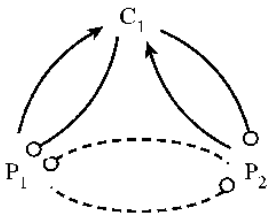
1. (2 points) In Wilson and Holdobler's 2005 article on the origin of eusociality, they argued that the following was important for the evolution of eusocial systems:
   a. individual selection
   b. kin selection
   c. group selection
   d. relatedness

2. (4 points) Draw a diagram of apparent competition. Show direct interactions with full lines, indirect interactions with dotted lines. Depict positive interactions with arrows, and represent negative interactions with circles at the end. Explain why this system is called "apparent competition".



b. Apparent competition

There is no actual direct competition going on between prey species 1 and 2, but their common predator makes an (-,-) indirect interaction between them.

3. (2 points) Explain how character displacement can be a result of competition. Use an example if this simplifies things.

Galapagos finches are more dissimilar when they live in sympatry then when they are allopatric. This seems to indicate that they evolve to be more different if they are living on the same island, competing for the same seed sources.

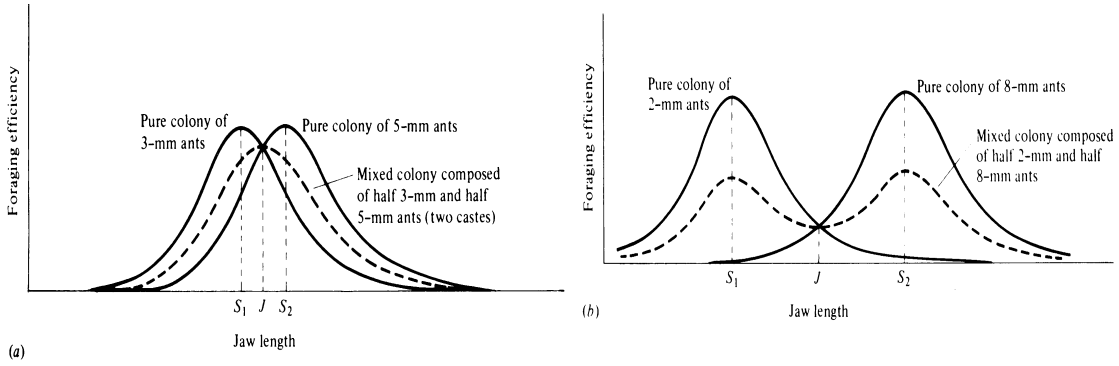
4. (6 points) Give three different dimensions of a lizard's niche. For each dimension, give an anatomical or physiological correlate.

Spatial dimension – where they live. E.g. prehensile tail
Temporal niche – when they are active. E.g. thermoregulation
Trophic niche – what they eat. E.g. head length

5. (4 points) Complete the following table.

	Sit and Wait predator	Widely foraging predator
Daily metabolic expense	Low	High
Relative clutch mass	High	Low
Learning ability	Limited	Enhanced learning and memory
Niche breadth	Wide	Narrow

6. (6 points) Explain graphically the theory of MacArthur and Levins, detailing which environments favor generalists and which environments favor specialists.



See pp. 280-282 in EE

7. (4 points) Describe an ecological experiment of your choice (Chapter 16: Paine, Connell, Menge, Dunham, Brown, Simberloff). What was an important outcome of the study you described?

See pp. 295-301 in EE

8. (6 points) Rosenzweig and MacArthur suggested a different prey isocline than the one in the Lotka Volterra predator-prey model. Describe this situation and add a very efficient predator. What kind of population cycles will you get?

See pp. 307-311 in EE

9. Explain the following or define (2 points each, total 30 pts.):

Batesian mimicry is a fundamental different interaction between species than Mullerian mimicry.

Batesian mimicry (+,-), Mullerian mimicry (+,+)

Hutchinsonian ratio

Explain and give a real-life example of a mutualism.

Complementarity of niche dimensions.

Niche overlap hypothesis

Niche compression hypothesis

Functional response of a predator to prey density

Head mimicry

Biological control

Aposematism

Clade

Independent Contrasts

Monophyly

Sister Group

Synapomorphy

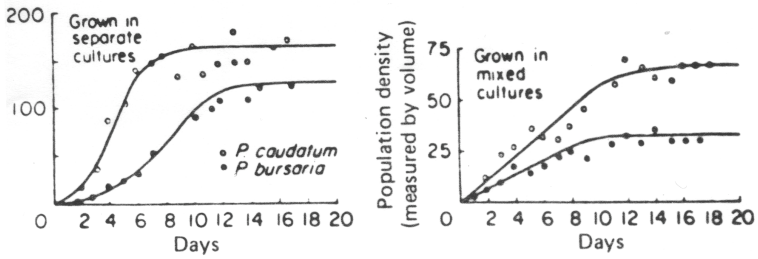
10. (4 points) What is a trophic cascade? How do top-down versus bottom-up effects vary with number of trophic levels?

An example of a trophic cascade is a food chain mutualism with a carnivore eating an herbivore, which eats plants. The indirect interaction between the carnivore and plants is mutually beneficial. With even numbers of trophic levels, top-down effects remain positive, but bottom-up effects are negative because of the odd number of negative links.

11. (6 points) Write equations for a two-species mutualistic interaction, explain all symbols, and graphically represent conditions required for an equilibrium.

See pp. 234-236 in EE

12. (12 points) Using the graphs shown below from Gause's experiments, and assuming the Lotka-Volterra competition equations, estimate competition coefficients for the interactions between *P. caudatum* and *P. bursaria*. Show and explain all your work, using standard Lotka-Volterra competition equations symbols.



$K_{caudatum} = 160$ $N^*_{caudatum} = K_{caudatum} - \alpha_{cb}N^*_{bursaria}$ $70 = 160 - \alpha_{cb}30$ $\alpha_{cb} = 90/30$
$K_{bursaria} = 125$ $N^*_{bursaria} = K_{bursaria} - \alpha_{bc}N^*_{caudatum}$ $30 = 125 - \alpha_{bc}70$ $\alpha_{bc} = 95/70$
$N^*_{caudatum} = 70$
$N^*_{bursaria} = 30$

13. (4 points) Give four examples of host altered behavior.

Rabies – virus transmitted in the saliva of biting host (caused by rabies virus)
Malaria – fever attracts mosquito vectors, coma facilitates biting and transfer
Lancet fluke – ant intermediate hosts change behavior so that they get eaten by mammals
STDs – cause nerve endings to tingle, enhancing sexual promiscuity

14. (4 points) Explain the distinction between so-called "apparent" and "unapparent" plants.

See pp. 330-332 in EE

15. (6 points) How can probable ancestral states be inferred from those of surviving extant species?

See pp. 338-340 in EE