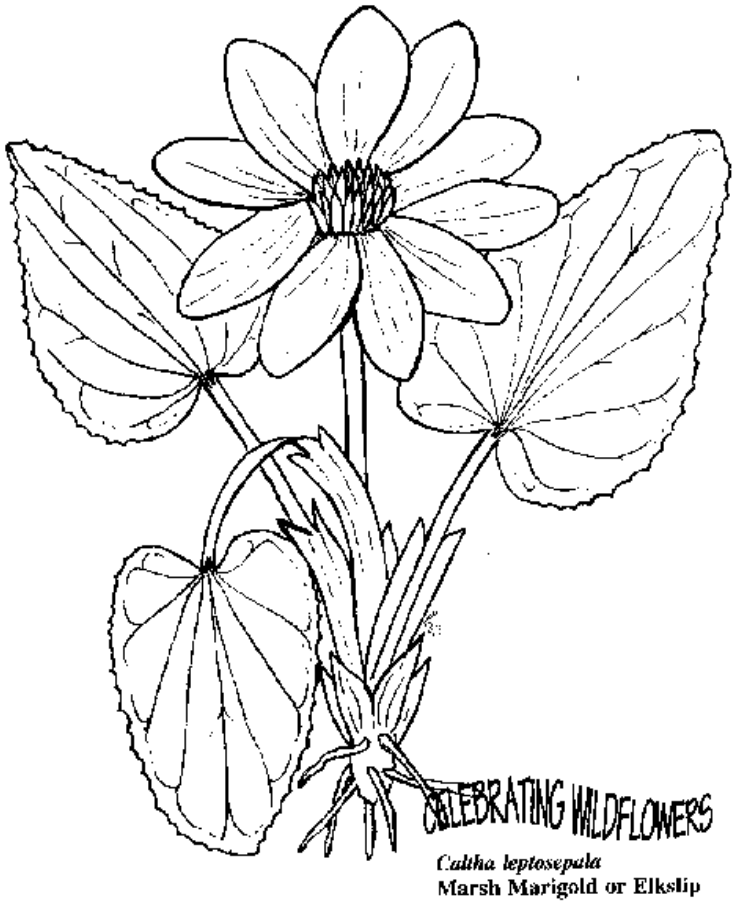
Biology 100
Introductory Biology

Updated August 2015



Department of Natural Sciences

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BIOLOGY 100

COURSEPACK AND WORKBOOK

Table of Contents

The chapters listed below are based on the Biology 100 Textbook:

Campbell Essential Biology with Physiology (4th edition)
Authors: Simon, Reece, Dickey. Benjamin Cummings / Pearson Publishers

Grading Scale for this Class

A: 92.5 – 100

B: 84.5 – 92.4

C: 75.5 – 84.4

D: 65.5 – 75.4

E: 65.4 and below

Grades

Exam and Quiz Average = 80%

Final Exam = 20%

Questions about this coursepack?
Patty Bostwick Taylor – 843.661.8225 / patty.bostwick@fdtc.edu

Biology 100 Instructor Contact Information:

Instructor's Name: _____

Instructor's Email: _____

Instructor's Phone: _____

Instructor's Office: _____

Office Hours (if applicable):

Monday _____

Tuesday _____

Wednesday_____

Thursday _____

Friday_____

Last Date to Withdraw from this Course with a "W"_____

Icebreaker! Day 1 Activity

Gather the signatures and contact information of four different classmates:

Plays a musical instrument	Has the same major as you
Went to the same high school as you	Lives in a different county from you

BIOLOGY 100 SYLLABUS
FLORENCE DARLINGTON TECHNICAL COLLEGE

	Course Information
Course Description and Prerequisites	Biology 100, Introduction to Biology (4 credits, non-transferrable). This is a non-laboratory course in general biology designed to introduce the student to the principles of biology, with an emphasis on human biology
Required Course Materials	1. Campbell Essential Biology with Physiology. 4th Edition (some sections may use the 5th edition) by Simon, Dickey, and Reece. Pearson Publishers. 2. Coursepack (purchased from the bookstore) 3. Scantron packets (bookstore), and pencils with erasers
	Course Policies
Attendance Policy	According to the FDTC student handbook, it is the responsibility of the student to attend all scheduled classes and observe all participation requirements in each of the courses in which he/she is enrolled. If a student is absent or fails to participate in more than 10% of the total hours that a course usually meets in a semester, the student will be subject to a failing grade or withdrawal by the instructor. It is the student's responsibility to initiate a withdrawal if he/she is unable to complete course requirements. Exceptions to this policy can be made only by the appropriate Associate Vice President. Please note the particulars for this course: • **Tardies** (up to 15 minutes late) count as ½ of an absence. If you arrive late on days in which quizzes or tests are administered, you will not receive additional time to complete the assessment. If you arrive after the quiz has been collected, you will not be offered an opportunity to take the quiz. Instead, a grade of zero (0) will be recorded. If you are 15 minutes late or more, you may be counted absent for the entire lecture period. • **Leaving early**: You will be docked for a partial or whole absence.
Withdrawal Policy	The last day to withdraw from this course with a W is noted on the www.fdtc.edu website; withdrawal after this date may be a WF. **The student must initiate the withdrawal from this course**. If you fail to initiate the withdrawal and stop attending the course, a grade of "F" will be recorded for the course. Please access the list of **IMPORTANT STUDENT INFORMATION SHEET** on the D2L website for this course, located at https://fdtc.desire2learn.com/ for more information about withdrawals.
Academic Dishonesty Policy	According to the FDTC student handbook, all forms of academic dishonesty including, but not limited to, cheating on tests, plagiarism, collusion, and falsification of information will be subject to disciplinary action. Cheating is defined to include, but is not limited to the following: • Copying another student's work or test. • Using unauthorized materials during a test. • Collaborating with another during a test or on assignments. • Knowingly obtaining, using, buying selling, transporting, or soliciting in whole or in part contents of a test or other work. • Bribing another person to obtain tests or information about tests. • Substituting for another student or permitting another to substitute for oneself. Any proven cases of academic dishonesty will result in an "F" for the assigned work or test and may result in administrative withdrawal from the course, with a grade of "F" assigned after a disciplinary hearing. Additional sanctions, including disciplinary probation or suspension, appropriate to the incidents may be imposed pursuant to the Student Code and Grievance Procedures. **Please note**: phones shall not be visible or heard at any time during assessments. Please store your phone, turned off, during quizzes and exams. Please take care of your personal needs prior to the start of the exam. Bathroom breaks will not be permitted during assessments. If you leave the room, you must forfeit your quiz/exam and will not be offered an opportunity to complete it upon re-entry.
	Grading Scale
A: 92.5 – 100 **B: 84.5 – 92.4** *Passing* **C: 75.5 – 84.4** D: 65.5 – 75.4 F: 65.4 and below	To continue on to BIO 110, 112, or 210, the end of course average in BIO 100 must be 75.5 (C) average or higher.
	How to Calculate Your Grade
	Course grades are based on: o Lecture exams 1-5 and the quiz average = 80% o Final exam = 20%

	Exam and Quiz Information
Lecture Exams	During the 15 week classes, exams are given during the first hour of class. If you complete the test early, take a break; class is held the second hour. During the 12, 10, and 8 week semesters, exams may be given during the first hour of class while instruction occurs during the second part of the class. If you leave after the exam, you'll be counted absent for the portion of time you miss. The format of the exam is approximately 60-80% multiple choice questions. The remaining 20-40% of the questions will be short answer or essay, identification of structures, true/false, or fill-in-the blank. No word banks are provided; **spelling always counts**! Scores will be posted within one week of administration in class on D2L.
Quiz Information	Vocabulary and/or daily quizzes are given during the first 10-15 minutes of each class period. The format is at the discretion of your instructor and may include the following questions: fill-in-the-blank, multiple choice, true/false, identification, or short answer. Scores will be posted within one week of administration in class on D2L. • **Vocabulary quizzes** cover root-words, prefixes, and suffixes. See the last pages of this coursepack for the vocabulary terms. Learn all word roots and all of the meaning(s). Examples are not necessary. • **Daily quizzes** cover material from the previous class period(s). Review questions from earlier chapters may also appear on daily quizzes. Pictures for identification may be part of the quiz.
Final Exam Information	The final exam is required and is a common departmental final exam. The format is 100 multiple choice questions and covers all chapters from the entire course. The final exam counts 20% of the overall course average. The final exam score may do **<u>one</u>** of the following: (1) the final exam replaces one lowest exam score if all 5 exams are taken *and* the final exam score is higher ***<u>or</u>*** (2) the final exam automatically replaces **<u>one</u>** missed exam score.
	Makeup Policies
Lecture Exams	• **<u>No make-up exams</u>** will be provided once the test has been administered in class, **regardless of excuse**. In the event of an absence, the final exam automatically counts in the place of the missed exam. • Please arrive on time for class! For those who arrive late the day an exam is administered, you will not be granted additional time to take the exam. • If you miss two exams or more, the final exam counts in the place of the **<u>one</u>** missed exam only. A grade of zero (0) will be recorded for a **<u>second</u>** missed test, etc. In the event that you take all 5 lecture exams, the lecture final exam will replace the **<u>one</u>** lowest lecture exam score ***only if*** the lecture final exam is higher than the lowest test score. However, if you are absent for one lecture exam, that one missed exam becomes the only test score replaced by the lecture final exam.
Quizzes	• **<u>No make-up quizzes</u>** will be provided once the quiz has been administered in class, **regardless of excuse**. • Please arrive on time for class! For those who arrive late the day a quiz is administered, you will not be granted additional time to take the quiz. If you arrive after the quiz has been collected, you will not be offered an opportunity to take the quiz. Instead, a grade of zero (0) will be recorded. • The lowest two quiz scores, which may be zeroes (0) from absences, will be dropped from your calculated average (either two daily, two vocab, or one daily/one vocab).
	Other
Students with Disabilities	If you have a documented disability and require special assistance or accommodations to participate fully as a student, or if you need more information, you should contact the Enrollment Center at 843-661-8218. Once the disability has been documented, it is the student's responsibility to disclose this information to the instructor with the accommodations that are needed.
FERPA	"*FERPA gives parents certain rights with respect to their children's education records. These rights transfer to the student when he or she reaches the age of 18 or attends a school beyond the high school level*." http://www.ed.gov/policy/gen/guid/fpco/ferpa/index.html This federal law, FERPA, prohibits instructors from discussing grades with parents of students. Waivers are available at the Registrar's Office, 100 building for any student who wants his/her parent(s) to be able to discuss grades with instructors. Otherwise instructors can only communicate with you, the student, about your enrollment, attendance, grades, etc., in this class.
Concerns	Please present concerns about this course first to your instructor. If you are unable to reach resolution, you may then contact the Chair for the Natural Sciences Department, Patty Bostwick Taylor at patty.bostwick@fdtc.edu (Room 5416). If resolution is unattainable, contact the Associate Vice President for Arts & Sciences, Dr. Marc David at marc.david@fdtc.edu (Room 7222).

BIOLOGY 100 SCHEDULE OF TOPICS

15 WEEK SEMESTER (FALL/SPRING); CLASSES MEET 2 DAYS PER WEEK
10 WEEK SEMESTER (SUMMER); CLASSES MEET 3 DAYS PER WEEK
Schedule is tentative and subject to change.

Reading assignments reference the Biology 100 Textbook
Campbell Essential Biology with Physiology by Simon, Reece, and Dickey. Pearson Publishers, 2012, 4th Ed.

Date	Exam Dates and Chapter Covered
1	**Syllabus and Introduction** **Chapter 1: Introduction: Biology Today** Topics to Read: The Scope of Life Evolution: Biology's Unifying Theme The Process of Science
2	**Chapter 1: Introduction: Biology Today** Topics to Read: The Process of Science **Chapter 2: The Molecules of Life** Topics to Read: Some Basic Chemistry
3	**VOCAB QUIZ #1** **Chapter 2: The Molecules of Life** Topics to Read: Some Basic Chemistry Water and Life
4	**QUIZ #1** **Chapter 2: The Molecules of Life** Topics to Read: Acids, Bases, pH **Chapter 3: The Molecules of Life** Topics to Read: Chemical Reactions
5	**Chapter 3: The Molecules of Life** Topics to Read: Large Biological Molecules (Carbohydrates, Lipids, Proteins, Nucleic Acids)
6	**QUIZ #2** **Chapter 4: A Tour of the Cell** Topics to Read: The Microscopic World of Cells/The Two Major Categories of Cells and An Overview of Eukaryotic Cells Membrane Structure The Nucleus and Ribosomes The Endomembrane System Mitochondria The Cytoskeleton
7	**EXAM 1 covers CHAPTERS 1-4** **Chapter 5: The Working Cell** Topics to Read: Some Basic Energy Concepts ATP and Cellular Work Enzymes

BIOLOGY 100 SCHEDULE OF TOPICS, Continued

Date	Exam Dates and Chapter Covered
8	**Chapter 5: The Working Cell** Topics to Read: Membrane Function
9	**VOCAB QUIZ #2** **Chapter 6: Cellular Respiration** Topics to Read: Energy Flow Cellular Respiration: Aerobic Harvest of Food Energy Fermentation: Anaerobic Harvest of Food Energy
10	**QUIZ #3** **Chapter 8: Cellular Reproduction** Topics to Read: What Cell Reproduction Accomplishes The Cell Cycle and Mitosis Meiosis, the Basis of Sexual Reproduction
11	**QUIZ #4** **Chapter 9: Patterns of Inheritance** Topics to Read: Heritable Variation and Patterns of Inheritance Variations on Mendel's Laws Sex Chromosomes and Sex-Linked Genes
12	**Chapter 9: Patterns of Inheritance** More time spent on genetics problems and non-Mendelian genetics
13	**EXAM 2 covers CHAPTERS 5, 6, 8, & 9** **Chapter 10: The Structure and Function of DNA** Topics to Read: DNA: Structure and Replication
14	**QUIZ #5** **Chapter 10: The Structure and Function of DNA** Topics to Read: The Flow of Genetic Information from DNA to RNA to protein Viruses and Other Noncellular Infectious Agents
15	**VOCAB QUIZ #3** **Chapter 13: How Populations Evolve** Topics to Read: Charles Darwin and *The Origin of Species* Evidence of Evolution The Modern Synthesis: Darwinism Meets Genetics Mechanisms of Evolution
16	**QUIZ #6** **Chapter 14:** Topics to Read: Macroevolution and the Diversity of Life Classifying the Diversity of Life *National Geographic Video* Arctic Bear Hybrid (may be shown)
17	**Chapter 15:** Topics to Read: Prokaryotes Protists

BIOLOGY 100 SCHEDULE OF TOPICS, Continued

Date	Exam Dates and Chapter Covered
18	**EXAM 3 covers CHAPTERS 10, 13, 14, & 15** **Chapter 16:** Topics to Read: Colonizing Land Plant Diversity Fungi
19	**Chapter 17:** Topics to Read: The Origins of Animal Diversity Major Invertebrate Phyla
20	**VOCAB QUIZ #4** **Chapter 17:** Topics to Read: Vertebrate Evolution and Diversity
21	**QUIZ #7** **Chapter 21:** Topics to Read: The Structural Organization of Animals
22	**QUIZ #8** **Chapter 21:** Topics to Read: Organs and Organ Systems Overview Regulating the Internal Environment
23	**EXAM 4 covers CHAPTERS 16, 17, & 21** **Chapter 27:** Topics to Read: Motor Systems: Skeletal System
24	**QUIZ #9** **Chapter 27:** Topics to Read: Motor Systems: Muscular System
25	**VOCAB QUIZ #5** **Chapter 27:** Topics to Read: An Overview of the Nervous Systems
26	**QUIZ #10** **Chapter 27:** Topics to Read: An Overview of the Nervous Systems
27	**Wrap up content and review period for Exam 5**
28	**EXAM 5 covers CHAPTER 27**
29	**Review Period for Final Exam**
30	**FINAL EXAM** The final exam for this course consists of 100 multiple choice questions covering content from all chapters covered in this course; a study guide is found at the end of this coursepack. A final exam schedule for fall/spring semesters may be located on the www.fdtc.edu website by searching for "final exam schedule." During the summer semester, the final exam is held during the last scheduled class meeting time. The Natural Sciences Department does not allow exemptions of the final exam.

Chapter 1: Introduction: Biology Today

*How would you define biology? (***bio-** *= life;* **-logy** *= study of*) _____

_____

*What contributions has biology made in your life?*_____

_____

_____

What are some current problems facing biology?

- _____
- _____
- _____

Organization of Life from Smallest Structure to Largest, Most Inclusive Category

1. **Atoms**: Basic building block of all matter, including nonliving substances like rocks and living organisms. Atoms can bond together to become molecules or compounds.

2. **Molecules**: Groups of atoms that have become bonded together. Molecules compose both _____ and _____ things.

3. **Cells**: Basic building block of **life**. All organisms are composed of at least one cell. Cells contain little factories called organelles.

4. **Tissues**: Two or more _____ working together in the body to perform a specific function. There are four major tissue groups: epithelial, connective, muscle, nervous tissue.

5. **Organs**: Two or more _____ working together in the body to perform a specific function. What are some examples of organs in your body? _____

6. **Organ System**: In the bodies of multicellular organisms, their organs are grouped together into organ systems. For example, the digestive system contains the mouth, esophagus, stomach, small and large intestines, and pancreas, gallbladder, liver, and salivary glands.

7. **Organism**: a living being; may be unicellular or multicellular

8. **Population**: An interacting group of one species that lives in a community.

   Example: A population of squirrels lives in your neighborhood.

9. **Community**: All the living organisms in a particular ecosystem. Does **NOT** include the abiotic factors.

   Example: A community could be your neighborhood—includes squirrels, trees, humans—all the living organisms.

10 **Ecosystem**: Consists of all the organisms living in a particular area. Includes the **abiotic** factors (nonliving, physical components of the environment such as soil, temperature, wind) and **biotic** factors (living organisms).

   Example: An ecosystem could be a tropical rainforest. An ecosystem includes the trees, birds, and insects AND the soil type, temperature, wind, etc.

Chapter 1: Introduction: Biology Today, *Continued*

THREE DOMAIN SYSTEM FOR LIVING ORGANISMS

*What is a domain?*_____

_____

What are the three domains and their characteristics?

1. **Domain _____**
   - prokaryotes (unicellular organisms that lack a nucleus and most organelles)
   - bacteria
2. **Domain _____**
   - prokaryotes (unicellular organisms that lack a nucleus and most organelles)
   - bacteria that is possibly more closely related to eukaryotes than they are to bacteria
3. **Domain _____**
   - eukaryotes (unicellular to multicellular organisms with a nucleus and organelles)
   - includes 4 kingdoms: Protista, Fungi, Plantae, Animalia

Review of the Three Domains

Identify the following types of organisms into the appropriate domain.
More than once answer may be appropriate for some questions.

A. Domain Archaea
B. Domain Bacteria
C. Domain Eukarya

_____1. classified as prokaryotes (lack a true nucleus)

_____2. probably more closely related to the Eukarya than to other prokaryotes

_____3. typically unicellular organisms

_____4. typically multicellular organisms

_____5. classified as eukaryotes (have a true nucleus)

_____6. contains kingdoms of organisms such as plants, protists, fungi, and animals

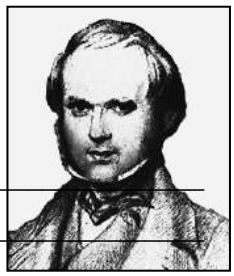
_____7. contains groups of bacteria

Chapter 1: Introduction: Biology Today, *Continued*

EVOLUTION: Life's Unifying Theme

A Theme Unifying Biology

Charles Darwin (1809-1882)



Where was he from? England

Where did he travel? Around the world on a boat for 5 years known as the HMS Beagle

What is the name of the book he wrote? On the Origin of Species by Means of Natural Selection

What ideas did he come up with? _____

_____

Why were his ideas controversial at the time? _____

_____

Modification with Descent - Evolution

Why are we studying evolution in the first chapter of this book?

*Write a scientific definition for evolution.*_____

_____

Natural selection

- Natural selection is the engine that drives evolution.
- _____I ndividuals don't evolve, populations do. An individual cannot change his or her genetic makeup, but through reproduction can pass those genes that make that individual well-adapted to the environment on to offspring.

The Peppered Moth Experiment: A Classic Example of Natural Selection

Scenario: England, before and after the Industrial Revolution. Before the industries arrived, the air was clean. After, the air was filled with pollution, and the bark fell off the trees; the wood turned dark.

Biston betularia is a species peppered moth that comes in two varieties: a light form and a dark form. These moths feed at night and rest during the day, often on trees or rocks encrusted with gray-to-white colored lichens. Before the pollution revolution: Light colored moths are camouflaged when they rest against a light background. Dark colored moths are fewer in number; they are more obvious to predators.

How was this moth able to avoid extinction during and after the Industrial Revolution? _____

_____

Chapter 1: Introduction: Biology Today, *Continued*

THE SCIENTIFIC METHOD

The **Scientific Method** is a planned, repeatable approach to solving problems in the scientific world.

Steps of the Scientific Method

1. _____ This first step of the scientific method involves our senses. How do you observe the world around you? Sight, sound, taste, touch, and smell. What if you want to measure a temperature, or look at the moon? Use an extension of your senses such as a thermometer or telescope!
2. _____ Ask questions such as *how, why, what*? Questioning helps us to understand what is happening. If you ask good questions, you'll be more likely to find out information to lead you to the answers!
3. _____ A statement of _____ and _____ in which you state your educated guess as what you think is going on.
4. _____ At this point, you think your hypothesis may lead you on the right path to answering the question. We say "___" we run this experiment, "_____" we think –x– will happen.
5. _____ Controlled experiments should follow the "5 Items that make a good hypothesis. For each experiment that you run, you should have a control group and an experimental group. The control group has no changes. *Why?* So you can measure the effects of the variable against this control group. The experimental group is the one group with **one variable** changed. Why change only one variable? _____
6. _____ This step of the scientific method allows your to review your data from the experiment and draw a conclusion. If your data supports your hypothesis, you accept it. If your data does not support your hypothesis, you reject it and start over at some particular stage of the scientific method.

What are five items that make a well-written hypothesis?

This information is NOT covered in your textbook!

1. **Repeatable:** Experiments should be repeatable so that someone else can duplicate your experiment to get the same results. Experimenting on lightning strikes is something that is not repeatable.
2. **Testable:** Make sure that your experiment can be testable. Running an experiment on the surface of Saturn is currently not possible.
3. **Quantitative Measurements:** Use numbers rather than qualities. Someone can duplicate your experiment much more reliably if you say "use two milliliters of water" rather than saying "use about one third of this glass." Quantities are scientific while qualities are not.
4. **One Variable:** In your experiment and hypothesis, plan to use only one variable. Why? _____

_____

5. **Anthropomorphic Statements:** Avoid phrases like "my computer, Sally, stopped running because she was dusty." Or, don't use phrases like, "the mother bird feeds her babies because she loves them." We avoid using these anthropomorphic statements because they can't be measured. How do we know the mother bird really feeds her babies because she loves them? Can we test and experiment on her love?

Chapter 1: Introduction: Biology Today, *Continued*

HYPOTHESIS, THEORY, LAW

Over time, hypotheses that have been tested and re-tested become more accepted by the scientific community. Eventually, those sound hypotheses have become **theories.** Theories include several hypotheses that cover a larger breadth of information. Theories have successfully withstood intensive testing. A theory can become **law.** Laws are uniform or constant facts of nature. However, there are no absolute truths in science because we cannot possibly perform the infinite number of truths required to show the theory holds true under all conditions.

Scenario for the Scientific Method: *Imagine that when you get home tonight, your place is dark. You reach to turn on a lamp, only to find it will not light. What's wrong? Go through the steps of the scientific method and write out your observations through the conclusion.*

Review of the Scientific Method

Identify these steps of the scientific method correctly.

1. _____: I saw that my gas indicator was nearly "E" yesterday when I parked the car. This morning, the car would not crank.
2. _____: If I put gas in my car, then it will crank.
3. _____: My hypothesis was correct; the car did need gasoline.
4. _____: In order to test my hypothesis, I will add 4.5 gallons of gas to the car. Then I will start the engine to see if it cranks.
5. _____: My car will crank when gas is added to the tank.
6. _____: What is causing my car not to crank? Is it the alternator? Do I have enough gas? Could the battery be dead?
7. _____: What is the step of the scientific method that uses the "IF-THEN" clause?
8. _____: What is the step of the scientific method that includes a statement of cause and effect?
9. _____: What is the step of the scientific method that uses "how," "why", and "what"?
10. _____: What is the step of the scientific method that utilizes your senses?

