Welcome to BEARSO, our first fully online SCIOLY invitational! For this invitational, there will be some modifications to what you might normally expect in a Water Quality test.

- We will NOT be doing salinometer testing. This test will only consist of questions from section I, II, and III as per rules
- This online format is a bit longer than the usual tests: 150 points, ~50 points per section
- More questions will be application based and require critical thinking rather than recalling facts. Expect short and long answer questions, and be thorough with your explanations!
- For calculation based questions, round your answers to the NEAREST WHOLE NUMBER and you must INCLUDE UNITS
- For fill-in-the-blank questions, be careful with spelling since these will be autograded. Some will contain additional information to specify what type of answer we're looking for.
- We recommend that you have a few sheets of scratch paper!

Best of luck!

PART I: Marine and Estuary Ecology

1. (1.00 pts) Coral bleaching occurs when _____ is expelled from the coral. (One word, lower case)

2. (1.00 pts) What is the primary cause of global coral bleaching events in recent years?

- A) Dumping of pesticides and herbicides
- B) Rising ocean temperatures
- C) Overfishing
- D) Chemicals like oxybenzone from sunscreen being toxic to coral

3. (1.00 pts) Name and describe one of the methods used for desalination of seawater.

4. (3.00 pts) Name the EPA's 6 groups of contaminants for evaluating water. (3 points total; 0.5 points each)

5. (1.00 pts) ____-selected species produce lots of offspring, many of which do not survive to adulthood. (Upper case)

6. (1.00 pts) Use the following equation for questions 6-9.

$$\frac{dN}{dt} = rN(1 - \frac{N}{K})$$

In this equation, what does K represent? (Max. 2 words, English only, lowercase)

7. (1.00 pts) Refer again to the equation in question 6.

What does r represent? (max. 3 words, no abbreviations, all lower case)

8. (1.00 pts) $\frac{N}{K}$ is a proportion/ratio of what?

9. (1.00 pts) In the equation from question 6, what 2 parameters are assumed to be constant?

(Mark **ALL** correct answers)

- ☐ A) N
- ☐ B) K
- ☐ C) r
- ☐ D) dN

10. (1.00 pts) The maximum sustainable yield is often (higher/lower/the same) as the optimum sustainable yield

- A) Lower
- B) The same
- C) Higher

11. (1.00 pts) What is another term for birth rate when talking about fisheries and young fish entering the population? (1 word, all lower case)

12. (1.00 pts) True or false. Carrying capacity can be exceeded in real life.

True False

13. (1.00 pts) What is the principle that organisms higher up in the food chain tend to have higher concentrations of toxins?

