Midterm 3, 2016

Form A

KEY

1. An animal whose eggs hatch inside the host, then the larvae 'consume' the host from within, is called a:

(A) competitor
(B) predator
(C) parasite
(D) parasitoid
(E) herbivore

^^^^^^^^^^^^^^^^^^^^The following 2 questions are linked^^^^^^^^^^
Recently, Chipotle Mexican Grill experienced a rash of events where patrons became seriously ill after ingesting food from the restaurant. Investigations showed that the source of the food-borne illness was STEC (Shiga toxin-producing *E. coli*). Like most E. coli, this variety can grow in numbers explosively when encountering a new, uncolonized stomach environment.

2. If the effective 'birth rate' of E. coli in the gut is 8.2 cells•cell^{-1}•day^{-1} and the 'death rate' is 0.6 cells•cell^{-1}•day^{-1}, what is the intrinsic rate of increase in the explosive growth phase?

(A) -7.6
(B) 0
(C) 7.6
(D) 8.2
(E) 13.67

3. If it takes 200 billion cells to make a person sick, how long would it take for this population size to be reached, starting with consumption of a population of only 100 cells? **THIS QUESTION WAS ELIMINATED DUE TO TYPO, THOUGH IF YOU GOT IT RIGHT I COUNTED IT**

(A) 1.2 days
(B) 1.8 days
(C) 2.9 days (best answer, BUT actual number is 2.8179)
(D) 3.1 days
(E) 3.4 days
^^^^^^^^^^^^^^^^^^^^^^^^end of 2 linked questions^^^^^^^^^^^^^^^^^^^

4. λ (the finite rate of increase) and r (the intrinsic rate of increase) are related to one another, mathematically. If you are told Population A has a λ of 1.022, and Population B has an r of 0.022, which one would grow faster from the same starting N, assuming exponential population growth holds for both?

Many asked about this question. If you take ln(λ)=.02176 and compare to e=.02200, you see that the population with r=.02200 actually is growing faster. Remember that small differences can result in huge N differences over time. So, while these values are close, C is not the correct answer due to the power of exponential growth.

(A) A would grow faster than B.
(B) B would grow faster than A.
(C) A and B would grow at the same rate.
(D) A would grow faster at first, but B would surpass it later.
(E) B would grow faster at first, but A would surpass it later.

5. Based on the three doubling times observed for the human population of planet Earth between 1804 and 1999 (1 to 2 billion, 2 to 4 billion, and 3 to 6 billion), what can we say about the growth of the global human population during that period?

(A) It was slower than exponential
(B) It was exponential
(C) It was faster than exponential
(D) It was logistic
(E) It followed the Lotka-Volterra competition equations

6. The common weedy plant, dandelion (*Taraxacum officinale*), exhibits a:

(A) Deevey Type I survivorship curve
(B) Deevey Type II survivorship curve
(C) Deevey Type III survivorship curve
(D) Deevey Type IV survivorship curve
(E) none of the above

**********The following 3 questions are related**********

7. A population of gray squirrels in the Arboretum would be:

(A) the total squirrel food resources available divided by the resources required per individual
(B) the total squirrel population of Morgantown multiplied by the fraction of Morgantown that is the Arboretum
(C) the number of squirrels within the boundary of the Arboretum
(D) the number of interbreeding squirrels within the boundary of the Arboretum
(E) the total number of squirrels minus the number of newborns within the Arboretum.

8. At any one time, squirrels may be foraging on the ground, resting or sleeping in their nests, gathering nuts and seeds from tree branches, or sleeping in the canopy. If someone wanted to estimate total population size of squirrels in the Arboretum, what would be the best method? [By the way, squirrel nests are often piles of branches and leaves stuck in the crook of a large tree. And the Arboretum is 91 acres (~35 hectares). These factoids might help you decide the answer]

(A) Quadrat sampling
(B) Mark-recapture
(C) Direct counts *via* binoculars
(D) Direct counts *via* remote sensing

9. Regardless of your answer to the question above, a wildlife student sets 30 squirrel traps out at random locations in the Arboretum, and returns one day later to find she caught 20 squirrels. She outfits them with small ear tags, and lets them loose. The following week, she returns and deploys the same 30 traps and captures 15 more squirrels. Of those recaptured squirrels, five had ear tags. What is the population size estimate for the Arboretum?