Answers: 1. Observations, 2. Prediction, 3. Conclusion, 4. Experiment, 5. Hypothesis, 6. Questions, 7. Prediction, 8. Hypothesis, 9. Questions, 10. Observations

Chapter 1: Introduction: Biology Today, *Continued*

Review of Chapter 1

1. Why are Darwin's ideas of natural selection and evolution appropriate to our study of biology?
2. How can we apply the scientific method to everyday life?
3. Describe how a hypothesis accepted differently in the scientific community from a theory and a law.
4. Why should we use only one variable in an experiment of the scientific method?
5. Why classify prokaryotes and eukaryotes into different domains? Explain.
6. Explain why classifying organisms is a practice of good science.
7. Differentiate between the prediction and hypothesis steps of the scientific method.
8. Describe the link between natural selection and evolution.
9. Explain why the peppered moth experiment is a good example of natural selection and evolution.
10. Describe Darwin's contributions to science.

Think about these questions; if you have any trouble answering them, visit with your instructor during office hours!

Chapter 1 Checklist for Success:

- ☐ *Did you read your textbook?*
- ☐ *Did you complete all exercises in this coursepack for this chapter?*
- ☐ *Did you make flash cards for items such as steps for the scientific method?*
- ☐ *Have you used your flashcards several times a day?*
- ☐ *Did you make a list of items that you don't understand (natural selection for instance) and visit your instructor about the difficult topics?*
- ☐ *Did you make an outline from your textbook and coursepack notes and type it on the computer?*
- ☐ *Did you keep track of how much time you have spent studying this chapter? Could you have spent more time? Did you review the material at least once per day?*
- ☐ *How did you study this material? Did you read it, write it, or talk about it?*

Chapter 2: Essential Chemistry for Biology

MATTER
Elements, Atoms, and Compounds

Elements: are composed of the same types of atoms. Elements are the simplest substances on earth; they cannot be broken down into simpler substances. All matter is composed of elements. Elements are found on a Periodic Table represented by symbols.

- Define "major elements:" _____
- Define "trace elements:"_____

Common Element Names and Symbols

Learn the names of the following elements and their symbols; use **flash cards***!*

Name of Element	Symbol
Four Most Common Elements	
Oxygen	O
Carbon	C
Hydrogen	H
Nitrogen	N
Other Major Elements	
Calcium	Ca
Phosphorus	P
Potassium	K
Sulfur	S
Sodium	Na
Chlorine	Cl
Magnesium	Mg

Chapter 2: Essential Chemistry for Biology, *Continued*

MATTER, *Continued*

Atoms: "*indivisible"* in Greek. Atoms cannot be further broken down and have those parts still retain the characteristics of the atom.

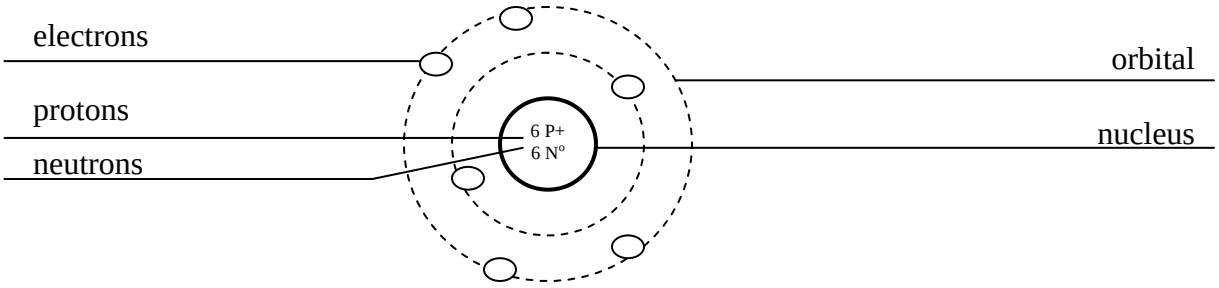
- Atoms compose elements.
- Atoms can bond together to form molecules and/or compounds.

Three Subatomic Particles found in Atoms

Complete this table with the three subatomic particles of atoms.

Particle	Charge	Location in Atom

Structure of an Atom



Orbitals house electrons

- In the innermost orbital there should be a maximum of **2** electrons.
- In the next orbital, there should be a maximum of **8** electrons
- Eight electrons in the second orbital (or beyond) creates stability. That's why it's called the **octet rule**.
- Start filling from the innermost orbital, if there are more than 2 electrons, you spill over to the next orbital. When you have placed 8 electrons in that orbital (if there are that many electrons in the atom), move to the next, and so on.
- Atoms can share, transfer (lose or gain) electrons to achieve the appropriate number of electrons.

Chapter 2: Essential Chemistry for Biology, *Continued*

ATOMIC NUMBERS AND MASS

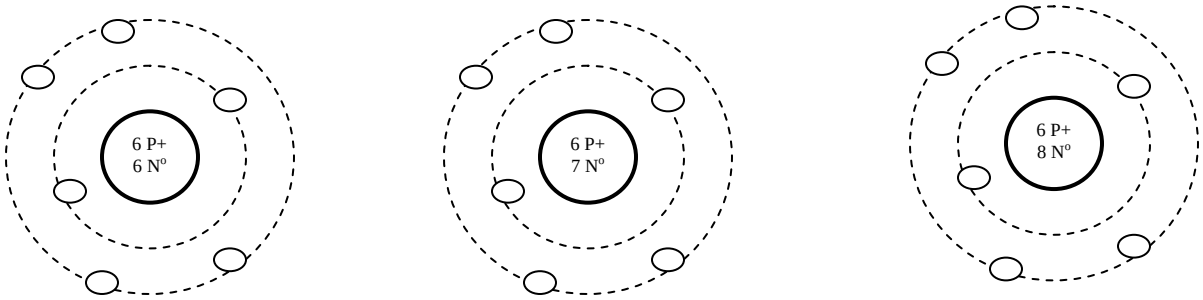
Atomic Number = number of _____ in an atom. The atomic number is unique to an atom. When the **number of protons = the number of electrons**, the atom's net electrical charge is zero and thus the atom is neutral.

Atomic Weight (Mass Number) = **sum** of the atom's _____ and _____ in its nucleus. The protons and neutrons account for most of the mass of the atom.

To determine the number of neutrons, subtract the atomic number from the weight.

Isotopes: Atoms of the same element have differing numbers of _____. The **atomic mass** differs for isotopes.

- For example: Carbon 12 has 6 protons, Carbon 13 has 7 neutrons, Carbon 14 has 8 neutrons (but all 3 carbon atoms have 6 protons). Examine these isotopes, below.



Practicing Atomic Numbers and Mass

1. Atomic # = 5
Atomic mass = 11
protons = _____
neutrons = _____
electrons = _____

2. Atomic # = _____
Atomic mass = 23
protons = 11
neutrons = _____
electrons = _____

3. Atomic # = _____
Atomic mass = 12
protons = _____
neutrons = _____
electrons = 6

4. Atomic # = 3
Atomic mass = _____
protons = _____
neutrons = 4
electrons = _____

5. Atomic # = 8
Atomic mass = 16
protons = _____
neutrons = _____
electrons = _____

6. Atomic # = _____
Atomic mass = _____
protons = _____
neutrons = 7
electrons = 7

7. Atomic # = _____
Atomic mass = 19
protons = 9
neutrons = _____
electrons = _____

8. Atomic # = 12
Atomic mass = _____
protons = _____
neutrons = 12
electrons = 12

9. Atomic # = _____
Atomic mass = 9
protons = 4
neutrons = _____
electrons = _____

10. Atomic # = _____
Atomic mass = 4
protons = _____
neutrons = 2
electrons = _____

11. Atomic # = 5
Atomic mass = _____
protons = _____
neutrons = 6
electrons = _____

12. Atomic # = 4
Atomic mass = 9
protons = _____
neutrons = 5
electrons = _____

Chapter 2: Essential Chemistry for Biology, *Continued*

Review of the Atomic Numbers, Weight, Protons, Neutrons, & Electrons

Complete the Following Chart

Element	Symbol	Atomic Number	Atomic Weight (Mass Number)	# Protons	# Neutrons	# Electrons
Carbon-12	C	6	12	6	6	6
Chlorine-35			35	17		
Carbon-14	C					
Nitrogen-14	N	7	14			
Phosphorus-31		15	31			
Sodium-23		11	23			
Oxygen-16	O		16			8
Oxygen-17	O		17			

1. An atom with an atomic number of 7 means that it has _____ protons and _____ electrons.
2. If an atom has 8 protons and 8 electrons, what is the atomic number of that atom? _____
3. If an atom has 8 protons and 8 neutrons, what is the atomic weight of that atom? _____
4. If an atom has 14 as its atomic weight, and 7 neutrons, how many protons are there? _____
5. If an atom has 16 as its atomic weight, and 9 neutrons, how many electrons are there? _____
6. An atom with 5 electrons will also have 5 _____.
7. An atom with an atomic weight of 20 and an atomic number of 10 means that there must be ____ protons.
8. If an atom has 16 subatomic particles in the nucleus and an atomic number of 8, then this atom must have _____ protons.
9. If an atomic has 5 electrons, 5 protons, and 5 neutrons, what is the atomic number of this atom? _____
10. If an atom has 7 electrons, 7 protons, and 7 neutrons, what is the atomic weight of this atom? _____
11. If an atom has an atomic number of 8, how many positive charges does the atom have? _____
12. If an atom has an atomic number of 13, how many negative charges does the atom have? _____
13. An atom with 18 as its atomic weight will have 9 electrons and 9 _____
14. An atom with 17 positive charges should also have _____ negative charges.
15. An atom with 12 protons and 12 neutrons has atomic number of _____ and an atomic weight of _____
16. An atom with 6 neutrons, 6 protons, and 6 electrons has an atomic weight of _____
17. If an atom has 3 positive charges and 3 negative charges, the atomic number is _____
18. If an atom has 14 protons, how many electrons does it have? _____

Chapter 2: Essential Chemistry for Biology, *Continued*

Answers to the Previous Page

Element	Symbol	Atomic Number	Atomic Weight (Mass Number)	# Protons	# Neutrons	# Electrons
Carbon-12	C	6	12	6	6	6
Chlorine-35	**Cl**	**17**	35	17	**18**	**17**
Carbon-14	C	**6**	**14**	**6**	**8**	**6**
Nitrogen-14	N	7	14	**7**	**7**	**7**
Phosphorus-31	**P**	15	31	**15**	**16**	**15**
Sodium-23	**Na**	11	23	**11**	**12**	**11**
Oxygen-16	O	**8**	16	**8**	**8**	8
Oxygen-17	O	**8**	17	**8**	**9**	**8**

Answers

1. 7 protons, 7 electrons
2. atomic number = 8
3. atomic weight = 8 + 8 = 16
4. 14- 7 = 7 protons
5. 16 – 9 = 7 electrons
6. 5 protons
7. 20 – 10 = 10 protons
8. 16 – 8 = 8 protons
9. atomic number = 5 = number of electrons = number of protons
10. atomic weight = number of protons + number of neutrons = 7 + 7 = 14
11. atomic number tells number of electrons and number of protons, so 8 positive charges
12. 13 (electrons)
13. 9 protons
14. 17 negative
15. atomic number = 12; atomic weight = 12 + 12 = 24
16. atomic weight = 6 protons + 6 neutrons = 12
17. atomic number = 3
18. 14 electrons

Chapter 2: Essential Chemistry for Biology, *Continued*

CHEMICAL BONDS

Why do atoms form bonds? Atoms form bonds to stabilize their outermost orbitals with electrons. Recall the octet rule for orbitals.

Ionic bonds are formed when two or more atoms **transfer** electrons in order to complete their outermost orbitals.

- An **ion** is an atom that has lost or gained electrons.
- Ions carry a charge:
  - **Cations**: the atom has lost electron(s) and has a **positive charge**, such as Na^+.
  - **Anions**: the atom has gained electron(s) and has a **negative charge**, such as Cl^-.

Use this space to draw an example of an ionic bond and identify the cation and anion.

Covalent bonds are formed when two or more atoms **share** electrons. Atoms that do not have the proper number of electrons in their outer orbital shells will tend to form bonds with other atoms.

Types of Covalent Bonds:

- **Polar** covalent bonds in which the electrons are **NOT** shared equally among atoms.
  - Examples: water, alcohol, and chemicals that dissolve in water
- **Nonpolar** covalent bonds in which the electrons are shared equally among atoms.
  - Examples: oil, fats, waxes

POLAR AND NONPOLAR SUBSTANCES DON'T MIX!

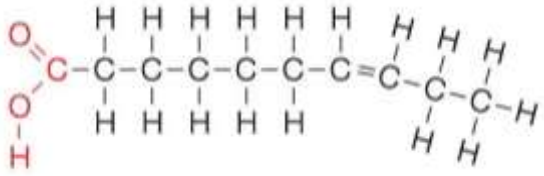
Use this space to draw an example of a covalent bond.

Chapter 2: Essential Chemistry for Biology, *Continued*

CHEMICAL SHORTHAND FOR COVALENT BONDS

- **Single bonds:** C–C shows that 1 pair of electrons (OR 2 electrons in total) are being shared between these 2 carbon atoms.
- **Double bonds:** C = C shows that 2 pairs of electrons (OR 4 electrons in total) are being shared.
- **Triple bonds:** C ≡ C shows that 3 pairs of electrons (OR 6 electrons in total) are being shared.

Can you identify any single, double, or triple bonds in this compound?



Molecules and Compounds

Molecules result when two or more atoms have chemically combined together, typically from **covalent bonds**. For example, a hydrogen atom bonded with another hydrogen atom gives a molecule of H_2. The molecule can be made of atoms from either the *same* or *different* kinds of elements. Water is made of molecules—each molecule contains two atoms of hydrogen and one atom of oxygen.

Compounds contain atoms from two or more elements combined together in a fixed ratio, typically result from ionic bonds. Water is a compound elements combined together in certain ratio: 2 parts hydrogen atoms to 1 part oxygen atom. A compound is a large class of chemical substances.

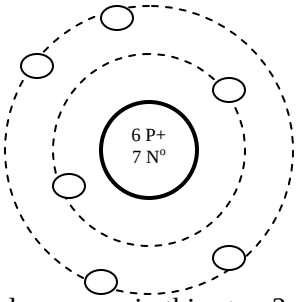
⇨ **In Summary:** Let's use $3CaCO_3$

- How many atoms of calcium are in $3CaCO_3$? _____
- How many atoms of oxygen are in $3CaCO_3$? _____
- How many atoms of carbon are in $3CaCO_3$? _____
- $3CaCO_3$ means that are ____ molecules (or compounds) of calcium carbonate

Chapter 2: Essential Chemistry for Biology, *Continued*

Review of Ionic and Covalent Bonds

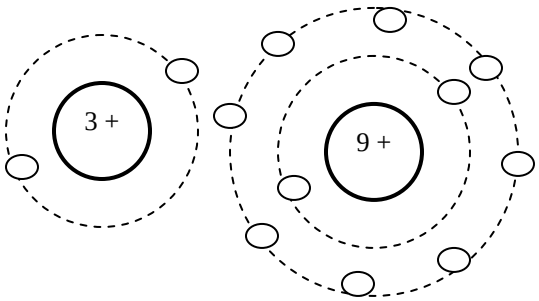
Use this atom, below, to answer questions 1-4.

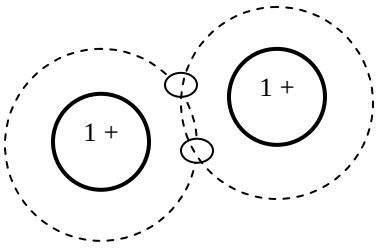


1. How many of the following subatomic particles do you see in this atom?
   protons_____
   neutrons_____
   electrons_____
2. Determine the number of positive charges in this atom_____ negative charges_____
3. How many more electrons would be needed to fill this atom's outer (valence) shell? _____
4. Is this atom chemically stable or chemically active? _____

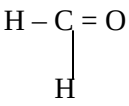
Two types of chemical bonding are shown below.

5. Identify each type as *ionic* or *covalent* bonds.
6. For each bond, identify if electrons are being *shared* or *transferred*.





7. Look at the ionic bond, above left. Which ion has become the cation?_____Anion?_____
8. How many electrons are being shared by the following atoms in this chemical formula?



   a. oxygen and carbon are sharing _____ pairs of electrons

   b. for <u>each</u> hydrogen and carbon bond, _____ pairs of electron are shared

Answers: 1. 6 protons, 6 neutrons, 6 electrons; 2. 6 positive charges, 6 negative charges; 3. 4 more are needed to complete the outermost orbital; 4. chemically active—the atoms needs to complete its outermost orbital; 5. left set = ionic; right set = covalent; 6. left set = transferred 1 electron; right set = sharing one electron; 7. atom with 3 protons is the cation while the atom with 9 protons is the anion. Count the numbers of positive and negative charges: The cation has 3 positive charges and 2 negative charges (an overall + charge); the anion has 9 positive charges and 10 negative charges (an overall – charge). In other words, the cation has lost an electron (giving it a positive charge) while the anion has gained an electron (giving it a negative charge).; 8. a. 2 pairs (or 4 electrons); b. 1 pair (or 2 electrons)

Chapter 2: Essential Chemistry for Biology, *Continued*

Review of Matter: Elements, Atoms, and Compounds

1. Write the names of the elements represented in each of the following compounds.

KCl _____ $MgCl_2$ _____

NaOH _____ $NaNO_3$ _____

H_2CO_3 _____ $Al_2(SO_4)_3$ _____

CaF _____ MgS _____

2. A molecule of O_2 contains how many atoms of oxygen? _____

3. Each molecule of glucose, $C_6H_{12}O_6$, contains:
   _____ atoms of carbon
   _____ atoms of hydrogen
   _____ atoms of oxygen

4. A molecule of water, H_2O, contains _____ atoms of hydrogen & _____ atoms of oxygen.

5. A molecule of carbon dioxide, CO_2, contains _____ atoms of carbon & _____ atoms of oxygen.

6. How many molecules of water do you see here: $5H_2O$ = _____ molecules

7. How many atoms of hydrogen do you see here: $5H_2O$ = _____ atoms of hydrogen

8. What do the following represent?
   $3O_2$ _____
   $4N_2$ _____
   $7H_2O$ _____

9. The symbol, Na, indicates: (*choose one*)
   _____ 1 molecule of sodium
   _____ 1 atom of sodium

10. The formula $2H_2$ indicates _____ total atoms of hydrogen.

11. Chlorophyll has the formula $C_{55}H_{68}O_5N_4Mg$. List the elements and number of atoms that it contains:
   C = _____ Number of atoms = _____
   H = _____ Number of atoms = _____
   O = _____ Number of atoms = _____
   N = _____ Number of atoms = _____
   Mg = _____ Number of atoms = _____

12. The formula H_2 represents _____ molecules of hydrogen while the formula $4H_2$ represents ____ molecules of hydrogen.

Answers: 1. List of elements in each compound: KCl = potassium, chlorine; $MgCl_2$ = magnesium, chlorine; NaOH = sodium, oxygen, hydrogen; $NaNO_3$ = sodium, nitrogen, oxygen; H_2CO_3 = hydrogen, carbon, oxygen; $Al_2(SO_4)_3$ = aluminum, sulfur, oxygen; CaF = calcium, fluorine; MgS = magnesium, sulfur; 2. 2; 3. 6 atoms of carbon, 12 atoms of hydrogen, 6 atoms of oxygen; 4. 2 atoms of hydrogen, 1 atom of oxygen; 5. 1 atom of carbon, 2 atoms of oxygen; 6. 5 molecules of water; 7. 10 atoms of hydrogen (because 5 x 2 = 10); 8. $3O_2$ = 3 molecules of oxygen; $4N_2$ = 4 molecules of nitrogen; $7H_2O$ = 7 molecules of water; 9. one atom because a molecule is defined as two or more atoms bonded together; 10. 4 atoms; 11. List of elements and number of atoms of each element: C = Carbon = 55 atoms, H = Hydrogen = 68 atoms, O = Oxygen = 5 atoms, N = Nitrogen = 4 atoms, Mg = Magnesium = 1 atom; 12. 1 molecule; 4 molecules

Chapter 2: Essential Chemistry for Biology, *Continued*

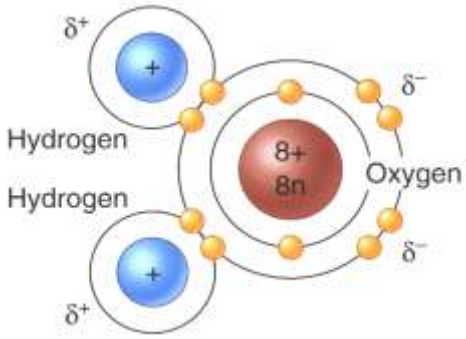
INORGANIC versus ORGANIC COMPOUNDS

Inorganic Compounds
* usually lack carbon and hydrogen
* examples include carbon dioxide, water, oxygen, and inorganic acids, bases, & salts
* often ionically bonded

Organic Compounds
* contain carbon, hydrogen, and oxygen
* examples include carbohydrates, proteins, lipids, and nucleic acids
* often covalently bonded

Inorganic Compounds

WATER



- **Polarity:** results when electrons are _____ shared among atoms that are covalently bonded together. _____ pulls more strongly on the two hydrogens in water.
- **Hydrogen Bonds**: result when hydrogen is weakly attracted to a partial negative charge present on another compound or molecule. These bonds are very weak. but they are the force that keeps water held together.
- **Cohesion**: water molecules tend to stick together as a result of hydrogen bonding. Cohesion is what helps trees and plants to pull water up the lengths of their trunks. Surface tension is related to cohesion; it's the measure of how difficult it is to stretch or break the surface of a liquid. Dip a paper clip in soap and watch it float on water's surface.
- **High Heat Capacity/High Heat of Vaporization:** water resists change in temperature. The high heat capacity means that it takes a certain amount of energy to increase one gram of water by 1° Celsius.
- **Chemical Reactivity**: water is a good solvent; it's involved in chemical reactions in your body.
- **Cushioning**: water provides a cushioning around many vital organs—such as the brain, spinal cord, it protects a baby during pregnancy for instance. Water is found in other places in the body:
  - **Intracellular fluid (ICF):** the nucleoplasm and cytosol; fluid inside cells; accounts for 66% of water in body
  - **Extracellular fluid (ECF):** fluid found outside cells; accounts for 33% of water in body
    - **Interstitial fluid:** the fluids that bathes the exterior of our cells; contains many nutrients
    - **Plasma**: the fluid found in blood

Chapter 2: Essential Chemistry for Biology, *Continued*

INORGANIC COMPOUNDS

ELECTROLYTES

- *What are electrolytes*? substances that ionize (break apart) when dissolved in water.
- *Why do we need them*? Hydration, muscle contraction, nerve impulse transmission.
- *What are some examples of electrolytes?* sodium chloride breaks apart into sodium and chlorine ions (these ions are also known as electrolytes)

SALTS: type of electrolyte that ionizes (break apart) in solution. Salts lack the H^+ and OH^- seen in acids and bases. They are combinations of electrolytes *without* those ions (**Examples** of salts are NaCl, K_3PO_4)

ACIDS: type of electrolyte that ionizes and donates hydrogen (H^+) ions when dissolved in water.

$$\underline{\mathbf{H}}Cl \rightarrow H^+ + Cl^-$$

Examples include: _____

BASES: type of electrolyte that ionizes and donates hydroxide (OH^-) ions when dissolved in water.

$$Na\underline{\mathbf{OH}} \rightarrow Na^+ + OH^-$$

Examples include: _____

The pH Scale

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

----------Acids----------Neutral----------Bases----------

Strong *Weak* *Weak* *Strong*

<u>The pH Scale Fast Facts:</u>

- pH is the measure of how many hydrogen ions are in solution.
- 7 is neutral. What does it mean to be neutral? _____
- Acids are found below 7.
- Bases are found above 7.
- The pH scale is based on logarithms (based on the number 10).
  - A change in pH from 6 to 5 is a 10-fold change in acidity.
  - The change in pH from 6 to 4 results in a solution that is 100 times more acidic (means 4 is 10 x 10 times or 10^2 more acidic than a pH of 6).
  - A pH of 12 is 10,000 or 10^4 times more alkaline (basic) than a pH of 8.
  - A pH of 2 releases _____ times more hydrogen ions than a pH of 5.

Chapter 2: Essential Chemistry for Biology, *Continued*

NEUTRALIZATION REACTIONS

1. Neutralization is the reaction between an _____ and a _____. Salt and water will yield (result). A commonly known neutralization reaction is the "homemade volcano" that many schoolchildren use for science projects. Vinegar, an acid, and baking soda, a base, are used to perform this reaction.