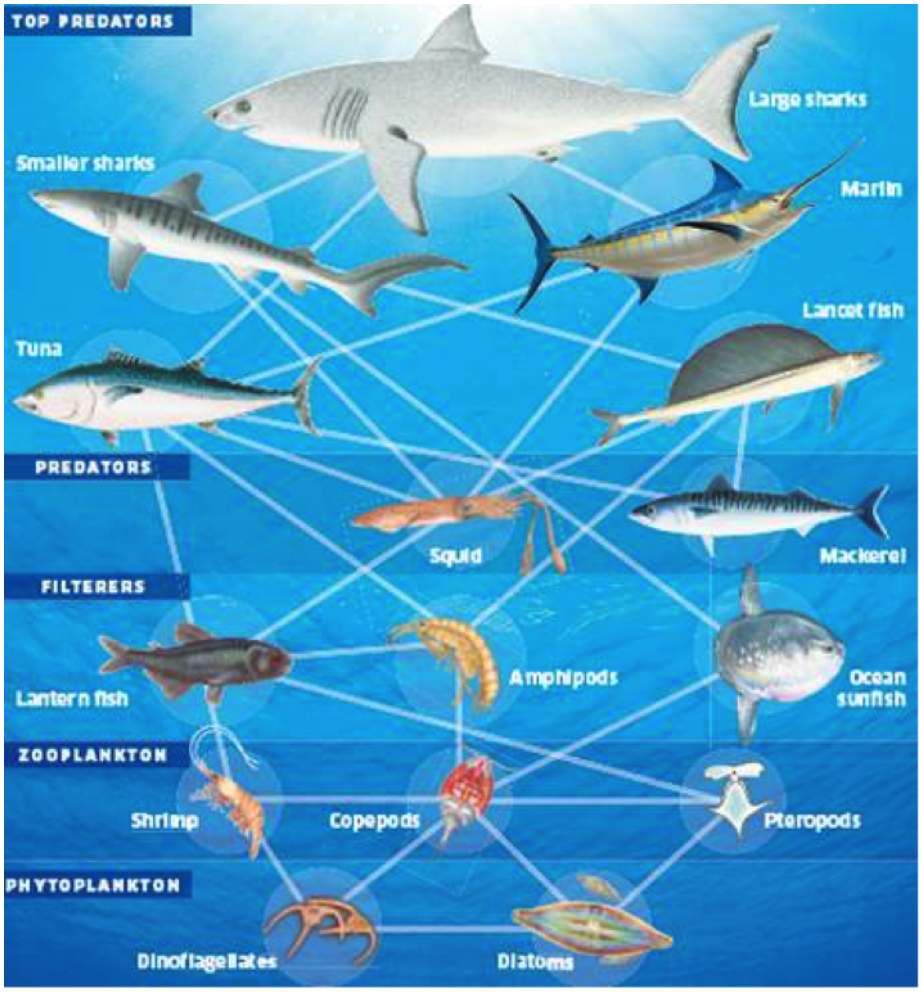
- A) Bioaccumulation
- B) Biotoxicity
- C) Biomagnification
- D) Higher order toxin amplification

14. (1.00 pts) La Niña is characterized by warmer than average sea surface temperatures across the central and eastern Pacific.

True False

15. (1.00 pts) What percent salinity is the ocean?

16. (1.00 pts) Use the following food web for questions 16-18.



Name all the primary consumers in this food web.

17. (1.00 pts)
In the food web, only small sharks prey on the ocean sunfish. If these sharks were to disappear and left the sunfish without natural predators, what would likely happen to the copepod population?

- A) It would decrease.
- B) It would stay the same.
- C) There's no way to tell because there's no relationship.
- D) It would increase.

18. (1.00 pts)
Based on your answer to the previous question, what term could be used to describe the smaller sharks and their importance to the ecosystem? (2 words, all lower case)

19. (1.00 pts) Why are invasive species able to thrive in new environments?

20. (1.00 pts) What is the source of most of the world's oxygen?

- ○ A) The Amazon rainforest
- ○ B) Grasslands and prairies
- ○ C) Kelp forests
- ○ D) High density phytoplankton near shores
- ○ E) Phytoplankton in open ocean

21. (1.00 pts) _____ exchange is the term used to describe how fish gills are able to maximize oxygen uptake from water using diffusion. (One word, all lowercase)

22. (4.00 pts)
Name the 3 salinity zones for brackish water in estuary environments from lowest salinity to highest. (1 point each for each correct zone, 1 point for having it in the correct order)

23. (1.00 pts) What is the primary cause of marine dead zones?

24. (1.00 pts) The Chesapeake Bay was one of the first dead zones identified in the 1970s.

○ True ○ False

25. (1.00 pts) How has the depletion of oysters in the Chesapeake Bay affected the Bay's water quality?

(Mark **ALL** correct answers)

- ☐ A) It has improved the Chesapeake Bay's water quality
- ☐ B) It has no effect on the Chesapeake Bay's water quality
- ☐ C) It improved oxygen levels in the Chesapeake Bay, but has caused higher amounts of phosphorous, calcium, and nitrogen pollution
- ☐ D) It has caused a decline in the Chesapeake Bay's water quality

26. (1.00 pts) The Chesapeake Bay is the 2nd largest estuary in the United States.

○ True ○ False

27. (1.00 pts) What is the most abundant inorganic phosphorous species found in nature?

○ A) Orthophosphate (PO_4^{2-})
○ B) Phosphonate ($PO(OH)_2$)
○ C) Pyrophosphate ($P_2O_7^{4-}$)
○ D) Phosphite (HPO_3^{2-})

28. (1.00 pts) Acidic water can cause lead from pipes to leach into the water supply.

