1. The forces that disturb the surface of the sea and generate waves are called
   A. wave-generating forces.
   B. disturbing forces.
   C. restoring forces.
   D. Both wave-generating forces and disturbing forces are correct.
   E. All of the choices are correct.

2. Which of the following are not a type of wind-caused wave?
   A. swell
   B. capillary waves
   C. tsunami
   D. chop
   E. breaker

3. For simplification, ocean waves are best described as
   A. a sine curve.
   B. an exponential curve.
   C. a straight line.
   D. a vertical line.
   E. None of the choices are correct.

4. Waves with wavelengths less than a few millimeters are
   A. seiche.
   B. capillary waves.
   C. chop.
   D. extreme waves.
   E. bores.

5. The restoring force for wind waves is
   A. gravity.
   B. wind.
   C. hydrostatic pressure.
   D. surface tension.
   E. None of the choices are correct.
6. A wave with a wavelength of 200 feet is traveling in water with a depth of 2000 feet. Which equation correctly expresses its speed?
   A. \( C = 1.56 \times T \)
   B. \( C = 1.56 \times L \)
   C. \( C = 3.1 \times \text{the square root of the period} \)
   D. \( C = 3.1 \div \text{the square root of the water depth} \)
   E. \( C = 3.1 \times \text{the square root of the water depth} \)

7. Which of the following is generally not a factor in wave generation in the open ocean?
   A. wind speed
   B. wind fetch
   C. wind duration
   D. wind direction

8. When the superposition of two waves is additive, the resultant displacement of the sea surface is called
   A. destructive interference.
   B. constructive interference.
   C. subtractive juxtaposition.
   D. additive juxtaposition.
   E. additive diffraction.

9. The bending of a wave front as it approaches the shoreline is called
   A. wave reflection.
   B. wave focusing.
   C. wave refraction.
   D. wave diffraction.
   E. wave interference.

10. Refraction of a wave on a headland
    A. causes less of an impact of wave energy on the headland.
    B. concentrates energy on the headland.
    C. has no effect in the distribution of energy on a headland.
    D. tends to erode headlands more rapidly.
    E. Both concentrates energy on the headland and tends to erode headlands more rapidly are correct.
11. The most deadly part of a hurricane is
A. the wind.
B. the lightning.
C. the tornadoes.
D. the storm surge.
E. the low atmospheric pressure.

12. When the tide is at its lowest height, the tide is said to be
A. spring.
B. neap.
C. high.
D. low.
E. normal.

13. The monthly tidal pattern where the tidal range is minimal is known as
A. neap tides.
B. full tides.
C. spring tides.
D. low tides.
E. high tides.

14. What is the position of the moon-Earth-sun system during spring tides?
A. the moon-Earth-sun are 90 degrees relative to each other
B. the moon-Earth-sun are in a direct line with each other
C. the moon-Earth-sun are 45 degrees to each other
D. the moon-Earth-sun are closest to each other
E. moon-Earth-sun are furthest away from each other

15. A daily tidal pattern with two high tides and two low tides of equal height is called
A. diurnal.
B. semidiurnal.
C. mixed semidiurnal.
D. rotating.
E. spring.
16. How long does it take the moon to complete one revolution around the Earth relative to an observer on the Earth?
A. 29.5 days
B. once per day
C. once every two weeks
D. once a year
E. the moon does not revolve around the Earth

17. In terms of celestial influences on ocean tides, which is more important?
A. distance from Earth
B. mass of celestial body
C. rotational speed
D. angle of tilt with respect to its plane of orbit around the Earth
E. hard to tell

18. The "point" around which a standing wave rotates is called
A. the point of no return.
B. the point break.
C. the amphidromic point.
D. the M2 point.
E. the S2 point.

