

Oceanography 320  
Mid-term Examination  
October 20, 2003

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Name

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Social Security Number

- 1) Classify the following transformations as being examples of either primary production (P) or secondary production (S)
  - a) Conversion of plant biomass into animal biomass by herbivores
  - b) Conversion of CO<sub>2</sub> into organic carbon via photosynthesis
  - c) Conversion of CO<sub>2</sub> into organic carbon by chemosynthetic bacteria
  - d) Conversion of detrital organic matter into animal biomass by detritivores
  
- 2) The ecological efficiency in a food chain is 20%. Pollutant X is transferred from one trophic level to the next in the food chain with an efficiency of 60%. If the concentration of pollutant X on trophic level 2 is 3 parts per million (ppm), what would you expect the concentration of X to be on
  - a) Trophic level 1
  - b) Trophic level 4
  
- 3) During the winter in a temperate latitude lake, the consumption of organic matter exceeds the production of organic matter within the mixed layer for which one of the following reasons
  - a) The mixed layer is deeper than the critical depth
  - b) The euphotic zone is deeper than the mixed layer
  - c) The critical depth is shallower than the euphotic zone

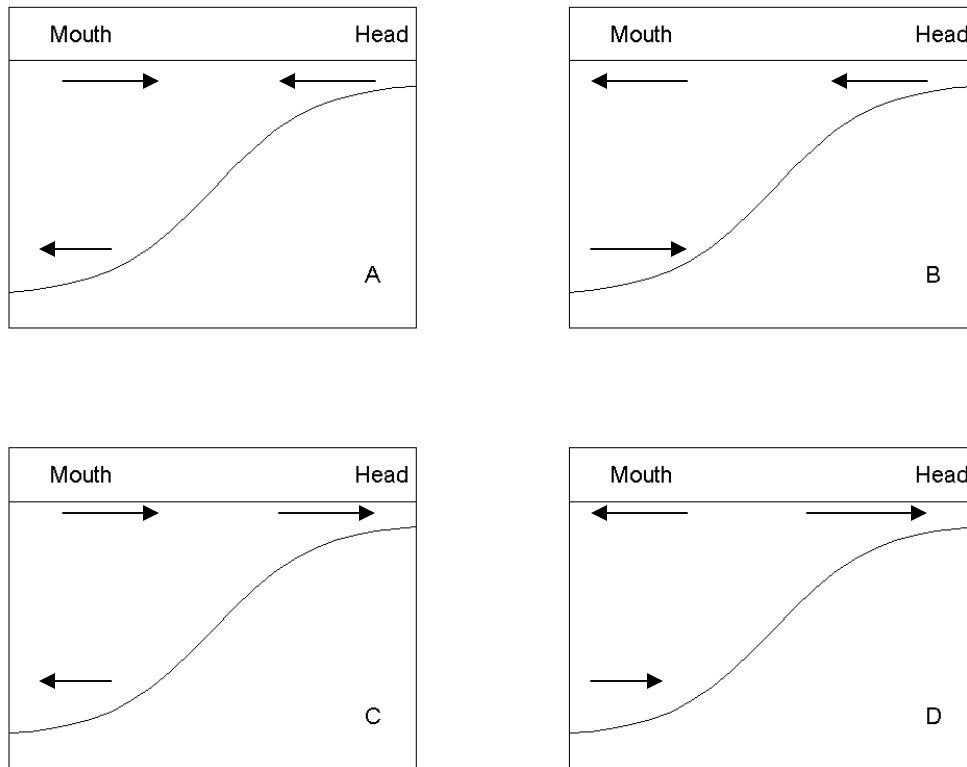
- 4) Which of the following might logically be cited as evidence that photosynthetic production of organic matter has exceeded respiratory consumption of organic matter on a geologic time scale?
- a) Oil deposits
  - b) Coal deposits
  - c) O<sub>2</sub> in the atmosphere
  - d) All of the above
  - e) None of the above
  - f) Only a and b
  - g) Only a and c
  - h) Only b and c
- 5) Precipitation more effectively removes phosphorus from lakes than the ocean because
- a) the concentration of calcium is higher in the ocean than in lakes
  - b) the concentration of iron is higher in lakes than in the ocean
  - c) the pH of the ocean is higher than the pH of most lakes
  - d) the ocean is much deeper than lakes
- 6) Nitrogen fixation is much more common in lakes than in the ocean because
- a) the concentration of calcium is higher in the ocean than in lakes
  - b) the concentration of iron is higher in lakes than in the ocean
  - c) the pH of the ocean is higher than the pH of most lakes
  - d) the ocean is much deeper than lakes
- 7) The fact that Lake Washington is a monomictic lake implies that
- a) The epilimnion (mixed layer) extends to the bottom of the lake
  - b) The salinity of the lake's water is greater than 24.7‰
  - c) The temperature of the lake is less than 4°C in the winter
  - d) The temperature of the lake is greater than 4°C in the winter

