1. Choose ONE of the following two cases of coexistence. Briefly describe the habitat difference between the species of the case.

✓ Lorikeets (nectar parrots) of New Guinea
✓ Rat-gut parasites

Lorikeets live at different elevations from each other on New Guinea mountain ranges.

Rat-gut parasites inhabit different positions in the rat gut, some living closer to the stomach, others farther away.

2. Two species compete in a region with two kinds of habitats. I have drawn their two isolegs in the following state-space. Label the three areas of the space with the behaviors of the two species. Draw two reasonable zero isoclines. (Hint: it is easiest to begin in the central area.) Label them as to species 1 or 2. Also indicate and label the two carrying capacities.

![State-space diagram]
3. The graphs below describe the activity patterns of two species of spiny mouse in an experiment. **Tell the story (in brief) that the graphs support.**

These two species are not both active at night. *Acomys cahirinus* forages then but *A. russatus* does not. When *A. cahirinus* was removed, then *A. cahirinus* also began to forage at night. This experiment shows that competition causes the difference between the species foraging schedules.

4. MacArthur studied the foraging of five species of colorful warblers in Maine spruce forests. **Why did he do that? What did he discover?**

The species all foraged in the same trees. They all eat insects. They are all about the same size. These facts suggested that the five species could not coexist, and yet they do. MacArthur discovered that, actually, the species forage in different parts of the tree, some among the new needles, some among the old needles, in some bare areas. Also some forage radially, while others hop from branch to branch.
5. Species of competitors may coexist spatially *despite* the fact that they share a habitat preference. Define ‘habitat preference’. What kind of difference between a shared-preference pair of species may allow them to coexist.

The habitat preference of a species is the set of environments in which individuals have the highest per capita population growth rate. In a shared preference pair of species, one may have little success except in habitats that both prefer whereas the other can do fairly well even in secondary habitat types.

6. What is plant succession?

Plant succession is the phenomenon in which certain plant species are very common colonists of bare ground or recently cleared patches of ground, and these are predictably replaced by other species, which are then replaced by still others until a predictable, self-replacing climax association of species takes over.

7. Give an example — a real one — of a tolerance-intolerance or shared-preference relationship between competitors. (Do not choose gerbils or reuse any other case you discussed above.) Briefly describe the species and their habitats. What evidence demonstrates that it is a shared-preference system?

Two species of crayfish live in the fresh waters of Minnesota and Iowa. One lives in well oxygenated water and requires that water to survive. The other prefers well oxygenated water that can also live in poorly oxygenated water and that is where it is generally found. Both the shared preference for well oxygenated water and the physiological difference between the species were demonstrated in laboratory experiments involving habitat choice and survival from the stress of low oxygen concentrations.

(Many other cases are also correct.)
8. Field experiments revealed the following isoclines for two species of gerbil. Circle all equilibrium points. Fill in the circle of any equilibrium that is also a steady state. What is the meaning of the horizontal segment of one of the isoclines?

The horizontal segment of the *G. allenbyi* isocline reflects the fact that its competitor does not influence the net reproductive rate of *G. allenbyi* in that part of the graph.