

1. A stratified 25 m deep lake in the summer has an epilimnion that is 20°C and a hypolimnion that is 8°C. The metalimnion is from 10 to 15 m. Draw a graph of the temperature profile with the depth on the Y axis with 0 at the top of the axis and 25 m at the bottom. On the X axis label temperature. On a second X axis label density. Draw the line representing temperature and label each of the 3 stratified layers. Draw a second line (dashed) of density with depth (15).
2. Who was G. E. Hutchinson (5)?
3. Give 5 reasons water is valuable to humans (5).
4. What proportion of the water that is temporally and spatially available does humankind currently use (5)?
5. Why is the density of water at exactly 1 g/cm³ at 3.98°C (5)?
6. Describe how a bacterium experiences viscosity, inertia, turbulence, and Re differently than a large fish swimming in the water (8).
7. Why do projections on a small organism lower sinking rate and increase inward diffusion rate (5)?
8. Assume it costs a macrophyte (submerged plant) energy and nutrients to synthesize a chemical that retards growth of epiphytes that grow on its leaves and compete with it for light and nutrients. An investigator finds that this chemical is released when the macrophyte lives in still water, but not when it lives in flowing water. Why might the macrophyte not release the chemical in flowing water (5)?
9. What do temperature increases and mixing of a fluid do to diffusion rates and which has more of an effect (5)?
10. Provide the term for the following definitions (10)

- _____ Zone above water table which has very low moisture content
 _____ Zone above water table where water moves up along sediment particles by capillary action
 _____ An aquifer with impermeable layers above and below
 _____ An aquifer with impermeable layers scattered though it
 _____ The process of water moving down through soil into an aquifer
 _____ The zone of shallow groundwater influenced by the stream
 _____ A topography characterized by very rough land surface that resulted from limestone dissolution
 _____ Plants that grow above the surface of water in a wetland
 _____ A wetland near a river
 _____ An aquifer that lies under the Great Plains that is being heavily depleted

11. Fill in the following table for 3 types of lakes (12)

Attribute	Oligotrophic	Mesotrophic	Eutrophic
Total light attenuation	low		
Total light transmission		medium	

Color of a white object at 10 m depth			
Color of lake			
Relative productivity			high

12. Describe (or draw) the process of formation of an oxbow lake (5)
13. Why are floods more intense with urbanization and channelization (5)?
14. What is the process that forms the very oldest lakes, and what are the two types of lakes formed by this process (5)?
15. Why would you expect Langmiur currents to be larger and rates of entrainment to be greater in lakes with longer fetches (5)?

1. Draw the nitrogen cycle as presented in class on the back of this page (15)
2. Complete the following table (20)

Organism	Characteristic
	Glass Frustule (shell)
Mollusca	Shell made of _____
	Infective RNA or DNA
	What was formerly the prokaryotes now includes this group and the Bacteria
	Gas vesicles, heterocysts, akenites
	Forms toxic blooms such as the red tide
	Motile protozoa with many flagella
	A fungi that is symbiotic with an alga
Nematoda	Can be eaten by a _____ that makes traps
	Plant that grows from below to above the water
	Invasive mollusk
<i>Daphnia</i>	Resistant structure that contains eggs called _____
	Uses lures to get fish to transport glochidia
	Mayflies
	Make case from materials taken from environment
	Group that includes crayfish and ostracods
	Tetrapod group declining world wide because of habitat destruction, UV radiation, chitrid fungal infection
	Group includes jellyfish and <i>Hydra</i>
	Organism that is “self feeding” using either chemical or light energy
	Crustacean that has a larval stage called a nauplius

3. Draw the carbon cycle as presented in class on the back of this page (15)
4. Describe how rRNA can be used to make taxonomic differentiations, and why some parts of the molecule can be used to differentiate closely related organisms

- and other parts of the molecule only vary as related to differences at the most broad levels of taxonomic divergence (5)
5. If you added large amounts of iron to a lake, why would both phosphate and sulfate concentrations decrease (5)?
 6. Why do invasive species sometimes increase α diversity but tend to decrease β diversity (5)?
 7. Why do tectonic lakes have many species (5)?
 8. What is the expected relationship between island area and species diversity and to what types of organisms does it apply (5)?
 9. Why are high levels of nitrate harmful to humans (5)?
 10. What is the most important cause of species extinctions and what types of species are most susceptible to extinction in the United States (5)?
 11. Give the equations for photosynthesis and respiration (5)
 12. What are the photosynthesis-irradiance characteristics of a low-light adapted photosynthetic organism (5)?
 13. Why are fish kills most likely in lakes and rivers in the summer early in the morning (5)?

