Nester's Microbiology A Human Perspective 9th edition Anderson Solutions Manual

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Chapter 1 Humans and the Microbial World

Chapter Overview

This chapter introduces microbiology with a discussion of some of the major events that have been important in the development of this field of study, including a timeline. The origin and discovery of microorganisms is explored, and the roles of microorganisms in the natural world are discussed, including the ways that microbes can both benefit and cause harm to humans. The concept of two cell types (prokaryotic and eukaryotic) is introduced, and the scale of microbe size is discussed. The three domains are described, and various kinds of microorganisms included in each domain are detailed. The non-living acellular infectious agents (viruses, viroids, prions) are also presented. Proper scientific naming of microorganisms is covered.

Section 1.1 The Dispute Over Spontaneous Generation

Experiments

The discovery of microorganisms in various specimens raised an interesting question: "Where did these microscopic forms originate?" This section details several major experiments that were carried out by scientists in an effort to answer the question, including:

- Francesco Redi, who placed meat in jars and observed the development or lack of development of maggots. His experiments led him to conclude that **spontaneous generation**—life arising from non-living matter—was false.
- John Needham, who boiled broth but observed microbes in it within a few days, even if the flasks used in the work were sealed with cork. He concluded that the work proved spontaneous generation.
- Lazzaro Spallanzani, who repeated Needham's broth boiling experiments but boiled broth for longer, and sealed his flasks by melting the necks closed, after which the broth remained microbe-free. He concluded that his work disproved spontaneous generation. Critics observed that sealed flasks lacked "vital force" (oxygen).
- Louis Pasteur, who boiled broth but used swan-necked flasks that were left open at the neck. After boiling, the broth remained sterile unless the flasks were tilted and broth ran into the u-bend of the neck. Pasteur's work led to the theory of **biogenesis**—life comes from previous life.
- John Tyndall and Ferdinand Cohn, who discovered the existence of **endospores** that can resist boiling.

Scientific Method

The experiments of Pasteur are used in this chapter to introduce students to **scientific method**, walking them through the steps that are taken in the process of science. These are:

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- Making an observation about something and asking a question about that situation.
- Developing an explanation and then devising an experiment that tests the explanation (testing an **hypothesis**).
- Doing the experiment, collecting the data, and drawing a conclusion.
- Communicating the methods, results, and conclusions.

The Golden Age of Microbiology

This subsection briefly describes the time during which microbiology blossomed as a science; the accompanying figure highlights some of the important developments during this period, including the **germ theory of disease**, **Koch's postulates**, development of the first **antimicrobial medications** and **vaccination**, among others. Details on these developments are highlighted in the Glimpse of History in subsequent chapters.

Learning Outcomes for Section 1.1

At the end of this section, students should be able to:

1. Describe the key experiments of scientists who disproved spontaneous generation
2. Explain how the successful challenge to the idea of spontaneous generation led to the Golden Age of Microbiology.
3. Describe the scientific method, using Pasteur's swan-necked flask experiment as an example.

Examples of Critical Thinking Questions for Section 1.1

Critical thinking questions include:

- Describing how Pasteur's experiment that disproved the idea that a "vital force" in air was responsible for spontaneous generation.
- Discussing why scientists must repeat the experiments of others

Section 1.2 Microbiology: A Human Perspective

The enormous impact the microorganisms have on humans is covered in this section. **Normal microbiota**, the **Human Microbiome Project** and the **National Microbiome Initiative** (U.S. government program started in 2016 that supports research on the microbiomes of humans as well as those of our surrounding environment) are introduced.

The benefits of microbes are discussed, including **food production, biodegradation, biotechnology, commercial products,** and **microbes as research tools**. The detrimental effects of microbes, including **pathogens** and disease, are also covered. The elimination of smallpox, and significant reduction of plague and polio cases are used to highlight how microbiological progress has led to improvement of human health. The subsection concludes with a description of **emerging infectious diseases,** including drug-resistant tuberculosis, Zika congenital syndrome, Ebola virus disease, HIV/AIDS, and MERS, among others.

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Learning Outcomes for Section 1.2

At the end of this section, students should be able to:

4. Explain the importance of microorganisms in the health of humans and the surrounding environment.
5. List three commercial benefits of microorganisms.
6. Describe why microorganisms are useful research tools.
7. Describe the role of microbes in disease, including examples of past triumphs and remaining challenges.