19. Tidal waves progress _______ in the northern hemisphere and _______ in the southern hemisphere.
A. counterclockwise; clockwise
B. clockwise; counterclockwise
C. counterclockwise; counterclockwise
D. counterclockwise; clockwise

20. Advance warning of a tsunami can be obtained by monitoring
A. sea surface height.
B. ocean bottom pressure.
C. tidal heights.
D. the geoid.
E. amphidromic points.
21. A high tide reaches 6 feet and the next low tide reaches -2 feet. What is the tidal range?
A. 4 feet
B. 6 feet
C. -2 feet
D. 8 feet
E. 0 feet

22. The inheritable change of a population of organisms over many generations is called
A. revolution.
B. survival of the fittest.
C. natural selection.
D. evolution.

23. The idea that species persist unchanged for long periods of time but undergo rapid speciation over short periods is called
A. evolution.
B. mass wasting.
C. mass extinction.
D. punctuated equilibrium.

24. Ocean genomics is
A. the study of the genetic material of marine organisms.
B. the search for marine life living on gnomes or seafloor mounds.
C. the study of the ecological relationships between marine organisms.
D. the search for the smallest forms of ocean life.

25. The surface of the ocean is classified in terms of a habitat as
A. the bathypelagic zone.
B. the epipelagic zone.
C. the abyssopelagic zone.
D. the hadopelagic zone.
E. the mesopelagic zone.
26. The epipelagic zone includes
A. the euphotic zone.
B. the abyss.
C. submarine trenches.
D. oceanic ridges.
E. All of the choices are correct.

27. The upwards and downwards movement of marine organisms on a daily cycle in the ocean is called
A. bioluminescence.
B. diel vertical migration.
C. deep scattering.
D. yo-yoing.
E. hopping.

28. Biologically produced light is called
A. phosphorescence.
B. the Aurora Borealis.
C. bioluminescence.
D. red tide.
E. the green flash.

29. Which of the following is not a characteristic of the bathypelagic zone?
A. temperatures from 2-5 degrees C
B. pressures as high as 400 atmospheres
C. abundant sunlight
D. generally high oxygen concentrations
E. biogeochemical transformations mostly independent of surface processes

30. The sum of all organisms living on or within Earth and the habitats that support life encompasses
A. the geosphere.
B. the hydrosphere.
C. the lithosphere.
D. the cryosphere.
E. the biosphere.
31. Which of the following is not a domain of life?
A. Archaea
B. Bacteria
C. Eukaryotes
D. Animalia

32. The most ancient of microbes are called
A. Archaea.
B. Bacteria.
C. Eukaryotes.
D. Animalia.

33. The principal difference between eukaryotes and prokaryotes is the presence of
A. a cell wall.
B. organelles.
C. DNA.
D. RNA.
E. All of the choices are correct.

34. A group of Archaea that produce methane from carbon dioxide and hydrogen are called
A. halophiles.
B. thermoacidophiles.
C. methanogens.
D. sulfur-reducing bacteria.
E. prokaryotes.

35. The first life appeared
A. at least 2.7 billion years ago.
B. at least 4.6 billion years ago.
C. at least 2.7 million years ago.
D. at least 2700 years ago.
E. at least 4.6 million years ago.
36. For a mussel, the name *Mytilus edulis* represents
A. its genus and species.
B. its kingdom.
C. its phylum.
D. its common name.
E. its genomic name.

37. Organisms living upon, within or attached to the sea floor are classified as
A. planktonic.
B. benthic.
C. nektonic.
D. pelagic.
E. epipelagic.

38. Organisms that drift in the ocean at the mercy of the currents and tides are classified as
A. planktonic.
B. benthic.
C. nektonic.
D. pelagic.
E. epipelagic.

39. Organisms that can swim under their own power through the ocean are classified as
A. planktonic.
B. benthic.
C. nektonic.
D. pelagic.
E. epipelagic.

