The exam will include 4-5 questions that you will answer mostly with short essays. Most of the questions will ask you to synthesize ideas or display facility with reasoning, rather than just spitting back jargon. Your answers should include references to examples given in class, in the book, from your own experience, or in papers we’ve read, to provide evidence that backs up your argument, and sketched graphs and diagrams may be used. Any necessary equations will be provided. The exam covers chapters 12-15 and 17-19.

The chapter review questions in the book are an excellent source of review information. While I reserve the right to incorporate all material covered in the text or in class, I think the following questions are particularly useful.

Ch. 12: 1-3, 5, 7-9. Ch. 13: 1, 3, 4, 6, 8, 10. Ch. 14: 1, 3-5, 7, 9.

Ch. 15: 1, 3-7, 9, 10. Ch. 17: 2-6, 9. Ch. 18: 1-5, 7-9. Ch. 19: 1-8, 10.

Below, I’ve also included some further review questions (in no particular order), to highlight other important information.

1. What is a ZNGI? What do they tell us? From the graphs below, identify the models that we examined describing competition, exploitation, and mutualism. In the three graphs, locate any equilibria, and tell whether they are stable or unstable. Also, for the two non-competition models, tell which species is which. Remember, the “mutualism” model describes an interaction in which one of the mutualists also exploits the other.

Match the authors to the models:

1. Lotka – Volterra  2. Rosenzweig and MacArthur  3. Holland and DeAngelis

2. Design an experiment to evaluate the relative roles of competition and herbivory as controlling factors in a meadow plant community. One possible hypothesis is that in the
absence of predation, one plant species outcompetes all others, and that predation reduces the strongest competitors and enables less competitive species to remain in the community. Assume that the community contains 20 species of plants and the prominent herbivores include several species of insect as well as elk, marmots, and mice. Remember to include controls and replicates in your experiment

3. Tilman’s R* model of resource competition is different from the Lotka – Volterra competition model because it explicitly describes the dynamics of the available resources as well as the species. Recall that the best competitor on a particular resource is that species that can reduce that resource to the lowest equilibrium level and still survive. Consider the meadow plant community described above and suppose that previous studies have shown that the meadow plants are limited by soil moisture, nitrogen, and phosphorus. In absence of predation, how many species would you expect to coexist in the long term? If you alleviated limitation of one of the resources, say by supplemental watering, under the R* theory would you expect the number of coexisting species to increase or decrease? What other factors might be affecting species coexistence in the meadow?

4. From the Jones et al. study of acorns, mice, deer, Lyme disease, and gypsy moths, we learned that important ecological interactions may be indirect. How do indirect effects complicate the classification of pairwise interactions as competitive (+/-), exploitive (+/-), mutualistic (+/+), etc.? Considering just the interaction between mice and oaks, describe the positive and negative aspects of their interactions, both direct and indirect. How would you go about quantifying the net effect of the two species on one another? How might the net effect of mice on oaks change between boom and bust years of acorn production? Which species interact only indirectly?

5. In Tuesday Lake, researchers carefully quantified average organism size, numerical abundance, total biomass, and trophic relationships among all primary producers and various invertebrate and vertebrate consumers (see figure from class notes). Among consumers, how are body size, total abundance, and total biomass related to trophic level? How might the size of a lake foodweb be affected by the size of the lake? What differences in the foodweb would you expect to see in much larger or smaller lakes? Webs like this make the transitions from species-centered trophic interactions to ecosystem level patterns of material and energy flow much clearer. However, in the context of Lindeman’s “trophic-dynamic aspect” of ecology (which is the basis of ecosystem ecology in many ways) what is missing from this web? Why are these missing links critical to understanding energy flow and material cycles in ecosystems?

6. Consider the role of species interactions in elemental cycles. What fluxes of carbon, nitrogen, or phosphorus entail interactions between species? Which species interactions (if any) stand out as particularly important for the maintenance of material cycles?

7. For each of the pairs of environments below, describe the principal factors that will determine how rates of 1) primary production and 2) decomposition will differ between the communities.
a. A temperate deciduous forest vs. a tropical savanna
b. A small headwater stream in the Appalachians vs. a broad river flowing through the central plains
c. A oak-dominated forest stand vs. an adjacent stand on very similar soils dominated by maples.
d. A lake surrounded by agricultural and residential development vs. a nearby lake of similar size surrounded by intact forest and a few cabins.

8. In central and southern Florida, there are 17 different species of oaks, and each species tends to be found in one of three different environments. Five species are characteristic of “scrub” habitats, four occur on “sandhill”, and the other eight are found most frequently in “hammocks.” The three environments differ principally in terms of soil moisture and fertility (low in scrub and sandhill, higher in hammocks) and fire frequency (which is highest in sandhill, intermediate in scrub, and low and unpredictable in hammocks).

Using Hutchinson’s niche hypervolume framework, how would you describe the fundamental and realized niches of the different species? Which groups of species would you expect to exhibit the greatest degree of fundamental niche overlap? How would you explain the coexistence of several oak species within each of the habitat types?

9. Huffaker’s predator – prey experiments demonstrated the importance of environmental heterogeneity and refugia for the maintenance of stable predator prey cycles. Be able to describe the basic components of his experiments. How do his results inform our understanding of natural predator – prey cycles like those observed among snowshoe hares and lynx? Hypothesize an environment in which you would not expect the cycles to be sustainable. How do these considerations reflect on Krebs’ food addition and exclosure experiments?

10. Describe how energy flow and material cycling are coupled in ecosystems. Which of the “big three” material cycles is most directly tied to primary production? Contrast the C:N:P “stoichiometry” of aquatic and terrestrial autotrophs. How does this difference affect the partitioning of primary productivity between the “grazing chain” and the “detrital chain”? Consider a gradient from an upland forest, through a lakeside wetland, into the open pelagic zone of the lake itself. How do changes in autotroph C:N:P effect the pools and fluxes of these elements, as well as their retention?

11. Recall the relationship between Senita cacti and Senita moths, which both pollinate flowers and consume seeds. Describe tradeoffs in the interaction in terms of the ratio of available flowers to flying moths in a particular growing season. What are the costs and benefits for each species if the ratio is high (that is, if there are many more flowers than there are moths)? Alternatively, what if there are many more moths than there are flowers? What if due to a mutation, a cactus phenotype occurred that could resist seed predation or kill the moth larva after pollination? Initially, would this “cheating” phenotype be successful? What about after a long period of time?

12. What are the links between a species life-history and it’s niche? Consider again the 17 species of oaks that populate the scrubs, sandhills, and hammocks of central and southern
Florida. Predict where the species would fall in Grime’s life-history triangle. What sorts of life-history characteristics (seed size, fecundity, longevity, growth rate, height) would you expect to see in sandhill oaks as opposed to hammock oaks? Does a life-history perspective give any further potential for understanding the coexistence of several species within each habitat?

13. A few decades ago, Paul Martin proposed the “Overkill Hypothesis,” that at the end of the last ice age, newly arrived *Homo sapiens* hunter-gatherers from Asia precipitated the extinction of the North American megafauna, including herbivores like wooly mammoths, omnivores like giant ground sloths, and top carnivores like sabre-tooth tigers and dire wolves. However, there is no evidence that humans hunted and consumed all of these species, especially the carnivores. If they did not hunt all the species, how could human hunters have driven this extinction? Compare this original discovery of the New World to Nile perch introduction to Lake Victoria.