# *Zoology*, 10th edition by Miller and Harley—Answers to chapter questions

## Chapter 1 Answers

Section Review Questions

1.1 Evolutionary relationships are ideally reflected in taxonomy. Closely related animals share taxonomic classification categories. These relationships are ultimately based on shared DNA. Organisms that are more closely related have more DNA in common. Since most morphological characteristics are genetically based, when taxonomists study morphology they are studying genetic relationships. Both DNA and morphology can be used in establishing taxonomic relationships.

1.2 There are many examples. One example is the introduction of the zebra mussel (*Dreissena polymorpha*) into the United States in the 1980's, probably being carried here in the ballast water of ships coming from Europe. The zebra mussel is a small bivalve native to southeast Russia. It lives as a filter feeder attached to firm substrates by strong protein (byssal) threads. In the United States the zebra mussel has become a serious threat to native mussels as it out-competes native mussels for food and substrate. The zebra mussel will often use the shells of other mussels as substrate for attachment, killing the native mussel. They also clog factory cooling intake pipes. These invaders first appeared in the Great Lakes in 1988 and have spread throughout the Great Lakes and into the Mississippi River drainage.

Concept Review Questions

1. e

2. b

3. d

4. c

5. d

6. b

Analysis and Application Questions

1. Biology is the study of life. Zoology is the study of one of the major kingdoms of life, the Animalia. In addition to evolution and ecology, all life (thus biology and zoology) is united by common genetic molecules (DNA and RNA), and a common unit of organization—the cell.

2. Current issues that involve both zoology and questions of ethics and public policy are far reaching. These issues include species preservation, habitat destruction, human population growth, the teaching of evolution in public schools, animal rights, and many others. Zoologists are united as scientists. Zoologists can inform public policy debates by providing accurate information on animals, the environment, evolutionary processes, and many other topics. Zoologists have a responsibility to convey information and application strategies as clearly and as accurately as possible to the public and public institutions. At the same time, zoologists are a diverse group of scientists with different world views. We can expect differences of opinion among zoologists in the light of insufficient data and differing world views.

3. Some solutions to environmental problems seem simpler than they really are because most of us live in countries where the standard of living makes ecological choices either easy or at least not a matter of immanent life or death. In many less developed countries, day-to-day survival choices are not necessarily ecologically minded. Cultures that have been sustained by hunting species that are now endangered or clearing tropical forests for agricultural use will not change simply because zoologists in developed countries tell them they need to change. Partnership with less developed countries can show how preservation will provide resources that will benefit these countries.

4. The story of cichlids in Lake Victoria documents how issues of day-to-day survival in less developed countries can lead to wide-ranging environmental degradation. It emphasizes the interconnected nature of ecological systems and how disturbing these systems can have consequences that are more severe than the original problem. We can all learn from this account and not repeat it in the future.

## Chapter 2 Answers

Section s Review Questions

2.1 Some similarities between eukaryotic and prokaryotic cells of Eubacteria and Archaea include the following: 1) they are comprised of single cells that lack a membrane-bound nucleus and extensive cytoplasmic organelles, 2) they both have a cell wall, 3) vacuoles and vesicles may be present.

2.2 The volume will increase by 1000 times. Remember, a cell's surface area must be large enough to meet the metabolic needs of its volume.

2.3 If just a single layer of phospholipids were present, the cell would not be able to regulate its contents and what moves into or out of the cell. Since proteins are not present, it would not function as a selectively permeable membrane to control the passage of specific molecules.

2.4 The concentration of the IV solution needs to be isotonic with your red blood cells. If it were excessively hypotonic, water would move in and the RBSs would burst (hemolyze); if it were hypertonic, your red blood cells would lose water and shrink or crenate.

2.5 Nuclear pores, vaults, ribosomes, and the ER are all structures involved in intracellular transport.

2.6 Pores allow the exchange of small molecules between the cytoplasm and nucleoplasm.

2.7 Most organs are made up of multiple tissue types. For example, the heart contains cardiac muscle, nervous tissue, connective tissue, and epithelial tissue.