(A) 6.667
(B) 60
(C) 120
(D) 180
(E) 240
**********end of 3 related questions**********

----------The following 6 questions are linked----------
Ground squirrels in Yellowstone Park have life histories similar to, but not identical to, that of gray squirrels in West Virginia. The following life table represents the life table, gleaned from years of trapping them, marking them, and following cohorts through time to measure survival and reproduction.

Age(x)	ℓ_x	s_x	b_x	F_x	lxbx	Lx	Tx	ex
0	1	.6	0	0.6	0	.8	1.64	
1	.6	.6	1	1.8	0.6	.48	0.84	$e_1=T_1/l_1=1.4$
2	.36	**0.5**	3	**0**	1.08	.27	0.36	
3	.18	**0**	0	**0**	0	.09	0.09	

Note: blanks are intentionally left that way; you may need to calculate those values to answer a question. Blank columns are there for your use in answering the questions.

10. First, what is the expected lifetime offspring production for a newborn ground squirrel in Yellowstone National Park? **R_0**

(A) 0
(B) 0.6
(C) 1.08
(D) 1.68
(E) 4

11. What is the chance of a ground squirrel surviving from age 2 to age 3? **S2**
(A) 0.36
(B) 0.5
(C) 0.6
(D) 0.18
(E) 0

12. What is the life expectancy of a 1 year old ground squirrel?

(A) 1.4 y
(B) 1.64 y
(C) 2.4 y
(D) 3 y
(E) 4.54 y

13. If a small population of ground squirrels in Yellowstone is governed by the parameters of the life table above, and there are <u>now</u> 10 newborns, 14 one year olds, 6 two year olds, and no three year olds in the population, what will the total population size be <u>next year</u>?
(A) 25.1
(B) 28.8
(C) 30
(D) 31.2
(E) 48.6

14. Given the life table above, what is <u>incorrect</u> about the transition matrix below?

$$A = \begin{pmatrix} 0 & 1 & 3 & 0 \\ .6 & 0 & 0 & 0 \\ 0 & .6 & 0 & 0 \\ 0 & 0 & .5 & 0 \end{pmatrix}$$

(A) the survival components are in the wrong place
(B) 0.5 is not the correct number
(C) the 1 and 3 are both incorrect (these should be F_x not b_x)
(D) the subdiagonal should contain the l_x
(E) nothing is incorrect; it is the appropriate transition matrix

15. While carrying out the gray squirrel study, Dr. Smith found one particularly successful squirrel he named 'Rocky' (after the character in Rocky and Bullwinkle). This squirrel had an individual survival rate of '1' at ages 0, 1, and 2, AND had a fertility of 2, 3, and 3 babies at ages 1, 2, and 3. What did this information allow Dr. Smith to determine?
(A) Rocky's propensity fitness
(B) Rocky's expected lifetime offspring production
(C) Rocky's life expectancy
(D) Rocky's reproductive value
(E) Rocky's genetic makeup

----------end of 6 linked questions----------

16. A WVU student taking Biology 221 goes home for spring break to the family farm where she grew up. She is walking around the farm pond with her grandpa, enjoying the nice spring weather, when her grandpa suddenly gets a sad look on his face. "Dewdrop [that's what he used to call her as a kid], there's something wrong with this here pond. Two years ago, we stocked it with 5000 young smallmouth bass [a local fish species], and just left them alone, hoping they would grow up and we could then reap a huge harvest of fish for the freezer, and maybe even sell some. But the local wildlife biologist came by and told us we now have wayyyy less than that, though most of the few we have left are fairly good sized. From what you've learned in your ecology class, Dewdrop, what in tarnation is wrong with our pond?"