○ True ○ False

29. (1.00 pts) What is biomanipulation?

30. (1.00 pts) Endorheic basins drain into larger bodies of water like oceans and rivers.

○ True ○ False

31. (1.00 pts) Chlorination is the predominant method of disinfecting wastewater in North America.

○ True ○ False

32. (2.00 pts) What types of substances are used to filter water in potable water treatment? Name 3 for full credit.

33. (1.00 pts) What is the purpose of the fourth treatment stage of wastewater treatment?

34. (1.00 pts) How much does wastewater treatment cost the US annually?

35. (1.00 pts) What is considered the universal solvent or the most powerful solvent? (all lowercase, no chemical formulas- write out the word)

36. (1.00 pts) Which of the following contribute to the turbidity associated with sediment pollution?

(Mark **ALL** correct answers)

- ☐ A) Ammonia
- ☐ B) Sand
- ☐ C) Silt
- ☐ D) Cadmium
- ☐ E) Salt

37. (1.00 pts) Poor sewage and sanitation conditions led to contaminated water in Victorian London and an outbreak of what disease? (All lower case)

38. (1.00 pts) What is the main source of energy for the water cycle? (one word, all lower case)

39. (1.00 pts) Water is denser as ice than it is as a liquid.

○ True ○ False

40. (1.00 pts) Water in the ocean has an average residence time of how long?

- ○ A) 2.5 years
- ○ B) 150 days
- ○ C) 320 years
- ○ D) 3,200 years
- ○ E) 32,500 years

41. (1.00 pts) What percentage of evaporation takes place over oceans? (full point for anything -/+ 10%)

42. (1.00 pts) Water vapor is a greenhouse gas.

○ True ○ False

43. (1.00 pts) What is the primary source of fixed nitrogen in the world's oceans?

○ A) Runoff of fixed nitrogen and organic matter from land
○ B) Lightning
○ C) Upwelling of fixed nitrogen from deep ocean
○ D) Nitrogen-fixing bacteria in the ocean

44. (1.00 pts) What is the primary form of sulfur that is assimilated by organisms?

○ A) H_2S
○ B) SO_2
○ C) SO_4^{2-}
○ D) SO_3^{2-}

PART II: Coral Reef Macroflora and Fauna Identification

Refer to this organism for questions 45-49.

45. (1.00 pts) What is the common name of this organism? (lowercase)

46. (1.00 pts) Describe how this organism mates and fertilizes its gametes.

47. (1.00 pts) What compound are the spines of this organism made of? (lowercase)

48. (1.00 pts) What does this organism eat? (select multiple answers if applicable)

(Mark **ALL** correct answers)

- [ ] A) Algae
- [ ] B) Coral
- [ ] C) Plankton
- [ ] D) Krill
- [ ] E) Small fish

49. (2.00 pts) What type of environment does this organism live in?

(Mark **ALL** correct answers)

- [ ] A) Tropical waters
- [ ] B) Coral reefs
- [ ] C) Estuaries
- [ ] D) Shallow water
- [ ] E) Open ocean
- [ ] F) Temperate waters

Refer to this organism for questions 50-53.

50. (1.00 pts) What is the common name of this organism? (lowercase, letters and spaces only, no punctuation)

51. (1.00 pts) This organism is beneficial to coral reef health, including reef health at the Great Barrier Reef.

○ True ○ False

52. (1.00 pts) What is the name of the toxin this organism uses to defend itself? (lowercase, plural)

53. (1.00 pts) What is the term used to describe when this organism appears at a high density? (lowercase, plural)

Refer to this organism for questions 54-59.

54. (1.00 pts) What is the common name of this organism? (lowercase)

55. (1.00 pts) What is the conservation status of this organism?

○ A) Least concern
○ B) Vulnerable
○ C) Endangered
○ D) Critically endangered
○ E) Near threatened

56. (1.00 pts) This organism is hermaphroditic.

