Last name_____ First name_____

BIOLOGY 107 Midterm Exam Winter 2014

Before you start please write your name on the top each page!

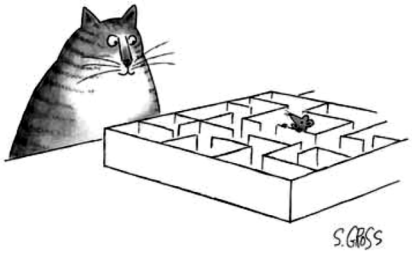
Read each question carefully before answering to ensure that you fully understand what the question is looking for. Answer the questions in sufficient detail to let us know that you fully understand the critical issues. Do not use the shotgun approach of throwing everything under the sun into your answer in the hope that something will hit the target because we deduct points for statements that are counter to the correct answer. The last page is scratch paper (work or your cartoon). 60 points. Good luck!

1. Experiments with 'risk-sensitive' foraging behavior reveal that animals sometimes "gamble".

a) Show that you understand what 'risk-sensitive' means by describing an experiment you could perform to demonstrate whether or not individual animals make 'risk sensitive' foraging decisions. What result would show that they are risk-sensitive? Be careful: we are interested in risk-sensitivity **in general** and recall there are two ways to show risk sensitivity—risk prone and risk averse—each shown by a different non-random outcome of your experiment. (5 points)

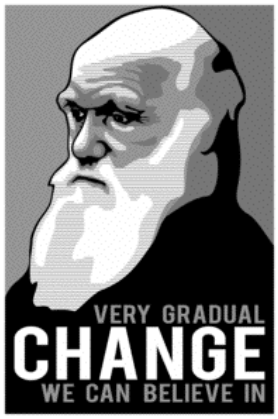
b) Would elephants make a good experimental system to study risk-sensitive foraging? Answer yes or no and then explain the logic of your answer. (2 points)

2. At time zero (t = 0) the population size of the Sneezy Weasel is 100. The annual growth rate of the Weasel population is $\lambda = 2$. What is the population size at time t = 3 years? Show the equation that allowed you to calculate your answer and show your calculations. (3 points)



"Well, you don't look like an experimental psychologist to me."

Wrong kind of risk-sensitive experiment!



Chuck E.'s in love with evolution

3. Tomorrow is Charles Darwin's Birthday!! In honor of Mr. Darwin, this question is designed to test your understanding of the process of natural selection as well as the field methods required to show natural selection in a wild population.

a) Outline the three conditions required for natural selection to occur. (3 points)

Condition

1) _____

2) _____

3) _____

b) Feral cats are introduced to an isolated island and begin to prey on the resident Island Sparrow. You suspect that this predation is causing natural selection for increased body size in the sparrow and you set out to document this selection in action. Outline exactly what you would need to do in a field study to show each of the components of natural selection outlined above: what data you would collect, how you would collect it, and what result would confirm each component of selection. Your study is an observational study (not experimental) of selection in action (just like the finches) and there is no immigration or emigration of sparrows. **Important:** the focus here is simply showing that selection for body size in the sparrow is occurring (the three parts of selection); the focus is not on figuring out what factor is causing the selection (i.e. you can ignore the cats and focus entirely on the sparrows). **Point form is preferred to full sentences**, but hit all of the key issues. (6 points)

4. Lake Humuhumunukunukuapua'a has an incredible diversity of fish, and they show remarkable variation in feeding morphology. You hypothesize that this might be an example of an **adaptive radiation**. (PS: this lake is named after a real fish, albeit a marine species!)

