 N_2(1-N_2/K_2 - a_{21}N_1/K_2)$

$dH/dt = rh-pHP$

$dP/dt = apHP-mP$

$PV = nRT$

$N = nM/x$

$e = 2.72$

$\pi = 3.14159$

$\ln(2) = 0.69$

$\ln(1) = 0$

$E = mc^2$

Multiple choice (17, @ 2 pts each): _____ x 2 =   _____/ 34 points

18) Essay (pre-prepared)   _____/ 15 points

19) Short Answer: _____/   2 points
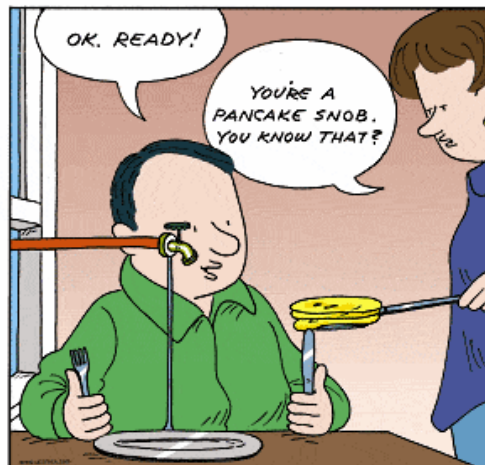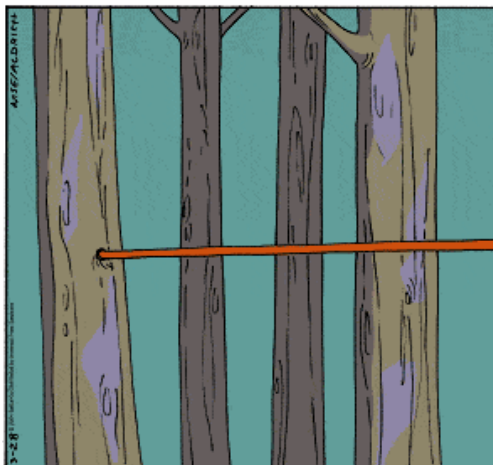
20) Short Answer   _____/   5 points

21) Short Answer   _____/   6 points

22) Short Answer   _____/   4 points

                                            _____

**TOTAL:**   _____/ **66 points**

Multiple Choice questions: 2 points each. Please put your answers to 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) A population with discrete generations is growing with λ, the population growth rate per generation = 3. If the population size now is 2 individuals, what will the population size be in 3 generations?
   a) 54
   b) $\sqrt{3}$
   c) 24
   d) 6
   e) 8
   f) 81

2) Which of these graphs demonstrates purely exponential growth?
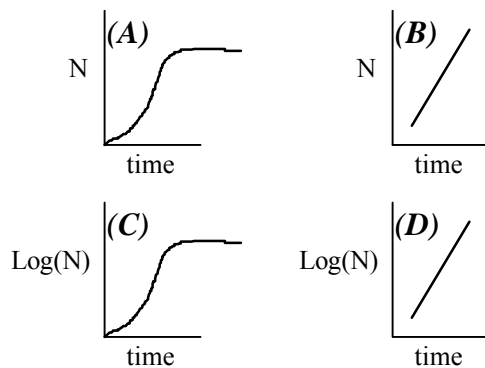
3) Which curve would apply if there is a constant death rate that is independent of age?
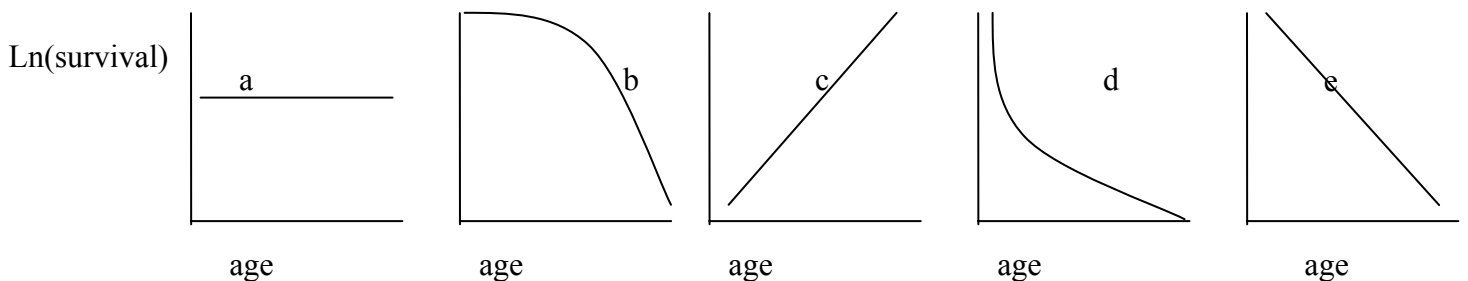
4) Imagine that you studied competition in two species. You learn that the carrying capacity for one species in 264, and that for the other species is 689. According the Lotka-Volterra competition model, which of the species will win in competition?
   a) Species one
   b) Species two
   c) They will coexist
   d) They will both go extinct
   e) There is not enough information to answer this question