Biology 612 Limnology Fall 2004 Exam 3 Name _____

1. Fill in the blanks (10). There are complex interactions among *Cladophora*, its epiphytes, and grazers of those epiphytes. The *Cladophora* is N limited, but some of the epiphytes are not, they include *Ephithemia* that have an endosymbiotic cyanobacterium that _____. The epiphytes may have a positive effect when _____ is high by alleviating photoinhibition, but a _____ effect when light is low. The epiphytes _____ flow through the *Cladophora*, interfering with diffusion of nutrients. They do this because they make the spaces between the filaments smaller and they _____ Reynolds number which _____ viscosity. Grazers remove epiphytes but eat _____ if the epiphytes are gone. The activities of grazers also _____ sediments that may clog *Cladophora*. The grazers living in the *Cladophora* receive protection from _____ and this is a benefit, as well as the *Cladophora* providing a place for _____ to grow. This is a complex interaction, but the grazers probably have net positive effects on the *Cladophora* and vice versa.
2. In a modern sewage treatment plant, such as the one in Manhattan, list the functions of primary, secondary and sludge (solid) treatment. Also list the function of tertiary treatment (though Manhattan does not have it) (10).

3. Fill in the table on the effects of decreased pH from acid rain (10).

Organism	Effect	Mechanism
Trout	Reduced reproduction in spring, even in watersheds with buffered soils	
Fish	_____ damage	Increased aluminum
Mollusks	Complete extirpation below pH 5.5	
Filamentous green algae		Moderate acidity changes community
Phytoplankton		Moderate acidity changes community
Microbes	Degradation of low molecular weight organic compounds	
Microbes	Degradation of high molecular weight organic compounds	
Fungus	Rates relative to bacterial degradation	
Waterfowl	Breeding fails	
Metals	Toxicity increases	

4. What adaptations are necessary for organisms to successfully utilize temporary waters (5)?
5. What nutrients most often limit productivity in freshwaters, and how do we know this (5)?
6. Describe Hutchinson's Paradox of the Plankton and how the "paradox" might not be a paradox after all (10).
7. Contrast the recoveries of Lake Trummen and Lake Washington, with particular reference to why much more drastic methods were required to recover Lake Washington (10).
8. Why does *Mysis* decrease Kokanee (land locked salmon) production in Flathead Lake (5)?
9. For *Daphnia*, plot algal (food density) on the x axis. Plot both the rates of filtering and the rate of particle ingestion on the y axis. Explain the shapes of the two curves (10).
10. List 5 adaptations that organisms can evolve to avoid predation (5).
11. How can stable isotopes of carbon and nitrogen be used to establish feeding relationships, and what advantage does this technique have compared to gut analyses (5)?
12. Why does trophic manipulation not always decrease primary production in small ponds even though it causes decreases in the phytoplankton community (5)?
13. Describe seasonal succession in a temperate dimictic lake (10).

Biology 612 Limnology Final Fall 2004 Name _____

1. Draw the nitrogen cycle as presented in class (10)
2. Give the equations for photosynthesis and respiration (5)
3. Fill in the following table about the expanded view of the River Continuum Concept (10)

Attribute	Stream order	Effect
P:R ratio	Headwater vs mid order	
P:R ratio	Mid order vs. large river	
Shredders		Highest numbers
Electrical or chemical sensory feeding fish	Large river	
Amount of leaf litter input		maximal
Flood abruptness	Headwater vs. large river	
Sediment characteristic (diameter)	Headwater vs. large river	
Phytoplankton	Headwater vs. large river	
Zooplankton	Headwater vs. large river	
Flood pulse concept	Headwater vs. large river	

4. Describe why southeastern Asian fish culture practices are so efficient (5)
5. What are some special characteristics of cyanobacteria that make them successful and why do they tend to be a nuisance (5)?
6. Why are fish imperiled in Lake Victoria (5)?
7. How does the fundamental response to pollutants such as phosphorus and organic toxins differ (5)?
8. Describe the process of stratification over a year in a dimictic 30m deep lake (you may use graphs 10)
9. What process forms the most lakes in temperate areas and what process forms the oldest lakes (5)?
10. Even though iron precipitates phosphate, why would it be a bad idea to add iron sulfate to a lake to lower eutrophication (5)?
11. Why are wetlands a globally important source of methane, even though they have ample numbers of methylotrophic bacteria in the upper, oxic part of their sediments (5)?
12. Zebra mussels have just been found in Kansas, what associated problems are expected (5)?
13. Why might controlling fishing for large fish decrease algal blooms in some large deep mesotrophic lakes (5)?
14. What do water striders and the capillary zone in groundwaters have in common (5)?
15. Why does organic carbon build up in *Sphagnum* wetlands, even to the point of preserving corpses that fall into the cold bogs (5)?
16. How are diatoms used in forensic science (5)?
17. Why does drag increase when net spinning caddis flies make finer mesh nets (5)?