○ True ○ False

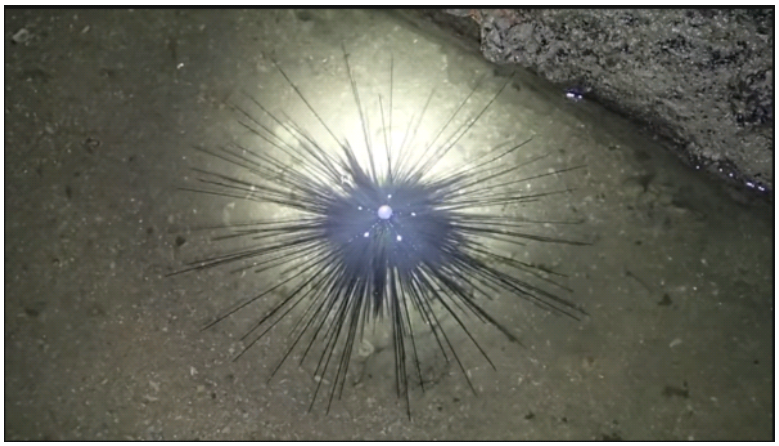
57. (1.00 pts) What is another common name for this organism? (lowercase, 2 words, hint for autograder: do not use the word "wrasse", think former world leaders)

58. (1.00 pts) What makes up the diet of this organism?

59. (1.00 pts) This organism can change coloring as it ages.

○ True ○ False

Refer to this organism for questions 60-63.



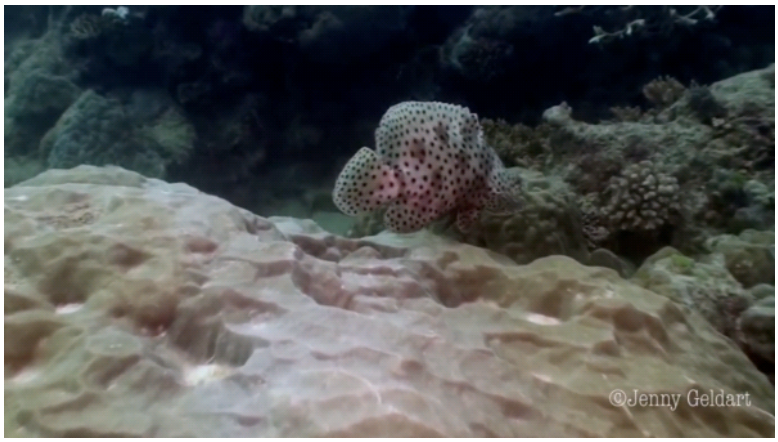
60. (1.00 pts) What is the common name of this organism?

61. (1.00 pts) Why is this organism important for coral reef health?

62. (1.00 pts) What is another term used to describe this organism's "shell"? (lowercase)

63. (1.00 pts) What makes up the diet of this organism?

Refer to this organism for questions 64-66. (center of the picture)



64. (1.00 pts) What is the common name of this organism? (lowercase, use the name given in the rules)

65. (1.00 pts) This organism is demersal.

○ True ○ False

66. (1.00 pts) All members of this organism are born male.

○ True ○ False

Refer to this organism for questions 67-71.

67. (1.00 pts) What is the common name of this organism? (lowercase)

68. (1.00 pts) What external factor does this organism rely on for nutrient uptake, waste removal, and sexual reproduction?

69. (2.00 pts) What modes of reproduction does this organism undergo? (select all that apply)

(Mark **ALL** correct answers)

- [ ] A) Sexual Reproduction
- [ ] B) Spore Formation
- [ ] C) Fragmentation
- [ ] D) Fission

70. (1.00 pts) True or False: This organism requires a high aragonite concentration in its environment to survive.

- ○ True
- ○ False

71. (2.00 pts) How is this organism useful if the coral reef system it belongs to suddenly becomes nutrient depleted?

Refer to this organism for questions 72-76.

72. (1.00 pts) What is the common name of this organism? (lowercase)

73. (1.00 pts) True or False: This organism can express both sexes/has hermaphroditic tendencies.

