Ocean Water, Ocean Life

I. Physics of sea water
  A. Composition
    1. Salinity
      a. parts per thousand=permil: sea water is 35 permil
      b. salt from dissolved mineral material and volcanic gases
      c. dissolved matter removed by
        1) organisms secreting hard parts and
        2) chemical precipitation
    2. variations in salinity due to variations in water
      a. additional water from
        1) precipitation
        2) melting ice
        3) runoff
      b. water removed by
        1) evaporation
        2) formation of sea ice—polar sea salinity varies seasonally
      c. variation from 33 permil to 38 permil, although some marginal areas
        1) to 42 permil (Persian Gulf) or
        2) 10 permil (Baltic)
  B. Temperature
    1. Varies from equator to pole, and from top to bottom
    2. Variation with depth
      a. in low latitudes it is warm at top, by sun energy
      b. declines sharply at about 300 m to 1000 m: the 'thermocline'
      c. below about 1000 m constant to sea floor: about 2^{o} C
      d. in high latitudes, cold and constant from surface to sea floor
      e. mid-latitudes may have seasonal thermoclines
    3. change in temperature over time would affect stability of life in the sea
  C. Density
    1. Affected by salinity and temperature
      a. temperature has inverse relation to density
      b. salinity has direct relation to density
      c. because sea water salinity varies only slightly, temperature has a greater affect on density of sea water
    2. density zones with depth—
      'pycnocline' is change in density with depth
      a. surface mixed zone—2% of ocean volume
        1) to 300 meters,
        2) depth varies with latitude and season
      b. intermediate transition zone—18%: includes thermocline and pycnocline
      c. high density zone—80%
        1) below 1000 m in mid latitudes
        2) somewhat more shallow in equatorial seas
        3) all high latitude sea water is high density

D. desalinization of sea water
   1. Expensive,
      a. minor source of drinking water
      b. unlikely source of agricultural water
   2. Processes
      a. distillation
      b. membrane processes use semi-permeable membranes
      c. freezing, chemical catalyst demineralization

II. Dynamic Ocean
   A. Circulation
      1. Surface Circulation
         a. Related to general circulation of atmosphere
         b. Pattern of 'gyres'
            1) include poleward warm current, and equatorward cool current
            2) North Pacific Gyre, South Pacific Gyre, North Atlantic Gyre, South Atlantic Gyre, Indian Ocean Gyre
            3) 'Coriolis Effect' deflects current to right in northern hemisphere, to left in southern hemisphere
            4) important named currents: Gulf Stream, California Current, Kuroshio Current, equatorial currents, West Wind Drift
         c. effect on climate: ~¼ of world heat transfer by ocean currents
            1) transfer of heat apparent in cold months in mid-latitudes
            2) cold currents apparent in tropics, and in mid-latitudes in warm months
         d. upwelling—vertical movement of water
            1) winds blow surface water away from continent
            2) phosphates, nitrates-rich water rises from deep ocean:
      2. Deep Ocean Circulation—thermohaline circulation
         a. Cold, saline polar waters sink
         b. Moves on sea floor 500 to 200 years
         c. Warm water moved poleward,
            1) draws up deep water in these areas
            2) this water is warmed and moves poleward

III. Ocean life
  A. Basis of sea life is algae—photosynthesis
    1. need sunlight
    2. provides food and oxygen for other organisms
  B. classifications
    1. plankton—float
      a. phytoplankton—plants (algae, etc)
      b. zooplankton—consumers (animals)
      c. most of Biosphere is plankton
    2. nekton—swim
      a. confined by environment constrains of
        1) temperature,
        2) salinity,
        3) depth,
        4) density of water,
        5) food sources
      b. fish
        1) most abundant near shore, in cold water
        2) some migrate between rivers and sea for reproduction
    3. benthos organisms
      a. live on the bottom—surface of it or beneath bottom surface
      b. seaweed and kelp live in shallow zones
      c. deep sea home to organisms that do not need light
  C. distribution—zones controlled by
    1. availability of sunlight
      a. photic zone affected by clarity, depth, season, time, latitude
      b. euphotic—good light:
        1) photosynthesis to about 100 m
        2) light to avoid predators to perhaps 1000 m
      c. aphotic zone—no light
    2. distance from shore
      a. intertidal zone—emergent from sea at times
      b. neritic zone—
        1) continental shelf from intertidal zone to shelf break at beginning of continental slope
        2) may be photic to bottom
        3) abundant nutrients from land runoff
      c. oceanic zone—open waters with less nutrients available
    3. water depth
      a. pelagic zone open ocean of any depth
      b. distinct differences of nekton to benthos organisms
      c. distinct differences from photic to aphotic
      d. abyssal organisms are benthos and aphotic
        1) high pressure of sea water due to depth
        2) low temperature, except at hydrothermal vents

IV. ocean productivity—
    A. primary from photosynthesis
        1. available nutrients
        2. solar radiation—
            a. seasonal,
            b. latitude control
    B. variation by latitude
        1. polar seas lack thermocline and pycnocline—constant supply of nutrients due to continual mixing, control due to sunlight variation
            a. diatoms flourish in spring
            b. copepods and krill increase after, feeding on diatoms
        2. tropical seas
            a. deep sunlight penetration
            b. permanent thermocline prevents much mixing with deeper water
            c. nutrients depleted in surface water, resulting in low biologic productivity
        3. temperate seas (mid-latitude)—significant seasonal variations
            a. winter—low productivity
                1) low sunlight is control
                2) nutrient levels high due to mixing
            b. spring—more sunlight
                1) bloom of phytoplankton
                2) nutrient level plummets—used up!
            c. Summer—thermocline prevents mixing, nutrients stay low
            d. Fall—
                1) cooling allows thermocline to break down,
                2) nutrient levels increase, allow fall phytoplankton bloom

V. ocean food relationships
    A. trophic levels—amount of food energy consumed at a certain feeding stage
        1. plants consumed by herbivores—planktonic and larger
        2. herbivores consumed by carnivores—planktonic and larger
    B. transfer efficiency—
        1. 2% sun energy absorbed by algae becomes algae structure
        2. remainder of energy used for its life processes
        3. 10% to herbivores, to primary carnivores, to top carnivores
    C. specific web example—herring of Atlantic
        1. Newfoundland herring eat copepods, with diatom food
        2. North Sea herring more complex

VI. Vent communities
    A. Energy supplied by Earth heat and sulfur
    B. Sulfur-consuming bacteria is the basis, not algae
    C. Communities of crabs, shrimp, tube worms