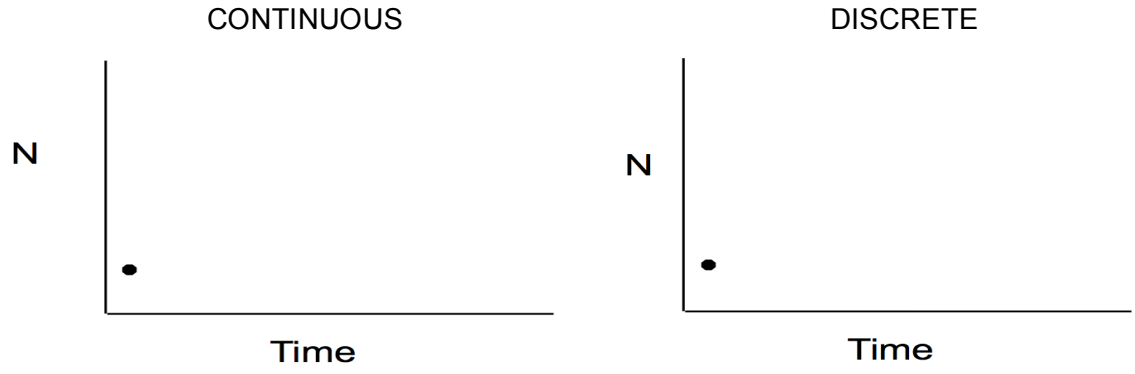
   i) What single most important information is needed to confirm that this is **an adaptive radiation** and not some other pattern of diversity that results in diverse niches (Hint: Darwin missed the boat on this key aspect in the Darwin's finch radiation). (2 points)

Yippee, I am a real Humuhumunukunukuapua'a!

   ii) Why are adaptive radiations of terrestrial organisms so often found on islands rather than the mainland? (1 point)

5. According to population models, the density-dependent effects of intraspecific competition can have very different and interesting consequences for the population dynamics of populations with discrete breeding seasons compared to populations with continuous breeding. These consequences are best illustrated by contrasting the population dynamics (changes in N over time) predicted by the continuous logistic ($dN/dt = rN(1-N/K)$) versus the discrete logistic model ($N_{t+1} = N_t + r_d N_t(1-N_t/K)$).

   a) Show on the graphs below the major difference between these models in terms of the population dynamics each model predicts when r is very high (e.g. r = 3). The dot is the initial population size and you should project the dynamics from that initial population size. (2 points)



   b) Why specifically do these two models produce such different outcomes? Don't just repeat the discrete vs. continuous difference—what is the biological mechanism that differs? (1 point)

6. Match each term on the left with one term on the right that is the BEST match and write the letter of the term in the space provided (7 points).

1. increased female body size _____
2. Cocos Island finch _____
3. Arctic Circle _____
4. Wallace's line _____
5. convergent evolution _____
6. seasons_____
7. pygmy deer & giant squirrels_____

A. random factors
B. continental drift
C. summer solstice
D. fecundity selection
E. speciation + ecological specialization
F. treeline
G. Island Rule
H. behavioral specialization
I. tilt of the earth
J. unrelated taxa that show same adaptations.

7. Match each biome on the left with the description on the right <u>that best applies to it</u> and write the letter of the description in the space provided. (4 points)

1. Tropical rainforest _____
2. Grassland_____
3. Tundra _____
4. Temperate deciduous forest_____

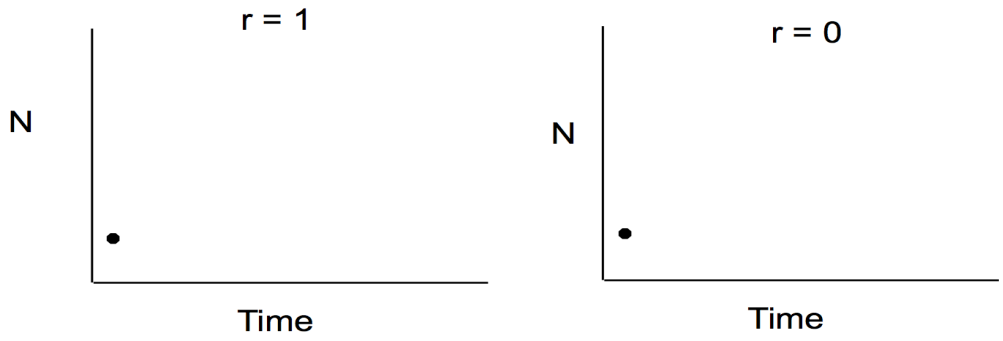
A. dramatic population cycles of mammals
B. extreme biodiversity
C. fire maintains boundary in some regions
D. spring ephemeral flowers
E. wet, warm, coniferous trees
F. treeline separates it from adjacent biome

8. The population growth rate per individual, r, is a very useful population parameter that is used in many population models.