○ True ○ False

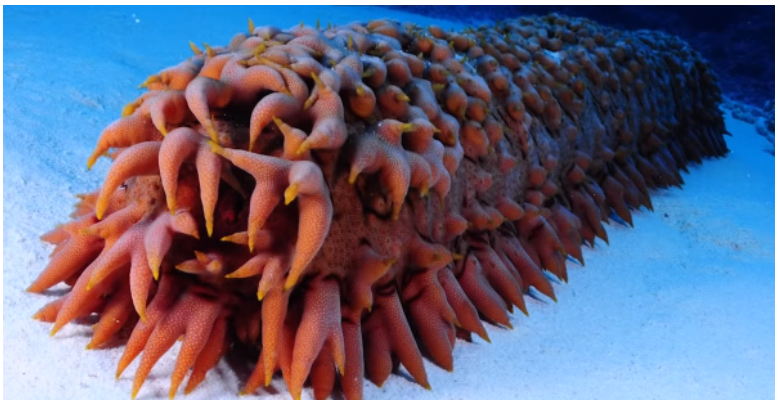
74. (1.00 pts) One species of this organism is the natural predator to what species that makes them valuable to coral reef ecosystems? (lowercase)

(hint: this other species is included in the official WQ list of species to know!)

75. (2.00 pts) Briefly describe how this organism is able to prey on the species in the previous question and other organisms much greater in size than itself. (2 points)

76. (1.00 pts) Why has this organism's populations decreased significantly outside Australia, where it is legally protected?

Refer to this organism for questions 77-81.



77. (1.00 pts) What is the common name of this organism? (lowercase)

78. (2.00 pts) What trophic level(s) does this organism belong to? (select all that apply)

(Mark **ALL** correct answers)

☐ A) Primary Producers

- [ ] B) Primary Consumers
- [ ] C) Secondary Consumers
- [ ] D) Tertiary Consumers
- [ ] E) Decomposers

79. (1.00 pts) What chemical substance does this organism produce that is used to provide insight into coral reef health? (2 words, lowercase)

80. (1.00 pts) True/False: This organism reproduces by external fertilization/spawning.

- ○ True ○ False

81. (1.00 pts) What region do you expect to find this organism?

- ○ A) Global
- ○ B) Indo-Pacific only
- ○ C) Atlantic only

Refer to this organism for questions 82-85.

82. (1.00 pts) What is the common name of this organism? (lowercase)

83. (1.00 pts) What organ does this organism use to eat?

84. (2.00 pts) Where does the coloration of this organism come from?

85. (2.00 pts) This organism repurposes a part of its prey's defenses as its own defense mechanism. What does this organism reutilize?

PART III: Water Monitoring and Analysis

(almost there! you can do this!)

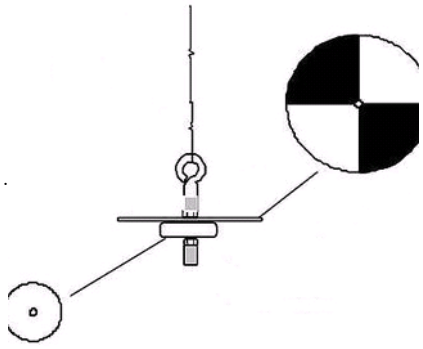
This is a glass salinometer/hydrometer used to measure salinity of a solution. Questions 86-88 reference this instrument.

86. (1.00 pts) What unit of measurement is this salinometer calibrated to? (use full words, lowercase)

87. (1.00 pts) If you have a solution oversaturated with salt, where do you expect the water level to reach relative to the number in red?

88. (2.00 pts) Explain why low salinity corresponds to numbers at the top of the salinometer while higher salinity corresponds to numbers at the bottom.

Please refer to this diagram for questions 89-91.



89. (2.00 pts) First blank: What is this instrument?

Second blank: What does this instrument measure? (use lowercase)

90. (3.00 pts) List 3 factors affecting the property this instrument measures (3 pts, 1pt each)

91. (2.00 pts)

You plan to use this instrument by lowering it into a nearby body of water off the edge of a flat attachment 2 ft long overhanging the edge of a boat. you stand 3 ft directly behind the attachment (opposite side of where the instrument is lowered).

