Biology Answers

Part 1/New Discoveries Sea

Activity 1/Putting “Goo” in Its Place

1. b
2. d
3. a
4. b
5. d
6. Larvaceans
7. Scuba (and glass jars)
8. Paradigm
9. Stinging tentacles
10. Nannoplankton
11. j
12. a, b, d, i
13. c, c, i, h
14. g
15. Scuba allowed us to see the abundance, diversity and feeding methods of blue-water plankton.
16. They make the food web more complex, and they provide a link between nannoplankton and the rest of the organisms, etc.

Activity 2/Ocean Upwellings

1. The biotic factors of the upwelling ecosystem are: diatoms, copepods and sardines.
2. Abiotic factors of the upwelling ecosystem are: high and low pressure systems in tropical Pacific, movement of surface water across the Pacific, coastal winds, nitrogen and phosphorus, and sunlight (light).
3. Producer organisms: diatoms
   First-order consumers: copepods
   Second-order consumers: sardines
   Decomposers: bacteria (not illustrated)—copepods and sardines also play a role in decomposing plant material
4. a. photosynthesis
   b. protein synthesis, ATP and DNA synthesis
   c. An increased concentration in the water of both chemicals would occur.
   d. Eventually a new balance would occur after a decrease in heterotrophs (consumers).
   e. A decrease in concentration would occur.
   f. A bloom might cause pollution and deaths or an increase in heterotrophs. Eventually a new balance would be established.

5. The guano industry would also suffer economic hardship.

For Further Study: Answers would depend on the article read.

Activity 3/Life in Hydrothermal Vent Communities

1. This is an open-ended question. Accept any suggestions that are factually correct. This should provide an opportunity for discussion of the conditions necessary for life. Try to focus on the adaptive ability of organisms to this hostile environment.