40. The most numerous and diverse type of plankton are the
A. zooplankton.
B. bacterioplankton.
C. phytoplankton.
D. jellyplankton.
41. Zooplankton whose life cycle includes a planktonic stage but who otherwise are not planktonic are referred to as
A. meroplankton.
B. holoplankton.
C. ichthyoplankton.
D. jellyplankton.
E. phytoplankton.

42. Baleen whales belong to a taxon called
A. Mysticetes.
B. Flipper.
C. Mirabilis.
D. Cetacea.
E. Odontocetes.

43. The most common color of bioluminescence is
A. infrared.
B. blue.
C. red.
D. green.
E. yellow.

44. Bioluminescence by dinoflagellates appears to
A. elicit a startle response from their copepod predators.
B. function for communication during vertical migration.
C. attract their mates.
D. have no function.

45. A ten-year initiative to assess and explain the diversity, distribution, and abundance of marine life in the oceans, past, present, and future is called
A. the Census of Marine Life.
B. NOAA's Hidden Ocean.
C. the Hershey Kiss Expedition.
D. Ocean Genomics.
46. A device used to collect plankton is called
A. a plankton net.
B. a fish net.
C. an otter trawl.
D. a longline.
E. a fluorometer.

47. The biomass of plankton refers to
A. the number of plankton present in a sample.
B. the species of plankton present in a sample.
C. the mass or weight of plankton present in a sample.
D. the cell sizes of plankton present in a sample.
E. All of the choices are correct.

48. Dissolved elements required by phytoplankton are called
A. salts.
B. acids.
C. bases.
D. food.
E. nutrients.

49. If a sample of natural seawater is placed in the dark for 24 hours, what will happen to its oxygen concentration?
A. it will increase
B. it will decrease
C. it will stay the same
D. it's impossible to determine from the information given

50. A sample of seawater has a dissolved oxygen (DO) concentration of 8 mg/L. After 24 hours, a clear bottle of the sample incubated at the surface has a DO concentration of 12 mg/L and a dark bottle of the sample incubated at the same depth has a DO concentration of 6 mg/L. What is the rate of gross primary production?
A. 12 mg/L/day
B. 20 mg/L/day
C. 6 mg/L/day
D. 8 mg/L/day
E. 14 mg/L/day
51. In the open ocean where concentrations of phytoplankton are small, biological oceanographers typically use ____ as a measure of primary productivity.
A. the oxygen light-dark bottle method
B. chlorophyll fluorescence
C. carbon-14 assimilation
D. counts of cell numbers
E. the weight of zooplankton

52. Which of the following is not a primary producer?
A. phytoplankton
B. seaweeds
C. chemosynthetic bacteria
D. seagrasses
E. zooplankton

53. The world ocean accounts for approximately ____ of global primary productivity.
A. 5-10%
B. 15-20%
C. 30-60%
D. 50-75%
E. 100%

54. Primary productivity in the world ocean contributes approximately ____ of the oxygen in the atmosphere.
A. 10%
B. 25%
C. 50%
D. 75%
E. 100%

55. All photosynthetic primary producers
A. have roots.
B. have leaves.
C. use chlorophyll a.
D. have zooxanthellae.
E. are unicellular.
56. Which of the following represents the correct general equation for photosynthesis?
A. carbon dioxide + sugar + light = water + oxygen
B. carbon dioxide + water + light = sugar + water + oxygen
C. water + light = sugar + oxygen
D. water + carbon dioxide = light + oxygen
E. carbon dioxide + water + light = carbon dioxide + oxygen

57. The breakdown of organic matter in the presence of oxygen is called
A. photosynthesis.
B. carbon reduction.
C. remineralization.
D. respiration.
E. lithification.

58. A limiting factor may alter all except the following:
A. chlorophyll concentration
B. species composition
C. rate of primary productivity
D. export production
E. salinity

59. Photosynthetically available radiation decreases in the water column
A. in a linear fashion.
B. in an exponential fashion.
C. in a hyperbolic fashion.
D. in a tangential fashion.
E. in a circular fashion.