5) Which of the following pieces of information would you need if you wanted to calculate the net reproductive rate (R_0)?
   a) The carrying capacity.
   b) The population size
   c) The birth schedule
   d) The survivorship schedule
   e) Both C and D

6) Your book presents results of a study of *Helicopsyche* caddisflies, in which the following results were presented:
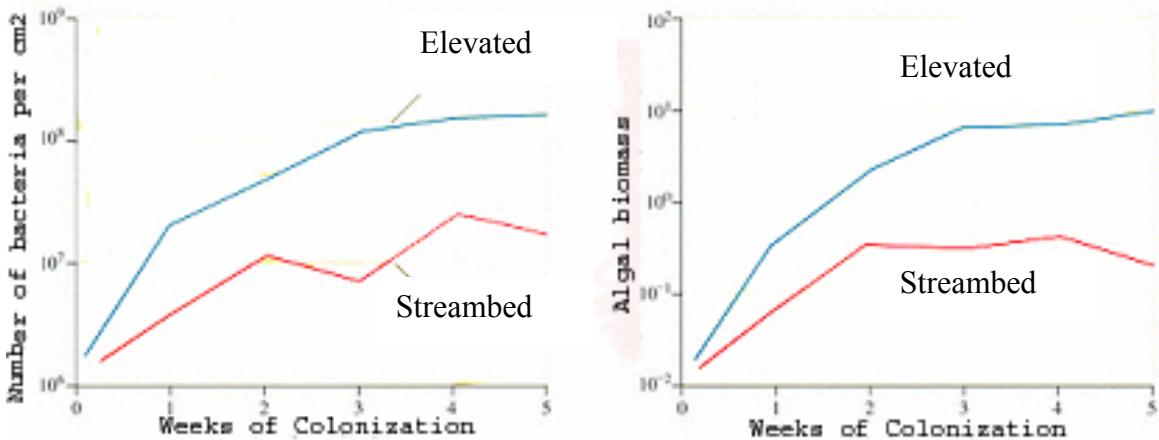
You should be familiar with this example. Remember that the caddisflies can reach the tiles on the streambed, while they could not reach those in the "elevated" treatment. The results in this figure (Figure 14.9) most clearly indicate that:
   a) *Helicopsyche* uses refuges to avoid its predators
   b) *Helicopsyche* is limited by competitors
   c) *Helicopsyche* requires the presence of mutualistic bacteria
   d) *Helicopsyche* reduces the abundance of its prey
   e) *Helicopsyche* shows a classic predator-prey cycle

7) Your book presents the following data on the number and size of eggs produced by darters (a type of fish). These data support which of the following conclusions?
   a) Darter reproductive effort increases with egg size
   b) The relationship is consistent with the principle of allocation
   c) Egg size and number are important life history traits
   d) Larger darters produced smaller eggs
   e) Gene flow between populations is greater when egg number is larger.
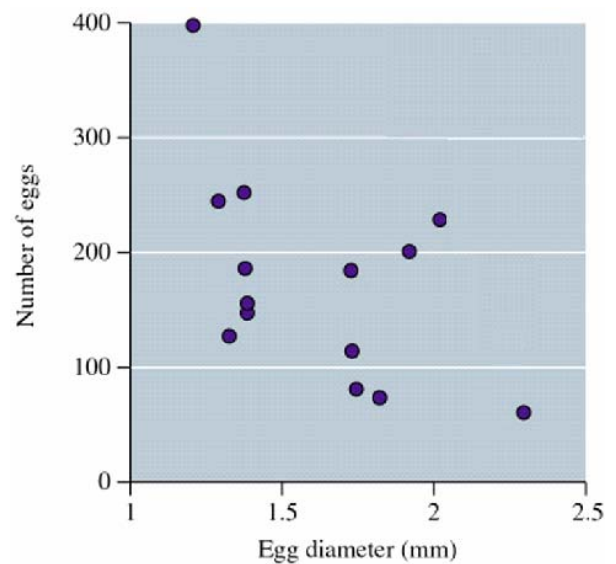
8) The difference between populations belonging to an r-selected species and those from a K-selected species is that
   a) Populations from a K-selected species tend to inhabit unstable environments
   b) Populations from r-selected species have an equilibrium density at or near the carrying capacity of the environment
   c) Populations from an r-selected species are better adapted to colonize and exploit new or disturbed habitats
   d) Populations from an r-selected species tend to increase in size exponentially in the absence of environmental restraints
   e) Populations from a k-selected species are better adapted to colonize a new environment

9) Schistosoma is a trematode worm (blood fluke) that often lives inside of humans, causing the incurable disease *Schistosomiasis*. Which of the following terms best fits this creature?
   a) Parasite
   b) Predator
   c) Competitor
   d) Mutualist
   e) Commensal