Examples of Critical Thinking Questions for Section 1.2

Critical thinking questions for this section include:

- Describing two microbial activities essential to life and three that make our lives more comfortable.
- Describing three factors that cause certain infectious diseases to become more common.
- Discussing why would it seem logical, even inevitable, that at least some bacteria would attack the human body and cause disease?

Section 1.3 Members of the Microbial World

The section includes a **Focus Figure**, which is used to introduce to students members of the microbial world, including those in the **domains *Bacteria*, *Archaea* and *Eukarya***, as well as the non-living agents: **viruses, viroids** and **prions**. **Prokaryotes** are single-celled organisms that do not have a membrane-bound nucleus. The genetic material is found in a region of the cell called the **nucleoid**. Bacteria are in a separate domain because they possess a cell wall of **peptidoglycan**, a compound unique to this group. **Archaea** also have a cell wall, but it is not composed of peptidoglycan. **Eukaryotes** may be single-celled or multicellular, and have a "true" membrane-bound nucleus in which the genetic material is contained. Members of the *Eukarya* include **fungi, algae, protozoa** and also the **helminths**. Characteristics of members of each domain are summarized in this section.

The comparative sizes of non-living agents, microbes and other organisms are illustrated on a figure. This section also covers **scientific naming of microorganisms,** covering the use of genus, species and strain.

Learning Outcomes for Section 1.3

At the end of this section, students should be able to:

8. Compare and contrast characteristics of members of the *Bacteria, Archaea,* and *Eukarya.*
9. Explain the features of an organism's scientific name.
10. Compare and contrast the algae, fungi, and protozoa.
11. Compare and contrast viruses, viroids, and prions.

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Examples of Critical Thinking Questions for Section 1.3

Critical thinking questions for this section include:

- Describing the chemical composition of viruses, viroids, and prions.
- Discussing the following scenario: A microbiologist obtained two pure biological samples: one of a virus, and the other of a viroid. Unfortunately, the labels had been lost. The microbiologist felt she could distinguish the two by analyzing for the presence or absence of a single molecule. What molecule would she search for and why?

Focus on a Case

The case presentation in chapter 1 discusses an opportunistic *C. diff.* infection that developed after antibiotic treatment, focusing on the role of a fecal transplant in resolving the infection!

Digital Case Studies

1. **Spontaneous Generation Debate**—examines the experiments involved in resolving this debate.
2. **Zika Preparedness Plan**—discusses how preparedness and a robust response program will limit the effects of Zika virus, and ensure proper screening, diagnosis and medical care of infected people.
3. ***C. difficile* Infection**—examines a CDI resulting from taking antibiotics for a tooth infection.

Focus on the Future

The Focus box gives more information on the Human Microbiome Project and the National Microbiome Initiative. The microbiome project is a good topic for additional student research.

Focus Your Perspective

This box describes some interesting microbes that are exceptions to the generally accepted information on microbial size.

Additional ideas for classroom discussion/ homework assignments

- As an ice-breaker in the class, after introducing students to various ways microbes are both helpful and harmful to us, break them into small groups and have them create a chart giving specific examples of each.
- Students are fascinated by the microbiome. Although the microbiome is covered more fully in subsequent chapters, this is a good place to expand a little on the current research etc. A good place to look for easy-to-read articles on the

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microbiome is https://www.sciencenews.org/search?st=microbiome. Download specific articles to give to your students, or direct them to this website and ask them to locate articles of interest. Alternatively, there are several excellent TED talks on YouTube on the microbiome.

- Scientific method is of key importance. After discussing Pasteur's experiment in terms of scientific method, have student design a simple experiment to show their understanding of the concepts. A good topic for this would be a simple handwashing experiment. The digital case study in the question bank for chapter 5 presents a simple handwashing experiment – use it as a resource for you, or have students do that case study.
- The digital case study in the question bank for chapter 2 directs students through reading a scientific abstract. This is a good homework exercise for reinforcing the scientific method.

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Case 1

A 24-year old female automotive technician presents herself at the doctor's office. She complains of fever and of pain in her left hand.

On physical examination, the patient had a deep wound on her left palm that was oozing pus. She had purplish, red streaks running up her left arm. She had enlarged lymph nodes at the elbow and under her arm. The patient's skin was warm and dry.

In her history, the patient had punctured her left palm with sharp metal from the undercarriage of a "real cherry" 1977 Malibu about a week earlier. She said the wound had bled for a few minutes and she thought that she had washed it "real good" with soap and water. She had covered the wound with a large "band-aid" and gone back to work. She developed a fever about three days later. For the past couple of days, she "did not feel so good" and had vomiting and diarrhea.