Example of a neutralization reaction (a type of double replacement reaction):

$$\underbrace{HCl}_{\text{acid}} + \underbrace{NaOH}_{\text{base}} \rightarrow \underbrace{NaCl}_{\text{salt}} + \underbrace{H_2O}_{\text{water}}$$

reactants → products

Identify the reactants, products, acids, bases, salts, and water in the following neutralization reactions:

$$NaOH + HF \rightarrow H_2O + NaF$$

$$KOH + H_2SO_4 \rightarrow K_2SO_4 + H_2O$$

$$HNO_3 + LiOH \rightarrow LiNO_3 + H_2O$$

2. *Why does your body perform neutralization reactions?* To maintain a proper pH balance. Your blood has a narrow range of pH values it must stay within (7.35 – 7.45). Buffers present in our blood stream and body help to shield against drastic changes in pH in the body.

a. **Acidosis:** when the blood pH falls below 7.35 toward the acid range.
b. **Alkalosis:** when the blood pH rises above 7.45 toward the basic range.

3. *What are buffers?* **Buffers** are substances that resist changes in pH by accepting H+ ions when they are in excess and donating H+ ions when they are depleted. In other words, they convert strong acids to weak acids and convert strong bases to weak bases. We will talk about various buffer systems if you take Bio 211 when we discuss acid-base balance.

Chapter 2: Essential Chemistry for Biology, *Continued*

Review of the Inorganic Compounds

For questions 1-12, identify the following descriptions as:

A. Acid
B. Base
C. Salt
D. Water
E. pH Scale

_____1. The two products formed when an acid and base combine.

_____2. Substance that releases OH^- ions when dissolved in water.

_____3. Substances such as lemon juice, vinegar; bodily fluids urine, saliva.

_____4. Substance with a pH of 4.

_____5. Substance that releases H^+ ions when dissolved in water.

_____6. The scale based on the concentration of H^+ ions in the substance.

_____7. Substance with a pH of 9.

_____8. Many electrolytes fall into this category; calcium, potassium, sodium ions are examples.

_____9. Substances such as bleach, milk of magnesia, aspirin; bodily fluids blood, semen.

_____10. Substances that are slippery to the touch.

_____11. On this scale, 7 is considered "neutral"—neither acidic nor basic.

_____12. This inorganic compound is characterized by possessing a high heat capacity, it's a good solvent, it's a polar compound, and it provides cushioning around your delicate body organs.

Fill in the Blank

_____13. Tomatoes, with a pH of 4, are ___ times more acidic than black coffee, which has a pH of 5.

_____14. Stomach acid, with a pH of 1, is _____ times more acidic than urine, which has a pH of 6.

_____15. Bicarbonate of soda has a pH of 12, this has 10 times more _____ ions than household ammonia, with a pH of 11. In other words, bicarbonate of soda is ____ times more basic then ammonia.

_____16. The compounds KOH and NaOH:

A. are acids because they yield hydrogen ions in solution

B. are not acids because they do not yield hydrogen ions in solution

17. Indicate whether the following are acids, bases, or salts:

_____$Ca(OH)_2$ _____KOH

_____H_2SO_4 _____$MgCl_2$

_____H_2CO_3 _____KCl

18. Look at the following and determine:

Place a ✓ by the pH which is a strong basic solution; place an **X** by the weak basic solution.

_____3.2 _____6.9 _____7.3 _____13.2

Answers: 1. C, D; 2. B; 3. A; 4. A; 5. A; 6. E; 7. B; 8. C; 9. B; 10. B; 11. E; 12. D; 13. 10; 14. 10^5 or 100,000; 15. OH^-; 16. B; 17. Base = $Ca(OH)_2$, Base = KOH, Acid= H_2SO_4, Salt = $MgCl_2$, Acid = H_2CO_3, Salt = KCl; 18. strong basic solution = 13.2; weak basic solution = 7.3

Chapter 3: The Molecules of Life

Basic Information for Understanding Chemical Reactions

Chemical Reactions involve a change in energy and a rearrangement in molecular structure. First, we need to understand four terms:

Monomer: single unit; building block

Polymer: two or more units bonded together

Reactants: substances entering into a chemical reaction

Products: substances made as a result from a chemical reaction

A—B—C → A + B + C

polymer 3 monomers

Example 1: Identify the reactants and products in this reaction:

A—B—C → A + B + C

Try these examples after you have learned about carbohydrates and chemical reactions. Identify the reactants, products, monomers and polymers.

Example 2

sucrose + water → glucose + fructose

Example 3

glucose + glucose → maltose + water

Example 4

soaking dirty dishes in the sink

Example 5

baking a cake

Chapter 3: The Molecules of Life, *Continued*

CHEMICAL REACTIONS

I. SYNTHESIS (Dehydration Synthesis Reaction = Anabolism): occur when two or more atoms or molecules combine to form a larger, more complex molecule. It can be represented as **A + B → AB**. These reactions involve bond formation and are the anabolic reactions in your body (reactions in which substances are built or made). The dehydration synthesis reaction can be summarized as "**monomers building polymers through the removal of water**."

$$A + B + C + D \rightarrow A - B - C - D + H_2O$$

Dehydration Synthesis: Monomers Joining To Form Polymers
Dehydration = removal of water
Synthesis = to make something

II. DECOMPOSITION (Hydrolysis Reaction = Catabolism): occur when a molecule is broken down into smaller molecules. It can be represented as **AB → A + B**. Hydrolysis reactions are the opposite of dehydration synthesis reactions. Bonds are broken in these reactions to produce smaller, simpler substances than the original substance. The hydrolysis reaction can be summarized as "**polymers breaking down into monomers through the addition of water**."

$$A - B - C - D + H_2O \rightarrow A + B + C + D$$

Hydrolysis: Polymers Breaking Down Into Monomers
Hydro = water
Lysis = to split or rupture

Chapter 3: The Molecules of Life, *Continued*

Review of 2 Chemical Reactions: Dehydration Synthesis and Hydrolysis

Determine if the following reactions are representative of:
A. Dehydration Synthesis
B. Hydrolysis

_____1. A + B → AB

_____2. Substances in the body are broken down into smaller parts.

_____3. Uses water to help decompose polymers to monomers.

_____4. Removes water when monomers are joined together to form polymers.

_____5. Builds up substances in the body such as muscle or hair or enzymes.

_____6. XY → X + Y + Z

_____7. H—monosaccharide—OH + H—monosaccharide—OH → H—polysaccharide—OH + H_2O

_____8. Digestion.

_____9. Water is split to protect the newly formed bonding sites of the monomers.

Determine if the following items are classified as: (Note the hints)
A. Monomer
B. Polymer

_____10. monosaccharide

_____11. polysaccharide

_____12. H—●—OH

_____13. H—●—●—●—●—●—OH

_____14. amino acids (*a building block)*

_____15. polypeptide

_____16. disaccharide

_____17. nucleotide (*a building block*)

_____18. DNA (*a macromolecule*)

_____19. steroid (*a macromolecule*)

Answers: 1. A; 2. B; 3. B; 4. A; 5. A; 6. B; 7. A; 8. B; 9. B; 10. A; 11. B; 12. A; 13. B; 14. A; 15. B; 16. B; 17. A; 18. B; 19. B

For Discussion:

20. Describe the role of water in dehydration synthesis and hydrolysis.

21. Explain why you need to drink lots of water for digestion, a type of hydrolysis, to occur properly.

22. Describe how polymers are formed during dehydration synthesis and how monomers are made as a result of hydrolysis.

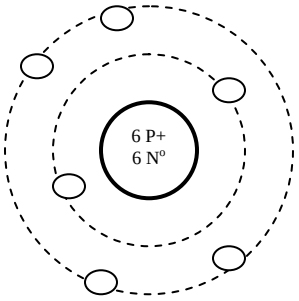
23. Explain why muscle building, a type of dehydration synthesis, will generate water molecules.

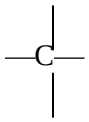
Chapter 3: The Molecules of Life, *Continued*

ORGANIC COMPOUNDS

Characteristics of Organic Compounds

- Organic compounds typically contain the element _____. Carbon forms a skeleton or backbone for these compounds. Carbon has 4 electrons in its outermost shell (a shell that can hold up to 8). Therefore, carbon typically forms covalent bonds with _____ atoms of other elements.
- Organic compounds are produced by a living organism or an organism that was once alive
- Organic compounds exist as small or large molecules that are covalently bonded together





What makes organic and inorganic compounds different? Organic compounds are produced by living organisms while inorganic compounds aren't necessarily produced by living organisms. Organic compounds contain the element carbon while inorganic compounds usually don't.

List the 4 Organic Compounds

1. lipids
2. carbohydrates
3. proteins
4. nucleic acids

Nutrition Facts
Serving Size 4 Cookies (29g)
Servings Per Container About 9

Amount Per Serving	
Calories 140 Calories from Fat 60	
	% Daily Value*
Total Fat 7g	**11%**
Saturated Fat 3.5g	**18%**
Cholesterol 0mg	**0%**
Sodium 100mg	**4%**
Total Carbohydrate 18g	**6%**
Dietary Fiber less than 1g	**3%**
Sugars 9g	
Protein 1g	

Vitamin A 0% • Vitamin C 0%
Calcium 2% • Iron 6%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Chapter 3: The Molecules of Life, *Continued*

ORGANIC COMPOUNDS

CARBOHYDRATES

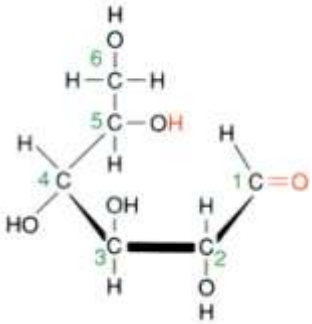
Building Block or Monomer: _____

mono = simple or one; *saccharide* = sugar

Function: to give quick energy.

carbo = carbon; *hydrate* = oxygen + hydrogen (water) in the ratio of CH_2O

Types of Carbohydrates



- **Monosaccharide = Simple Sugars**: contain between _____ and _____ carbon atoms and can be quickly broken down by the body to give energy.
  - **Glucose** (*shown at right*)
  - **Fructose**
  - **Galactose**
- **Disaccharides =** monosaccharide + monosaccharide (assembled through synthesis reactions)
  - **Maltose** = glucose + glucose. The joining of 2 glucose molecules through anabolism builds maltose.
  - **Sucrose** (table sugar) is formed from anabolism involving glucose and fructose.
- **Polysaccharides = Complex Carbohydrates**: complex carbs are made of many monomers and require more energy for the body to break the bonds between them. Complex carbs give energy over a longer period of time; pasta, breads, and starches are examples of these polymers. There are three polysaccharides common in animals and plants: starch, cellulose and glycogen.
  - **Glycogen** (animal polysaccharide) is the storage form of _____ in humans. This polysaccharide is stored in the **liver** by the hormone **insulin**. The body tries to maintain the blood glucose level at 0.1%.
  - **Starch** (plant polysaccharide) is how plants commonly store excess glucose. Starch is also known as "soluble fiber."
  - **Cellulose** (plant polysaccharide) is commonly known as fiber. Humans are unable to digest cellulose because we do not have the necessary enzyme for cellulose digestion; it passes through the digestive tract as roughage. Cellulose is also known as "insoluble fiber."
- **Food Examples**: honey, soft drinks, starches, sweets, breads, pasta, muffins, cereals, grains

Chapter 3: The Molecules of Life, *Continued*

ORGANIC COMPOUNDS

LIPIDS

Building Blocks or Monomers: _____ + _____

carbon and hydrogen are found in the ratio of 1:2 but have less oxygen than carbohydrates

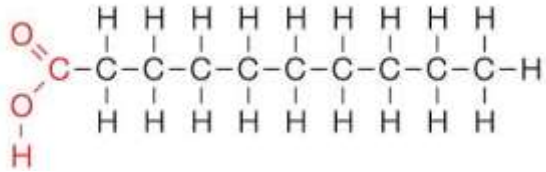
Function: to store energy, form structures of cells, insulate around organs lipids have a _____ region which causes portions to be hydrophobic ("water-fearing")

2 Types of Fatty Acids Chains

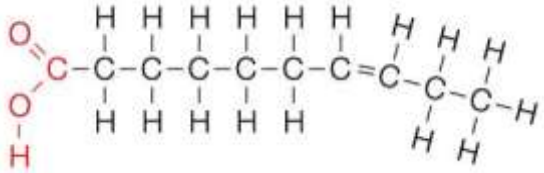
- **Unsaturated Fats**: unsaturated fats do not have hydrogens bonded to every possible bonding site. In other words, they lack the maximum number of hydrogen atoms on their fatty acid chains and are thus, unsaturated. The carbon atoms form **DOUBLE** bonds in places where they may be only one hydrogen atom. Since these fats don't have the max number of hydrogens, the molecules "kink" up and trap air between the fatty acid chains. Therefore, they are typically **LIQUID** at room temperature (think of unsaturated oils like canola oil, vegetable oil, oils coming from **PLANTS**)

- **Saturated Fats**: saturated fats have the maximum number of hydrogen atoms bonded to the molecule; in other words, they have no double bonds between the carbon atoms. Therefore, we use the word "saturated". These fats "lie flat" unlike the unsaturated fats; thus, they are **SOLID** at room temperature because there is less space between the fatty acids (animal fats like butter).

Saturated Fatty Acid Chain

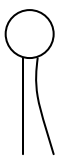


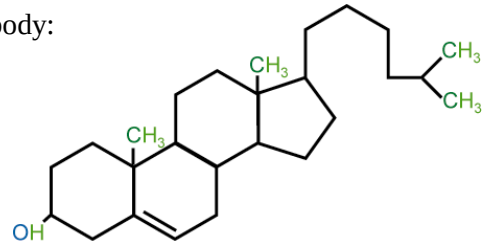
Unsaturated Fatty Acid Chain



Other Types of Lipids

- **Phospholipids**: (*pictured at left*) these are lipids that contain a phosphate group that contains both phosphorous and nitrogen. These phosphate groups are carrying a charge and become the polar heads of the plasma membrane while the nonpolar tails forms the rest of the membrane bilayers. Since the tails are **nonpolar**, they are **hydrophobic** (*water-fearing*). The heads, being **polar**, are **hydrophilic** (*water-loving*).
- **Steroids**: (*pictured at right*) have a backbone of 4 fused carbon ring; their structures differ entirely from other fats (different functional groups are attached to the basic structure).
  - **Cholesterol** is a type of steroid that is a precursor to other steroids (like **aldosterone**, **estrogen**, and **testosterone**). Cholesterol is obtained in two ways in the body:





Chapter 3: The Molecules of Life, *Continued*

ORGANIC COMPOUNDS

PROTEINS

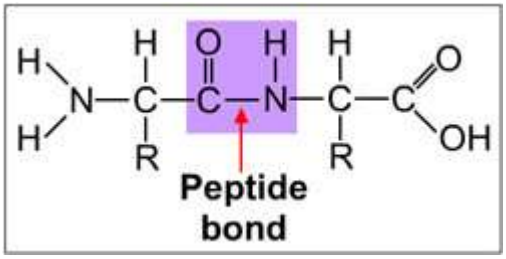
Building Blocks or Monomers: _____

Function: some proteins serve as *structural* proteins; others serve as *functional* proteins

Types or Examples: proteins serve many roles in the body, such as:

- structural proteins such as nails and hair
- transport proteins such as hemoglobin on red blood cells
- hormones
- muscles
- enzyme
- antibodies
- form part of plasma membranes

Unique Characteristic: Amino acids are joined together with **peptide** bonds.



During protein synthesis (a type of dehydration synthesis) amino acids are joined together

- A **dipeptide** contains 2 amino acids
- A **polypeptide** can have hundreds of amino acids.

Structure of Proteins: Some proteins have 1 polypeptide chain while others have more than one; yet, each polypeptide chain has its structure.

- **Primary**: linear sequence
- **Secondary**: alpha helix
- **Tertiary**: 3D shape
- **Quarternary**: 2 or more linked polypeptides (some proteins have this fourth level of structure)

Chapter 3: The Molecules of Life, *Continued*

ORGANIC COMPOUNDS

NUCLEIC ACIDS

Building Block or Monomer: nucleotide

Function: store genetic information, make proteins, and serve as an energy molecule.

General Characteristic of nucleotides: Nucleotides contain the following three items:

1. some number of phosphate groups
2. some type of sugar molecule
3. some type of nitrogenous base

} **see details below!**

3 Specific Types of Nucleic Acids

- **DNA = Deoxyribonucleic Acid**. DNA is the way genetic information is stored in the body. DNA is built of nucleotides--2 strands are wound like a helical staircase. The backbones of the two DNA strands are composed of repeating sugar and phosphate groups. The "rungs" of the ladder are composed of bases paired together (adenine with thymine; cytosine with guanine).
    - A nucleotide of DNA contains:
        1. phosphate
        2. 5 carbon sugar = _____
        3. nitrogen base (either adenine, guanine, cytosine, or thymine*)*

- **RNA = Ribonucleic Acid**. RNA is used to create proteins. RNA is written from a template of DNA and therefore, they are similar in their composition. RNA is also built from nucleotides—however there is only 1 strand. *What are three differences between DNA and RNA structure?*
    - A nucleotide of RNA contains:
        1. phosphate
        2. 5 carbon sugar = _____
        3. nitrogen base (either adenine, guanine, cytosine or uracil)

- **ATP = Adenosine Triphosphate**. ATP is an energy molecule that is "spent" in the body when work needs to be performed. When energy is required, the 3rd phosphate group is removed and the molecule becomes ADP. The phosphate group is readded via glucose metabolism (aerobic cellular respiration). *Why is ATP placed into this general category of organic compounds?*
    - A nucleotide of ATP contains:
        1. 3 phosphate groups
        2. 5 carbon sugar = ribose
        3. nitrogen base (_____)

Chapter 3: The Molecules of Life, *Continued*

Review of the 4 Organic Compound Groups

Complete this chart and make **flash cards** *to learn these characteristics of the organic compounds!*

	Carbohydrates	**Lipids**	**Proteins**	**Nucleic Acids**
Building Block (*Monomer)*	Monosaccharide *mono*=simple *saccharide*=sugar		Amino acids … linked together by peptide bonds to form polypeptides	
Function		Stores energy, serves as insulation for organs		Serves the body as the blueprint for life as DNA
Contains these elements or functional group	Contains the elements Carbon, Hydrogen, Oxygen in a ratio of CH_2O			
Characteristics or Types	Monosaccharides Disaccharides Polysaccharides	Unsaturated Fats Saturated Fats Phospholipids Steroids	Can be denatured by heat and acids. Denaturation: the protein changes shape and can no longer perform its function.	
Examples	Sucrose, fructose, galactose, lactose	Oil, wax, steroids, some hormones	Muscle, hair, nails, enzymes, some hormones	DNA, RNA
Food in which this organic compound is found	Pasta, bread, candy, cookies, cakes, muffins, some vegetables, fruits, soft drinks	Oil, butter, lard, cheese, some meats, beeswax	Fish, red meat, pork, turkey, peanut butter, some legumes (beans)	N/A

Chapter 3: The Molecules of Life, *Continued*

Review of Organic Compound Groups

Identify the group as
A. carbohydrates
B. nucleic acids
C. proteins
D. lipids

_____ 1. Building block are the nucleotides
_____ 2. Function is to provide quick energy
_____ 3. Function is to store energy and provide insulation around organs.
_____ 4. Building block are monosaccharides.
_____ 5. Examples include sugars, starches.
_____ 6. Function is to provide genetic blueprint for life.
_____ 7. Examples include DNA and RNA.
_____ 8. Building block are amino acids.
_____ 9. Examples are muscles, nails, enzymes, hormones, hair.
_____ 10. Function is to provide structure and molecules for the body.
_____ 11. Examples are phospholipids, waxes, oils.
_____ 12. Found as the two layers of the plasma membrane
_____ 13. Found embedded in the two layers of the plasma membrane
_____ 14. Found in the nucleus of a cell
_____ 15. Produced by the rough endoplasmic reticulum
_____ 16. Produced by the smooth endoplasmic reticulum
_____ 17. Composed of carbon, hydrogen, and oxygen in the ratio of CH_2O
_____ 18. Twists into a 3-D structure.
_____ 19. Not considered necessary in our diets.
_____ 20. Some of these are considered hydrophobic (do not mix with water.)

Answers

1B, 2A, 3D, 4A, 5A, 6B, 7B, 8C, 9C, 10C, 11D, 12D, 13C, 14B, 15C, 16D, 17A, 18B, 19B, 20D

Chapter 4: A Tour of the Cell

Where did the term "cell" come from? 1600's, Robert Hooke first observed slices of dead cork under a primitive microscope. He saw the outlines of the cells and remarked that they resembled rooms of a monastery—very tiny "cells."

List the tenets of the Cell Theory:

_____

_____

_____

_____

_____

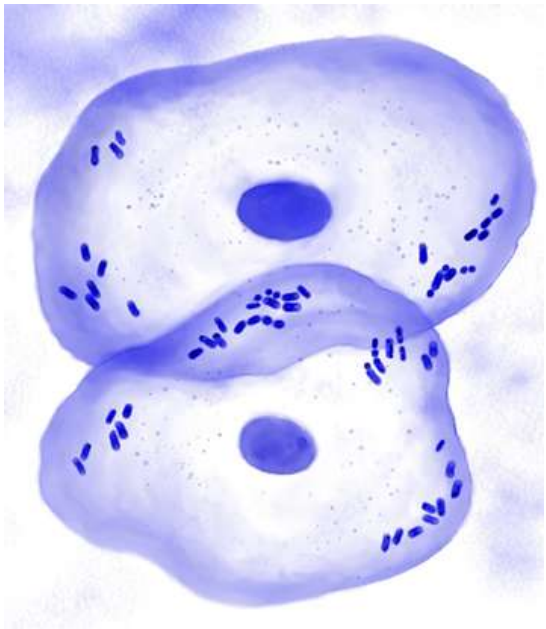
TWO MAJOR TYPES OF CELLS

1. **Prokaryotes** are organisms such as bacteria. Prokaryotes are characterized by:

- unicellular
- small in size (smaller than a unicellular eukaryote)
- lack of a nuclear envelope around the _____
- lack of membrane-bound organelles
- reproduce simply by binary fission

2. **Eukaryotes** are organisms such as protists, plants, fungi, and animals. Eukaryotes are typically:

- unicellular or multicellular
- have a _____ that surrounds and protects the DNA
- have membrane bound organelles such as mitochondria or golgi apparatus
- reproduce _____ (body) cells by mitosis; reproduce _____ (sex cells) by meiosis



Notice the larger eukaryotic cells (from human cheeks) and the much smaller prokaryotic cells (bacteria from the mouth)

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Chapter 4: A Tour of the Cell, *continued*

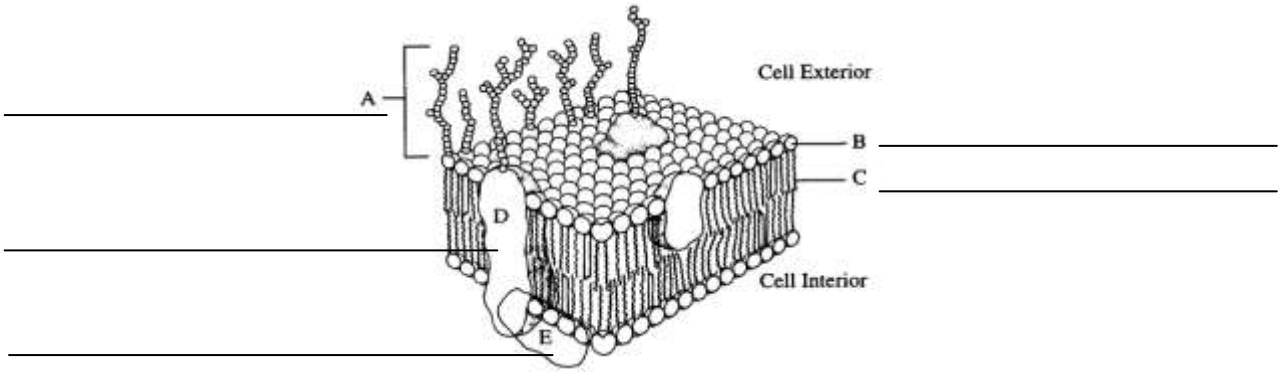
MAJOR PARTS OF EUKARYOTIC CELLS

Plasma Membrane

Structure:

- **Lipid component**: 2 layers of _____ with portions that are hydrophobic ("water-fearing"). The nature of these phospholipids create a selectively permeable membrane.
- **Protein component**: The double layer of phospholipids are embedded with **integral** (more common) and **peripheral** _____.

Function: provides a boundary around the cell to physically isolate it; acts as a place for chemical reactions to occur, regulates the exchanges of ions and nutrients with the environment; receptors allow the cell to respond to the environment; structural support.