- 8) By adding nitrogen and phosphorus to the water, Canadian scientists were able to produce massive blooms of phytoplankton in experimental lakes in Canada despite the fact that the concentration of inorganic carbon in the water was much too low to produce an algal bloom. Where did the inorganic carbon come from to produce the blooms of phytoplankton?
- a) Discharges of wastewater from sewage treatment plants
  - b) Bicarbonate stored in the sediments of the lakes
  - c) Carbon dioxide in the atmosphere
  - d) Dissolution of calcium carbonate deposits

Wastewater with a N:P ratio of 45 is entering a lake. The N:P ratio of the algae in the lake is 15. The wastewater is the only significant source of nutrients for the lake.

- 9) What will happen to the algae in the lake if the N in the wastewater is reduced by a factor of 12?
- a) Reduced by a factor of 12
  - b) Reduced by a factor of 4
  - c) Reduced by a factor of 3
  - d) No change
- 10) What will happen to the algae in the lake if the P in the wastewater is reduced by a factor of 12?
- a) a Reduced by a factor of 12
  - b) Reduced by a factor of 4
  - c) Reduced by a factor of 3
  - d) No change

- 11) What will happen to the algae in the lake if the N in the wastewater is increased by a factor of 12?
- a) Increased by a factor of 12
  - b) Increased by a factor of 4
  - c) Increased by a factor of 3
  - d) No change
- 12) What will happen to the algae in the lake if the P in the wastewater is increased by a factor of 12?
- a) Increased by a factor of 12
  - b) Increased by a factor of 4
  - c) Increased by a factor of 3
  - d) No change
- 13) At the peak of eutrophication, summer chlorophyll concentrations in Lake Washington were about ten times higher than the highest summer chlorophyll concentrations in Lake Erie, yet Lake Washington never experienced late summer anoxia. Late summer anoxia was a common occurrence in Lake Erie. An explanation for this difference is
- a) Lake Washington was N limited, and Lake Erie was P limited.
  - b) Lake Washington is about twice as deep as Lake Erie.
  - c) Lake Washington is monomictic, and Lake Erie is dimictic.
  - d) Lake Washington was polluted primarily by sewage, and Lake Erie was polluted primarily by land runoff.
- 14) The figure on the next page shows a cross section of an estuary, and the arrows indicate the direction of the currents in the surface and bottom waters. Which set of current vectors (arrows) correctly depicts the classic estuarine circulation pattern?
- a) A
  - b) B
  - c) C
  - d) D



15) The development of late summer anoxia in the hypolimnion of Lake Erie's central basin has frustrated attempts to reduce phosphorus loading to the lake because

- Organic matter decomposes more slowly under anoxic conditions.
- Nitrate is reduced to ammonium under anoxic conditions.
- Nitrate undergoes denitrification under anoxic conditions.
- Ferric iron is reduced to ferrous iron under anoxic conditions.