2. Energy supply is the most limiting factor. Since there is no light at these depths, the available energy should severely limit the abundance of living things. Instead, we find a well-developed biological community. The key is the existence of chemosynthetic organisms at the base of the food web. Students may also suggest that a higher temperature than normal is found at this depth. This is true. But as one moves away from the vent, the temperature drops sharply. In addition, low temperatures do not seem to limit organisms in other locations on the deep sea floor.
3. The specifics of the feeding relationships will be determined by future research. The following diagram shows what is known:

```
  |chemosynthetic bacteria|
  |                        |
  v                        
clams                    mussels
  |                       |
  
  tubeworms
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In addition, crabs and eelpout are scavengers, eating almost anything that is available.

4. The most noteworthy adaptation is the abundance of hemoglobin in large tubeworms and clams. The organisms' large size is possible because they concentrate oxygen in hemoglobin-rich tissues.

Another adaptation is the symbiotic relationship developed by the tubeworms, clams and mussels with the chemosynthetic bacteria. The relationship appears to be mutualistic. The bacteria supply food to the three hosts and the hosts concentrate the minerals the bacteria need to live.

5. It was thought that the absence of light precluded the development of a large community. Chemosynthesis had never been considered a basis for the abundance of large organisms.

6. This is also an open-ended question. However, some questions that are likely to be listed are: How do these cases of life come to be colonized? How stable are these communities in view of the limited number of species adapted to the stressful conditions? Hydrothermal vents are not permanent features, so what is the impact on the life history of the vent communities? What are the feeding relationships of the other members of the community? Are there practical applications of what has been discovered about this unusual ecosystem?

Activity 4/Living Between Sand Grains

Answers, observations, drawings and analysis will depend upon the organisms observed.

Part 2/Biochemistry

Activity 1/Photosynthesis and Decomposition

1. Nutrients \((\text{CO}_2, \text{NO}_3^-, \text{PO}_4^{3-})\) + water \(\rightarrow\) organic matter + oxygen

Photosynthesis occurs when chemicals containing carbon, nitrogen and phosphorus combine with the hydrogen and oxygen in water and with the energy from sunlight to produce solid organic matter and gaseous oxygen. Decomposition is the oxidizing of organic matter back into simpler compounds.

In photosynthesis, the energy is that of sunlight trapped by chlorophyll and reacted with nutrients to form organic matter. In decomposition (or respiration), the energy liberated is in a chemical form that can provide energy for muscle contraction or other energy requiring biochemical processes.

2. \(106 \text{ CO}_2 + 16 \text{ NO}_3^- + \text{PO}_4^{3-} + 9 \text{ H}_2\text{O} + \text{energy} \rightarrow \text{C}_{106}\text{H}_{183}\text{O}_{194}\text{N}_{16}\text{P}_{12} + 154 \text{ O}_2\)

a. to the right
b. to the left
c. photosynthesis
d. decomposition (respiration)
e. life processes
f. yes; heat and molecular bonds

3. Oxygen would be lower in some lower layers—the \(\text{O}_2\) minimum. It is not lower in all deep water because oxygen-rich water from high latitudes supplies the cold water that occurs deep in the ocean.

4. Nitrate and phosphate concentrations would be lower in the surface layers since they react in photosynthesis and are incorporated into organic matter.

5. If one nutrient is exhausted, the process of photosynthesis will slow down and stop. At this point, the composition of organic matter produced may have different chemical ratios than the ratio presented in this exercise. This is brought about by having smaller concentrations of the nutrient in limited supply.

6. Physical mixing between layers brings nutrients and light together to react in photosynthesis.

Activity 2/The Effects of Decay on \(\text{O}_2\)

1. The decomposition in jar 1 used \(\text{O}_2\).

2. Temperature changes might cause differences; water holds less \(\text{O}_2\).

3. The decomposition in jar 1 used up \(\text{O}_2\).

Activity 3/Effects of Plants on \(\text{O}_2\)

1. There is more \(\text{O}_2\) in Jar 1 because of photosynthesis.
2. Temperature changes might cause differences:
   water holds less O₂.

3. Photosynthesis caused the difference.

**Activity 4/ Temperature and O₂**

1. As the water is heated, the amount of O₂ decreases.

2. When algae bloom, the ones that are lower die due to lack of light. Thus there is decomposition which releases heat. Water holds less O₂, and fewer fish can live.

**Activity 5/ Determining Pigments in Marine Algae Using Paper Chromatography**

1. The answers to this depend on algae used and results.

2. Spinach will have bolder colors (more pigment) and will be similar to green algae (Ulvæ).

3. Chlorophyll and other pigments are soluble in acetone but not in water.

4. The darker the color on the chromatogram, the greater the concentration of pigment will be. However, this is a very qualitative observation.

