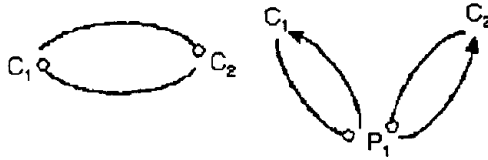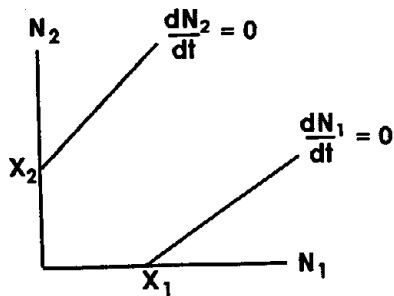1. (6 points) Why is the existence of sexual reproduction an evolutionary enigma?
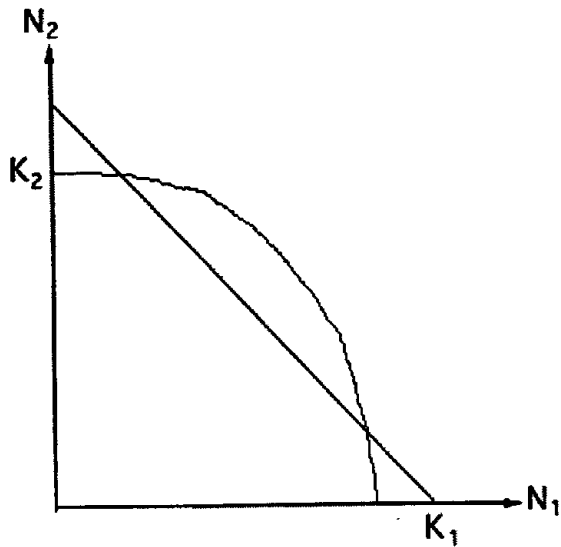

2. (6 points) Above drawings indicate two fundamentally different types of competition. (a) Name each type of competitive scenario. (b) Show all indirect interactions on the diagrams.

3. (10 points) The above diagram shows the interaction between two species, with population densities of N_1 and N_2. (a) Give the two equations that describe each isocline. Define each variable and constant. (b) using vector analysis, show where all equilibria are (both in the presence and absence of the other species). (c) Explain the results in your answer to part b.

4. (10 points) Indicate with arrows the dynamics of this competitive interaction. Using vectors, describe as fully as possible the dynamics in each of the five quadrants. Label all of the x- and y-axis intercepts and mark ALL equilibria, indicating whether they are stable or unstable. Finally, draw another diagram that describes the effects of doubling the carrying capacity of species 1 and indicate how this would change various equilibria, their stability and dynamics.

5. (10 points) Two hypothetical species obey perfectly the Lotka-Volterra competition equations and coexist. Their equilibrium population densities N_1^* and N_2^* are 200 per hectare and 100 per hectare, respectively. In the absence of the other species, species 1 reaches an equilibrium population density at 250 per hectare and species 2 equilibrates at 200 per hectare. Calculate competition coefficients. *Please show all your work.*

6. (10 points) Write the Lotka-Volterra competition equations for a competitive community composed of n species. Solve for the equilibrium population density of the i th species. *Show all steps in your work.* Use the resulting equation to explain the concept of diffuse competition.

7. (12 points) a) Draw the trophic structure of interactions depicted by the following 4-species community matrix. Be sure to label nodes and indicate the signs of all interaction arrows.

Species Affected	Species having effect			
	1	2	3	4
1	-1	-0.5	-0.2	0
2	-0.3	-1	0	0
3	0.1	0.07	-1	-0.25
4	0	0	0.15	-1

b) What effect, if any, would an increase of species 4 have on the population density of species 2? c). List all the different direct interactions present in this community.

8. (6 points) Contrast aquatic and terrestrial ecosystems in terms of trophic cascades.

9. (4 points) Describe R. T. Paine's famous ecological experiment.

10. (6 points) Two species overlap in their utilization of different resources. List and briefly summarize 3 qualitative reasons why these species need not necessarily experience interspecific competition.

11. (2 points each, 20 points total) Briefly explain each of the following:

Character Displacement

Hutchinsonian Ratios

Reciprocal Altruism

Complementarity of Niche Dimensions

Frequency Dependent Selection

Polygyny Threshold

Economic Defendability

Runaway sexual selection

Commensalism

Pseudoreplication