Nucleus

Structure: The DNA is surrounded and protected by a nuclear envelope (a membrane). The nuclear envelope has _____. *Why?* _____ So, the *nucleus* is a collective term for the DNA and its nuclear envelope.

Function: The nucleus is part of the cell that houses the _____. DNA is the genetic blueprint for life; it's necessary for cell reproduction. Nucleus is the genetic control center of cells.

Cytoplasm is a generic term for the material found between the plasma membrane and the nucleus.

Structure: semi-fluid medium (jelly-like substance) known as **intracellular fluid** or **cytosol.**

Function: hold the organelles in place inside a cell.

Organelles are small organs found within a cell. Their job is to perform a specific function for the cell.

You will need to know the organelles and structures listed on the following pages. We will complete the structures and functions of the organelles in the chart in a few pages. Try making some **flash cards** to learn these organelles & functions.

Chapter 4: A Tour of the Cell, *continued*

ORGANELLE STRUCTURE AND FUNCTION

Organelle/Structure	Structure	Function
Ribosomes	*Some* = body. These small organelles can be found 1) free in the cytoplasm or 2) attached to the rough endoplasmic reticulum.	
Endoplasmic Reticulum **Smooth ER and Rough ER**	The endoplasmic reticulum (ER) is a network of membranes connected to the nucleus. They receive their directions directly from the nucleus	Rough ER synthesizes _____ (enzymes, hormones, muscle); the surface is studded with _____. Smooth ER synthesizes lipids (such as phospholipids, waxes); it lacks _____ on its surface.
Golgi Apparatus	This organelle appears to be a stack of flattened pancakes. At the edges are rounded _____ and _____.	Modify, package, and secrete substances from the cell. Also, makes another organelle called the _____.
Lysosomes	Some = body. These organelles are larger than ribosomes and are found free in the cytoplasm. They are produced by the Golgi apparatus.	These sacs contain digestive enzymes that 1) _____ _____ and 2) _____ _____
Mitochondria	Two layers (outer and inner) membrane	Often called the "powerhouse" of the cell because it is the site of cellular respiration in which glucose and oxygen are converted into ATP, an energy molecule (carrier) used by your body. Write the reaction for cellular respiration below:

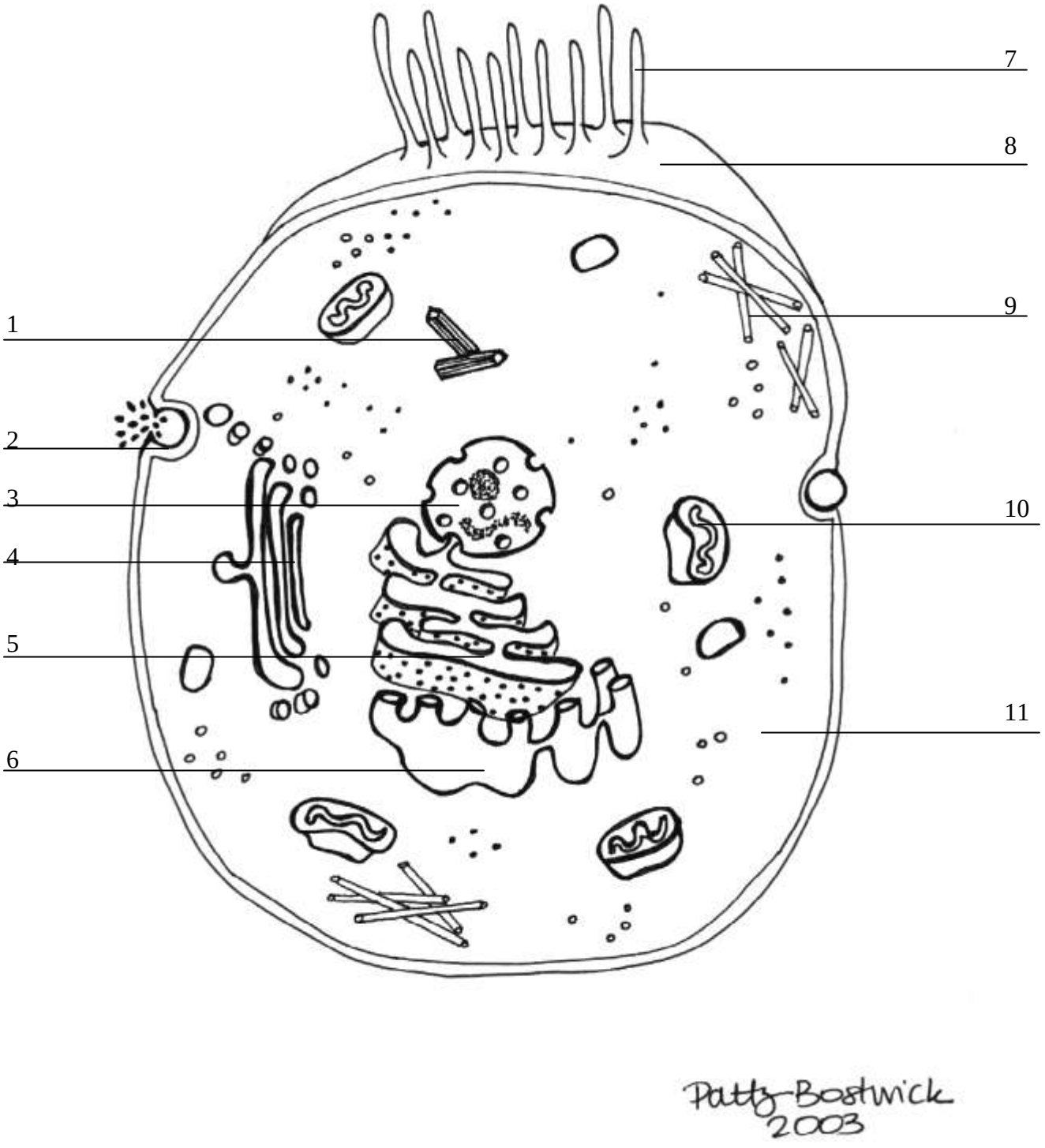
Chapter 4: A Tour of the Cell, *continued*

Organelle/Structure	Structure	Function
Centrioles	Composed of tubes of protein called microtubules	Believed to be used in mitosis and meiosis in order to help pull the chromosomes apart; form the basal bodies that give rise to _____ and _____.
Cytoskeleton	Network of proteins called microtubules and microfilaments form right under the plasma membrane.	Forms a flexible internal framework for the cell.
Cilia	Short hair-like extensions of the plasma membrane	Move in unison to clean the respiratory tract of debris or to move an egg from the fallopian tube to the uterus.
Flagella	Long tail-like whip found as an extension of the plasma membrane. Only found in one place in the human body: _____.	Moves the cell
Chloroplasts	Partitioned into 3 compartments. The stroma is a thick fluid held within two membranes while the grana are stacks of disks used for trapping solar energy. Found only in plants and photosynthesizing organisms.	

Chapter 4: A Tour of the Cell, *continued*

Label the Organelles & Structures of the Eukaryotic Cell

Use the names of organelles and structures found on the 3 previous pages to label this cell.



Chapter 4: A Tour of the Cell, *continued*

Review of the Organelles & Structures of a Eukaryotic Cell

Identify each of the following organelles or structures by its function or description.

_____1. modifies, packages, secretes substances from the cell.

_____2. recycling center where damaged organelles can be sent.

_____3. site of cellular respiration where glucose and oxygen are converted to ATP

_____4. forms an envelope around the cell; described as "selectively permeable"

_____5. synthesizes lipids **or** proteins upon receipt of directions from nucleus

_____6. genetic control center of the cell where DNA is housed

_____7. contains hydrogen peroxide to detoxify substances such as free radicals.

_____8. can be found on endoplasmic reticulum or free in the cytoplasm; produces proteins

_____9. can be described as rough or smooth.

_____10. short hair-like structures that can create a current by beating in unison.

_____11. long tail-like whip that propels sperm.

_____12. semi-fluid medium that helps hold the organelles in place.

_____13. composed of microtubules; help form the bases of cilia and flagella.

_____14. stores nucleic acids

_____15. "powerhouse" of the cell

_____16. connected to the nucleus by a network of membranes

_____17. composed of 2 layers of lipids embedded with proteins

18. Describe the role of the nucleus in the cell.

19. Describe the structure and role of the plasma membrane in the cell.

20. Compare and contrast the functions and structures of the 2 types of endoplasmic reticulum.

21. Explain what might result if your ribosomes weren't working in your cells.

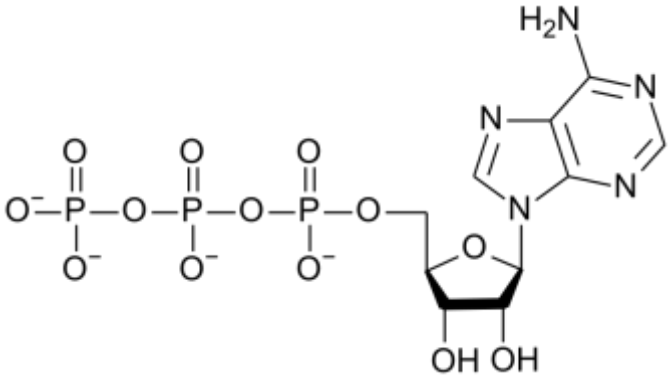
Answers: 1. Golgi apparatus, 2. lysosomes, 3. mitochondria, 4. plasma membrane, 5. ER, 6. nucleus, 7. peroxisomes, 8. ribosomes, 9. ER, 10. cilia, 11. flagella, 12. cytoplasm, 13. centrioles, 14. nucleus, 15. mitochondria, 16. ER, 17. plasma membrane, 18-21. *Think about these questions; if you have trouble answering any of them, please see your instructor!*

Chapter 5: The Working Cell

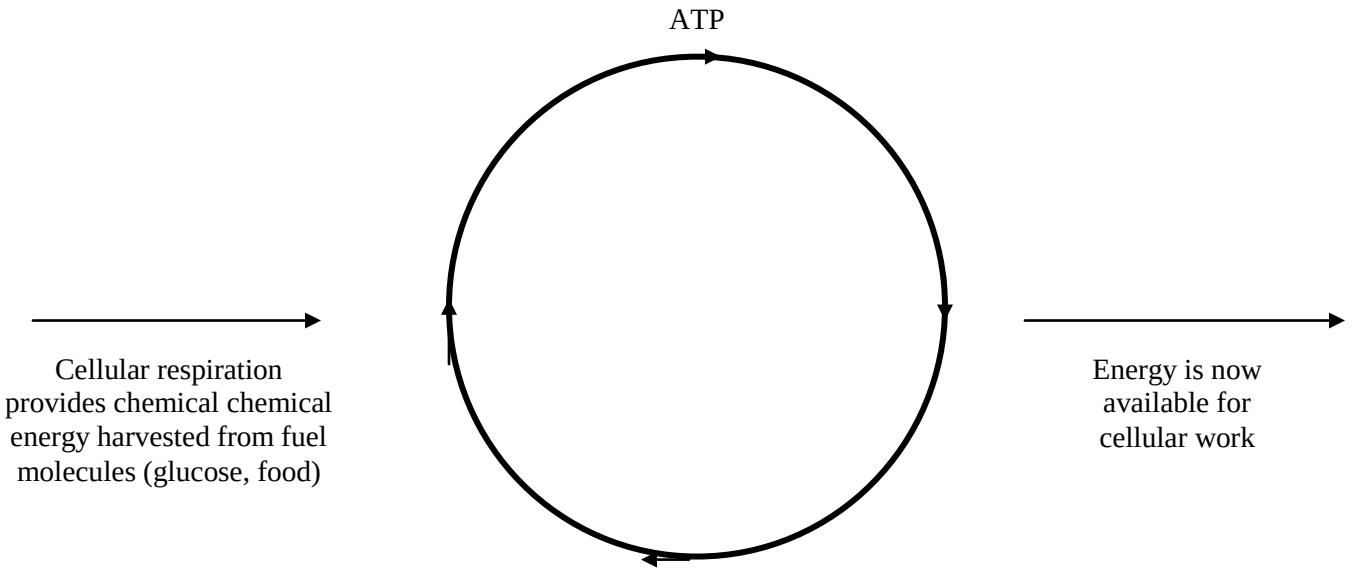
ATP AND CELLULAR WORK

ATP = Adenosine Triphosphate. ATP is a type of nucleic acid; it's an _____ molecule that is "spent" in the body when work needs to be performed. When energy is required, the 3rd phosphate group is removed and the molecule becomes ADP. The phosphate group is readded via glucose metabolism (aerobic cellular respiration). ATP is made of 3 items:

1. 3 phosphate groups
2. 5-carbon sugar known as ribose
3. nitrogenous base (_____)



Sketch and Describe the ATP Cycle



Describe Phosphate Transfer

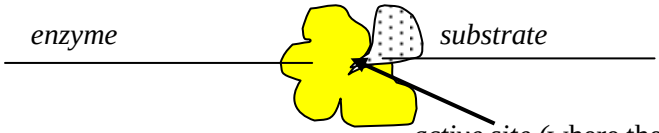
How does ATP generate energy? Through the addition and removal of the third _____ group. When a phosphate group is removed, you're left with A __ P (known as adenosine diphosphate). The phosphate group that is removed allows protein pumps to work, for instance. When the phosphate group has done its work, it can be replaced to the molecule and become ATP again.

Chapter 5: The Working Cell, *continued*

ENZYMES

A Special Type of Protein

- **Metabolism**: the sum of all _____ that occur in your body. Enzymes aid these chemical reactions.
- **Enzymes and Substrates**: substances that help to speed up a reaction, but are not used up by the reaction. Enzymes are specific to a particular _____; they only work on certain substances that they have a particular "fit" with. Enzymes are proteins and catalysts (since catalysts are a general group of substances that speed up reactions).
    - Enzymes often have an ending of _____. For example, *maltase* is an enzyme that acts on *maltose*, a carbohydrate substrate.
    - Substrate is the substance acted on by the enzyme. The substrate name typically ends in –_____.
- **Active Site**: The location where the enzyme and substrate fit together. Think of it like a piece of a puzzle. They each have a place where they come together like a lock and key.
- **Activation Energy**: Enzymes _____ the activation energy of a chemical reaction.



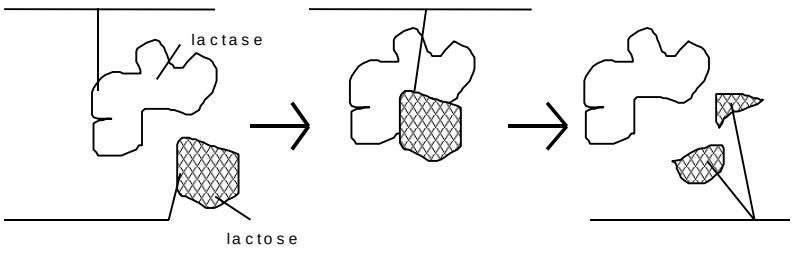
*active site (*where the enzyme and substrate join)

- **Factors Influencing Enzyme Activity**
    - pH (acid)
    - temperature (heat)

    } *These two factors can denature the enzyme so its active site no longer works.*

    - concentration of reactants or products
- **Denaturation** is when the shape of an enzyme is changed so that the active site no longer fits with the enzyme.

Identify the parts of this enzyme reaction. On the lines provided, label the:
enzyme, substrate, active site, and products.

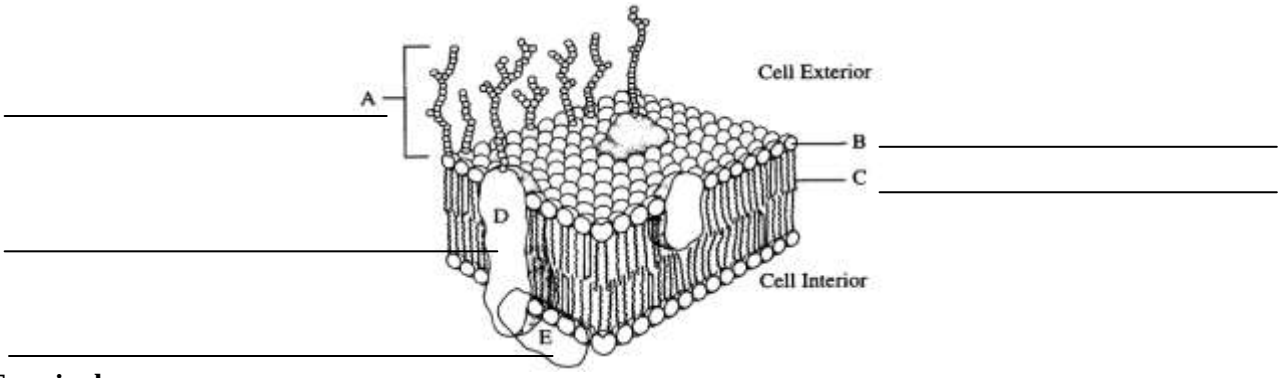


Chapter 5: The Working Cell, *continued*

MEMBRANE TRANSPORT

Membrane Transport is how membranes move substances into the cell.

Plasma Membranes: recall that cell membranes are composed of organic molecules called phospholipids. Each phospholipid has 2 water-fearing **tails** (hydrophobic region) and 1 water-loving **heads** (hydrophilic region). Membranes are known as _____ because they select what can enter due to the nature of their composition (lipids/nonpolar substances don't mix with water/polar substances).



Basic Terminology:

- **Solutes** are substances (solid, liquid, or gas) dissolved by solvents in a solution (lesser amount).
- **Solvents** are the substances that dissolve solutes (greater amount).
- **Solutions** contain a solvent and the solute.

Example: Salt dissolved in water; salt is the solute while water is the solvent. The result is a salt water solution. Or, carbon dioxide becomes dissolved by the blood plasma. Which part is the solute? _____ The solvent? _____

Types of Membrane Transport

I. PASSIVE METHODS means that the movement of the substance across the membrane is passive, no energy is required. The type of passive transport used by the cell is dictated by the 1) charge of the substance moving through the membrane and 2) size of the substance. *We'll cover the following 3 types over the next few pages:*

A. Diffusion

B. Osmosis

C. Facilitated Diffusion

II. ACTIVE METHODS means that the movement of the substance across the membrane is active, energy or ATP is required. These process do require ATP. *Again, more detail about this in a few pages.*

A. Solute Pumping

B. Endocytosis (Phagocytosis and Pinocytosis)

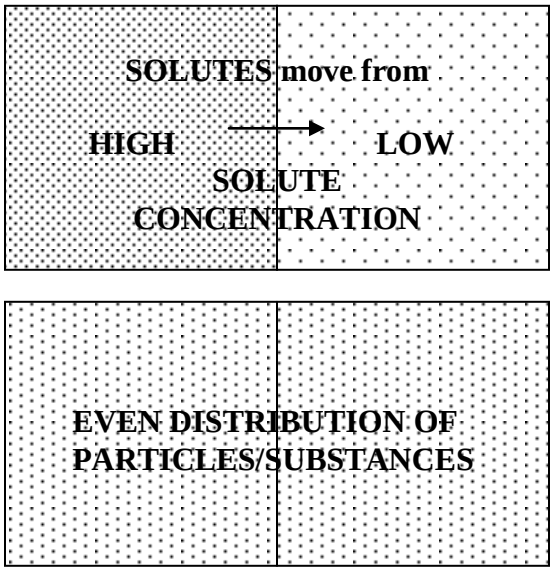
C. Exocytosis

Chapter 5: The Working Cell, *continued*

I. PASSIVE TRANSPORT

A. DIFFUSION means that the substance moves across the membrane, from _____ to _____ concentration. The phospholipid bilayer is selectively permeable and allows substances to travel through because of (1) size of the substance and (2) charge of the substance. In other words, _____ substances and substances made of _____ can travel through the phospholipid bilayer.

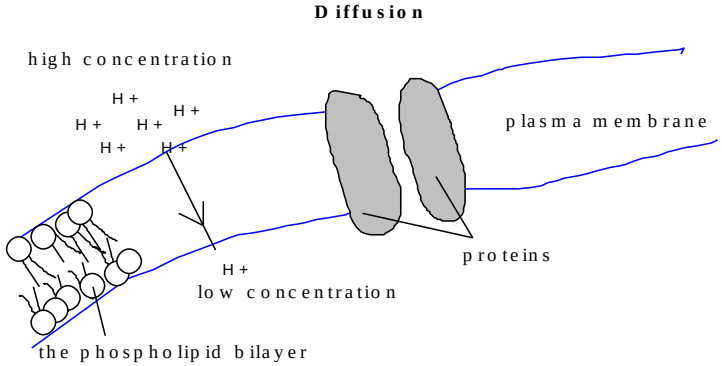
1. Diffusion occurs when molecules are unevenly distributed. The **concentration gradient** is created by unequal distribution of particles on either side of the plasma membrane. Particles or substances move from HIGH to LOW solute concentrations.



Before Equilibrium

At Equilibrium

2. Diffusion results from the random movement and kinetic energy of atoms and molecules.
3. **<u>No energy (ATP) is required</u>** for diffusion to occur.
4. Examples of substances that can move by diffusion: _____
5. Net movement of a substance across a membrane slows when **EQUILIBRIUM** is reached.



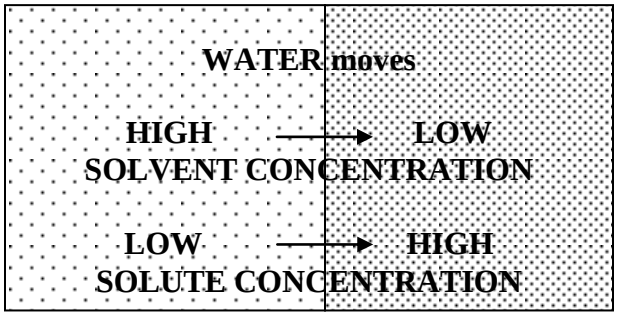
What are the main points you've learned so far about diffusion?

- _____
- _____
- _____

Chapter 5: The Working Cell, *continued*

I. PASSIVE TRANSPORT, *continued*

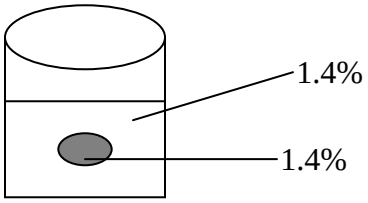
B. OSMOSIS is the diffusion of **<u>water</u>** across a membrane through protein channels called **aquaporins**. For instance: if there is a high concentration of solutes on one side of a membrane and a low concentration of solutes on the other side of a membrane, water will move to equalize the concentrations. Solutes do not move to equalize concentrations—the solvent, **<u>water</u>**, moves from HI to LO concentrations to equalize concentrations!



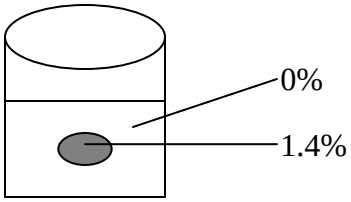
WATER ALWAYS FOLLOWS SALT!