16) Although diversion of sewage discharges from Lake Washington resulted in a roughly tenfold reduction in chlorophyll concentrations, rates of oxygen consumption in the hypolimnion of Lake Washington were almost the same before and after sewage diversion. A logical explanation for this is

- Prior to sewage diversion, much of the algal biomass was accounted for by filamentous cyanobacteria that were unpalatable to herbivores and decomposed in

the surface waters of the lake. After sewage diversion, the algal biomass was dominated by diatoms, which were consumed by herbivores. The herbivores' waste products sank into the hypolimnion and decomposed there.

- b) The lake was N limited prior to sewage diversion and P limited after diversion of the sewage
  - c) The improvement in water clarity after sewage diversion allowed sunlight to penetrate into the hypolimnion
  - d) Land clearing in the watershed following the diversion of sewage resulted in large amounts of nitrogen entering Lake Washington from the Cedar River.
- 17) The two biggest water quality problems associated with land runoff are
- a) Heavy metals and suspended solids
  - b) Fecal pathogens and nutrients
  - c) Suspended solids and nutrients
  - d) Fecal pathogens and heavy metals
- 18) Within the context of sewer systems, what is meant by the term stranded filth?
- 19) Which of the following is more effectively leached from exposed soils by rainwater runoff?
- a) Nitrate
  - b) Phosphate
- 20) In Tallahassee, Florida, rainfall is very seasonal. During the summer, rains occur almost every day. During the winter rainfall is infrequent. During which time of year, summer or winter would you expect the first flush effect to be most apparent?
- a) Summer
  - b) Winter

21) In the Lake Jackson study, rainfall on the urban forested watersheds was virtually identical, but runoff was about 50% higher from the urban watershed. How would you account for the higher runoff from the urban watershed?

22) A number of strategies have been suggested to reduce pollution of the Ala Wai Canal caused by land runoff. Which of the following strategies is designed to address this problem by routing more water into the ground? More than one answer may be correct.

- a) Groundwater recharge basins
- b) More frequent street sweeping
- c) Use of porous or modular pavement
- d) Use of filter strips on storm drains

23) In the United States, federal law requires that secondary sewage treatment remove at least

- a) 30% of the BOD and 30% of the suspended solids
- b) 30% of the BOD and 85% of the suspended solids
- c) 85% of the BOD and 30% of the suspended solids
- d) 85% of the BOD and 85% of the suspended solids

24) How would you account for the fact that standard primary treatment removes about twice as much of the suspended solids as BOD from raw sewage?

25) Activated sludge wastewater treatment plants generally remove a slightly higher percentage of the BOD and suspended solids from raw sewage than do trickling filter plants because

- a) Secondary sludge is more effectively separated from the water in the secondary clarifier of an activated sludge plant
  - b) Organic matter is more efficiently oxidized in the secondary treatment step of an activated sludge plant
  - c) Primary sludge is more effectively separated from water in the primary clarifier of an activated sludge plant
  - d) Organic matter is more efficiently decomposed in the anaerobic digester of an activated sludge plant
- 26) From the standpoint of water pollution, land application (e.g., spray irrigation) of the liquid portion of sewage effluent is constrained by which one of the following issues
- a) Accumulation of phosphate in groundwater
  - b) Accumulation of ammonia in groundwater
  - c) Accumulation of heavy metals in groundwater
  - d) Accumulation of nitrate in groundwater
  - e) Accumulation of pathogens in groundwater
- 27) Which of the following methods of tertiary treatment does not involve raising the pH of the water
- a) Denitrification
  - b) Ammonia stripping
  - c) Phosphate precipitation with calcium
- 28) Which two of the following pathogens are not effectively killed by chlorination because they produce encysted eggs?
- a) *Shigella* and *Salmonella*
  - b) *Giardia* and *Cryptosporidium parvum*
  - c) The hepatitis A and Norwalk viruses
  - d) *Vibrio cholerae* and *Campylobacter jejuni*

29) Why is the use of ultraviolet light to kill pathogens a viable alternative to chlorination in wastewater treatment but not in the treatment of public water supplies, i.e., drinking water?

