

NAME: \_\_\_\_\_

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**Part I. Multiple Choice Questions. Choose the one best answer from the list, and write the correct letter legibly in the blank to the left of the question. 2 points each.**

- \_\_\_\_\_ 1) All of the following are adaptations to prevent sinking **except**:
- a. using a gas bladder
  - b. decreasing density
  - c. decreasing cellular fat content
  - d. increasing surface area to volume ratios
- \_\_\_\_\_ 2) ENSO events and Pacific Decadal Oscillations are
- a. caused by ocean-atmosphere interactions
  - b. decreasing in frequency
  - c. not important to marine fisheries
  - d. caused by global warming
- \_\_\_\_\_ 3) In light/dark bottle estimates of primary productivity, the dark bottle yields an estimate of:
- a. gross production
  - b. respiration
  - c. standing stock
  - d. net primary productivity
- \_\_\_\_\_ 4) Productivity in tropical waters is:
- a. light limited
  - b. nutrient limited
  - c. temperature limited
  - d. oxygen limited
- \_\_\_\_\_ 5) A small size is advantageous for marine phytoplankton because it
- a. increases the ratio between surface area and body weight
  - b. increases the ability to take in nutrients (normalized to body volume)
  - c. increases the ability of wastes to diffuse out of the organism
  - d. all of the above
  - e. none of the above
- \_\_\_\_\_ 6) An area where 90% of the total biomass is regularly recycled in the photic zone is described as:
- a. dominated by export production
  - b. eutrophic
  - c. in steady state
  - d. dominated by regenerated production
- \_\_\_\_\_ 7) An example of an autotrophic prokaryote is:
- a. Pseudo-nitzschia
  - b. the arrow worm (chaetognath)
  - c. Karl Woese
  - d. Prochlorococcus
- \_\_\_\_\_ 8) Which of the following are NOT one of the basic types of Harmful Algal Blooms?
- a. Indiscriminate kills of marine fauna
  - b. Dimethyl sulfide producers
  - c. Selective marine fauna killers
  - d. Toxic vectoring through the food chain
- \_\_\_\_\_ 9) Salps are important in the marine food web because
- a. they are a favorite food of fish
  - b. they export a lot of material to depth
  - c. they aren't important
  - d. they chemosynthesize
- \_\_\_\_\_ 10) Which environment shows the greatest species diversity (using non-molecular methods)?
- a. bathypelagic
  - b. hadal
  - c. epipelagic
  - d. neritic



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19) Benthic productivity generally follows the same patterns (high benthic productivity where surface productivity is high, etc) as seen in the surface ocean, except for places such as

\_\_\_\_\_.

20) The \_\_\_\_\_ depth is the depth at which gross oxygen production exactly equals

community respiration, assuming no mixing; the \_\_\_\_\_ depth is the depth to which phytoplankton can be mixed, and still have positive (net) growth.

21) A \_\_\_\_\_ surface-area to volume ratio is a competitive advantage for organisms using active transport to acquire nutrients, and is an example of how organisms such as

\_\_\_\_\_ have adapted to the oligotrophic open ocean.

**Part III. Short Answer. Provide the best answer to each question in a few words (not an essay), or using a diagram. 5 points each.**

22) You are talking to some colleagues at UCSC in the Marine Biology program, and they mention that they are monitoring primary production in Monterey Bay using a fluorometer (measures chlorophyll fluorescence). Explain to them why it is highly unlikely that they are measuring primary production.

23) Based on what you know about adaptations to the marine environment, explain why it is unlikely that we would ever discover a photosynthetic organism smaller than *Prochlorococcus*, or a carnivore larger than a whale, in the oceans.

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24) What causes the North Atlantic Spring Bloom?

25) Look at the photo of the organism on the back page of this sheet. Describe 3 adaptations that you think it has made to its environment, and where you think it lives in the ocean.

26) Based on your term paper, the selection committee for the Tyler Prize has selected you for an Environmental Achievement award. While flying down to LA, you mention this to the flight attendant, and they ask you to explain (briefly and in terms for a layperson) what your term paper was about, and why it is a topic which everyone should be interested in.

27) Describe briefly the difference between a food chain, and a food web. If you included bacteria, which term would be more accurate?

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**Essay Question (20 points): Answer ONE of the two questions. You will be graded on completeness, organization, and content, and your ability to synthesize the various points we have covered in class.**

1) President Bush recently released his proposed budget, which includes targets for funding both ocean and space research. As part of that, President Bush has suggested decreasing ocean research by about 40%, while increasing space research, and specifically the search for life on other planets, by about 25%. You have been asked, based on your prestigious Tyler Prize nomination, to prepare a report for the President that explains how ocean research can be used to prepare us for future exploration of other planets. How would you convince the President of this? Topics you may want to include are: use of technology to explore the oceans; searching for “extreme” life forms in the ocean, and adaptations to the marine environment that we might not expect; discovery of new types of organisms; evolution of life on Earth.

2) Based on the lecture material, text, and the articles on whaling and whale abundance, explain how Roman and Palumbi estimated the historical size of the whale populations before industrial whaling. From the PNAS article, describe what the long-term effects on the food-web structure of the North Pacific have been. Include in your answer a discussion of top-down versus bottom-up effects, trophic transfer, and the concept of “fishing down the foodchain” (not necessarily as it relates to humans). Finally, one major criticism of these papers is that there is no way to ecologically sustain the population sizes of whales that the authors suggest (pre-industrial whaling). Explain how you, as a marine scientist, would determine if it were even possible to support the whale populations in the context of a marine food web.

3) Based on the lecture material, text, and the article from Nature discussing the large Harmful Algal Bloom event in Monterey Bay (if you read it for extra credit) discuss the following. What is a Harmful Algal Bloom? Why was the 1998 event in Monterey considered to be a HAB event? If you were put in charge of the Monterey Bay National Marine Sanctuary, how would you go about monitoring for the occurrence of HABs (including the advantages and disadvantages of your methods)?

4) Using all of the information available from this class, the textbook, and your readings, describe the physical, chemical, and biological processes which lead to phytoplankton and zooplankton dynamics in the ocean from high latitudes to low latitudes (so from the poles, or greater than 60 degrees north or south, the mid-latitudes, and the equatorial tropics) seasonally. Describe the seasonal patterns for each season, including a description of the changes in biomass, productivity, chemistry, and physics, and what biological adaptations are likely to be found in each region.