Three Osmotic Scenarios

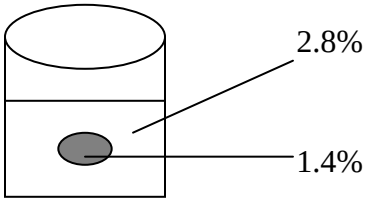
1. **Isotonic Solutions**: the cell and its surrounding solution or environment have the _____ concentrations! There is no net movement of water across the membrane; the cell is in _____ with its environment.
(*Iso* = _____)



2. **Hypotonic Solutions**: the cell is placed in a solution which has a _____ solute concentration than the cell's solute concentration. The cell will allow water to _____ to equalize concentrations.
(*Hypo* = _____) BLOAT/LYSIS



3. **Hypertonic Solutions**: the cell is placed in a solution which has a _____ solute concentration than the cell's solute concentration. The cell will allow water to _____ to equalize concentrations.
(*Hyper* = _____) SHRIVEL/CRENATE



Chapter 5: The Working Cell, *continued*

Understanding Osmotic Solutions

Scenario #1

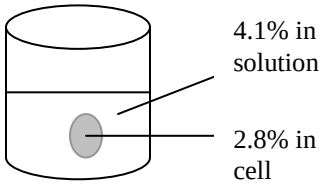
Where is the higher concentration of solutes? ***Outside the cell***

Will water move in or out of this cell? ***Water will move out of the cell***

Will this cell bloat or shrivel? ***Shrivel***

Hypertonic/Hypotonic/Isotonic? ***Hypertonic***

Why is water leaving this cell? ***The water is moving out of the cell in an attempt to equalize solute concentrations on the inside and outside of the cell's membrane. Water is moving to the 4.1% area to dilute it to 2.8% (value inside cell).***



Scenario #2

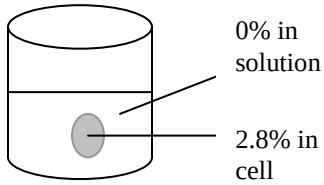
Where is the higher concentration of solutes? ***Inside the cell***

Will water move in or out of this cell? ***Water will move into the cell***

Will this cell bloat or shrivel? ***Bloat and rupture (lysis)***

Hypertonic/Hypotonic/Isotonic? ***Hypotonic***

Why is water entering this cell? ***The water is entering this cell to dilute the solute concentration inside the cell. The water is attempting to bring the 2.8% concentration down to 0%--same as the concentration outside the cell. However, the cell will rupture before it can take in enough water to reach the concentration outside the cell.***



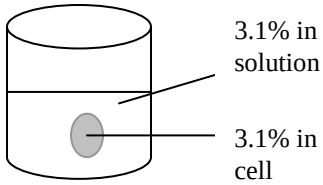
Scenario #3

Where is the higher concentration of solutes? ***Same***

Will water move in or out of this cell? ***No net movement into or out of cell***

Will this cell bloat or shrivel? ***Neither, it's in equilibrium***

Hypertonic/Hypotonic/Isotonic? ***Isotonic***

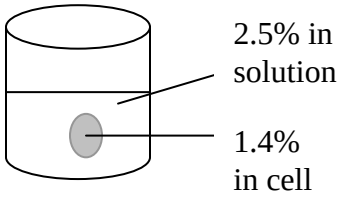


Chapter 5: The Working Cell, *continued*

Review of 3 Types of Osmotic Solutions

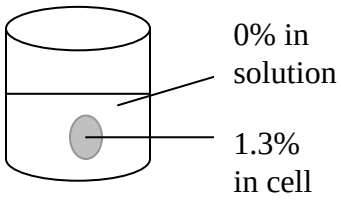
Practice Problem #1

_____Where is the higher concentration of solutes?
_____Will water move in or out of this cell?
_____Will this cell bloat or shrivel?
_____Hypertonic/Hypotonic/Isotonic?



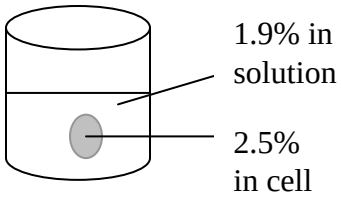
Practice Problem #2

_____Where is the higher concentration of solutes?
_____Will water move in or out of this cell?
_____Will this cell bloat or shrivel?
_____Hypertonic/Hypotonic/Isotonic?



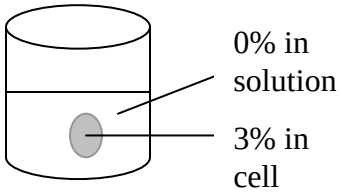
Practice Problem #3

_____Where is the higher concentration of solutes?
_____Will water move in or out of this cell?
_____Will this cell bloat or shrivel?
_____Hypertonic/Hypotonic/Isotonic?



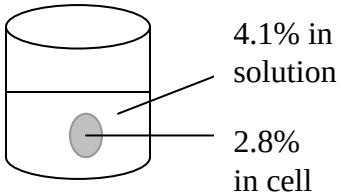
Practice Problem #4

_____Where is the higher concentration of solutes?
_____Will water move in or out of this cell?
_____Will this cell bloat or shrivel?
_____Hypertonic/Hypotonic/Isotonic?



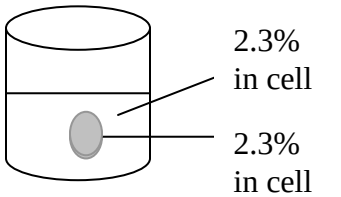
Practice Problem #5

_____Where is the higher concentration of solutes?
_____Will water move in or out of this cell?
_____Will this cell bloat or shrivel?
_____Hypertonic/Hypotonic/Isotonic?



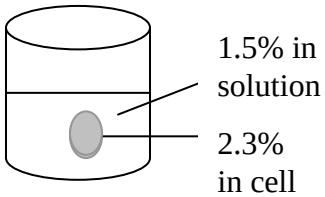
Practice Problem #6

_____Where is the higher concentration of solutes?
_____Will water move in or out of this cell?
_____Will this cell bloat or shrivel?
_____Hypertonic/Hypotonic/Isotonic?



Practice Problem #7

_____Where is the higher concentration of solutes?
_____Will water move in or out of this cell?
_____Will this cell bloat or shrivel?
_____Hypertonic/Hypotonic/Isotonic?



Chapter 5: The Working Cell, *continued*

Review of 3 Types of Osmotic Solutions, *Continued*

1. Explain why a cell with a high solute concentration than its surrounding environment will bloat.

2. Explain why an injection should be isotonic for maintainence of blood homeostasis for a patient.

3. Explain why a cell with a lower solute concentration than its surrounding environment will shrivel.

4. Explain why a patient injected with a hypotonic solution will experience lysis of the red blood cells.

5. Explain why a patient injected with a hypertonic solution will experience a shriveling of the red blood cells.

_____6. A cell with a higher solute concentration than the solution in which it is placed will:
- A. gain water
- B. lose water
- C. gain salt
- D. be in equilibrium with its environment

_____7. A cell with the same solute concentration as its environment will experience:
- A. water loss
- B. lysis
- C. no net movement of water into or out of the cell
- D. water gain

_____8. In order to rehydrate the eyes, eyedrops should be ____ in relation to the saline of the eyes.
- A. hypotonic
- B. hypertonic
- C. isotonic
- D. mesotonic

_____9. A patient is receiving a drip of 5% dextrose. At this rate, the concentration of dextrose is isotonic to the blood stream. If we increase the concentration of dextrose, then dextrose becomes ___ to the bloodstream.
- A. hypotonic
- B. hypertonic
- C. isotonic
- D. none of these

_____10. If you were to drink sea water as opposed to tap water, you would expect your body's cells to:
- A. bloat with water to equalize concentration
- B. lose water to equalize concentration
- C. do nothing as the cells are already in equilibrium with the salt water environment

Answers

1-5. *Think about these questions; if you have trouble answering them, please see your instructor!*
6. A
7. C
8. A
9. B
10. B

Chapter 5: The Working Cell, *continued*

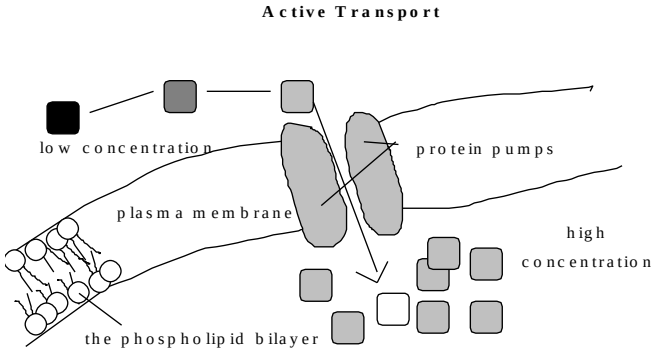
I. PASSIVE TRANSPORT, *continued*

C. FACILITATED DIFFUSION is a type of selective transport in which specific substances are moved into a cell by means of a type of integral protein, known as a **protein channels**. These substances are typically too large to pass through the membrane as in diffusion or osmosis.

- With facilitated diffusion, protein channels assist/facilitate diffusion of substances such as larger molecules.
- **No energy (ATP) is required!** (Because solutes are still moving from HI to LO concentration)
- What are two differences between the way diffusion and facilitated diffusion operate?
  1. _____
  2. _____

II. ACTIVE METHODS

A. SOLUTE PUMPING: requires **_____ (ATP)** for movement across a membrane. The cell employs protein pumps to move substances (often from LO to HI concentration).



B. ENDOCYTOSIS: The phospholipids and proteins of the plasma membrane are bypassed altogether when the cells is transporting very large sacs across cell membranes. During endocytosis, the plasma membrane forms a pit around a molecule. The pit will pinch closed to form a vacuole (phagocytosis) or vesicle (pinocytosis) that carries the molecule into the cytoplasm. Once inside, the membrane is broken down and contents are released into the cell.

1. **Phagocytosis**: essentially, "cell eating" in which the cell incorporates large sacs (vacuoles).
2. **Pinocytosis**: essentially, "cell drinking" in which the cell incorporates smaller sacs (vesicles).

C. EXOCYTOSIS: export of large molecules from a cell. First the membrane enclosed vesicle fills with macromolecules. Then the vesicle moves to the plasma membrane. Next, the vesicle fuses with membrane and the contents spill out of the cell.

Chapter 5: The Working Cell, *continued*

Review of Membrane Transport

Answer these questions about membrane transport.

_____1. Type of passive transport involving the use of a protein channel

_____2. Type of transport requiring the use of energy

_____3. Passive transport type involving movement through the phospholipid bilayer

_____4. Type of transport requiring the use of a protein pump to move substances against the concentration gradient

_____5. Diffusion of water

_____6. Any type of transport in which substances move with the concentration gradient

_____7. Movement of large substances with the concentration gradient requires the use of a protein channel

_____8. Type of transport in which substance is moved against its concentration gradient

_____9. Water always follows what substances during diffusion and osmosis?

_____10. A cell is moving some small molecules with their concentration gradient through the phospholipids. What type of membrane transport is the cell using?

_____11. A cell is moving a large sac out by having it fuse with the plasma membrane; then the sac ruptures once outside the cell to release its contents. What type of membrane transport is this?

12. When would a cell use facilitated diffusion rather than diffusion?

13. Describe the roles that proteins play in facilitated diffusion and active transport.

14. Describe how the size and composition of substances influences the type of membrane transport used.

15. Describe when a cell would use endocytosis rather than passive or active transport.

16. A cell is importing oxygen with its concentration gradient. The cell will move oxygen through the phospholipid bilayer. Name the type of membrane transport and describe what's happening here.

17. Explain why a cell could not perform active transport if there was no ATP present.

18. Explain why a cell could not transport substances by active transport or facilitated diffusion if the ribosomes weren't working properly.

19. A cell is moving a protein against its concentration gradient. The cell will move the protein through the protein pump. Name the type of membrane transport and describe what's happening here.

Complete this chart on membrane transport.

	Diffusion	**Osmosis**	**Facilitated Diffusion**	**Active Transport**
Is the substance moving *with* or *against* its concentration gradient?				
Can equilibrium be reached?				
Is energy required for this process?				
Does the size or charge of the particle affect its movement?				
Are proteins used to aid in the movement of the substance? If so, what type?				

Answers: 1. facilitated diffusion, 2. active transport, 3. diffusion, 4. active transport, 5. osmosis, 6. passive transport, 7. facilitated diffusion, 8. active transport, 9. salt or the highest solute concentration, 10. diffusion, 11. exocytosis, 12-19 and the chart. *Think about these questions; if you have trouble answering any of them, please see your instructor!*

Chapter 6: Cellular Respiration: Harvesting Chemical Energy

Do you know how or why…

- Your body produces carbon dioxide that you must exhale?
- Sugar increases your energy and gives you a quick energy boost?
- Your muscles feel like they're burning if you exercise without proper breathing?
- You must have oxygen to live?

CELLULAR RESPIRATION

The purpose of cellular respiration is to convert _____ (food we eat) and _____ (air we breathe in) into an energy molecule for the body, known as _____. Cellular respiration occurs in and around the _____, an organelle in eukaryotic cells.

The reaction for Aerobic Cellular Respiration is:

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 34\text{-}36$ ATP

glucose + oxygen –*yields*--> carbon dioxide + water + 34-36 energy molecules

What are the reactants of cellular respiration? _____

What are the products of cellular respiration? _____

What reactant(s) makes this process "aerobic?" _____

What organelle is the site of cellular respiration? _____

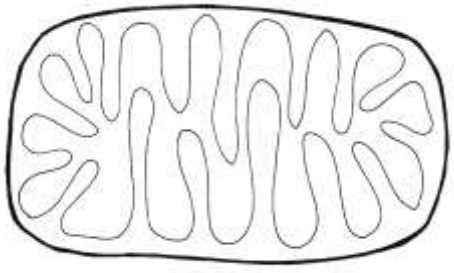
How many molecules of ATP are made? _____

There are 3 step to Aerobic Cellular Respiration.

Mark each step as to where it occurs in relationship to the mitochondria, below.

1. Glycolysis
2. Krebs Cycle
3. Electron Transport Chain and Chemiosmosis

Mitochondrion



Chapter 6: Cellular Respiration: Harvesting Chemical Energy, *continued*

THREE STEPS OF AEROBIC CELLULAR RESPIRATION

STEP 1: GLYCOLYSIS

- Where does this take place inside the cell? _____
- *Glycolysis* => glyco means "*sugar*" and lysis means "*split* or *ruptured*"
- The reaction that occurs in glycolysis is a molecule of _____is broken down into two molecules of a compound called _____ .
- *Keep track of the carbon atoms here: 6 carbons in glucose are separated into 2 molecules of pyruvic acid, each with 3 carbon atoms. 2 ATP are made during this step also.*

STEP 2: KREBS CYCLE

- Where does this take place inside the cell? _____
- Before pyruvic acid can be used in the Krebs Cycle, it must first be prepared. It's converted from a three carbon compound into a two carbon compound called acetic acid. Acetic acid must enter the Krebs Cycle bonded to a carrier molecule called _____ (at this point, when those two are bonded together, we call it "_____."
- The Krebs Cycle finishes breaking acetic acid down into _____. What happens to this CO_2? _____

  _____
- Some energy is captured in the form of NADH and $FADH_2$. Electron transport converts these two energies (NADH and $FADH_2$) into ATP energy.
- _____ ATP are made during this phase

STEP 3: ELECTRON TRANSPORT (AND CHEMIOSMOSIS)

- Where does this take place inside the cell? _____
- During this portion of aerobic cellular respiration, there is an electron transport chain set up across the mitochondrial membrane. It is fueled by the fall of electrons used to pump Hydrogen ions (H^+) across the inner mitochondrial membrane. The H^+ ions diffuse to areas of _____ concentration (outside the mitochondrial membrane). They are pumped back into the mitochondrion through an _____ (a tiny machine made of proteins that move the H^+ ions across the membrane.) ATP synthase converts ADP into ATP as the H^+ ions diffuse back in…
- As the H^+ ions diffuse back into the mitochondrion, they join with _____, present on the mitochondrial membrane (this is why we consider cellular respiration to be *aerobic* and also the reason you breathe in oxygen). H^+ ions + oxygen + electrons yields _____ .
- A total of _____ ATP molecules are generated by this step of cellular respiration.

Chapter 6: Cellular Respiration: Harvesting Chemical Energy, *continued*

ANAEROBIC CELLULAR RESPIRATION

The organism uses another pathway, called Anaerobic Cellular Respiration (also called Fermentation).

The Anaerobic Cellular Respiration (Fermentation) pathway is similar to the Aerobic Cellular Respiration, except for STEP 2, the Krebs Cycle.

- **Anaerobic =** *without oxygen*
- **Instead of going through the Krebs Cycle, the pathway goes through one of two routes:**

1. **Lactic Acid Fermentation**: The metabolic pathway that provides ATP during fermentation is glycolysis. A waste product called _____ is produced as a result of this type of fermentation. Your muscles use this process and build up this painful substance when you do not breathe in enough oxygen during exercise. The cells utilize glycolysis which makes ___ ATP compared to the _____ made during aerobic respiration. Painful _____ builds up on muscles causing the "burn." That lactic acid is eventually disposed of by the liver.

   Industrial Uses: dairy industry to make cheese, yogurt, soy sauce, pickles, and sauerkraut

2. **Alcohol Fermentation**: yeasts are capable of this type of fermentation in which _____ is produced as a waste product instead of lactic acid. They convert sugar into _____ (#) ATP and make this gas, _____ (CO_2) as a product.

   Industrial Uses: wine, beer, makes bread rise

Review of Cellular Respiration

Answer the following questions by determining if the description fits:

A. Glycolysis
B. Krebs Cycle
C. Electron transport chain and chemiosmosis

_____1. Glucose is split into two molecules of pyruvic acid.
_____2. 34-36 ATP are made in this step.
_____3. Carbon dioxide and acetyl CoA are made in this step.
_____4. Water is made as the hydrogens re-enter the mitochondria and join with oxygen and electrons.
_____5. This step occurs in the cytoplasm outside the mitochondria.
_____6. This step occurs inside the mitochondria.
_____7. Glucose is decomposed without oxygen into pyruvic acids.
_____8. Anaerobic respiration affects this step of cellular respiration.
_____9. This step may pass through the fermentation route in which lactic acid is produced.
_____10. In what step is carbon dioxide produced?
_____11. In what step is water made?

Answers: 1A, 2C, 3B, 4C, 5A, 6B, 7A, 8B, 9B, 10B, 11C

Chapter 6: Cellular Respiration: Harvesting Chemical Energy, *continued*

Review of Cellular Respiration, *Continued*

1. What is the 6-carbon sugar molecule that is the fuel for respiration? _____

2. What are the reactants that enter the Krebs Cycle during aerobic respiration? _____
And what are the products that leave the Krebs Cycle? _____

3. How many ATP are created by the entire aerobic cellular respiration process? _____

4. During which step is carbon dioxide made during aerobic respiration and from what reactants? _____
_____

5. During which step is water made during aerobic respiration and how is it made? _____
_____

6. Where in the cell does each of these three steps occur during aerobic respiration?
   glycolysis: _____
   Krebs Cycle: _____
   electron transport: _____

7. Describe how ATP is made if anaerobic respiration is used: _____
_____

8. Write the full equation for aerobic cellular respiration, below.

9. What are the reactants of aerobic cellular respiration? _____
_____

11. What are the products of aerobic cellular respiration? _____
_____

12. What are the products of lactic acid fermentation? _____

13. What are the products of alcohol fermentation? _____

14. How many ATP are made in each step, below:
   glycolysis: _____
   Krebs Cycle: _____
   electron transport: _____

Think about these questions; if you have trouble answering any of them, come see me!

Chapter 8: The Cellular Basis of Reproduction and Inheritance

SEXUAL AND ASEXUAL REPRODUCTION

Sexual reproduction occurs with egg and sperm (gametes). These egg and sperm are genetically different and therefore, produce an offspring who has different genes from the parents.

Asexual reproduction = *a* means *without. Asexual reproduction* requires no partner and results with the parent and offspring having the *exact* _____ genetic material. Budding of yeast, binary fission of bacteria, runners in strawberries, making rootings from cuttings of plants are all examples of asexual reproduction.

Two Types of Asexual Reproduction:

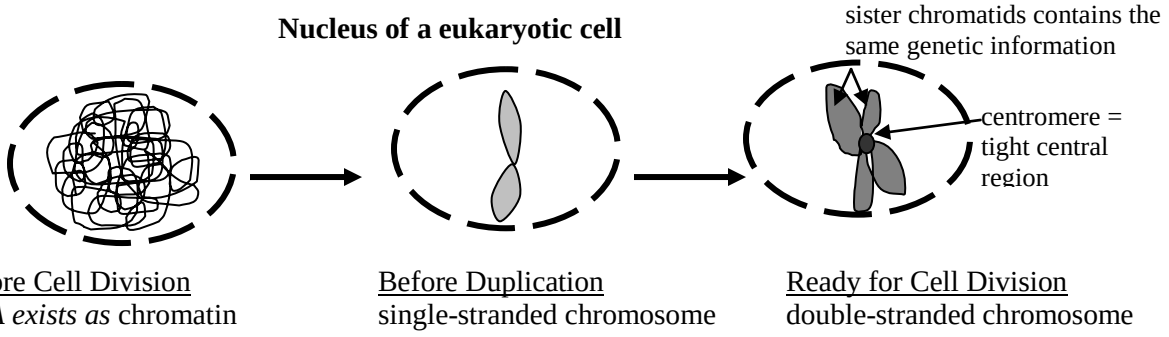
Binary fission*:* Literally, *binary* means "_____" and *fission* means "_____." Binary fission is a way for **prokaryotes** such as **bacteria** to simply split themselves in half producing two cells identical to the parent cell. Some bacteria can divide as quickly as every twenty minutes. They can do this because they lack a _____. Binary fission is a type of asexual reproduction.

Mitosis*:* Mitosis is a way for **eukaryotes** such as **plants, animals, fungi**, and **protists** to divide their cells into two. These eukaryotes face a few problems that the prokaryotes do not. The eukaryotes have:

1. membrane-bound organelles that must be shared between the two new cells
2. cytoplasm that must be shared between the two new cells
3. nuclear envelopes that must be broken down prior to cell division

Eukaryotic Chromosomes

Chromosome (*chromo = color; some = body*). Chromosomes are made of DNA and are called such because of their ability to absorb stains/dyes.



Chromosomes Numbers (Ploidy Numbers)

Cells have DNA in their nuclei. DNA exists as chromosomes during part of the cell's life cycle.

DIPLOID: **2** sets of chromosomes. We have 46 total chromosomes (23 pairs). Most of the cells of our bodies (somatic cells) exist in this diploid state.

HAPLOID: **1** set of chromosomes. Sex cells (gametes such as egg and sperm) have only 23 chromosomes (*half* the diploid number).

Sex chromosomes constitute 2 of the chromosomes in your body's 46 total chromosomes.

XX if you are female **XY** if you are male

Your mother always contributes the X chromosome; your father contributes either an X or a Y.

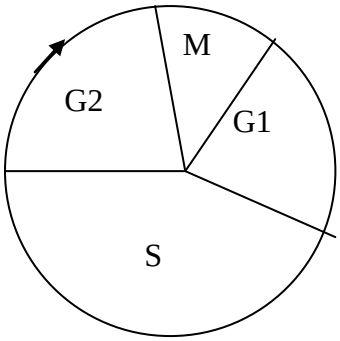
Chapter 8: The Cellular Basis of Reproduction and Inheritance, *continued*

THE CELL CYCLE

The Cell Cycle is a process under which eukaryotic cells undergo. Phases include interphase, a period of division known as mitosis, followed by another period of interphase. The cell cycle is similar to your own life: growth during childhood is followed by reproduction after puberty has onset. Just like you do not spend your entire life reproducing, cells do not either. In fact, cells spend approximately 10% of the life cycle in mitosis.

The 2 major parts of the cell cycle are:

1) **Interphase**: Includes subphases G1, S, G2
2) **Mitosis**: Includes subphases PMAT



Two Phases of the Cell Cycle

I. Interphase: _____

_____

Gap 1 (G1): Gap of time prior to DNA Synthesis; extra _____ and _____ are made.

S Phase (DNA Synthesis): time during Interphase in which the DNA is replicated/copied/synthesized.

By having an extra copy of DNA, one set of DNA can be kept and the other set can be given away.

- Once the cell is ready to enter mitosis, it must duplicate (replicate) its DNA. This process is performed with ease if the DNA condenses into chromosomes.

Gap 2 (G2): time after DNA Synthesis, waiting period for Mitosis to begin.

II. Mitosis: the portion of the cell cycle when the cell reproduces itself (cell division)

What is mitosis? cell reproduction or cell division

Purpose: growth, repair, and maintenance of the body's cells

Where does this occur (in what types of cells)? somatic cells

How many cells result? 2

Are these cells identical? Yes, they have the same DNA; they just express themselves differently

Cytokinesis is a part of mitosis; it's the division of _____ and _____

What are the 4 phases of mitosis?

1) _____
2) _____
3) _____
4) _____

Chapter 8: The Cellular Basis of Reproduction and Inheritance, *continued*

MITOSIS

There are four phases in Mitosis: **(PMAT)**

Draw the major events of mitosis. List the major activities that occur during each phase.