Which would be Dewdrop's best answer (identifying the *most probable cause*), based on what YOU have learned?

(A) "Oh grandpa, I think the higher CO2 levels in the atmosphere have poisoned your fish, causing a die-off."
(B) "Oh grandpa, I suspect the chemical spill from the Kanawha river has somehow gotten into our pond. I wouldn't eat even those fish that are left!"
(C) "That's sad, grandpa. We know that UV-B radiation has increased because of the ozone hole; I suspect that is what is killing the fish."
(D) "Oh my, I suspect a bald eagle has moved into the area and has been just feeding on those fish like there's no tomorrow."
(E) "Actually, grandpa, I don't think anything is wrong with the pond. These fish are just undergoing natural density-dependent thinning according to the -3/2 thinning rule."

17. Why is the lynx-hare cycling example a poor test of the Volterra Predator-Prey theory?
(A) Lynx and hare pelts were from different parts of Canada, so the cycles were not really linked
(B) Cycles are observed in the same region, but on islands with no predators, prey populations still cycle
(C) There appears to be cycling between prey and the vegetation, which may actual be driving the population dynamics
(D) All of the above
(E) None of the above (A-C) are valid criticisms

18. Prudent predators remove a sustainable number of prey from the population, keeping their prey population size near K/2. What is the evidence that humans are generally not 'prudent predators' of ocean fish populations?
(A) The number of underexploited fish populations has declined between the 1950s and today
(B) The proportion of overexploited fish species has increased between the 1950s and today
(C) The proportion of fish species whose populations has crashed has increased between the 1950s and today
(D) All of the above

(E) None of the above (A-C)

19. If species 2 is removed from a community, and species 1's population increases, but when species 1 is removed from a community, there is no effect on species 2, we know the relationship species 1 and 2 had was:

(A) competition
(B) predator-prey
(C) mutualism
(D) amensalism
(E) commensalism

%%%%%%%%%%The following 3 questions are linked%%%%%%%%%%
Bald eagles are returning to northern West Virginia! Yay! Bald eagles nest along the edges of rivers and lakes so they can be near their 'hunting' grounds (they are primarily fish eaters). Eagle population growth in a region is determined largely by the linear length of the rivers (and dammed rivers, such as Cheat Lake) in an area like WV. As numbers of nesting eagles goes up, eagles will chase neighboring eagles off their 'territory' so that only a limited number of eagles can be found per linear mile of river. Time spent chasing neighbors exposes young to dangers in the nest and parents become less successful at raising their young due to lower food provisioning for the young as well. The following questions flow from this understanding.

20. In northern WV, the intrinsic rate of increase for Bald Eagles declines as a function of N according to the following equation: $r = 0.3 - .01N$. What is the carrying capacity of northern WV for Bald Eagles? **Solve for N when r=0**

(A) 0.3
(B) 3
(C) 30
(D) 100
(E) cannot be determined from the data given

21. If we know that northern WV contains 300 km of river, what is the territory size of one eagle, in theory? (for the time being, ignore the fact that eagles are nesting in pairs). **Use definition of K (total resources (km)/resources required per individual). Knowing K is 30, and knowing the total linear km in the habitat, we can determine resources required per individual.**

(A) 3 km
(B) 10 km
(C) 30 km
(D) 100 km
(E) 1000 km

22. If there are currently 3 nesting pairs of eagles along northern WV rivers, what will the population size of eagles be in 10 years, assuming population growth as regulated by the forces described above? **3 pairs = 6 = N_0**

Use integrated form of logistic with 'r' being the rmax (find by setting N=0 in for r=f(N).)
(A) 3
(B) 6
(C) 21
(D) 25
(E) 30

%%%%%%%%%%%%%%%%end of 3 linked questions%%%%%%%%%%%%%%

==========The following 4 questions are linked==========
As wolves have reduced elk herds within Yellowstone Park, they have increasingly relied on Bison for their food source. Indeed, there are certain packs that appear to rely on Bison alone for their food. This sets up a classic two-species Volterra predator-prey situation. The following questions surround the Bison-wolf relationship:

23. Bison are quite large, so an entire wolf pack can feed on a bison carcass for about 2 weeks, and not 'need' to take down another one for a week beyond that (3 weeks between 'kills'). A wildlife biologist calculates that the period of time from conception to birth of wolf pups is about 6 weeks. And the average number of wolves in a litter is 5. Therefore, each bison killed results in the birth of 3 wolf pups. But then, the pack also only breeds once per year, so on an annualized basis, a wolf pack will kill about 20 bison per 5 pups whelped (born). This figure allows the wildlife biologist to calculate:

(A) N_1
(B) N_2
(C) p
(D) a
(E) K

24. Looking over historical data, the wildlife biologist then wishes to determine the functional response of the predator to prey population density. She discovers that bison density has varied over time and in different parts of the park, and plots bison killed per predator per unit time (y-axis) vs. bison N, finding the following relationship: $y=0.004\ N_1$. What has she now estimated by discovering this relationship? p is the slope of the functional response.
(A) N_1
(B) N_2
(C) p

(D) a
(E) r

25. If the intrinsic rate of increase of the bison is 2 and the death rate of wolves is 0.2, what will be true if N_1=2000, and N_2=100? **Find zgi's and place N_1 and N_2 on figure; draw arrows to determine change.**
(A) N_1 will increase, and N_2 will decrease
(B) N_1 will increase, and N_2 will increase
(C) N_1 will decrease, and N_2 will increase
(D) N_1 will decrease, and N_2 will decrease
(E) N_1 will stay the same , and N_2 will stay the same

26. Based on actual observations of wolf N in Yellowstone, the theory developed by the wildlife biologist appears to be missing an important component, resulting in potential wolf N's that are far too high. What is missing from the Volterra model that could explain this incorrect prediction?
(A) prey density-dependence
(B) predator density-dependence (note; we learned about strong territoriality of wolves – when they get too high in numbers they can actually kill each other in a very intense form of intra-specific competition among packs).
(C) predator satiation
(D) the Volterra principle
(E) human predation on wolves
==========End of linked questions==========

!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!The following 4 questions are linked!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Mountain lions and Lynx are competing in Yellowstone National Park in a manner approximating the Lotka-Volterra Equations. Both have fairly large territories. In the absence of Lynx, the Mountain Lion population would be 40. In the absence of Mountain lions, the Lynx population would be 50.

27. What is the carrying capacity of Yellowstone for the Lynx?

(A) 40
(B) 50
(C) 90
(D) 2000
(E) in the absence of information about α and β, this cannot be determined.

28. Examination of fur within the 'scat' (i.e., feces) of the two cats reveals that their diets overlap only a small amount. Some snowshoe hare fur is found in both their diets, and occasional young mule deer are caught by both. Otherwise, mountain lions generally take larger prey species and Lynx eat smaller prey species. The niche overlap between the two is 20%, and is symmetrical (equal for both). What variable(s) does this allow us to estimate in the Lotka-Volterra equations?
(A) K
(B) r
(C) α
(D) β
(E) α and β

29. Given what you know about the interaction between these two, what is the long-term outcome of competition between them? **Draw rough sketch of zgi's to determine outcome.**

(A) Mountain Lions will win
(B) Lynx will win
(C) Mountain Lions and Lynx will coexist
(D) One species or the other could win, depending on initial starting N
(E) One species or the other could win, depending on r's for the two species

30. A comparison of Mountain Lion diets in northern Arizona (where there are no Lynx) and Lynx diets in Canada (where there are no Mountain Lions) shows much greater similarity in the types of prey the two species consume. What is likely to explain the lower overlap in Yellowstone?
(A) Optimal predation theory
(B) The Volterra Principle
(C) The Fundamental Theorem of Ecology
(D) Character Displacement
(E) Allee Effect

!!End of 4 linked questions!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!