30) Which of the following pathogens should be a concern to people who go wading in streams in Hawaii?

- a) *Leptospira*
- b) Hepatitis A virus
- c) *Vibrio cholerae*
- d) *Salmonella*

31) Which of the following is not a reason that the Sabin polio vaccine is preferred over the Salk vaccine?

- a) Persons vaccinated with the Sabin vaccine can vaccinate other persons via person-to-person contact
- b) The Sabin vaccine is cheaper than the Salk vaccine
- c) There is no change of the Sabine vaccine's causing a case of polio in a person who receives the vaccine
- d) The Sabin vaccine can be administered orally

32) Which one of the following indicator organisms is currently recommended by the EPA to determine whether water is polluted with fecal pathogens?

- a) Total coliforms
- b) *Enterococcus*
- c) Fecal coliforms
- d) *E. coli*
- e) *Clostridium perfringens*

33) When chlorine is used to disinfect water, the effective killing agent is

- a)  $\text{Cl}_2$
- b) HOCl
- c) HCl

34) The table below lists concentrations of four toxic substances and their associated 96-hr TLM and acute chronic ratios. Complete the table by calculating the number of chronic toxicity units of each toxic substance.

Toxic substance	Concentration	96-hr TLM	Acute/chronic ratio	Chronic toxicity units
W	5	500	10	
X	10	500	10	
Y	15	750	5	
Z	20	500	5	

35) If the water in question 34 is found to be exerting a chronic stress, which of the following may characterize the nature of the interactions between the toxic substances in the water?

- a) Antagonistic
- b) No interaction
- c) Infra-additive
- d) Strictly additive
- e) Supra-additive

36) If the water in question 34 is not exerting a chronic stress, which of the following may characterize the nature of the interactions between the toxic substances in the water?

- a) a) Antagonistic
- b) No interaction
- c) Infra-additive
- d) Strictly additive
- e) Supra-additive

37) Assume that a person drinks two liters (2 kilograms) of water per day and consumes on average 17.7 grams (0.0177 kilograms) of fish and shellfish per day. Both the drinking water and the fish and shellfish come from a nearby lake. Toxic substance X is present in the lake water at a concentration of 20 micrograms per liter. The biological concentration factor (BCF) for the fish and shellfish is 50.

- a) How many micrograms of X does the person consume per day via drinking water?
- b) How many micrograms of X does the person consume per day via the consumption of fish and shellfish?

38) The table below lists information concerning the toxic substance Y.

Final acute value	100
Final chronic value	10
Final plant value	20

Given this information, what would be

- a) The EPA criterion maximum concentration for Y
- b) The EPA criterion continuous concentration for Y

39) The EPA final acute value for a toxic substance is the concentration of the toxic substance that, in the EPA's judgment, would

- a) Kill no more than half the individuals of half the genera in the water in 96 hours
- b) Kill no more than 5% of the individuals of half the genera in the water in 96 hours
- c) Kill no more than half the individuals of no more than 5% of the genera in the water in 96 hours
- d) Kill no more than 5% of the individuals of no more than 5% of the genera in the water in 96 hours

40) Which of the following considerations is take into account when the EPA sets water quality standards for heavy metals such as lead and cadmium?

- a) Acclimation of organisms to the metals
- b) Temperature effects on metabolic rates
- c) Effects of water hardness on metal toxicity

41) Correct the grammar/spelling/punctuations errors in the following sentences:

- a) An educated person is less likely to dump or litter into their streams.
- b) The problems in the Ala Wai Canal need to be identified and then solutions can be developed.
- c) Three fourths of the sediments come from the conservation district.
- d) Each of the three watersheds contribute to the pollution.

42) Correct the grammar/spelling/punctuations errors in the following sentences:

- a) People were warned not to swim in it's waters.
- b) Those modifications prevent the stream from filtering the pollutants like a natural, unmodified stream would.
- c) If the Manoa Palolo channel was dredged, it could act as a detention basin.
- d) Urbanization of the surrounding vicinity had lead to major runoff problems.