Prophase

Metaphase

Anaphase

Telophase

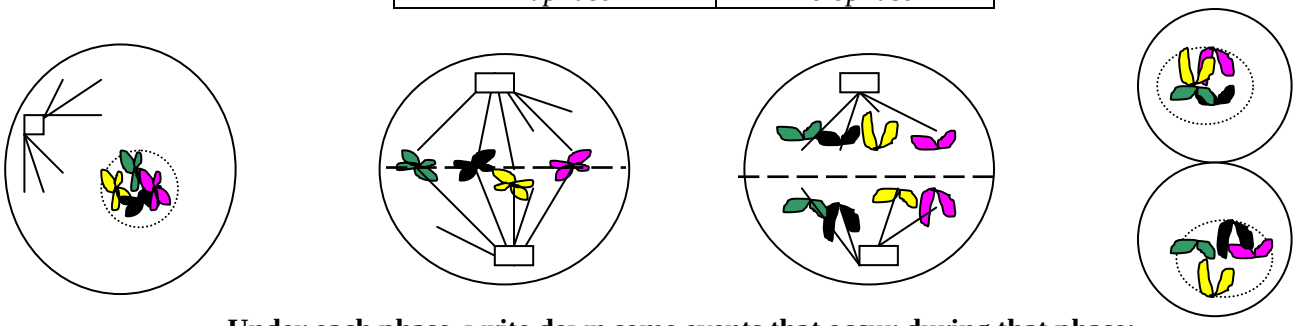
Chapter 8: The Cellular Basis of Reproduction and Inheritance, *continued*

Review of Mitosis and the Cell Cycle

Part I

Identify the following four phases of Mitosis:

Prophase	*Metaphase*
Anaphase	*Telophase*



Under each phase, write down some events that occur during that phase:

_____ _____ _____ _____

_____ _____ _____ _____

_____ _____ _____ _____

_____ _____ _____ _____

Part II

1. Is mitosis the same as the cell cycle? _____
2. Where does cytokinesis fit into this cell cycle? _____

_____

3. How many cells are produced by Mitosis?_____
4. Where does interphase fit into the cell cycle? _____
5. What phase does a cell enter after telophase? _____
6. Does a cell spend more of its life in interphase or in Mitosis?_____
7. What is the ploidy number of cells resulting from Mitosis? _____
8. In what types of cells would you find Mitosis occurring? _____
9. What is the purpose of the mitotic spindle fibers? _____
10. During which phase of Mitosis are the chromosomes separated and pulled toward opposite ends of the cells by the mitotic spindle fibers? _____
11. During which phase of Mitosis does the nuclear envelope disappear, the mitotic spindle fibers form, and the chromosomes appear as DNA? _____
12. Does Mitosis make sex cells like egg and sperm? _____
13. During cytokinesis, what constituents of the cell are divided into two? _____

_____

14. During which phase of Mitosis do the chromosomes line up on the metaphase plate? _____

Review of Mitosis and the Cell Cycle

Answers to Part I

From left to right:

Prophase	Metaphase	Anaphase	Telophase
◆ DNA appears as double stranded chromosomes; ◆ Nuclear envelope begins to break down; ◆ Mitotic spindle fibers form with the help of centrioles	◆ Chromosomes line up on the metaphase plate; ◆ Mitotic spindle fibers attach to the centromeres of the chromosomes to get ready to pull them apart	◆ Sister chromatids of each of the 46 chromosomes are separated and pulled in opposite directions by the mitotic spindle fibers	◆ Nuclear envelope reforms around the DNA of each cell; ◆ Mitotic spindle fibers disappear; ◆ Cells divide into two along the cleavage furrow; ◆ Division of organelles & cytoplasm is accomplished via cytokinesis

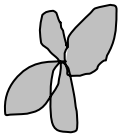
Answers to Part II

1. No, mitosis is part of the cell cycle
2. It's part of telophase
3. 2
4. before and after mitosis
5. interphase
6. interphase
7. 2N (46 chromosomes)
8. somatic cells (not sex cells)
9. to attach to the chromosomes to help them separate
10. anaphase
11. prophase
12. no—that's meiosis
13. cytoplasm and organelles
14. metaphase

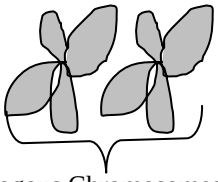
Chapter 8: The Cellular Basis of Reproduction and Inheritance, *continued*

HOW DO MEIOSIS AND MITOSIS DIFFER?

1. First, somatic cells have 46 chromosomes (23 pairs). When replicated and ready to enter the division process, they look like this one:

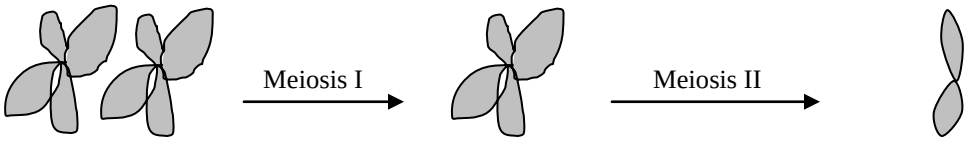


2. However, during meiosis, all 46 do not line up single-file on the metaphase plate to be separated. Instead, they find their "pair" and go together through the division process. We call the pair "homologous chromosomes." Why do the chromosomes do this? To reduce the chromosome numbers immediately from 46 to 23…think about it & draw it out



Homologous Chromosomes

3. During meiosis, the cell must undergo 2 divisions (Meiosis I and II)…to reduce the chromosome numbers from diploid → haploid, then from double stranded to single-stranded chromosomes. Here's how:



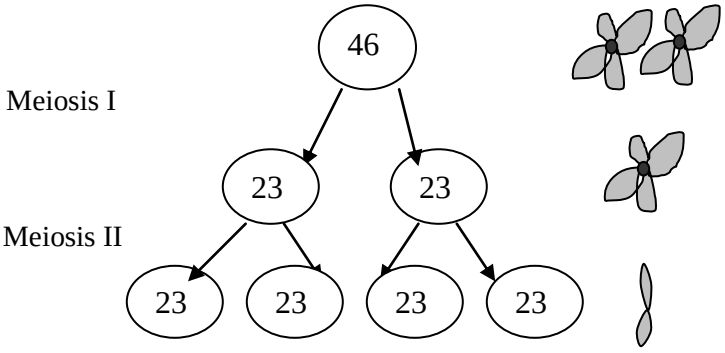
Diploid
2 sets of chromosomes

Haploid
1 chromosome (double stranded)

Haploid
1 chromosome (single stranded)

Meiosis: Cell Division to Make Sex Cells

- **What is meiosis?** Meiosis is called "reduction division" because one sex cell will undergo 2 divisions to reduce the chromosome number from 46 double-stranded chromosomes to 23 single-stranded chromosomes
- **Purpose?** To create 4 haploid sex cells
- **How many cells result?** 4 haploid sex cells: 4 sperm cells result in males; 1 viable egg cell results out of 4 possible cells in females (3 are discarded and called "polar bodies")
- **Are these cells identical?** No, due to a process called "crossing over" in which chromatids break off and become a part of another chromosome.
- **Why are there two divisions?** During meiosis I, the homologous chromosomes are separated into 2 separate cells—making the resulting cells have a haploid number of chromosomes. During meiosis II, the <u>double</u> stranded chromosomes are split into <u>single</u> stranded chromosomes.



The Process of Gamete Production

In males, sperm production begins with 1 cell. That cell undergoes two divisions to produce sperm. The result is four cells, each of which has only 1 set of single-stranded chromosomes.

Why is it necessary to have only 1 set of chromosomes (haploid) in sex cells?

Chapter 8: The Cellular Basis of Reproduction and Inheritance, *continued*

MEIOSIS DISORDERS

Assignment: *Use your textbook to complete the following*:

Some genetic disorders are inherited rather the result of a mutation. These disorders, below, result from problems arising during meiosis to form sex cells.

Down's Syndrome: is a genetic disorder caused by 3 copies of the chromosome # _____. It's also called **trisomy 21** for that reason. Does the extra 21st chromosome become part of the sex cell during mitosis or meiosis? _____

_____

Klinefelter Syndrome: males are affected by Klinefelter syndrome; males has 3 sex chromosomes: X ____ ____.

What has happened during meiosis to allow 3 sex chromosomes become part of a sperm?_____

_____

_____

Explain the symptoms that a male with Klinefelter Syndrome would exhibit:_____

_____

_____

Turner Syndrome: females are affected by Turner syndrome; female inherit only 1 sex chromosome: _____.

Explain what happens during meiosis so that females inherit only 1 sex chromosome:_____

_____

_____

Explain the symptoms that a person with Turner Syndrome would exhibit:_____

_____

_____

_____

Chapter 9: Patterns of Inheritance

MENDEL'S EXPERIMENTS WITH PEA PLANTS

Through the selective growing of common pea plants (*Pisum sativum*) over many generations, Mendel discovered that certain traits show up in offspring plants without any blending of parent characteristics. For instance, the pea flowers are either purple or white--intermediate colors do not appear in the offspring of cross-pollinated plants. Mendel observed seven traits that are easily recognized and have one of two forms:

1. flower color is purple or white
2. flower position is axil or terminal
3. stem length is long or short
4. seed shape is round or wrinkled
5. seed color is yellow or green
6. pod shape is inflated or constricted
7. pod color is yellow or green

What if you crossed a pure-breeding purple flower and a pure-breeding white flower?

mated with

1. How do you know what the outcome of a cross between a purple pure breeding and a white pure breeding flower will be?

2. If we are dealing with the gene for *flower color*, what are the 2 alleles?

3. For the gene *flower color*, which color is considered dominant in pea plants?

Which color is considered recessive?

4. In order to have a phenotype of a white flower, we must have the genotype of _____.

5. You have 2 alleles for a particular gene. Where does each allele come from?

6. What if you get a dominant allele from one parent and a recessive allele from the other parent . . . what is your genotype?

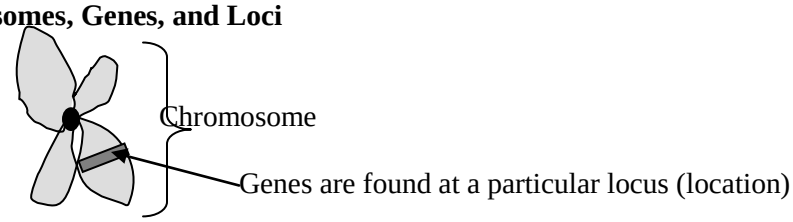
7. What if you receive a dominant allele from both parents . . . now what is your genotype?

8. What if you receive a recessive allele from both parents . . . what is your genotype?

Chapter 9: Patterns of Inheritance, *continued*

HEREDITY AND GENETICS

- **Heredity:** physical, biochemical and behavioral traits are passed from generation to generation. Pioneered by Gregor Mendel. He devised two principles or laws:
- **Chromosomes, Genes, and Loci**



- **Genes:** discrete regions on chromosomes are responsible for transmitting traits from parent to child. For each trait, you have a gene. And, each gene has two possible forms, called alleles.
- **Alleles:** two different forms or alternate forms of genes. Each sperm or egg carries only one allele for each inherited trait. So, you inherit one form from your father and one form from your mother.
    - If the two alleles of a gene are the same, then the individual is **HOMOZYGOUS** for that trait. The letters chosen to represent the gene are simply arbitrary. Choose any letters of the alphabet that you like to represent the alleles.
        - AA is called **HOMOZYGOUS DOMINANT**
        - aa is called **HOMOZYGOUS RECESSIVE**
    - If the two alleles of a gene are different, then the individual is **HETEROZYGOUS** for that trait.
        - Aa is called **HETEROZYGOUS**
- **Dominant** or **recessive**: the dominant form of the gene is expressed any time that it is present. The dominant form masks the recessive form. The only time you see a recessive trait is when both alleles are recessive. There are many recessive traits that are considered "normal": 5 fingers, for example.
    - **PHENOTYPE:** an organism's expressed or physical traits.
    - **GENOTYPE:** an organism's genetic makeup.

MENDEL'S LAWS (PRINCIPLES)

- **Law of Segregation**: Pairs of alleles segregate (separate) during gamete formation; the fusion of gametes at fertilization creates allele pairs again.
- **Law of Independent Assortment**: Each pair of alleles segregates independently of the other pairs during gamete formation.

Punnett Squares are used to perform test crosses between two parents with known alleles. The parental generation is known is the **P1** generation. The possible offspring produced in the Punnett Square are called the **F1** generation. If we test-cross one set of traits, we call this a **monohybrid** cross while a **dihybrid** cross occurs when we test two traits.

Chapter 9: Patterns of Inheritance, *continued*

BASICS OF GENETICS: PHENOTYPES AND GENOTYPES

Determine the phenotype or genotype from the information given.

Scenario #1: *Dark hair is carried on the dominant allele; light hair is carried on the recessive allele. Determine the phenotype for each of the following genotypes.*

1. Genotype of Dd; Phenotype is: _____
2. Genotype of dd; Phenotype is: _____
3. Genotype of dD; Phenotype is: _____
4. Genotype of DD; Phenotype is: _____

Scenario #2: *Sickle cell anemia is carried on the recessive allele; determine if the following people have sickle cell, are normal, or are carriers for sickle cell.*

1. Genotype of Ss; Phenotype is: _____
2. Genotype of SS; Phenotype is: _____
3. Genotype of ss; Phenotype is: _____

Scenario #3: *Six fingers is carried on the dominant allele. Determine if the following people have five or six fingers.*

1. Genotype is heterozygous; Phenotype is: _____
2. Genotype of homozygous recessive; Phenotype is: _____
3. Genotype of homozygous dominant; Phenotype is: _____

Scenario #4: *The ability to taste a chemical called PTC is carried on the dominant allele. If you can't taste PTC, you don't have the allele for this trait. Determine the genotypes for the following people.*

1. Joey is a taster; genotype could be: _____ or _____
2. Sarah cannot taste, her genotype is: _____
3. Mark doesn't know, but both of his parents are tasters; his genotype is probably _____
4. Gina is not a taster, but both of her parents are; her genotype is _____

Scenario #5: *Albinism is carried on the recessive allele; people with this condition have no pigment in their skin, hair, or eyes. Determine the following genotypes.*

1. Nicole is an albino; her genotype is _____
2. Julie isn't an albino, but her mom is (her dad is not); her genotype is probably _____
3. Sam isn't an albino; neither of her parents is either; his genotype is _____

Chapter 9: Patterns of Inheritance, *continued*

THREE TYPES OF GENETICS PROBLEMS

1. **Monohybrid Autosomal Punnett Squares**: These are Punnett Squares tracks one trait (*eye color*) that is carried on an autosome. Autosomes are:

_____

_____

Examples

- hair color
- eye color
- eyelash length
- tongue rolling
- ability to taste PTC

2. **Sex Linked Disorders**: These disorders or conditions are carried on the sex chromosomes—specifically on the X chromosome.

- The sex chromosomes for females are XX while the male's are XY. Say we're dealing with hemophilia, a recessive disorder. We must use XX and XY when performing these Punnett Squares.
  - Normal female: X^HX^H
  - Carrier female: X^HX^h
  - Hemophiliac female: X^hX^h
  - Normal male: X^HY
  - Hemophiliac male: X^hY

a. How does a daughter inherit the sex linked disorder? _____

_____

b. How does a daughter become a carrier of a sex-linked disorder? _____

_____

c. How does a son inherit the sex linked disorder? _____

_____

Examples

- color blindness
- male pattern baldness
- hemophilia

3. **ABO Blood Groups**: There are 3 alleles for blood type: A, B, and O. A and B "dominate."

Your blood type is:	Then your genotype is:
A	AA or AO
B	BB or BO
AB	AB
O	OO

Figure out the phenotype or genotype for the following:

Phenotype	**Genotype**
A	_____, _____
_____	AO
_____	BB
AB	_____
O	_____

Chapter 9: Patterns of Inheritance, *continued*

HUMAN GENETICS

This page is included for reference; you don't have to memorize it!

Chin	Chin cleft is produced by a dominant allele. D (dimpling); d (no dimpling)
Hairline	Continuous hairline (w) is recessive to a dominant allele (W) that results in the hairline forming a distinct point or widow's peak.
Earlobe	Unattached or free earlobes (E) are dominant to earlobes attached directly to the head (e).
Skin Pigmentation	Freckles (F) are dominant to no freckles (f).
Tongue	The ability to roll one's tongue (R) is dominant to the non-rolling (r) condition. Tongue rolling involves folding the tongue down its length so that the left side and right side meet above the middle forming a hollow tube.
Eyelashes	Short eyelashes (s) are recessive to long eyelashes (S).
Taste Perception	Ability to taste a chemical, PTC, is dominant (T) while non-tasters have the recessive (t).
Mid-digit Hair	Hair on the middle joint of one or more fingers is due to a dominant allele (M).
Thumb Hyperextension	"Hitch-hiker's thumb" is the ability to bend one's thumb back to almost a 90-degree angle and is controlled by a recessive allele (h). The lack of this ability is dominant (H).
Bent Little Finger	A dominant allele (B) causes the last joint of the little finger to bend toward the ring finger. A straight finger (b) is recessive.
Interlocking Fingers	When the fingers of the hand are interlocked, some individuals place the left thumb on top of the right (dominant; L), while others place the right over the left (recessive; l).
Relative Finger Length	Sex-influenced (not sex-linked) traits determine the relative lengths of the index and ring fingers. In males, the alleles for a short index finger (S) is dominant. In females, it is recessive. If one or both fingers are greater than or equal to the length of the ring finger, the recessive genotype is present in males, and the dominant is present in females.
Vision	Nearsightedness or myopia (n) is recessive to normal vision (N).
Eye Size	Large eyes (G) are dominant to small eyes (g).
Irises	Homozygous recessive people (i) lack pigment in the front of the eyes and have blue eyes as their phenotype. Eyes appear blue because of a blue layer at the back of the iris that shows through when there is no overlying pigment. The dominant allele (I) causes pigment to be deposited in the front layer of the iris, thus masking the blue to varying degrees: brown, hazel, green, violet, black.

Chapter 9: Patterns of Inheritance, *continued*

HOW TO COMPLETE A PUNNETT SQUARE AND PREDICT OUTCOMES

For starters, here are some things you should know:

- Punnett Squares can be used to predict the possibility of an offspring's genotype or phenotype.
- Read the problem one sentence at a time. Write down any information that you can determine from the problem.
- When working with genotypes, pick a letter of the alphabet to represent the trait. Choose letters that you won't get the capital and lowercased letters confused (P/p, S/s, and W/w are easily confused while E/e or G/g are not. Sometimes people have messed up their answers cause they simply can't read their own handwriting!) Stick with that letter you have chosen for the duration of your Punnett Square. The capital letter represents the dominant allele (R) while the lowercased letter represents the recessive allele (r).
- Draw a box like the ones you see below—these are your Punnett Squares.
- Write the male's genotype (his two alleles) across the top of the Punnett Square. Write the female's genotype (her two alleles) across the left side of the Punnett Square.
- When you're writing the possible outcomes in the Punnett Square box, look UP and to the LEFT. I typically write the dominant letter first if it's present in the genotype (that way I keep straight the fact that the dominant allele will dominate and its phenotype will appear).

EXAMPLES OF HOW TO WORK AN AUTOSOMAL, MONOHYBRID PUNNETT SQUARE

SAMPLE PROBLEM 1: AUTOSOMAL PUNNETT SQUARE

In humans, normal pigmentation is due to a dominant gene (A) and albinism (no pigment development) is due to a recessive gene (a). A homozygous, normally, pigmented man marries an albino woman. What is the probability that they will produce normally pigmented children?

① *Determine the following before you fill in the Punnett Square.*

- Phenotype of woman: albino Genotype of woman: aa
- Phenotype of man: normal pigmentation (not albino) Genotype of man: AA

② *Place the male's genotype across the top of the square; place the woman's along the left. Put only 1 letter above or to the left of each box. Then, to fill in the boxes, look UP and to the LEFT. Write those two letters in the box.*

	A	A
a	Aa	Aa
a	Aa	Aa

③ *Answer the question. Look back at the problem: <u>What is the probability that they will produce normally pigmented children?</u> Well, you have 4 possible offspring (remember the four possible cells produced from meiosis?). So, in each square we had Aa = heterozygous = normal pigmentation. To answer the question, there's a 4 out of a 4 chance, or 100% chance of having a child with normal pigmentation.*

Chapter 9: Patterns of Inheritance, *continued*

EXAMPLES OF HOW TO WORK AN AUTOSOMAL, MONOHYBRID PUNNETT SQUARE

SAMPLE PROBLEM 2: AUTOSOMAL PUNNETT SQUARE

In summer squash, white fruit color (W) is dominant over yellow (w), which is recessive. If a heterozygous (Ww) white-fruited plant is crossed with a yellow-fruited plant (ww), what will be the expected phenotypic and genotypic ratios in the F1 generation?

① *Determine the following before you fill in the Punnett Square.*

- Genotype of white-fruited plant: Ww
- Genotype of yellow-fruited plant: ww

② *Complete the Punnett Square.*

	W	w
w	Ww	ww
w	Ww	ww

③ *Answer the question. It reads: … what will be the expected phenotypic and genotypic ratios in the F1 generation? Look at your 4 possible phenotypes: 2 are yellow while 2 are white. Your phenotypic ratio is a 50% chance yellow/white or a 1:1 ratio. Look at your 4 possible genotypes: 2 are heterozygous (Ww) while 2 are homozygous (ww). Again the ratio is 1:1.*

SAMPLE PROBLEM 3: AUTOSOMAL PUNNETT SQUARE

In human genetics, the ability to roll one's tongue is inherited. If you can roll your tongue, you have at least one dominant allele (R). If you cannot roll your tongue, you must have two recessive alleles (also known as homozygous recessive, rr). Predict the probability of a tongue-rollin' child if two heterozygous parents are having a baby.

① *Write down what you know:*

- Male's genotype: Rr
- Female's genotype: Rr

② *Complete the Punnett Square.*

	R	r
R	RR	Rr
r	Rr	rr

③ *Interpret your results. Go back to the question, it reads: Predict the probability of a tongue-rollin' child if two heterozygous parents are having a baby. You have a genotype of RR, Rr, and rr. Those with the RR and Rr genotypes can roll their tongues because the presence of the R (dominant allele) ensures that the child can roll its tongue. The one with rr cannot roll its tongue—it's homozygous recessive. So, there's a 3 out of 4 chance, or 75% chance that they will have a baby who can roll its tongue.*

Chapter 9: Patterns of Inheritance, *continued*

AUTOSOMAL, MONOHYBRID PUNNETT SQUARES

1. John and Mary are a normal couple. John's mother is an albino (a recessive trait), and Mary's father was also an albino. What it the probability of this couple having an albino child?

2. In human beings, brown eyes are usually dominant over blue eyes. Suppose a blue-eyed man marries a heterozygous brown-eyed woman (her father has blue eyes.) What percentage of their children would you expect to have blue eyes?

3. Cystic Fibrosis is an autosomal recessive condition in humans. Susan and Tom are both normal, but they have a son with cystic fibrosis. They want to know the probability that their next child will also have this disorder. Can you tell them?

4. What is the probability that two people who are both heterozygous for phenylketonuria (PKU) will have a child with PKU? PKU is recessive in humans.

5. About 70% of Americans taste the bitter compound phenylthiocarbimide (PTC). The ability to taste this compound results from a dominant allele. Mr. Jones is a non-taster, and Ms. Jones is a taster but her father was a non-taster, so she is heterozygous. What are the possible genotypes and phenotypes of the Jones children?

ABO BLOOD GROUPS

1. Mom has a blood phenotype of AB and dad has a blood phenotype of A. What are their genotypes? Now, complete a Punnett Square and predict the phenotypes of their offspring.

2. Mom has a blood phenotype of B (her dad had blood type B also) and dad has a blood phenotype of O. What are their genotypes? Now, complete a Punnett Square. Predict the phenotype of their offspring. What is the chance they have a child with blood type B?

3. Mom has a blood phenotype of AB and dad has a blood phenotype of O. Complete a Punnett Square. Predict the phenotypes of their offspring.

4. Mom has a blood genotype of AA and dad has a blood genotype of AB. Complete a Punnett Square. Predict the phenotypes of their offspring. What is the chance they have a child with blood type O?

5. What are the possible phenotypes of the children of Steve Heme who has type A blood and his wife Stella who has type B blood? Steve's dad has type 0 blood, and Stella's mother had type AB blood.

6. A woman with type A blood, whose father had type 0, marries a man with type B blood, whose father was also type O. What would be the possible blood types of the children?

SEX-LINKAGE

1. Mom is color blind. Dad is normal for this sex-linked, recessive disorder. He is not color blind. What are their genotypes? Complete a Punnett Square and predict the phenotypes of their offspring.

2. A non-hemophiliac man marries a normal female whose father was a hemophiliac. List the phenotypes of their children. Hemophilia is a recessive, sex-linked condition in humans.

3. Both Mr. and Ms. Jones have normal vision. Is it possible that they have a red/green color blind daughter? Explain your answer. Red/green color blindness is a sex-linked, recessive trait in humans.

4. Hemophilia in humans in a recessive, sex-linked condition. What would be the phenotypes of the possible offspring if a hemophiliac man marries a woman who is heterozygous for hemophilia?

5. Mr. Bleeder is a hemophiliac and his wife is normal with respect to hemophilia. One of their sons is a non-hemophiliac and a daughter is a hemophiliac. What is the genotype of Mrs. Bleeder? Hemophilia is a sex-linked recessive in humans.

6. Mom is a carrier for male-pattern baldness. Dad is normal for male-pattern baldness. Male-pattern baldness is a sex-linked recessive disorder. What is the probability mom and dad will have a child with male-pattern baldness?

Chapter 9: Patterns of Inheritance, *continued*

GRAB BAG OF PUNNETT SQUARES, SET #1

Assignment: *Complete these Autosomal, Blood Types, or Sex Linked Monohybrid Punnett Squares at home. If you can't work them without looking at the answers below, then ask your instructor for help!*

1. Hemophilia is a sex-linked trait carried on the recessive allele. Mark has hemophilia, but Karen does not. She is homozygous dominant. What's the probability that they have a child with hemophilia?