60. The region of the upper ocean in which photosynthesis occurs is called
A. the abyssal zone.
B. the hadopelagic zone.
C. the twilight zone.
D. the euphotic zone.
E. the neuston layer.
61. Which of the following is not an element that is essential for phytoplankton growth?
A. carbon
B. nitrogen
C. oxygen
D. potassium
E. fluoride

62. The excretion of solid waste by zooplankton typically takes the form of
A. a bait ball.
B. a fecal pellet.
C. phytodetritus.
D. marine snow.
E. marine slop.

63. Of the 7.1 billion tons of carbon dioxide released, approximately ____ tons accumulate in the atmosphere.
A. 1.6 billion
B. 1.6 million
C. 3.8 billion
D. 5.5 million
E. 7.1 billion

64. How can so few phytoplankton, 0.2% of the world's autotrophic biomass, account for half the world's productivity?
A. lack of light limitation
B. rapid turnover
C. lack of woody parts like land plants
D. lack of insect grazers
E. lack of nutrient limitation

65. If fifteen people are in line at Starbucks and a new person is served every two minutes, what is the turnover time of the line?
A. thirty minutes
B. forty-five minutes
C. sixty minutes
D. fifteen minutes
E. forever
66. Iron limitation refers to
A. iron as a limiting factor for phytoplankton growth.
B. the lack of iron in many tropical soils.
C. the rusting of old oceanographic vessels.
D. the lack of iron in coastal waters.
E. iron-poor blood in marine mammals.

67. Regions of high nitrate and low chlorophyll likely occur because
A. of zooplankton grazing on phytoplankton.
B. of upwelling.
C. of iron limitation of phytoplankton growth.
D. of light limitation of phytoplankton growth.
E. of dispersal of phytoplankton by tides and currents.

68. The feeding relationships of organisms--who eats whom--are best depicted as
A. trophic pyramids of numbers.
B. trophic pyramids of energy.
C. trophic pyramids of biomass.
D. food webs.
E. food chains.

69. A characteristic biota that develops in response to a particular set of physical, chemical, and biological factors and which exhibits identifiable flows of energy and matter defines, for oceanographers, is
A. an ecosystem.
B. a trophic pyramid.
C. trophic efficiency.
D. bottom-up control.
E. a food web.

70. Which of the following does not belong to the microbial food web?
A. flagellated protists
B. cyanobacteria
C. heterotrophic bacteria
D. diatoms
E. ciliates
71. How many tons of top predator can a 6-level food web support annually if the primary producers manufacture 1,000,000 tons annually? Assume a trophic efficiency of 10%.
A. 10,000 tons  
B. 1 ton  
C. 100 tons  
D. 1000 tons  
E. 10 tons

72. A key component of the microbial loop is
A. dissolved organic matter.  
B. inorganic matter.  
C. particulate organic matter.  
D. marine snow.  
E. regenerated nutrients.

73. Oceanographers estimate that at least ____ of world ocean primary production may cycle through the microbial loop.
A. 15%  
B. 75%  
C. 50%  
D. 100%  
E. 25%

74. The functions of the microbial loop include
A. decomposition of organic matter into inorganic nutrients like nitrate.  
B. transfer of dissolved organic matter back into the classical food web.  
C. excretion of regenerated nutrients, like ammonium.  
D. transfer of picophytoplankton and bacterioplankton carbon into the classical food web.  
E. All of the choices are correct.

75. Upwelling systems are among the ______ ecosystems in the world ocean.
A. most productive  
B. least productive
76. Upwelling systems contribute up to ___ of the world's fisheries productivity.
A. 10%
B. 15%
C. 5%
D. 20%
E. 50%

77. The transport of nutrient-rich water from below the euphotic zone to the surface in upwelling systems results from
A. geostrophic flow.
B. the Coriolis effect.
C. surface currents.
D. Ekman transport.
E. tides.