5. Greens and to a lesser extent yellow, blue and orange are least useful in providing energy since these are the colors that are being reflected. The other light waves are being used for energy.

6. Other pigments are not soluble in acetone or petroleum ether.

7. The pigments might dissolve right into the solution.

8. The auxiliary pigments function to transfer energy to chlorophyll; this allows the utilization of more of the light energy.

**Part 3/ Animal Adaptations**

**Activity 1/ Plankton, Nekton and Benthos—Their Underwater Environment**

1. d

2. c

3. a

4. c

5. d

6. drag (forces)

7. boundary layer

8. low

9. drag

10. Surface area = 5cm x 6 sides = 150cm²
    Volume = 5cm x 5cm x 5cm = 125cm³
    \[
    \frac{150}{6} = 5 \text{ units of volume}
    \]

    There is only one unit of surface area for every 5 units of volume. This is not enough surface to feed the plankton.

11. Anemone A lives in a high turbulent area, such as a surge channel. The short, fat shape reduces the amount of surface exposed to drag and therefore stress. Anemone B lives in a quiet, stable environment. The tall, thin shape shows that this anemone doesn't experience a great deal of stress.

12. At a low Reynolds number, water is thick like butterscotch. Consequently, copepod arms act more like scoops than filters. They push parcels of water to their mouths. This makes them an even bigger part of the oceanic food chain.

**Activity 2/ What Shapes Mean Speed**

Answers will vary.
Part 4/Geologic History and the Oceans

Activity 1/Personal Timeline

Check individual timelines.

Activity 2/A Classroom Geologic Timeline

1. The benefit of radiometric dating is that it is reasonably accurate. The disadvantage is that not all rock has a radioactive sample with a half-life that is in a useful range. Some rocks don’t have any radioactive isotopes.

2. Marine invertebrate fossils are the most abundant.

3. We find humans in the Cenozoic era and the Quaternary period.

4. Glass sponges, sharks and horseshoe crabs are examples of very ancient organisms that are still alive today.

5. Possible explanations for mass extinctions include changes in the shape and geographical distribution of oceans, meteorites and comets.

6. The Earth was in existence for about 2 billion years before the first life appeared.

7. Blue-green algae appeared about 2.7 billion years ago, marine algae about 600 million years ago and the first land plants about 475 million years ago.

8. Life was in the oceans about 2 billion years before life appeared on land.

9. Since life is so dependent on water, beginning in the oceans meant that no special adaptations were necessary for obtaining and preserving water. Reproduction was simple in the watery environment, and maintaining shape was simple in the buoyant waters. The first cell was bathed in water and the necessary chemicals for life. It did not risk drying out.

10. As competition for space and food increased and the number of organisms increased, those with special adaptations that suited them for new environments had a survival advantage. This process continues as vacant niches are filled.

11. Ocean life contributed to an increase in the concentration of the ozone layer thus providing protection from radiation and making it possible for terrestrial life to safely evolve.

12. The theory of plate tectonics proposes that the continents are riding “plates” that cover the earth like skin. New material is added to a plate at the ocean ridge end and destroyed at the trench end, resulting in constant movement.

13. The word “evolution” means change over time.

14. As the continents move, the shape of the ocean basins can change. If the shape of the basin changes, then the water level will change.

15. If oceans become deeper, organisms that depend on shallow seas will become extinct. They are not adapted to the deeper oceans. Shallow waters are warmer with more uniform water movements. If these factors change, then organisms adapted to them will die.

16. Extinction today might be occurring due to thermal or chemical pollution, loss of the ozone layer, loss of territory such as rain forests, overhunting or overharvesting, etc.

17. Organisms change over time because they are reacting to changes in the environment. Natural variations are selected by changing environments.

18. B is the oldest rock because more of the U-236 has decayed.

Activity 3/Fossil Lab

Answers vary depending on choice of lab fossils.
Part 5/Seashells and Scientific Names

Activity 1/Designing a Dichotomous Key

Answers will vary according to shells used.

Activity 2/Using a Dichotomous Key

1. a) G  
   b) B  
   c) C  
   d) RC  
   e) P  
   f) RG, B, C  
   g) B  
   h) C  
   i) PB  
   j) G  
   k) B  
   l) C  
   m) P

2. Answers will vary with student. Possibilities include alphabetically, by type, etc.

3. The system is called the Linnaeus system of classification.

4. Taxonomists

5. It is a key used to identify organisms. It has at least two choices at every step.

6. The common features are: soft bodied, muscular foot or arms, visceral mass, mantle, shell, gills, trophophore larva.

7. The four major classes of mollusks are: polypacophora, gastropoda, pelecypoda, cephalopoda.