At a point in time, if the angle between your feet and the vertical rope is 45°, how much rope is used to lower the instrument? (hint: draw a diagram, include units (ft)!)

92. (1.00 pts) What is NOT a sufficient way to kill fecal coliform bacteria in water?

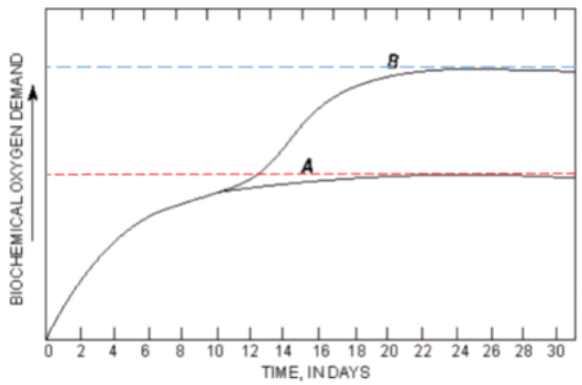
- A) boiling water
- B) treating with chlorine
- C) treating with acidic agents
- D) UV disinfection
- E) All of the above can be used

93. (1.00 pts) Fecal Coliform (aerobically/anaerobically) decomposes organic matter.

94. (2.00 pts) An excess of fecal coliform bacteria is harmful to biodiversity because:

95. (2.00 pts)
As temperature increases, biological oxygen demand _____ and dissolved oxygen tends to _____. (Fill in the blanks with "increases" or "decreases"). (2 points total)

Use the BOD graph to answer questions 96-98.



Population B has two phases where BOD increases, stalled by an upper limit at each phase.

96. (1.00 pts) What does the red line represent? (select all that apply)

(Mark **ALL** correct answers)

- A) Carbonaceous Demand

- [ ] B) Nitrogenous Demand
- [ ] C) Phosphogenic Demand
- [ ] D) Dihydrogen Monoxide Demand
- [ ] E) Calcium Carbonate Demand

97. (1.00 pts) What does the blue line represent? (select all that apply)

(Mark **ALL** correct answers)

- [ ] A) Carbaceous Demand
- [ ] B) Nitrogenous Demand
- [ ] C) Phosphogenic Demand
- [ ] D) Dihydrogen Monoxide Demand
- [ ] E) Calcium Carbonate Demand

98. (2.00 pts) Why is line B demand higher than line A? (2)

99. (3.00 pts) BOD measurements over 5 days can be quantified using this equation:

$\mathrm{BOD}_5 = \frac{\mathrm{D}_1 - \mathrm{D}_2}{\mathrm{P}}$

Where D_1= initial sample dissolved-oxygen (DO) concentration (in mg/L)

D_2= sample DO (in mg/L) after 5 days

P = decimal volumetric fraction of sample used, ($\frac{samplevol}{dilutesamplevol}$)

Given the data set below, what is the BOD of the sample? (include units!)

D_1	D_2	Sample Vol (mL)	Dilute Sample Volume (mL)
3	1	100	400

100. (3.00 pts) Rank these stages from highest to lowest expected BOD of water in a wastewater treatment plant: primary clarifier, aeration tank, grit chamber

(use lowercase, first blank= highest BOD)

101. (1.00 pts) A pH of 4 has _____ times more hydrogen ion concentration than a sample of water with a pH of 7.

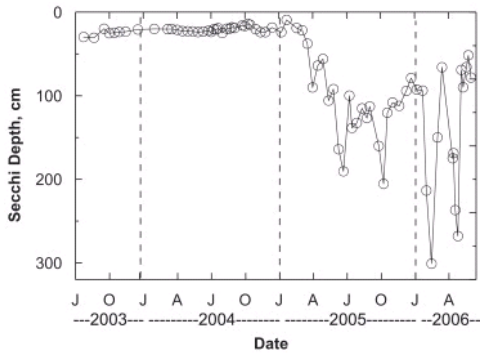
- A) 3
- B) 100
- C) 300
- D) 1000
- E) 3000

102. (1.00 pts) An estuary rich in limestone is (more/less) susceptible to radical pH changes caused by acid rain. (lowercase)

103. (1.00 pts) Seawater is able to resist changed in pH because it is a _____. (use lowercase)

104. (1.00 pts) Dead Zones are areas where no life is able to be sustained and they result from the growth of a hypoxic environment. Define Hypoxic.