78. What effect do El Niño conditions in the Pacific have on upwelling on the coast of Peru?
A. El Niño enhances upwelling by deepening of the thermocline in the eastern Pacific.
B. El Niño shuts off upwelling of cold water by deepening the thermocline in the eastern Pacific.
C. El Niño enhances upwelling by a shallowing of the thermocline in the eastern Pacific.
D. El Niño shuts off upwelling of cold water by a shallowing of the thermocline in the eastern Pacific.

79. Which of the following trophic levels is missing from the mesopelagic and bathypelagic zones?
A. herbivores
B. detritivores
C. autotrophs
D. carnivores
E. top predators

80. Most organisms in mid-water food webs depend primarily upon
A. bacteria growing on DOM.
B. primary productivity by non-photosynthetic autotrophs.
C. a rain of food from above.
D. vertical migration into the euphotic zone to graze.
81. Zooplankton that incompletely graze phytoplankton and leave bits of detritus behind engage in what oceanographers call
A. detritivory.
B. pinocytosis.
C. phagocytosis.
D. sloppy feeding.
E. coprophagy.

82. The organisms that dwell on the sea floor in the abyss belong to
A. the deep-sea vent fauna.
B. the deep-sea benthos.
C. the deep-sea neuston.
D. the deep-sea nekton.
E. the deep-sea plankton.

83. The hypothesis of early benthic oceanographers that biodiversity decreases from shallow water to the deep sea has been ___ by modern-day studies.
A. rejected
B. confirmed

84. The sinking of dead whales, fish carcasses, and the occasional unfortunate sailor represent a type of food source known as
A. macrodetritus.
B. flotsam.
C. episodic food falls.
D. carcass bounty.
E. marine debris.

85. Hydrothermal vent communities are mostly supported by autotrophs that are
A. photosynthetic.
B. chemosynthetic.
C. heterotrophic.
D. mixotrophic.
86. The practice of fishing at ever-lower trophic levels is called
A. fishing off the top.
B. bottom fishing.
C. fishing until the cows come home.
D. fishing down the food web.
E. fishing up the food web.

87. What percentage of the U.S. population lives within 50 miles of the ocean?
A. 10%
B. 25%
C. 50%
D. 75%
E. None of the choices are correct.

88. The arrangement of organisms according to who eats whom defines the ___ of a community of organisms.
A. trophic structure
B. food web
C. food chain
D. All of the choices are correct.

89. Planktonic species live
A. on the seafloor.
B. on rocky shores.
C. in deep-sea muds.
D. in the water column.
E. on the beach.

90. The clustering of marine organisms into distinct bands based on tide heights along the shoreline is called
A. intertidal zonation.
B. organismal attraction.
C. bioerosion.
D. a biomosaic.
E. a feeding aggregation.
91. The highest intertidal zone is called
A. the middle intertidal.
B. the high intertidal.
C. the low intertidal.
D. the splash zone.
E. the twilight zone.

92. Biogenic coasts are formed
A. during sea level rise.
B. along active continental margins.
C. by the activities of organisms, namely, corals and reef-building algae.
D. from the erosion of volcanic platforms.

93. Symbiotic microalgae that live within the tissues of stony corals are called
A. phytoplankton.
B. alginates.
C. foraminifera.
D. zooxanthellae.
E. plants.

94. Runoff of fertilizers and other human-released biologically important nutrients that stimulate excessive algal growth is a condition called
A. eutrophication.
B. habitat alteration.
C. remineralization.
D. photolysis.
E. respiration.

95. Harmful algal blooms
A. are on the rise worldwide.
B. are becoming less frequent.
C. pose no threat to humans.
D. pose no threat to marine life.
For a typical deep-ocean wave form sketched below, what is the name of:

Point A_________________
Point B_________________
Distance “d”_______________
Distance “e”_______________

If the distance from A to C was 600 m, this wave should begin to interact with the bottom of the ocean at a depth of ~__________m (ie the wave base).