(i) In the simplest model of exponential growth, dN/dt = rN. List two assumptions of this model (2 points)

(ii) If r = 1/day, what is r per week? (1 point)

(iii) If dN/dt = rN, what would the pattern of population growth look like on the two graphs below? The dot is the initial population size and you should project the growth from that initial population size. (2 points)



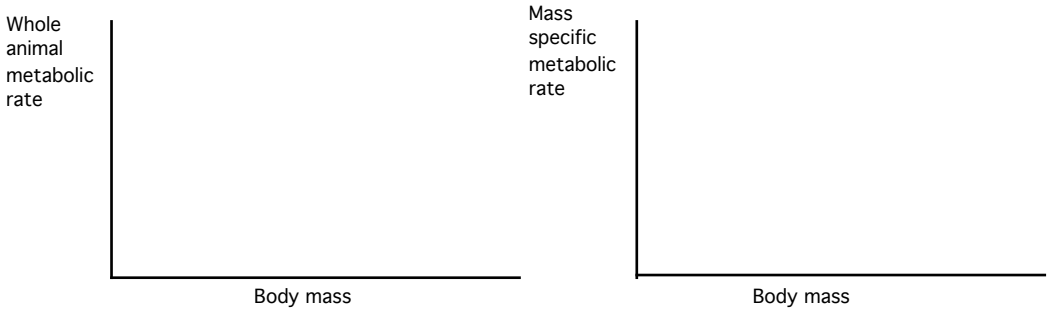
9. You are in charge of conserving the small global population of San Francisco Garter Snakes. On your annual snake counts, you notice that the population size fluctuates, and this is also reflected in your careful estimates of λ, a measure of per individual population growth rate or decline across years. In good years λ = 3.0, in bad years λ = 0.3, and good and bad years occur with equal frequency. Your colleague insists that the snake population is in fine shape because the arithmetic mean of λ is 1.15 and plugging this value into the deterministic population model shows that the population will grow over the long-term. Being a well-trained ecologist, you correct them and insist that a stochastic population model is needed here.

a) What is the fundamental difference between stochastic population model and deterministic population models? (1 point).

b) Even without running any model you can do a quick calculation with the above λ values to obtain the appropriate estimate of some sort of 'average' λ value that accurately predicts long-term prospects for the snake population. What is the name of the average needed to predict long-term population trajectory? Show the calculation that allows you to see what the population is doing. Is the population growing, stable or declining over the long-term? Explain in terms of the value of the average you calculate. (3 points)

10. Allometry is the study of how traits or factors change in relation to body size. The relation between metabolic rate and body mass, in particular, has been the focus of intense interest and a couple of key patterns have been discovered.

a) Fill in the graphs below with a line or curve to show the relation between <u>whole animal metabolic rate</u> (Kcal/unit time) and body mass (left) and <u>mass specific metabolic rate</u> (Kcal/gram/unit time) and body mass (right). Graphs are arithmetic, not logarithmic (2 points)