1. What type of infection do you believe she has in this hand?
    a. *Streptococcus pyogenes*
    b. *Staphylococcus aureus*
    c. *Clostridium*
    d. *Pseudomonas*
    e. *Pasteurella multocida*
2. From complaint and physical examination, which of the symptoms lead you to your choice of agent?
    a. the fever and pain in the hand
    b. the fever, wound with oozing pus and enlarged lymph nodes
    c. the lymph nodes and red streaks
    d. the warm dry skin
    e. the pain, red streaks and enlarged lymph nodes
3. From the history, which of the information confirmed your choice?
    a. The wound had bled for a while.
    b. The wound was cleaned with soap and water.
    c. The wound had been covered and had perhaps become anaerobic.
    d. She had diarrhea and vomiting.
    e. The cut was from a rusting car frame.
4. Which of the following is most likely to follow this infection?
    a. gangrene and amputation
    b. toxic shock syndrome
    c. muscle spasms
    d. neurological disfunction of the hand

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e. arthritis

Answers

1. b
2. b
3. d
4. b

Chapter # and Question type	Question	Answer
Chapter 1		
Ch 1 Short answer #1	How did Louis Pasteur help disprove spontaneous generation?	Pasteur demonstrated that swan necked flasks containing sterile growth medium would remain sterile indefinitely if the bend in the flask did not come in contact with the medium.
Ch 1 Short answer #2	Describe the scientific method.	Scientists formulate a question and then develop a testable explanation (a hypothesis). An experiment that includes appropriate controls is done to test the hypothesis. Data is collected and then a conclusion is drawn, which is communicated to other scientists who can do further experiments to test the validity of the conclusion.
Ch 1 Short answer #3	Explain why life could not exist without the activities of microorganisms.	• Nitrogen would not be available in a form that humans and plants could use. • The supply of O_2 would eventually be depleted if microorganisms were not available to replenish it. • A wide variety of materials would pile up if microorganisms were not present to degrade them.
Ch 1 Short answer #4	How is the normal microbiota important to human health?	The normal microbiota plays a number of essential roles such as competing with disease-causing microbes, helping the body digest foods, and promoting the development of the immune system.
Ch 1 Short answer #5	List four commercially important benefits of microorganisms.	• Their role in food and beverage production • Role in pollutant degradation • Synthesis of commercially valuable products • Their importance in synthesizing medically important products, following genetic modification • Their importance as model organisms for the study of universal biological processes
Ch 1 Short answer #6	What characteristics of microorganisms make them important research tools?	They grow quickly on inexpensive media, and the processes they use to duplicate their DNA, harvest energy,

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		and synthesize cell structures are similar to those of other organism, so they serve as a model organism used in research experiments
Ch 1 Short answer #7	List three factors that contribute to the emergence of infectious disease.	• Aging population is more susceptible to disease • Organisms controlled by antimicrobial medications have become resistant to the medications • Children are not being routinely vaccinated against many diseases
Ch 1 Short answer #8	In the designation *Escherichia coli* B, which part of the name indicates the genus? Which part indicates the species? Which part indicates the strain?	*Escherichia* is the genus; *coli* indicates the species and *B* is the strain.
Ch 1 Short answer #9	Why are viruses not microorganisms?	They are not composed of cells. Viruses do not have all of the machinery necessary to replicate and so they obligate intracellular parasites.
Ch 1 Short answer #10	Name three non-living groups in the microbial world and describe their major properties.	• Viruses contain a protein coat and either DNA or RNA. They are obligate intracellular parasites and as a group, infect of all forms of life. • Viroids contain only a short RNA molecule. They cause serious plant diseases • Prions consist only of protein that is a misfolded version of normal cellular protein found in the brain of animals. They are resistant to the commonly used sterilizing procedures that destroy viruses and bacteria.
Ch 1 Multiple Choice #1	The property of endospores that led to confusion in the experiments on spontaneous generation is their a) small size. b) ability to pass through cork stoppers. c) heat resistance. d) presence in all infusions. e) presence on cotton plugs.	C
Ch 1	The Golden Age of	C