10) The Lotka-Volterra competition equations predict that two competing species can coexist if:
   a) both species inhibit each other equally
   b) each species inhibits itself more than it inhibits the other species
   c) each species inhibits itself less than it inhibits the other species
   d) each species inhibits itself more than it is inhibited by the other species
   e) each species is not inhibited by the other

11) Which of the following is an example of interference competition?
   a) Kangaroo rats and Desert Ants both feed on seeds, but at different times of day.
   b) A rust fungus causes mustard plants in the rocky mountains to produce "pseudoflowers" that attract pollinators and spread the fungus.
   c) Bumblebees drink the nectar from flowers and reduce the availability of nectar to other animals.
   d) Male damselfish patrol and defend their mating territories against other fish.
   e) Drought in the Galapagos islands reduces the availability of seeds to finches.

12) Gray Squirrels mature after their first year of life, and may live for 5-10 years. These Squirrels often reproduce many times over their lifespan. The technical term to describe this aspect of their life history is:
   a) Trade-off
   b) Iteroparous
   c) Ruderal
   d) Semelparous
   e) Age Distribution

13) If two species eat similar diets, the types of food they both consume is said to represent a region of:
a) Competitive exclusion
b) Logistic growth
c) Age structure
d) Niche overlap
e) Character displacement

14) As N approaches K for a certain population, which of the following is predicted by the logistic equation?
a) The growth rate will not change
b) the growth rate will approach zero
c) the population will show an Allee effect
d) the population will increase exponentially
e) the carrying capacity of the environment will increase

15) Which of the following equations would be most appropriate to use in predicting the number of bacteria on a petri dish? Assume that no density dependent factors were at work
a) $dN_1/dt = r_1N_1(1-N_1/K_1 - a_{12}N_2/K_1)$
b) $N_t = N_o\lambda^t$
c) $dN/dt = rN(1-N/K)$
d) $N_t = N_o e^{rt}$
e) $R_o = \Sigma\, l_x\, m_x$

16) Dispersal distances for most species resemble which of the following graphs?
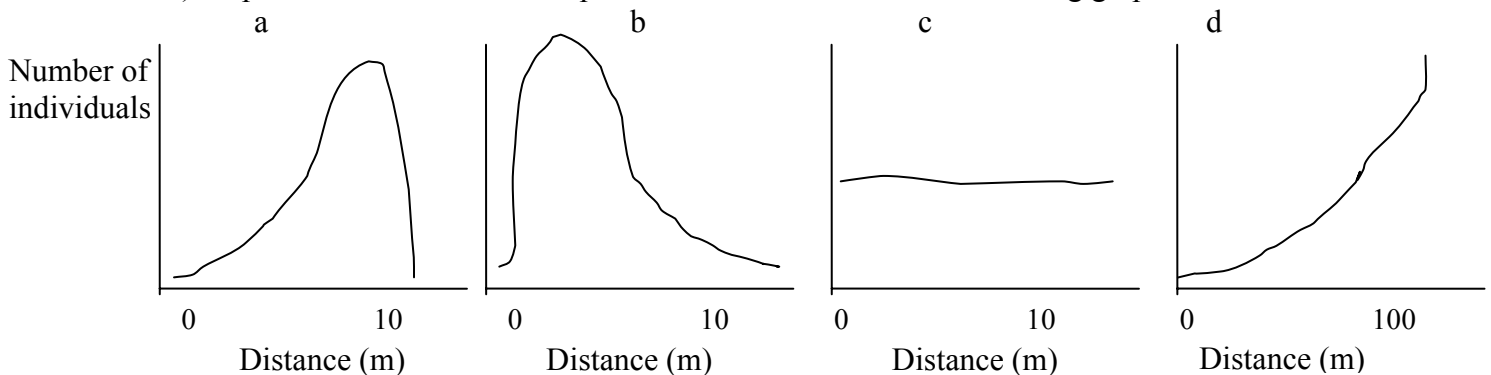
e. none of the above

17) Your book discussed which of the following as a common life-history response to low adult survival?
a) Early reproduction and more investment in reproduction
b) Later reproduction and less investment in reproduction
c) Faster growth and smaller offspring
d) The principle of allocation
e) K-selection

18) 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).*

Discuss the factors that are likely to help set the carrying capacity for white-tailed deer in the Cuyahoga Valley, and how one might determine what that carrying capacity is.

19) 2 points) Approximately how many people now live on the Earth? _____

20) (5 points). What information would be useful for predicting whether two competitors will coexist? What leads you to believe that information be important?

21) (6 points) Draw a graph that depicts the age structure of a rapidly growing human population. Be sure to label the axes clearly. Briefly explain the graph.

22) (4 points). Draw a fully labeled graph depicting the abundances of a predator and its prey over time, based on what we covered in class. Explain your graph in a sentence or two.