Use the graph of Secchi Disk measurements in Lake Elsinore to answer the following question.



105. (2.00 pts)
In the winter of 2005, there was an increase in precipitation and runoff, which increased the amount of water in Lake Elsinore. What effect on electrical conductivity does this result in?

106. (1.00 pts)
Power plant emissions release sulfur dioxide and nitrogen oxides into the atmosphere. If there is a estuary nearby with a pH of 7, over a long period of time the pH of the estuary will:

- A) Stay the same

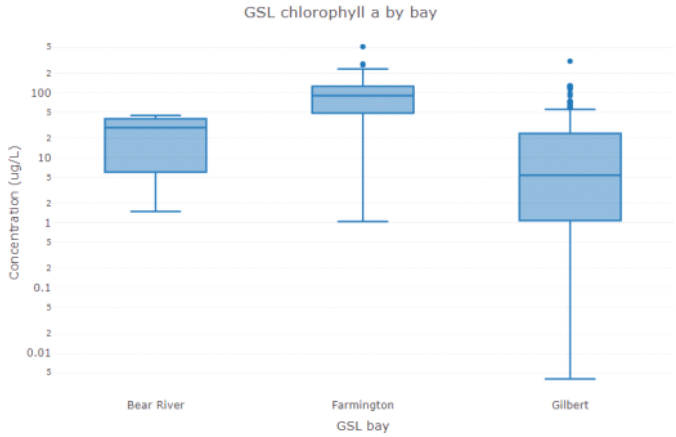
B) Increase

C) Decrease

D) Disappear

107. (2.00 pts) What are the chemical formulas of a nitrogen and a sulfur species that can be found in considerable quantities in a lake that is nearby a power plant?

Please refer to the diagram below to answer questions 109-111.



108. (2.00 pts) Why would chlorophyll a be used to measure the health of a body of water?

109. (1.00 pts) Which body of water is most likely to have the greatest amount of nitrates present?

A) Bear River

B) Farmington

C) Gillbert

110. (1.00 pts) What phenomenon associated with an abundance of nitrates and phosphates is lethal to an ecosystem? (lowercase, 1 word)

111. (1.00 pts) Nitrates and phosphates are measured using what units?

A) mg/L

- B) M
- C) ppb
- D) ppm
- E) µg/L
- F) None of the above

112. (1.00 pts) When monitoring phosphorus in water, which of the following is NOT measured?

- A) Orthophosphate
- B) Pure phosphorous
- C) Organic phosphates
- D) Condensed phosphates
- E) All of the above are measured

113. (2.00 pts) Give two examples of diseases associated with high levels of fecal coliform in the water (2 points, 1 each)

114. (1.00 pts) $CO_3{}^{2-}$ is an ion whose concentration is measured to track what global phenomenon?

- A) Ocean Acidification
- B) El Nino
- C) La Nina
- D) Global Warming
- E) Ocean Current Patterns
- F) None of the above

Precipitation and dissolution of aragonite in seawater is given by the equation $Ca^{2+} + CO_3{}^{2-} \rightleftharpoons CaCO_3$.

The saturation state of seawater with respect to aragonite is given by the equation

$$k = \frac{[Ca^{2+}][CO_3{}^{2-}]}{[CaCO_3]}$$

115. (2.00 pts) If k = 1, do you expect to find any aragonite precipitate in the water? Why or why not?

116. (1.00 pts) If k = 1, life in coral reefs are:

- A) extremely healthy

B) decently healthy

C) at slight risk

D) at much risk

117. (2.00 pts) Explain your answer about life in coral reefs with respect to k = 1. What long term effects on coral reefs would you expect?

Thank you for participating in BEARSO!!
We know this test was challenging, but this will hopefully prepare you for future water quality competitions. This is also the first time we've hosted a virtual competition so it was a new process for event supes as well.
Regardless of how you did, thank you for taking the day to maintain the spirit of Science Olympiad during these times.