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Multiple Choice #2	Microbiology was the time when a) microorganisms were first used to make bread. b) microorganisms were first used to make cheese. c) most pathogenic bacteria were identified. d) a vaccine against influenza was developed. e) antibiotics became available.	
Ch 1 Multiple Choice #3	If all prokaryotes were eliminated from the planet, a) animals would thrive because there would be no disease. b) archaea would thrive because there would be no competition for nutrients. c) all animals would die. d) animals and archaea would thrive.	C
Ch 1 Multiple Choice #4	All of the following are emerging infectious diseases except a) smallpox. b) hepatitis C. c) Lyme disease. d) hantavirus pulmonary syndrome. e) mad cow disease.	A
Ch 1 Multiple Choice #5	All of the following are biological domains except a) Bacteria. b) Archaea. c) Prokaryota. d) Eukarya.	C
Ch 1 Multiple Choice #6	Which name is written correctly? a) *staphylococcus aureus* b) *escherichia Coli* c) *Staphylococcus epidermidis* d) bacillus Anthracis e) Clostridium Botulinum	C
Ch 1 Multiple Choice #7	Members of which pairing are most similar in appearance to each other? a) fungi and algae b) algae and archaea c) archaea and bacteria	C

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	d) bacteria and viruses e) viruses and algae	
Ch 1 Multiple Choice #8	If you wanted to increase your chances of obtaining a member of the *Archaea* (rather than a member of another domain), which would be the best site to obtain a sample? a) intestine of an elephant b) skin of an elephant c) a 95ºC hot spring in Yellowstone d) a 45ºC hot spring in Hawaii e) a raw hamburger patty	C
Ch 1 Multiple Choice # 9	Viruses 1. contain both protein and nucleic acid. 2. infect all domains of life. 3. can grow in the absence of living cells. 4. are generally the same size as prokaryotes. 5. always kill the cells they infect. a) 1, 2 b) 2, 3 c) 3, 4 d) 4, 5 e) 1, 5	A
Ch 1 Multiple Choice #10	Antony van Leeuwenhoek could not have observed a) roundworms. b) *Escherichia coli*. c) yeasts. d) viruses.	D
Ch 1 Applications #1	The American Society for Microbiology is preparing a "Microbe-Free" banquet to emphasize the importance of microorganisms in the diet. What foods could not be on the menu?	Nothing would be available to eat. Not only are microorganisms used to produce products such as cheese, bread, coffee, chocolate, and alcoholic beverages, they are needed for crop production, so vegetables or fruits would not be available to eat. Cattle, chickens, pigs and other animals need microorganisms to assist with the digestion of food. They would be undernourished and not provide quality meat or products adequate for human consumption. Do not look for fish or any other lake or ocean products because these ecosystems are needed for their survival. Any beverage prepared with water would be unsafe to

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		consume. Microorganisms are used to treat wastewater, so without them water supplies would be polluted.
Ch 1 Applications #2	If you were asked to nominate one of the individuals mentioned in this chapter for the Nobel Prize, who would it be? Make a statement supporting your choice.	Any answer that is supported.
Ch 1 Critical Thinking #1	A microbiologist obtained two pure biological samples: one of a virus, and the other of a viroid. Unfortunately, the labels had been lost. The microbiologist felt she could distinguish the two by analyzing for the presence or absence of a single molecule. What molecule would she search for and why?	Test for proteins.
Ch 1 Critical Thinking #2	Why would archaea that grow in extreme environments be more intensively studied than those that do not?	Because their unusual abilities make them interesting to scientists and important industrially; enzymes that can function at extreme temperatures can be quite useful in certain processes.
Chapter 2		
Ch 2 Short Answer #1	Differentiate between an atom, a molecule, and a compound.	An atom is the basic unit of all matter. A molecule is composed of two or more atoms joined through chemical bonds. A compound consists of atoms of two or more different elements.
Ch 2 Short Answer #2	Why is water a good solvent?	Because of its polar nature, water can form hydrogen bonds with all polar molecules thereby preventing the association of the atoms comprising the solute.
Ch 2 Short Answer #3	Which solution is more acidic, one with a pH of 4 or a pH of 5? What is the concentration of H^+ ions in each?	A pH of 4 is more acidic. A solution of 4 has a H^+ concentration of 1×10^{-4}. A solution with a pH of 5 has a H^+ concentration of 1×10^{-5}.
Ch 2 Short Answer #4	What is the significance of cellulose?	Cellulose is a polysaccharide found in the cell walls of plants. Only certain bacteria and fungi have the enzymes required to break the chemical bonds in cellulose.
Ch 2 Short Answer #5	Show how dehydration synthesis and hydrolysis reactions are related, using an example of each.	Dehydration synthesis is involved in the joining together of two amino acids (or other chemical subunits) with the loss of water (H_20) in the chemical