2. The widow's peak is a trait carried on the dominant allele. A person with a widow's peak has a bit of hair that "peaks" along the forehead hairline. The recessive form of this trait is a continuous hairline. Bill is homozygous for the widow's peak while Marie has a continuous hairline. What's the probability that they have a child who is homozygous dominant?

3. Mendel found that yellow pod color is dominant over green pod color in pea plants. What's the probability of a yellow pea plant if two green pea plants are mated?

4. Mendel found that tallness is dominant in height of pea plants. If two heterozygous tall pea plants are mated, what's the probability of a short offspring?

5. In fruit flies, gray body color is dominant to ebony body color. Determine the probability of an ebony colored fruit fly if a heterozygous gray fruit fly is mated with an ebony fruit fly.

6. PKU (phenylketonuria) is a problem metabolizing a certain amino acid. PKU is carried on chromosomes number 12 and it's a recessive disorder. Two heterozygous parents are concerned their child will have this disorder. What is the chance they will have a child with PKU?

7. Sally has blood type of AB; Mario has blood type of O. Is it possible for them to have a son with a blood type of O?

8. James is bald; his wife Kim is heterozygous for male-pattern baldness. Male pattern-baldness is a recessive sex-linked disorder. What's the chance that they have a son who will become bald?

Answers

1. Mark = X^hY, Karen = X^HX^H; The probability that they have a child with hemophilia is 0% since the four boxes of the Punnett Square comes out to be Hh.
2. Bill = WW, Marie = ww; There is a 100% chance that they will have a child with a widow's peak since the results of the Punnett Square is Ww for all 4 boxes.
3. Green pea plant = pp; There is a 0% chance that the offspring can be a yellow pea plant. The genotype of a yellow pea plant must contain a dominant allele, such as Pp or PP.
4. Pea Plants are both = Tt; If these two heterozygous pea plants are mated, there is a 25% chance that a short pea plant can arise. The boxes of the Punnett Square would contain TT, Tt, Tt, and tt.
5. Gray fly = Ee, Ebony fly = ee; The boxes of the Punnett Square would be Ee, Ee, ee, ee. So, there would be a 50% chance that an ebony colored fruit fly would result from this crossing.
6. Both parents are = Aa; The boxes of the Punnett Square result in AA, Aa, Aa, aa. So, there is a 25% chance that they can have a child with PKU.
7. Sally = AB; Mario = OO; After doing the Punnett Square, you should be able to see that the only offspring are AO and BO. No, it's not possible to have a son with O blood.
8. James = X^bY, Karen = X^BX^b; 50% chance of having a <u>son</u> with male-pattern baldness.

Chapter 9: Patterns of Inheritance, *continued*

AUTOSOMAL, MONOHYBRID PUNNETT SQUARES, SET #2

Assignment: *Complete these Autosomal, Monohybrid Punnett Squares at home. If you can't work them, please see your instructor for help (no answers provided for this page).*

1. An extra finger in humans is rare but is due to a dominant allele. When one parent is normal and the other parent has an extra finger (but is heterozygous for the trait), what is the probability that their first child will be normal in regard to this trait? Their second child? The third child?

2. Mr. and Mrs. Blue have four sons. What is the probability that their next child will be a girl?

3. Mr. and Mrs. Iris have brown eyes. Their four children have blue eyes. What are the genotypes of Mr. and Mrs. Iris? Brown eyes are dominant and autosomal.

4. Mr. and Mrs. Hair have a widow's peak and both of their fathers did not have a widow's peak. What are the genotypes and phenotypes of all possible children Mr. and Mrs. Hair might have? A widow's peak dominates over no widow's peak and is autosomal.

5. A man who has sickle cell anemia marries a woman who does not have sickle cell anemia, but her father had this type of anemia. Give phenotypes of children relative to sickle cell anemia. Sickle cell anemia is a recessive, autosomal trait.

6. Joe and Floe both have normal skin yet both of their parents have thickened epidermis. What are the genotypes of both parents? Thickened skin is a dominant, autosomal trait.

7. Mr. and Mrs. Phalanges have webbed toes. Their first child has webbed toes, but their second and third children have normal (unwebbed toes). What are genotypes of Mr. and Mrs. Phalanges? Webbed toes is a dominant, autosomal trait.

8. Mr. Lung has cystic fibrosis; his son does not have this condition. What are possible genotypes and phenotypes of Mrs. Lung? Cystic fibrosis is a recessive, autosomal trait.

9. Mr. and Mrs. Sad had a child who died at the age of 2 months with Tay Sachs. This couple asks you what is the probability that another child of theirs would have Tay Sachs? Tay Sachs is a recessive, autosomal trait.

Chapter 9: Patterns of Inheritance, *continued*

NON-MENDELIAN GENETICS

1. **Incomplete Dominance**: results when the F1 generation has an appearance that is:_____

Why does incomplete dominance exist? _____

_____

Example: a red snapdragon crossed with a white snapdragon will produce pink snapdragons. The red alleles and the white alleles are incompletely dominant—neither color dominates—so you get an in-between phenotype.

2. **Multiple Alleles**: Most genes have ___ alleles (or alternate forms) that control the trait. However, some genes have more than 2, as is the case with blood types. With human blood types, there are 3 alleles that control the blood type.

Example: the ABO blood types are the best example here. Most genes have 2 alleles. For blood type, there are 3 alleles: A, B, and O.

3. **Codominance**: A situation that arises when both the dominant and recessive allele assumes dominance and are displayed as the phenotype.

Example: a horse with red coat color is crossed with a horse with white color. Both the red and white alleles are dominant, so the offspring of these horses is a coat containing both red and white hairs.

4. **Pleitropy**: the impact of a single gene on more than one _____

Example: Sickle cell anemia is controlled by a gene that tells the red blood cells to make abnormally shaped hemoglobin. People who are homozygous recessive for this trait often have many varied symptoms.

5. **Polygenic Inheritance**: This is a situation when 1 phenotypic characteristic or trait is controlled by _____

_____

_____.

Example: hair, eye, and skin color come in a variety of shades. We have several genes controlling our skin color for example. And, that is how the gradation in colors is possible.

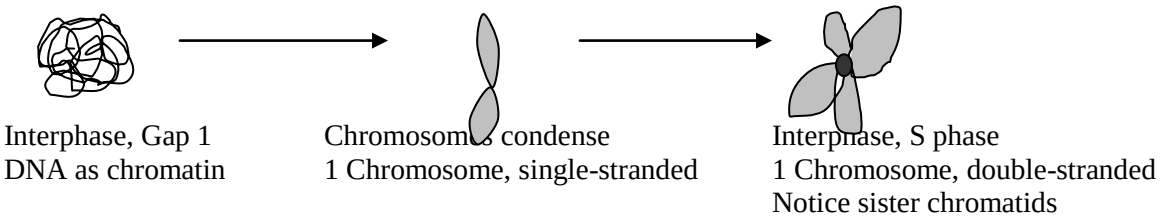
Chapter 10: Molecular Biology of the Gene

DISCOVERING DNA AND ITS STRUCTURE

- Griffith (1928) discovered some transforming factor caused a heritable change when he experimented on rats and bacteria. By the 1930's, scientists had discovered that this "transforming factor" was DNA, but many scientists remained skeptical.
- Hershey and Chase Experiment (1952) demonstrated that _____ not protein was responsible for the genetic material of a phage. A phage is a virus that infects a bacterium (often called a *bacteriophage*).
- Watson and Crick (1953) discovered the structure of DNA through the process of X-ray diffraction. Because of their experiements, we learned that DNA is…

Review of the Structure of DNA

- Composed of 2 strands twisted together (called a *double helix*).
- DNA appears in the nucleus as **chromatin** when the cell is in Interphase. It looks like threads. Notice the chromatin in the nucleus on the far left picture, *below*.
- Once the cell is ready to enter mitosis, it must duplicate or replicate its DNA during S phase of Interphase. This process is performed with ease if the DNA condenses into chromosomes. Notice the middle picture is of 1 *single-stranded* chromosome while the far right picture shows 1 *double-stranded* chromosome that has been replicated.



Interphase, Gap 1
DNA as chromatin

Chromosomes condense
1 Chromosome, single-stranded

Interphase, S phase
1 Chromosome, double-stranded
Notice sister chromatids

- DNA is made of building blocks called _____. Each nucleotide contains 3 items. Part of the nucleotide makes a backbone for the DNA. The sugar and phosphate groups make up this backbone. The nitrogenous bases, Adenine, Thymine, Cytosine, and Guanine, constitute the "rungs of the ladder."

What are the base pairing rules for DNA?

- Adenine pairs with _____; Thymine pairs with _____
- Cytosine pairs with _____; Guanine pairs with _____

Chapter 10: Molecular Biology of the Gene, *continued*

STEPS OF DNA REPLICATION

① Double-stranded DNA must unwind using an enzyme called DNA helicase.

② An enzyme must help the DNA strands to unzip from one another. The strands of DNA unwind at "bubbles" all along the length of the DNA.

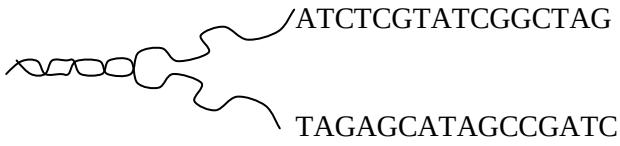
③ Enzymes bring complementary base pairs to the unwound, unzipped DNA to match the bases. Base pairing occurs on each strand, but run in opposite directions (for speed). The bases adenine and thymine pair while cytosine and guanine pair together.

④ The two new strands of DNA must wind together. Each new double strand of DNA contains a _____ strand and a _____ strand.

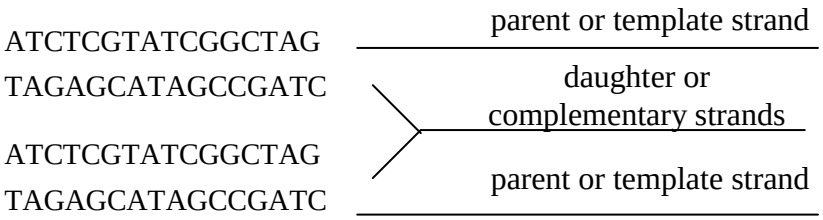
DNA Replication in Action

The following is a double strand of DNA.

In order to replicate that strand, an enzyme called DNA helicase must first unwind the two strands.



Next, an enzyme called DNA polymerase pairs the complementary bases to the template strands



Each parental (original) strand of DNA serves as a template to make a new complementary strand of DNA. The parental strand and its copied DNA then wind together.

Problem #1: Perform DNA Replication on the following strands. Indicate the parental & daughter strands.

C G T C G A T C G C A T T A

G C A G C T A G C G T A A T

Problem #2: Perform DNA Replication on the following strands. Indicate the parental & daughter strands.

T G G C A T T C A T G G A C C T

A C C G T A A G T A C C T G G A

Chapter 10: Molecular Biology of the Gene, *continued*

RNA AND PROTEIN SYNTHESIS

List three differences between DNA and RNA.

DNA	RNA

RNA and Protein Synthesis

What is RNA used for? Protein Synthesis. Goal is to transform DNA → RNA → Proteins

What is the purpose of Protein Synthesis? To make proteins such as hair, muscles, enzymes, hormones, nails.

Steps of Protein Synthesis

There are two main processes that occur: DNA → RNA → Proteins

1. Transcription
   a. Occurs in the _____.
   b. Rewrites _____ into _____.
2. Translation
   a. Occurs on ribosomes (either free in the cytoplasm or attached to rough ER).
   b. Rewrites _____ into _____.

The three types of RNA and their functions are:

a. **mRNA** is known as _____ RNA because it carries the code for the amino acid. The mRNA also carries the codon that is a group of three nucleotides in a specific order. Each codon codes for a specific _____ _____.

b. **tRNA** is known as _____ RNA because it transfers the appropriate amino acid to the growing polypeptide strand. Each tRNA is complementary to the codon; therefore, the tRNA carries the _____. For example, if the mRNA codon is AUG, the tRNA anticodon is UAC. It uses this information to retrieve amino acids.

c. **rRNA** is known as _____ RNA because it is composed of 2 _____ subunits. Recall that ribosomes are responsible for protein production.

How does translation begin and end?

- **Start codon** is AUG which also codes for the amino acid called methionine
- **Stop codons** are UAA, UAG, and UGA.
- It's helpful to know these codons so that you can recognize them in a strand of RNA.

Protein Synthesis Demonstration

Perform protein synthesis on the following strand of DNA.
Use the codon chart on the next page to understand where the amino acids come from for this process.

strand of DNA	T A C C G C A C A G C T T G C A T T
strand of mRNA	A U G / G C G / U G U / C G A / A C G / U A A
amino acids	start-/-alanine-/-cysteine-/-arginine-/-threonine-/-stop

Chapter 10: Molecular Biology of the Gene, *continued*

PROTEIN SYNTHESIS PRACTICE PROBLEMS

1. Transcribe the following strand of DNA, then translate it using the codon chart.

T A C G G C A G G C G A A T C

2. Transcribe the following strand of DNA, then translate it using the codon chart.

T A C C A C G C G A C C T A G A T T

3. Transcribe the following strand of DNA, then translate it using the codon chart.

T A C G T C T A A G C T A C T

4. Transcribe the following strand of DNA, then translate it using the codon chart.

T A C G G G C T A A C G T C A A T T

Chapter 10: Molecular Biology of the Gene, *continued*

CODON CHART

This chart is included for the Protein Synthesis Demo. Do NOT memorize this chart.

UUU	Phenylalanine	UCU	Serine	UAU	Tyrosine	UGU	Cysteine
UUC	Phenylalanine	UCC	Serine	UAC	Tyrosine	UGC	Cysteine
UUA	Leucine	UCA	Serine	UAA	STOP	UGA	STOP
UUG	Leucine	UCG	Serine	UAG	STOP	UGG	Tryptophan
CUU	Leucine	CCU	Proline	CAU	Histidine	CGU	Arginine
CUC	Leucine	CCC	Proline	CAC	Histidine	CGC	Arginine
CUA	Leucine	CCA	Proline	CAA	Glutamine	CGA	Arginine
CUG	Leucine	CCG	Proline	CAG	Glutamine	CGG	Arginine
AUU	Isoleucine	ACU	Threonine	AAU	Asparagine	AGU	Serine
AUC	Isoleucine	ACC	Threonine	AAC	Asparagine	AGC	Serine
AUA	Isoleucine	ACA	Threonine	AAA	Lysine	AGA	Arginine
AUG	Start (Methionine)	ACG	Threonine	AAG	Lysine	AGG	Arginine
GUU	Valine	GCU	Alanine	GAU	Aspartic Acid	GGU	Glycine
GUC	Valine	GCC	Alanine	GAC	Aspartic Acid	GGC	Glycine
GUA	Valine	GCA	Alanine	GAA	Glutamic Acid	GGA	Glycine
GUG	Valine	GCG	Alanine	GAG	Glutamic Acid	GGG	Glycine

Review of RNA and Protein Synthesis

Protein Synthesis

Match:

_____1. DNA is rewritten into 3 types of RNA
_____2. this process occurs in the cytoplasm with ribosomes
_____3. RNA is rewritten into amino acids
_____4. the anticodons of tRNA reads the mRNA codons
_____5. this process occurs in the nucleus
_____6. only one strand of DNA is used
_____7. Uracil replaces Thymine
_____8. the rRNA acts as a substrate for this process to take place

A. Transcription
B. Translation

RNA Types

Match:

_____1. carries the codon for the amino acid
_____2. called messenger RNA
_____3. carries the anticodon which is complementary to the codon
_____4. forms a substrate of two ribosome subunits
_____5. called transfer RNA
_____6. called ribosomal RNA
_____7. brings the amino acid from the cytoplasm to join the growing peptide strand

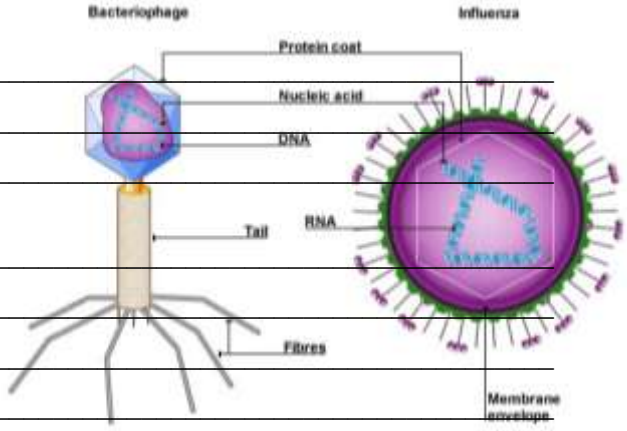
A. mRNA
B. rRNA
C. tRNA

Answers
Protein Synthesis: 1A, 2B, 3B, 4B, 5A, 6A, 7A, 8B
RNA Types: 1A, 2A, 3C, 4B, 5C, 6B, 7C

Chapter 10: Molecular Biology of the Gene, *continued*

VIRUSES

1. **Viruses contain**:
   a. _____
   b. _____
   c. _____
2. **Viruses lack:**
   a. _____
   b. _____
   c. _____
   d. _____



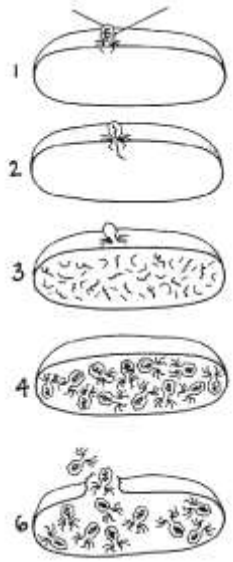
Characteristics of Viruses

Scientists consider viruses to be *nonliving* outside a living cell. They lack enough of the characteristics needed for life. The only way viruses become "alive" is to seize a host cell and use its DNA to reproduce.

1. Viruses are "**obligate intracellular parasites**" meaning they must use a cell in order to reproduce. They cannot reproduce without the living cell as a host.
2. Thus, they are parasitic on living organisms to propagate (reproduce).
3. Viruses don't attack all of the cells of your body. For instance, the virus that causes polio only attacks nerve cells.

Reproduction of an Animal Virus

1. Viral envelope fuses with the plasma membrane.
2. Viral RNA or DNA that is protein-coated is released into the cell. Enzymes remove the protein coat.
3. The virus takes over genetic control of the cell and makes copies of the RNA or DNA strand. These copies perform 2 functions:
   a. Serve as the mRNA for making new viral proteins
   b. Serve as templates for making new viral RNA or DNA.
4. The cell produces and assembles proteins for the virus
5. These proteins then assemble a new virus
6. The new viruses escape the host cell by breaking through the cell membrane.



Viral Diseases

1. **Vaccinations**: comes from the Latin word, *vacca*, for cow. The first vaccination was for cowpox/smallpox in the 1800's. People were inoculated with sores from cows. Vaccinations introduce viruses (in a changed form) so we can form antibodies.
2. **Viral diseases:** smallpox, influenza, common cold, chicken pox, polio, AIDS

Chapter 10: Molecular Biology of the Gene, *continued*

Review of Viruses

1. What is a virus composed of? _____
2. What will you *not* find in a virus? _____

_____

3. Is a virus living or nonliving? _____
4. Where do viruses reproduce? _____
5. Do viruses have organelles? _____
6. Can viruses attack any kinds of cells? _____
7. Why is it useless to treat the common cold with antibiotics? _____

_____

_____

8. If we came up with a drug that prevented the protein coat from being removed from the virus, would the virus still be able to reproduce? Why or why not?_____

_____

_____

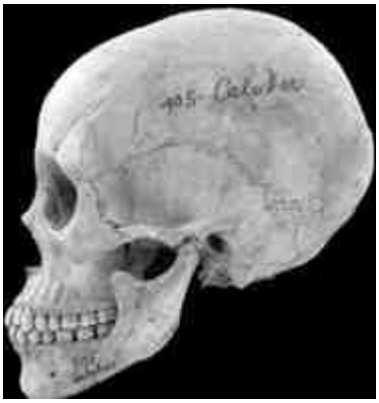
Think about these questions; if you have any trouble answering them, come see me!

Chapter 13: How Populations Evolve

Welcome to The Lucy Test! This is your chance to evaluate fossil evidence for *Australopithecus afarensis*, an extinct primate that some say was our evolutionary ancestor. Lucy is a one million year old fossil found in Africa. Compare her bones to the two specimens and see if you think she's an ancestor to chimps or humans!

A. afarensis

Specimen 1

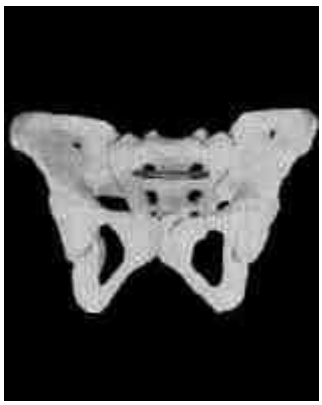


Specimen 2

Fossil #1: The Skull

Which specimen looks more like *A. afarensis*? _____

A. afarensis

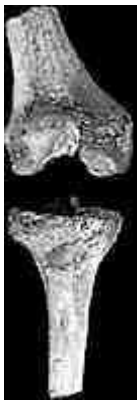


Specimen 3

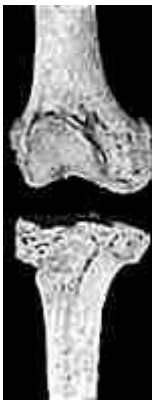
Specimen 4

Fossil #2: The Pelvis

Which specimen looks more like *A. afarensis*? _____



A. afarensis



Specimen 5

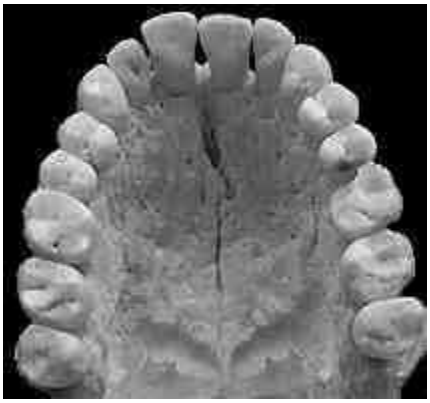
Specimen 6

Fossil #3: The Knee

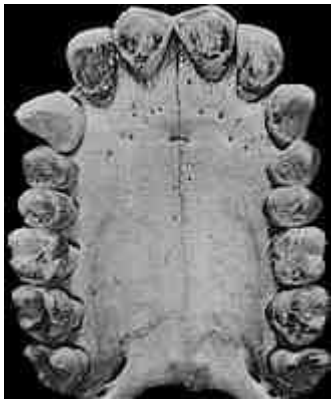
Which specimen looks more like *A. afarensis*? _____

Chapter 13: How Populations Evolve, *continued*

A. afarensis



Specimen 7



Specimen 8

Fossil #4: The Palate

Which specimen looks more like *A. afarensis*? _____

A. afarensis

Specimen 9

Specimen 10

Fossil #5: The Tooth

Which specimen looks more like *A. afarensis*? _____

A. afarensis

Specimen 11

Specimen 12

Fossil #6: The Hand

Which specimen looks more like *A. afarensis*? _____

Chapter 13: How Populations Evolve, *continued*

Lucy Test Results

For each fossil, there is a chimp and human to choose from. However, you didn't know which fossil was which when taking this quiz. So, to understand the results, go through a "scoring" process. This scoring process doesn't indicate a right or a wrong; it just gives us a way to interpret the results.

For Fossil #1, give yourself:	Specimen 1: 1 point (chimp) Specimen 2: 2 points (human)
For Fossil #2, give yourself:	Specimen 3: 2 points (human) Specimen 4: 1 point (chimp)
For Fossil #3, give yourself:	Specimen 5: 1 point (chimp) Specimen 6: 2 points (human)
For Fossil #4, give yourself:	Specimen 7: 2 points (human) Specimen 8: 1 point (chimp)
For Fossil #5, give yourself:	Specimen 9: 1 point (chimp) Specimen 10: 2 points (human)
For Fossil #6, give yourself:	Specimen 11: 1 point (chimp) Specimen 12: 2 points (human)

Now, add your points together.

6……..7……..8……..9……..10……..11……..12
chimp……..ape-like……..midway……..human-like……..human
with human features between ape and human with ape features

If you scored 6, based on visual exam alone, you think *A. afarensis* looks most like an ape based on phenotypic characteristics of the bones. In other words, you believe Lucy, a million year old fossil, resembles modern day apes. If you scored 7 or 8, you think *A. afarensis* looks more ape than human.
And so on…

What do the results of this quiz mean? It may change or challenge your view on evolution. What if evidence supports that humans evolved from humans, yet the quiz results show that the million year old fossil seems to be an ancestor to both apes and humans? Do you think the visual exam is enough *or* could DNA comparisons serve as a better indicator of descent?