2.8 Blood is a type of connective tissue because it contains a lot of extracellular material in the form of plasma and it is derived from bone marrow—a connective tissue.

2.9 The skin is the largest organ in a mammal.

2.10. Yes, the organ systems can overlap. Consider the circulatory and respiratory systems being dependent on each other in order to maintain homeostasis.

Concept Review Questions

1. d
2. b
3. a
4. e
5. d

Analysis and Application Questions

1. The mitochondrion is called the “power generator” of the cell since this is where the energy molecule, ATP, is produced. ATP powers all energy requiring processes in the cell.
2. The plasma membrane regulates the passage of molecules into and out of the cell. The concept of “membrane biology” implies this common function. This commonality is due to the selective permeability, meaning that certain substances can freely pass through the membrane, some are transported across, and others are prohibited from either entering or leaving. In addition the proteins embedded within the plasma membrane have varied common functions such as channel proteins, transport proteins, cell recognition proteins, receptor proteins, enzymatic proteins, and junction proteins.
3. The “fluid-mosaic model” states that the protein molecules embedded in the membrane have a pattern (a mosaic) within the phospholipid bilayer. The protein pattern varies with the type of cell and within the same membrane at different times. Cholesterol molecules present in the plasma membrane of eukaryotic cells, lend support to the membrane, giving it the general consistency of fluid olive oil.
4. An osmotic gradient is created when there are more solute molecules on one side of a membrane compared to the other side; conversely, there are more water molecules on the side with fewer solute molecules.
5. Some animal cells can transport molecules against a concentration gradient by using energy to move molecules across the plasma membrane toward a higher concentration of solute molecules. Note that the transport protein will change shape during the process.

Some invertebrates, such as a protozoan, can survive without this process but it is a necessity in all higher animals.

**Chapter 3 Answers**

Section Review Questions

3.1 Eukaryotic organisms have much more chromatin than do prokaryotic organisms. DNA of the latter is usually circular in form and histone proteins are not present or used in DNA packaging. In addition, prokaryotes have many fewer genes. For example, the common bacterium *Escherichia coli* has just over 4,000 genes. Humans have about 20,000 protein-coding genes, and much more DNA that is noncoding. The use of histone proteins in chromatin condensation is unique to eukaryotes and is apparently required to facilitate the distribution of large amounts of DNA during cell division processes.

3.2 Mitotic cell division results in daughter cells that are genetically identical to the parental cell. This means that a 2*N* cell undergoing mitotic cell division produces 2*N* daughter cells. If these daughter cells were sperm or egg cells, fertilization would result in 4*N* zygotes with the number of chromosome sets doubling with every generation. In addition, mitotic cell division does not promote variability, which is so very important for sexual reproduction. (See the answer to 3.3 below.)

3.3 Meiotic cell division accomplishes two things that are so very important in the formation of gametes: the reduction in the chromosome number from 2*N* to 1*N* and the introduction of variation into the products of meiosis. The reduction of chromosome number occurs after homologous pairs undergo synapsis during prophase I, line up at the equator of the cell in metaphase I, and segregate to opposite poles of the cell in anaphase I. The cells produced in the first meiotic division thus contain one member of each homologous pair of chromosomes and are 1N. Similarly the crossing over events of prophase I and the independent assortment of homologous chromosomes of anaphase I are the reasons why cells produced from meiosis of a parent cell are genetically different. The second meiotic division of a daughter cell is just like mitotic cell division and does not change chromosome numbers or introduce new genetic variation into the daughter cells.

3.4 The second strand would be 5’TCACGTAAG3’
The messenger RNA would be 5’UCACGUAAG3’
The amino acid sequence would be serine-arginine-lysine (*see table 3.11*)

3.5 Segregation is the separation of genes on homologous chromosomes into separate gametes and this occurs during anaphase I. Independent assortment is the random distribution of

nonhomologous chromosomes into separate gametes. This random distribution in influenced by how chromosomes in synapsis line up during metaphase I and their separation during anaphase I.