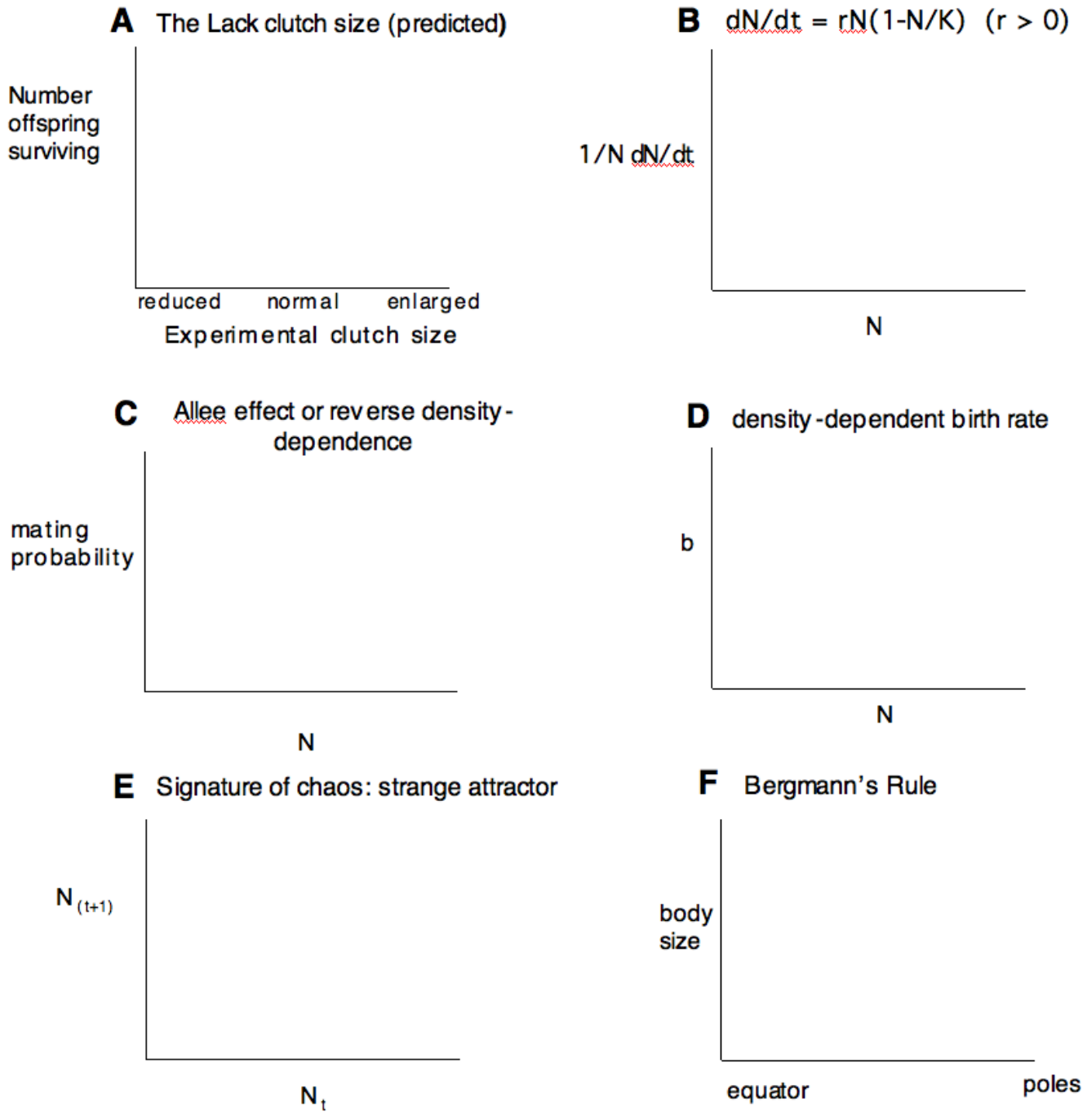
b) Two new mammals fossils have just been discovered in Alaska, an elephant and a tiny shrew-sized creature. Based on what you know about the physiological consequences of body size, speculate about (i) the expected diet differences between these two species (what they were likely to have eaten) and (ii) the risk that a three-day cold period without food would have posed to each. <u>Justify your speculation with reference to the graphs.</u> (2 points)

11. The Ideal Free Distribution is a theory about how animals should distribute themselves among patches that differ in resources. In an experiment with fish, feeding station A dispenses 5 times more food per minute than feeding Station B. If the fish reach an Ideal Free Distribution, and Station B has 10 fish, how many fish are at Station A? State the number and <u>show how you figured this out</u> (**zero points if you just state the number!)** (3 points)

"Shall we join the ladies?"

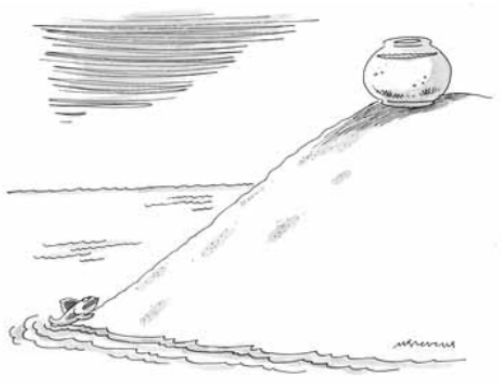
Free but not Ideal

12. Fill in each graph below with the **curves or lines** predicted by the equation or phrase at the top of the graph beside the large letters. **For B you should also add and label the Y and X intercepts.** Read the x and y axes carefully: don't jump to conclusions. (all worth 1 point except B which is worth 3 points)



Last name_____ First name_____

SCRATCH PAPER FOR ORGANIZING YOUR THOUGHTS OR DRAWING A CARTOON.
DO NOT LEAVE IMPORTANT THINGS ON THIS PAGE — WE THROW IT OUT.
Draw a cartoon to illustrate something you learned in the class and win a prize (small chocolate bar).



"What are you going to do when you become enormous?"