8. It is in the class gastropoda. This class has a radula, one-coiled shell, head and eyes, and an asymmetrical visceral mass.

9. It is in the class cephalopoda, which means "head-foot." Yes, it is internal.

10. Chitons. Yes, they have eight internal shell plates.

11. Pelecypoda. Bivalves have two shells, no radula, no head, primitive eyes and two siphons. Univalves have one shell, a radula and a well-developed head and eyes.

12. Snails crawl on the surface of rocks and scrape algae with their radula. Clams burrow into sand or mud and filter food from the water by pumping it through their siphons and gills.

13. A chambered nautilus is a cephalopod, not a gastropod. It has no radula and uses arms and tentacles to capture food. The shell is filled with hollow chambers. Snails have none of these characteristics.

14. Scientific names are always in Latin, do not change from place to place, are based on the Linnaeus system of classification, are made from the genus and species name, and are always underlined. Common names are in any language, can be different from place to place, are based on local culture and are not underlined or capitalized.

15. Clams filter seawater to eat plankton.

16. Chitons are found stuck to rocks in the sea.

17. The seven divisions are: kingdom, phylum, class, order, family, genus and species.

18. Humans use mollusks for money, jewelry, food, buttons, decorations and pearls.

19. Answer varies by student.

20. Their food doesn't move so that they don't have to be quick to catch it. They can pull their bodies all the way into their shell for protection.

21. Organization of living things is important so that people can communicate intelligently about them. The organization helps explain relationships and evolution of the organisms. In addition, a good system makes identification much easier.

Part 6/Behavior of Ocean Creatures

Activity 1/Biological Clocks

1. Green crabs are most active during a combination of high tide and darkness.

2. Solar rhythm is the most important factor.

3. Green crabs are darkest at noon.

4. Solar rhythm is the most important factor.
5. The green crabs’ behavior is internally/genetically controlled.

6. Solar rhythms control the migration of the diatom, Hantzschia.

7. Staying below the surface keeps Hantzschia from being carried away by waves.

8. Coming to the surface at noon allows the organism to take advantage of light for photosynthesis.

9. Again, the behavior of Hantzschia is internally/genetically controlled.

10. During high tides, fiddler crabs are quiet in their burrows, during low tides, fiddler crabs emerge to look for food.

11. In conditions of constant light and temperature, the rhythm periods lengthen and no longer correspond to the tidal rhythms.

12. Immersing the crabs in seawater or lowering their temperature can restore their environmental clock.

13. Hiding during high tide allows the fiddler crab to avoid predators.

**Activity 2/The Fiddler Crab Experiment**

Answers depend on students.

**Activity 3/Salinity Changes and Sea Animals**

1. The body fluids in organism C remain unchanged as the external salinity changes. Since salt tends to diffuse into organism C when the salinity of the environment goes above 2%, the organism must do one of the two things: prevent the salt from entering or excrete salt at a rate to maintain a constant internal concentration.

2. Organisms A and B have an increase in internal salinity as the salinity of the environment increases. Organism A eventually reaches a point where its internal body fluids are in balance with the external salinity. Organism B always maintains an internal salinity less than the environment.

3. It is difficult to say which situation is more efficient or adaptable. The important thing is the organism survives. Whether it does so by tolerating higher external salinities or by altering its internal salinity is not crucial. Both ways solve the problem of a changing environment.

**Activity 4/The Sea Worm**

1. The maximum weight gain was 60 percent above its initial weight.

2. The weight gain is due to the diffusion of water into the worm. This occurs because the concentration of water is less inside the worm than it is outside. According to the principles of diffusion, molecules will tend to move from an area of greater concentration to an area of lesser concentration.

3. The weight loss can be explained by active transport. The worm begins to excrete the water that entered during the first five to six hours.

4. This is an example of homeostasis. After a time, the worm begins to restore the balance of salt in its body fluids. It is interesting that it does not seek to maintain this balance immediately.

5. An organism that lives in coastal regions is subjected to frequent changes in salinity due to runoff from the land and the effects of the tides. Active transport requires the expenditure of energy. The sea worm has developed an intriguing physiological adaptation. Rather than expending energy for a temporary change in salinity, it simply tolerates a period of imbalance in its internal body fluids. However, if the higher environmental salinity persists, then it begins to lower the water content of its fluids by excretion. This is useful and efficient for an organism that is subjected to frequent changes in environmental salinity.