Concept Review Questions

1. c.

2. c.

3. g.

4. d.

5. b.

Analysis and Application Questions

1. The similarities of the stages of meiosis and mitosis have led cell biologists to the conclusion that the two processes share an evolutionary history. The evolutionary events in this common history are under investigation. Mitosis is believed to be the older of the two processes. It is first seen in protists and primitive fungi, some of which have a closed mitosis in which all chromosomal events occur without the dissolution of the nuclear membrane. Open mitosis, with the dissolution of the nuclear envelope, may be a later evolutionary development. Meiotic cell division involves the use of many genes that also control mitotic cell division. Obviously, the complex proteins associated with carrying out and controlling some aspects of meiosis—synapsis, crossing over, and independent assortment—are unique to this form of cell division and came about later in evolution.

2. Both chromatids of one chromosome would travel together to the same pole of the cell. One daughter cell would have 5 chromosomes and the other daughter cell would end up with 7 chromosomes. Changes in chromosome number like these are usually detrimental to the cell.

3. The genetic material for the development and function of an entire organism is carried by the DNA of every cell, except for gametes. All cells, however, do not express all genes. Stomach cells are different in form and function from skin cells, and cells that form sperm in the testes of a male are not fully functioning until sexual maturity. In order to account for differences in cell types and differences in organisms during different life stages one must look to complex genetic control systems that turn some genes on and some genes off in different cells and at different stages in development.

4. Genes carried by the same chromosome are said to be “linked.” Two genes very near each other on the same chromosome tend to be carried together to the same pole of the cell during anaphase I of meiosis, thus they do not segregate independently. On the other hand, genes that

are far apart on the same chromosome undergo crossing over frequently enough that these genes do segregate independently even though the entire chromosomes on which they reside do not.

## Chapter 4 Answers

Section Review Questions

4.1 Lamarck's idea of evolutionary change was based on the idea that characteristics are acquired by organisms as the environment changed and a new need arose, for example longer necks in giraffes would have arisen as they needed to reach higher into trees. If this idea was true, extinction would be less likely because every environmental challenge would be met by a change that would permit survival. Clearly, this is not the case as extinction has been the fate for most species that have lived on planet Earth.

4.2 Darwin grew up in rural England where his interests centered around collecting and hunting. Darwin had parents who insisted that he receive a university education. Darwin had close relationships with Cambridge scientists who encouraged his love of nature.

4.3 Adaptive radiation is the formation of multiple forms from one ancestor as a result of the opening of new habitats. The first finch populations on the Galapagos Islands encountered environments that were devoid of predators and had few other birds occupying the diverse habitats available on the islands. Finches with bill and other variations that allowed them to exploit these available habitats passed their variations on to offspring. Eventually many bird habitats were occupied by the 14 species of finches seen today, each with distinctive adaptations not seen in mainland finches.

4.4 Natural selection occurs as a result traits being selected against or "weeded out" of a population. The result of this "weeding out" is that adaptive traits are more likely to be passed on to a future generation. These traits that are being passed into future generations are often thought of as being selected for, although the section for these traits is indirect. Selecting for adaptive variations does not mean that natural selection picks "good" variations out of a "variation pool" and promotes their perpetuation. This kind of thinking about natural selection as a positive force can lead to erroneous teleological ideas, where evolution is represented as occurring in response to needs.

4.5 Laboratory, or experimental, science is just one method in science. Science also uses observational and historical methods. These latter approaches to science use field observations and historical data to document and explain natural phenomena. These are the same methods that are used, for example, in forensic science to reconstruct events at the scene of a crime. We are so very confident in the use of this kind of science that individuals are given very harsh sentences based on this science. In the same way, biogeography, paleontology, and concepts of homology and analogy present convincing evidence of evolution. Virtually all scientists are