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Figure number	Question	Answer
Chapter 1		
1.1	What kinds of organisms did van Leeuwenhoek observe though his microscope?	Microorganisms, including bacteria, protozoa, some fungi and algae
1.2	If the broth in Pasteur's swan-necked flasks had contained endospores, what results would have been observed?	Growth might occur in the flask without tipping if the spores were not killed by heating
1.3	What is the Golden Age of Microbiology?	The time period when most disease-causing microbes were identified and early work on viruses had begun.
1.4	Why would the creation of health departments lower the disease rate?	The goal of health departments is to prevent diseases. They study disease occurrence, and use that information to develop ways to prevent spread of diseases.
1.5	Why might so many of the diseases first appear or be identified in the United States and Western European countries?	Methods for isolating and identifying the causative agents are more advanced in these countries.
1.6	Members of which two domains are prokaryotes?	*Bacteria* and *Archaea*
1.7	Why is a logarithmic scale necessary when comparing sizes of members of the microbial world?	The range in size of members of the microbial world is so great that their sizes can only be compared on a logarithmic graph
1.8	What type of cells make up molds?	Eukaryotic cells
1.9	What general features of algae distinguish them from other eukaryotic microorganisms?	Algae are photosynthetic and so can harvest the energy of light.
1.10	How do protozoa differ from both fungi and algae?	Protozoa do not have a cell wall.
1.11	Why can viruses be so much smaller than cells and still replicate?	Viruses use the machinery and enzymes of the cells they invade to replicate.
1.12	How are prions different from the normal versions of the related proteins made by cells?	Prions are misfolded versions of normal proteins. The misfolded versions bind together to form aggregates and are resistant to destruction.
Chapter 2		
2.1	How does the number of electrons in an atom compare to the number of protons?	They are the same.
2.2	Based on the Lewis structure of carbon, is the atom likely to enter into chemical reactions?	Yes, because the outer shell is not filled.
2.3	Why is radioactive iodine concentrated in the thyroid gland?	The thyroid gland uses iodine in the synthesis of thyroid hormones.
2.4	Which of the ions in this figure is an anion, and which is a cation?	The anion is Cl^- and the cation is Na^+
2.5	Is methane an organic molecule?	Yes, because it contains C-H bonds.

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	Explain.	
2.6	Why is the oxygen atom in a water molecule more electron-rich than the hydrogen atoms?	It has a greater attraction for electrons than do the H atoms.
2.7	Explain why two identical atoms joined by a covalent bond cannot form a hydrogen bond.	The electrons are shared equally by identical atoms so the covalent bond is not polar, a requirement for hydrogen bonding.
2.8	Why does ice float in water?	The water molecules are farther apart from one another in a solid lattice. Ice is therefore less dense than water.
2.9	If water were not polar, would it dissolve sodium chloride? Explain.	No; dissolving depends on the electrical attraction between polar water molecules and the ions of the salt.
2.10	Does the H^+ concentration increase or decrease when the pH drops from 5 to 4?	The H+ concentration increases (and the OH- decreases) when the pH drops from 5 to 4
2.11	What are the four major classes of macromolecules?	Carbohydrates, lipids, proteins, and nucleic acids
2.12	What is the major chemical difference between ribose and deoxyribose?	Ribose has a –OH group attached to carbon 2 whereas deoxyribose has a H atom
2.13	What is a structural isomer?	Two molecules that have the same molecular formula, but the atoms are arranged differently, leading to different properties of the two molecules
2.14	What type of reaction would reverse the step shown in this diagram?	The addition of water; a hydrolysis reaction
2.15	Where are the three polysaccharides shown above found in nature?	Cellulose is found in the cell walls of plants; glycogen is the storage form of glucose found in many animals and dextran is a storage form of glucose found in bacteria.
2.16	What components of the fat in this figure make it a triglyceride?	Three fatty acids joined to a glycerol molecule make it a triglyceride.
2.17	What features in the chemical composition of phospholipids make them ideal components of the cytoplasmic membrane?	The polar head group contains primarily ionized atoms making it hydrophilic; the tail of the fatty acids consists of C-H groups, which confer hydrophobic properties on this portion of the molecule.
2.18	Why are steroids classified as lipids?	They are insoluble in water.
2.19	Which portion of an amino acid is responsible for the unique properties of the molecule?	The side chain represented by the R group
2.20	What chemical groups characterize a hydrophobic amino acid? A hydrophilic amino acid?	Hydrophobic groups are C-H and C-S; Hydrophilic groups are C-OH and ionized amino and carboxyl groups.
2.21	What two chemical groups are involved in the formation of a peptide bond?	A carboxyl group and an amino group.