If the same wave was traveling above the continental rise on the Eastern coast of the USA, this wave’s speed should depend on ________________.

How would you calculate wave steepness?

Describe how marine mammals are well-adapted for deep diving in the ocean.

Describe the phenomenon of the spring bloom. In what parts of the world would you expect to observe the spring bloom? Why?

Describe 2 strategies used to mitigate coastal erosion. Explain how each works, and discuss the effect that each has both locally and downstream (further away).

(a) How many kgs of phytoplankton would be required for a human to gain 1 kg if they were eating herring? How many kgs of phytoplankton would be needed to achieve the same goal if the human was eating salmon? (Herring are at the 3rd trophic level, salmon are at the 4th. Assume a 10% transfer efficiency at each trophic level).

(b) Think about the implications of this calculation. You are a top official with the FDA. Should you promote a greater consumption of salmon or herring in the typical diet of citizens? Why or why not? What are the alternatives? Briefly explain why this is a difficult issue.

In the oceans, many organisms employ a “bipartite lifestyle”, where they spend part of their life in the plankton, and part as benthic organisms. Why?

Why do scientists prefer the name “Harmful Algal Bloom”, rather than “Red Tide”?

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.

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.

In the North Atlantic, there is both a spring and a fall bloom, but if we move further north (to the Barents Sea for example), there is only one bloom. Why?
Organisms that live in cold water generally live ___________ and grow ______________ than similar organisms that live in warm water.

Plant life in the oceans is restricted to the _______________ zone.

In deep-water communities along hydrothermal vent systems, primary production takes place by _________________.

Jellyfish are considered to belong to the _______________ group, because they _______________ overcome the effects of ocean currents.

Shown below are two currents flowing in the direction of the arrow.

Imagine these currents to be very large in scale (1000’s of km). Knowing that they are found on a rotating Earth, you expect there to be a significant influence of the_________________. In the ocean, these large-scale rotating features are called _________________ and they each are composed of ___________ (indicate number) currents.

This phenomenon causes the transport of water to create hills or valleys, depending on the direction of circulation. Think about how this works. Which of the two will exhibit a hill?_______ A valley? _______ With arrows, show how hills or valleys are set up within these features.

What is transport by this mechanism called? ____________________________

Having identified the hills and valleys, with an arrow beneath each drawing, indicate the direction of the pressure gradient (HINT: gradient goes from high to low pressure).
Lost at sea, we notice that our watch (set to the time at the Prime Meridian) says it’s 3:00PM when the sun is directly overhead (local apparent noon). What is our approximate longitude?

a) 15° W  
b) 45° W  
c) 15° E  
d) 35° E

True or false. The tide-generating force is inversely proportional to the cube of distance.

How many kg of phytoplankton are required to produce a 10 kg (22 lb) salmon? Recall that salmon are carnivorous fish, found at the 4th level of the trophic pyramid. Please show your work (use diagrams if desired). Assume a trophic efficiency of 10% at all levels.

Compare the strength of the Tide Generating Force due to the Sun and Moon using the following equation:

\[ F = \frac{2GM_1M_2a}{R^3} \]

where,
- \( F \) = tide generating force felt by the Earth due to another object in space.
- \( M_1 \) = mass of the Earth = 5.98 x 10^{24} kg
- \( M_2 \) = mass of the object in space.
- \( R \) = distance between the Earth and object (in meters).
- \( G \) = Universal gravitational constant = 6.6720 x 10^{-11} m^3/kg\cdot s^2
- \( a \) = radius of the Earth = 6400 km

\( M_m \) = mass of Moon = 7.348 x 10^{22} kg  
\( M_s \) = mass of Sun = 1.983 X 10^{30} kg  
\( R_m \) = distance between Moon and Earth = 3.840 X 10^5 km  
\( R_s \) = distance between Sun and Earth = 1.495 X 10^8 km

Please show your work and give your answer as a ratio of the larger TGF / smaller TGF.