

1. Draw the nitrogen cycle as it was drawn in class, with oxic above, anoxic below and reduced to oxidized inorganic forms from left to right in the middle. (15)

2. Draw the carbon cycle as it was drawn in class, with oxic above, anoxic below and reduced to oxidized inorganic forms from left to right in the middle. (15)

3. Describe a Winogradsky column, and how it illustrates that Precambrian life may have been driven by sulfur cycling. (10)

4. Why is a chemostat useful in the determination of long-term physiological effects of toxins on growing microorganisms, and why is a spring more like a chemostat than a river? (10)

5. If you fertilize a lake with phosphorus alone for a number of years, why will there eventually be massive concentrations of cyanobacteria, even in the absence of nitrogen fertilization? (5)

6. Why would one attempt to bioremediate excessive nitrate in groundwater by pumping in organic C and why might this ultimately lead to problems with water taste related to sulfide odor or appearance problems related to flocculent iron precipitates? (10)

7. Draw the Monod equation that relates growth to nutrient concentration for a low-nutrient and a high-nutrient species. Label μ_{\max} and K_s for both species, and briefly describe the tradeoffs involved in each strategy. (15)

8. Phosphate is remineralized more rapidly from dying cells than silicon is in the ocean. Why should this lead to more rapid loss of silicon than phosphorus from the surface waters of the ocean? (5)

9. Unsaturated (all pore spaces not filled with water) wetland soils have much higher rates of gas exchange than waterlogged wetland soils, but methane production rates are much lower in the unsaturated soils, why is this? (5)

10. Why are microbial diversity and biogeochemical cycling often very high around anoxic/oxic interfaces? (10)