6. To survive in coastal waters an organism must evolve mechanisms for tolerating or adjusting to frequent changes in salinity. Most marine organisms have not developed this ability. Therefore, they cannot inhabit coastal regions. The salinity of the open ocean is fairly constant. Consequently, the ability to cope with changes is not found in most marine organisms.

7. The cells must tolerate the changes in salinity. One way to do this is by actively transporting the diffusing salt molecules outward.

8. With the development of specialized tissues and organs, more highly evolved organisms can regulate processes that simpler organisms do not.

9. Organisms such as salmon and eels are migratory fish. To cope with the change in salinity from a freshwater river or lake to the open ocean, these organisms must tolerate internal changes or counter the changes with regulatory processes.
Activity 5/Homeostasis on a Graph

Figure 8 Changes in salinity

<table>
<thead>
<tr>
<th>% saline</th>
<th>Organism A</th>
<th>Organism B</th>
<th>Organism C</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% external salinity

Activity 6/The Homeostatic Relationship Between Water Temperature and Respiration Rate in Marine Fish

1. Generally, the higher the temperature, the faster the respiration rate.
2. It varies.
3. It varies.
4. Thermal pollution is likely to increase the rate of respiration in fish.
5. Other factors that might affect respiration rate are: activity level of fish, depth of water, health, light and amount of oxygen dissolved in the water.
6. Breathing is increasing (the passing of water over the gills); this suggests that the metabolic rate may be increasing due to increased intake of oxygen. However, it is possible that the fish is simply increasing breathing because the oxygen level in the water is decreasing.
7. Answers may vary.
8. The student should answer that the fish respiration rate increased to maintain a constant oxygen supply to the tissues.
9. The fish has to adapt (breathe faster) when the water temperature increases to maintain a stable internal environment (i.e. a constant level of oxygen).

Part 7/Man Under the Ocean's Surface

Activity 1/Understanding Diving Physiology

1. A diver feels the effects of increasing pressure in the lungs, sinuses and ears.
2. Increasing pressure (external) reduces the size of the lung air spaces.
3. The air in the lungs expands.
4. Divers can get nitrogen narcosis at great depths because the partial pressure of nitrogen is greater at higher pressures and therefore enters the tissue fluid in greater amounts.
5. The symptoms of nitrogen narcosis are similar to intoxication—acting silly, irrational and in an unsafe manner.
6. A hangover, fatigue, alcohol, excess carbon dioxide, inexperience and anxiety can lower a diver's resistance to nitrogen narcosis.
7. Ascending quickly from great depths can cause the bends; too many of the gases in the tissues and blood come out of solution and form gas bubbles that get in the joints and cause pain.
8. Recompression in a hyperbaric chamber with subsequent slow decompression can be used to treat the bends.
9. Obesity, sleep loss, certain drugs, hypercoagulability, high altitude diving and work rate at the specific depth can reduce the validity of the No-Decompression Limits Table.

Activity 2/The Hemosponge

1. The Bonaventuras are able to remove oxygen from seawater with the hemosponge, which is a mixture of polyurethane plastic and hemoglobin. The hemoglobin maintains its ability to pick up oxygen and is able to remove oxygen from seawater.
2. The hemosponge could modify diving equipment and the method used to supply air for submarines and submersibles.
3. Yes. It is believed that a tank that will filter seawater and remove oxygen will replace the compressed air system used in scuba diving.

4. It will allow divers to dive for longer periods of time without fear of running out of air.

5. Hemoglobin absorbs the oxygen. It is known for its ability to bind oxygen at the interface between the organism and his environment, either at the air-lung interface or the water-gill interface.

**Activity 3/ Helium Diving**

1. Helium

2. Four and a half times

3. Commercial divers use the helium system the most. It allows them to dive at greater depths without developing nitrogen narcosis.

4. It allows greater diving depths.

5. False

**Activity 4/ Submersibles**

1. Depth and time

2. The internal pressure of the submersible remains equal to surface pressure so there will be no problem with nitrogen narcosis or the bends.

3. The Trieste I

4. Divers in submersibles are at surface pressures. This system offers the ability to dive to the bottom of the ocean floor without developing the bends or nitrogen narcosis.

**Activity 5/The Hydrolab Underwater Research Facility**

1. During saturation diving, a diver is exposed to an inert gas at a fixed high pressure long enough for all the body tissues to absorb all the gas they can. No additional gas can be dissolved in the tissues.

2. He may develop the bends. An incomplete decompression will leave nitrogen bubbles in the diver's tissues at a higher level than the partial pressure at the surface. When he ascends, if it is not slow enough, he risks developing the bends.

3. Time and depth