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MicroAssessment number (Question#)	Question	Answer
Chapter 1		
1.1 (#1)	Describe Pasteur's experiment that disproved the idea that a "vital force" in air was responsible for spontaneous generation.	Pasteur used a swan-necked flask that was open to air. The broth in the flask remained sterile, because microorganisms from the air settled out in the bends of the flask neck.
1.1 (#2)	How is the meaning of the word "theory" in science different from its meaning in everyday conversation?	In science, the word theory is only used to describe an explanation that is supported by extensive experimental evidence; in common use the word implies a speculation or guess.
1.1 (#3)	Why is it important for scientists to repeat the experiments of others?	It helps ensure the accuracy of the data.
1.2 (#4)	Describe two microbial activities essential to life and three that make our lives more comfortable.	Essential activities—(1) Conversion of nitrogen of the air into a form that is useable by plants and animals, and (2) replenishment of O_2 in the atmosphere by photosynthetic microorganisms. Activities that make life more comfortable—(1) Synthesis of many products used in everyday life (amino acids, vitamins, etc), (2) involvement in food and beverage production, and (3) degradation of environmental pollutants
1.2 (#5)	Describe three factors that lead to certain infectious disease becoming more common.	(1) Reduction of vaccination against certain diseases, (2) diseases under control by antimicrobial medications become resistant to the medications, and (3) the aging population is more susceptible to infectious diseases
1.2 (#6)	Why would it seem logical, even inevitable, that at least some bacteria would attack the human body and cause disease?	The human body is an ecological location that provides many of the requirements that bacteria require to grow. Organisms that have the ability to invade our cells or damage our tissues have access to additional nutrients.
1.3 (#7)	List two features that distinguish prokaryotes from eukaryotes.	(1) Prokaryotes have no true nucleus; eukaryotes do, and (2) prokaryotes typically do not have membrane bounded internal structures
1.3 (#8)	Describe the chemical composition of viruses, viroids, and prions.	Viruses consist of a protein coat surrounding either DNA or RNA; viroids consist of only RNA; and prions consist of only protein
1.3 (#9)	In the binomial system of	The first part of the name indicates the

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	classification, why is a two-part name used?	genus, and the second part the species. Members of the same genus share several common features; the various species of a genus have properties that distinguish them from other organisms in the genus.
Chapter 2		
2.1 (#1)	Why are electrons not considered in determining the mass number of an element?	They are too light to contribute to the atomic mass.
2.1 (#2)	What is the "octet rule" and its biologically important exception?	Atoms of biological importance contain a maximum of 8 electrons in their outer shell to achieve maximum stability. The exception is the H atom which has only a single shell which is filled with a maximum of 2 electrons.
2.1 (#3)	What do atoms of ^{14}C and ^{14}N have in common? How do they differ?	Both atoms have the same mass number (protons plus neutrons). They differ in the number of protons (atomic number).
2.2 (#4)	Compare the properties of covalent, hydrogen, and ionic bonds.	Covalent bonds are formed when atoms share electrons. They are strong bonds. Hydrogen bonds form between charged portions of molecules and are weak bonds that are easily broken and reformed. Ionic bonds are formed when electrons are gained or lost, forming ions. Positive and negative ions attract one another. They form strong crystals, but dissolve in water.
2.2 (#5)	Which type of bond requires an enzyme to break it?	Covalent bond
2.2 (#6)	Why are hydrogen bonds associated with polar covalent bonds, but not with non-polar covalent bonds?	Polar covalent bonds produce molecules with slight charges on some atoms as electrons are not shared equally. Non-polar covalent bonds share electrons equally so no slight charges arise
2.3 (#7)	What characteristics of a water molecule make it polar? Give two examples of why this property is important in microbiology.	The oxygen atom has a greater attraction for electrons than does the hydrogen atom. Because of this polarity, water is an excellent solvent and liquid water is denser than ice, so ice floats.
2.3 (#8)	What is the role of a buffer in living organisms?	Buffers maintain stable pH.
2.3 (#9)	What must be added to pure water to decrease the OH^- concentration? To decrease the H^+ concentration?	Add an acidic material (H^+) to decrease the OH^- concentration. Add a base (OH^-) to decrease the H^+ concentration.
2.4 (#10)	Name the subunits that are used to build a carbohydrate, a simple	Monosaccharide, fatty acid and glycerol, amino acid, nucleic acid

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