Some facts about evolution:

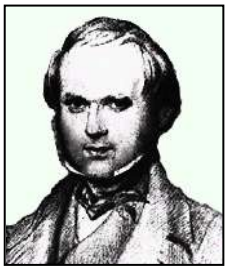
- Evolution is a scientific theory; one doesn't choose to "believe" in evolution or choose "not to believe" in evolution. You have to examine the evidence that supports evolution and accept or refute it based on scientific evidence.
- Evolution is not a religious idea. Only one small part of the evolution theory deals with the origins of human beings. There are religious stories of the origins of human beings (often known as creationism), but this is neither fact nor theory. It's the *idea* that a supernatural being created human beings (but without scientific evidence).
- In order for scientific hypotheses to qualify as a *theory* there must be substantial scientific evidence to support it. Evolution is one such theory with much supporting evidence.

Chapter 13: How Populations Evolve, *continued*

EVOLUTION AND NATURAL SELECTION

_____ is a change in species over time while _____ is the driving force that causes evolution.

Charles Darwin and *The Origin of Species*



Darwin sailed around the world on a ship as a naturalist for 5 years in the 1830's. He made notes of his trip, especially to the Galapagos Islands along the western coast of South America. He traveled on a ship called the _____. When he returned to England, he didn't immediately publish his ideas of evolution and natural selection about the organisms he observed on the Galapagos Islands. But, in 1859, he published *On the Origin of Species by Means of Natural Selection.*

He made two main points in this book:

1. Species of organisms inhabiting earth today descended from ancestral species. He didn't use the word "evolution" in his first edition; he called it "descent with modification."
2. Natural selection is the mechanism for descent with modification (evolution).

Some questions to think about & answer as you're reading this chapter in your textbook…

What do you perceive Charles Darwin's contribution to science to be? _____

_____

_____

_____

What led Darwin to his revelations about evolution and natural selection? _____

_____

_____

_____

Explain how you think natural selection can cause the formation of new species. _____

_____

_____

_____

Why do you think that evolution only occurs to populations *and not to individual organisms*? _____

_____

_____

_____

Why do you think that natural selection only occurs to individuals *and not to populations*? _____

_____

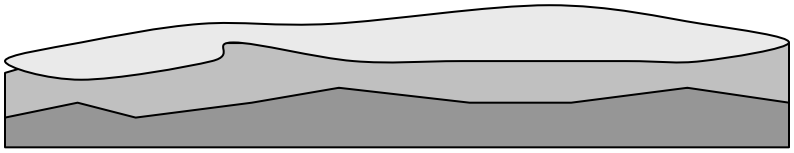
_____

Chapter 13: How Populations Evolve, *continued*

EVIDENCE FOR EVOLUTION

A. _____: Fossils are preserved in layers of rock. Look at the layer of rock pictured below. Which is the oldest layer?___Which is the newest layer containing the organisms most recently preserved?___What does this tell you about the age of the organism preserved on the bottom layer?

Layer 1
Layer 2
Layer 3



B. **_____:** is the study of the geographic distribution of species. Many unique species have evolved on islands where they have been isolated from other populations of similar organisms for many thousands or millions of years. Why do you think that's the case? _____

_____

The earth was once a great land mass called Pangaea; that land mass separated into continents that drifted apart over the millennia. Organisms once together on a land mass may have been separated as continents moved apart, or as land bridges disappeared.

C. **_____:** is the comparison of body structures between different species; some structures point to a common ancestry among organisms. Such a phenomenon is called **homology** and those structures are called **_____ structures**. Examples are _____

_____

D. **_____:** is the comparison of structures that appear during the development of different organisms. For example, humans have gill pouches and a post-anal tail during embryonic development, these are features that are also present in embryonic chickens. What do you think the presence of these features suggests? _____

E. **_____:** is the study of evolutionary relationships using DNA and proteins. This has proven to be a valuable and reliable way to map phylogenies (relationships among organisms). Using DNA, we can determine when branching of the "evolutionary tree" occurred between two species.

Look at the two sequences of DNA, below. Which two organisms do you think are most closely related?

Organism 1: ATGCGCTATCCTAG

Organism 2: TTGGGCAAGCCAAG

Organism 3: TTGGGCTATCCAAG

Organism 4: ATGCGCTATCCAAG

Chapter 13: How Populations Evolve, *continued*

DARWIN'S THEORY OF NATURAL SELECTION

- Natural selection is the engine that drives evolution.
- *Individuals* don't evolve, *populations* do. An individual cannot change his or her genetic makeup, but through reproduction she or he can pass those genes that make her well-adapted to the environment on to her offspring.
- Darwin's ***Theory of Evolution by Natural Selection*** (1859)
  1. The individuals that make up a population of a species are not identical
  2. Some variation is heritable
  3. All populations have the *potential* to populate the whole Earth
  4. Different individuals leave different numbers of descendants
  5. The number of descendants an individual leaves depends on the interaction between the characteristics of the individual and the environment of the individual.
- **Example of Natural Selection:** Peppered Moth, *Biston betularia*
  - **Two color varieties**: light with splotches of darker pigment; and darker moths

  - **Feeding habits**: feed at night and rest during the day, often on trees and rocks encrusted with gray-to-white colored lichens.
  - **Camouflage**: light moths are hidden on light-colored lichens; dark moths are obvious and eaten by birds
  - **Before Industrial Revolution**: dark peppered moths were rare in Great Britain
  - **After Industrial Revolution**: pollution in the late 1800's killed large numbers of lichens, uncovering dark tree bark, dark moths became more abundant. Now, the dark moth is camouflaged against a tree that lacks lichens, but the light moth is conspicuous. Birds have preyed on the light moths and reversed the numbers.
  - **Today**: over the past two decades, pollution has been curbed and light-colored lichens have returned along with the light moths.
  - Natural selection is regional and timely, tending to adapt organisms to their environments. Population-level changes show that evolution can occur in a short period of time.

Questions about the peppered moth:

Which color of moth was more prevalent before the Industrial Revolution? _____

Which color of moth was more prevalent after the Industrial Revolution?_____

Which color of moth was being favored by natural selection before the revolution?_____

Which color of moth was being favored by natural selection after the revolution? _____

Describe how this moth was able to avoid extinction during and after the Industrial Revolution._____

_____

Chapter 13: How Populations Evolve, *continued*

SOURCES OF GENETIC VARIATION

Sources of genetic variation which cause evolution

1. Changes of allele frequencies in populations can cause genetic variation.
2. New alleles and genes can be generated by:

A. **_____:** Mutations introduce new genetic material to a population. Mutations can slightly alter allele frequencies and occur in DNA (sometimes creating a new allele.) Mutations are most important in providing new alleles on which natural selection or drift can act. Mutations usually result in harm to the organism and are removed from the population by natural selection.

B. **_____:** Nonrandom mating is the tendency of individuals of one particular genotype to mate with individuals of another specific genotype can lead to changes. (*Think of yourself: do you prefer people with similar phenotypes to yourself? Do you prefer someone is similar to yourself? Do you prefer someone intelligent, funny, etc.? Humans do not randomly mate: we choose whom we want to be with based on genotypic and phenotypic characteristics*). Nonrandom mating often occurs in plants, which are rooted in the same place.

C. _____**:** Gene flow is migration into or out of an area (which is also called _____ and _____. Gene flow changes the genetic makeup of a population. (*Think about yourself: have you moved around from one location to another within your lifetime? This migration makes an impact on who you may find to mate with!)*

D. **_____:** Genetic drift is when a population shrinks. Losing members means the population loses genetic variation. Random events can cause allele changes and remove an allele from a population. Genetic variation within a population becomes reduced.

1. **Population bottleneck**: sudden shrinkage in variation; a type of genetic drift
    a. can be due to disaster: earthquakes, floods, fires where a large amount of the population is lost
    b. very small population; lose much genetic variation (a common example is the Amish in Pennsylvania where not a lot of gene flow occurs)
2. **Founder effect**: also occurs when a few individuals break off to form a new population.
    a. *founder effect* is a special kind of population bottleneck

E. **_____:** Natural selection involves the ability to produce offspring. More offspring influences alleles in population. Natural selection acts on alleles already present in a population. Only the fittest individuals survive and reproduce. Adaptation is the accumulation of traits that increase fitness and is a result of natural selection. This factor is most likely to cause changes in the gene pool.

Chapter 13: How Populations Evolve, *continued*

Review of Evolution and Natural Selection

Causes of Evolution

Match the term with its best description.

_____1. Change through time	A. Adaptation
_____2. Random change in the genetics of a population	B. Evolution
_____3. Splitting of one type of organism into others	C. Genetic Drift
_____4. Mechanism that drives biological evolution	D. Natural Selection
_____5. Beneficial characteristic of an organism	E. Speciation

Answers
1B, 2C, 3E, 4D, 5A

Evidence for Evolution

Match the term with its best description.

_____1. Study of geographical distribution of species.	A. Biogeography
_____2. Chronology of fossil appearances in the rock layers.	B. Comparative Anatomy
_____3. Comparison of body structures between difference species.	C. Comparative Embryology
_____4. Use of DNA and proteins to map ancestry.	D. Fossil Record
_____5. Comparison of structures that appear during the development of different organisms.	E. Molecular Biology

Answers
1A, 2D, 3B, 4E, 5C

Chapter 14: How Biological Diversity Evolves

SPECIATION: HOW DO NEW SPECIES ARISE?

How would you define a *species* for sexually reproducing organisms? _____

_____

_____

_____

Speciation is the emergence of new species. The key in order for this to happen is a change in genetics so that the two populations can no longer breed; thus, they become genetically different.

NEW SPECIES EMERGE THROUGH TWO MECHANISMS

1. **Allopatric Speciation** (*caused by geographic barriers*): In the absence of gene flow between geographically separate populations, new species form gradually, by divergence. Allopatric speciation is caused by _____. Speciation occurs as a result of an organism's inability to surpass barriers. Some organisms are able to surpass such barriers such as wind-blown pollen, birds that can fly over mountains and lakes. Allopatric speciation is likely to occur when the population is small and isolated. Small, isolated populations are more likely to have gene pools changed substantially by factors such as genetic drift or natural selection. Why? _____

_____

Factors that cause geographic isolation of populations:

_____

_____

2. **Sympatric speciation** ("*Same land*"): Species evolve within the _____. Restriction of gene flow is one factor in causing sympatric speciation. Two other items may also play a role: ecological isolation and chromosomal (differences or changes).

> **First**, **ecological isolation**: a population of one species may inhabit a large geographical area. However, there may be ecological differences within that habitat: moist areas, dark areas, dry areas, etc. Over time, the populations may find niches and adapt to those particular differences within the habitat. Eventually, they may not be able to interbreed and thus, form two species.
>
> **Second, chromosomal aberrations**: *polyploidy* is one example of a chromosomal aberration. Strawberries, ferns, and other plants often are polyploids. Polyploidy is a situation where an organism has more than one set of chromosomes. Fertilization becomes difficult with other plants, and thus, they can become genetically isolated with small populations with the same chromosome number.

Chapter 14: How Biological Diversity Evolves, *continued*

BARRIERS TO REPRODUCTION

These barriers to reproduction are typically associated with "Sympatric Speciation."

Assignment: Using your textbook, describe how each of these mechanisms works:

Premating Isolating Mechanisms: anything that prevents two organisms of the same species from mating.

- Temporal Isolation _____
  _____
- Habitat Isolation _____
  _____
- Behavioral Isolation _____
  _____
- Mechanical Isolation _____
  _____
- Gametic Isolation _____
  _____

Postmating Isolating Mechanisms: anything that prevents a viable, fertile offspring from being produced after mating has occurred.

- Hybrid Inviability _____
  _____
- Hybrid Sterility _____
  _____

CASE STUDY
What do you think about how species form?

Imagine that you are in a group of scientists who are first to explore a large island. In the course of your investigation, you discover that two large populations of flying birds coexist on the island. The two populations seem similar in general appearance, but you can detect small but consistent differences in plumage (feathers). The bird beaks are similar, but you notice that some birds with short feathers consume insects while other birds with longer feathers consume berries.

Do the populations constitute one species or two?

What key evidence would you need if the two populations are allopatric?

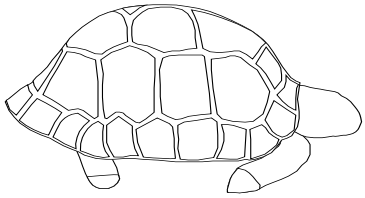
What additional information do you need to know about these birds?

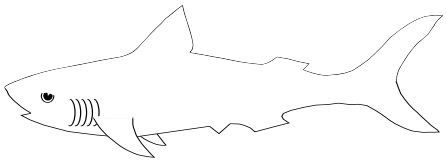
What portions of the two populations inhabit a zone of sympatry?

Chapter 14: How Biological Diversity Evolves, *continued*

TAXONOMY

What makes the following two organisms different?





Characteristics of Organism A	Characteristics of Organism B

Taxonomy is a method of naming, classifying, and organizing species. The exercise you just completed about the shark and turtle was a function of taxonomy.

Phylogeny is the study of the evolutionary history of a species.

Similarity among organisms present on earth today:

We can determine the degree of relatedness among organisms by examining their features.

- **Homologous structures**: Examine the arm of a human, the cat's leg, whale's flipper, and bat wing. There are certain bones that are homologous structures. Homologous structures may look different and function different in different species, but are fundamentally the same because they evolved from the same structure in a common ancestor. Homologous structures indicate **divergent evolution**.
- **Analogous structures**: Often, characteristics look similar but have evolved differently. These do not indicate common ancestry. Analogous structures are due to **convergent evolution**: species from different evolutionary branches may come to resemble one another if they live in very similar environments.

SCIENTIFIC NAMES

Binomial System of Nomenclature is a way of writing scientific names. In the scientific community, we do not use scientific names because they are universally known and common names are localized and easily confused.

Binomial = *two names*, a genus and a species.

Nomenclature = method of naming organisms.

Who came up with the idea of the Binomial System of Nomenclature? _____

How did he rewrite his name to reflect his new system? _____

Chapter 14: How Biological Diversity Evolves, *continued*

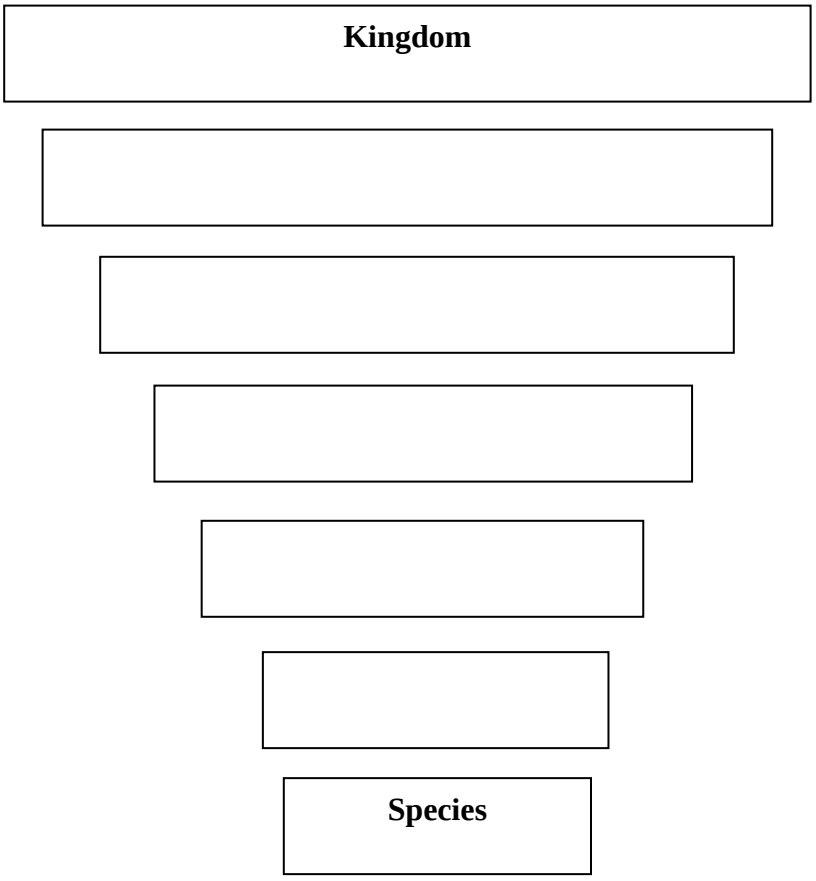
HOW TO CONSTRUCT A SCIENTIFIC NAME

1. Use <u>two</u> names, a _____ and a _____. The genus always comes first. This is the more general classification. The specific epithet (species name) is written second and is the more specific name.
2. Capitalize the genus. Place the species in lower case letters.
3. *Italicize* or <u>underline</u> the names.

Practice writing scientific names correctly.
Each of these scientific names are currently written incorrectly; write them correctly making the necessary changes.

Written Incorrectly	Written Correctly
homo sapiens	
Acer Rubrum	
<u>Camellia sinensis</u>	
<u>Magnolia Grandiflora</u>	
MORCHELLA ESCULENTA	
<u>peziza Domiciliana</u>	

What is the scheme for classifying organisms, from the most general to the most specific category?



Remember: *<u>K</u>eep <u>P</u>ots <u>C</u>lean <u>O</u>r <u>F</u>amily <u>G</u>ets <u>S</u>ick … <u>K</u>ing <u>P</u>hilip <u>C</u>ame <u>O</u>ver <u>F</u>rom <u>G</u>reece <u>S</u>aturday*

Chapter 14: How Biological Diversity Evolves, *continued*

FIVE KINGDOM SYSTEM

Not all of these details are covered in your book in this particular chapter:

	Monera	**Protista**	**Plantae**	**Fungi**	**Animalia**
Pro or Eukaryote?	prokaryote	eukaryote	eukaryote	eukaryote	eukaryote
Uni or Multicellular	unicellular	both	multicellular	both	multicellular
Mode of Nutrition	both autotrophic and heterotrophic modes are used	both autotrophic and heterotrophic modes are used	autotrophs; photosynthesize	heterotroph	heterotroph
Contains organisms such as…	bacteria	plankton, diatoms, amoeba, *Plasmodium*, *Euglena*, *Paramecium*	ferns, mosses, liverworts, pines, grasses, oaks, roses, daisies, maples	yeasts, molds, mildew, mushroom, truffles	bats, dogs, earthworms, fish, frogs, humans, snakes, jellyfish
Classified into the ___ domain	Bacteria and Archaea	Eukarya	Eukarya	Eukarya	Eukarya

Chapter 14: How Biological Diversity Evolves, *continued*

Extra! Taxonomy in Action

Your instructor may choose to complete the following activity.

Use the classification below to answer the following questions.

	Man	Dog	Wolf	Nostoc	Prairie Rose	Black-eyed susan
Kingdom	Animal	Animal	Animal	Monera	Plant	Plant
Phylum	Chordata	Chordata	Chordata	Cyanophycota	Anthophyta	Anthophyta
Class	Mammalia	Mammalia	Mammalia	Cyanophyceae	Dicotyledonae	Dicotyledonae
Order	Primates	Carnivora	Carnivora	Oscillatoriales	Rosales	Asterales
Family	Hominidae	Canidae	Canidae	Nostochaceae	Rosaceae	Asteraceae
Genus	*Homo*	*Canis*	*Canis*	*Nostoc*	*Rosa*	*Rudbeckia*
Species	*Homo sapiens*	*Canis familaris*	*Canis lupis*	*Nostoc commune*	*Rosa setigera*	*Rudbeckia serotina*

1. Which two organisms are the most closely related to each other?

2. Why did you choose these?

3. Which group(s) of organisms are least related to the wolf?

4. At what level of classification is the man and dog separated into different categories?

5. If you want to refer to a certain kind of organism, why is it better to use the scientific name rather than the common name?

Using a Dichotomous Key

Dichotomous keys help to correctly identify organisms. All dichotomous keys are constructed on the same basis. To identify a species properly, the user is given a series of choices, usually two.

We are trying to find the Class Kermit the Frog belongs to. We have determined frogs are in the Kingdom Animalia, Phylum Chordata. Now, below, we have the dichotomous key for Class in the Phylum Chordata. Which class?

1a. Hair present.....Class Mammalia
1b. Hair absent.....2

2a. Feathers present.....Class Aves
2b. Feathers absent.....3

3a. Dorsal fins present.....4
3b. Dorsal fins absent.....6

4a. Jaws present.....5
4b. Jaws absent.....Class Agnatha

5a. Skeleton bony.....Class Osteichthyes
5b. Skeleton cartilaginous.....Class Chondrichthyes

6a. Skin scales present.....Class Reptilia
6b. Skin smooth lacking scales.....Class Amphibia

Chapter 14: How Biological Diversity Evolves, *continued*

Review of Taxonomy

Scientific Names

1. How should a scientific name be correctly written? Use the following scientific name to demonstrate.

   Incorrectly written: homo sapiens

   Correctly written:

2. On the above scientific name, identify the genus and the species.
3. Who devised the Binomial System of Nomenclature? _____
4. Why is it better to use a scientific name than common names? _____
5. Which part of the scientific name do you capitalize? _____

The Six Kingdoms: *Determine which kingdom is described. Often, more than one kingdom may be correct.*

_____1. prokaryotes
_____2. eukaryotes
_____3. single celled organisms only
_____4. contains both single celled and multicellular organisms
_____5. trees, ferns, mosses, flowering plants
_____6. contains members that are heterotrophs
_____7. organisms that do not have membrane-bound organelles
_____8. mushrooms, yeast, molds
_____9. multicellular organisms (mostly)
_____10. contains organisms that can photosynthesize
_____11. contains members that are autotrophs
_____12. diatoms, amoeba, plankton
_____13. halophiles, acidophiles, streptococcus
_____14. bears, geese, turtles, fish, frogs, kangaroos
_____15. organisms that have a true nucleus and membrane-bound organelles

A. Kingdom Monera
B. Kingdom Protista
C. Kingdom Fungi
D. Kingdom Plantae
E. Kingdom Animalia

For Discussion

1. Explain why a gap in the fossil record may cause difficulty for scientists trying to map the phylogeny of a genus of organisms.
2. Describe the difference between analogous and homologous structures. What do these structures tell us about their origins?
3. Why are there two domains for the bacteria?
4. Explain why plants, protists, animals, and fungi are placed into different kingdoms, but are all in the same domain.

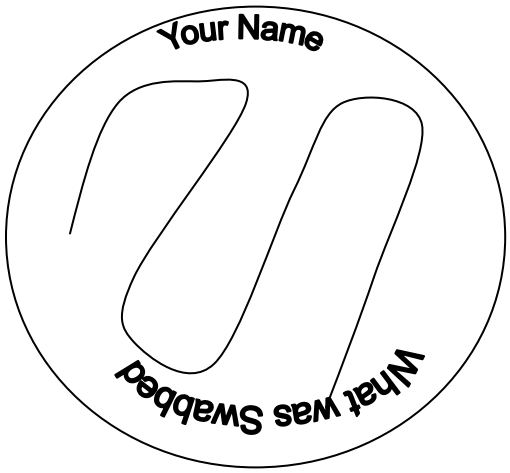
Scientific Names Answers: 1. Homo sapiens 2. Genus = Homo; and species = Homo sapiens. The specific epithet is *sapiens*; 3. Karl von Linne, better known as Carolus Linnaeus; 4. Organisms can have more than one common name, so it's more efficient to refer to them by their universally known scientific names; 5. The Genus is always capitalized
The Six Kingdoms Answers: 1A; 2B, C, D, E; 3B, 4B, C, D, E; 5D; 6A, B, C, E; 7A; 8C; 9C, D, E; 10A, B, D; 11A, B, D; 12B; 13E; 14E; 15B, C, D, E

Chapter 15: The Evolution of Microbial Life

BACTERIAL CULTURES

We're going to start this chapter by performing a swab to observe bacterial growth.

1. Using the swab, rub the surface of something that you think may provide a good growth of bacteria.
2. *Very gently*, using a "S" motion, swipe the swab onto the agar plate.
3. Throw swab in trash can.
4. Label the top of the dish as below.
5. We will incubate your petri dish for 48 hours at about 100 ° F then check for colonies of bacteria.



Ideas of Places to Swab
with a good chance of bacterial growth*

bathroom sink	bathroom faucets
bathroom door handles	telephone receiver
water fountain	floor
mud puddles	backs of earrings
under watch band	run swab through hair
door knobs	top of soda can
shoe bottom	ashtrays
lunch counter	money slot on vending machine
money (coins)	fish tanks
lab counters	elevator buttons

* avoid swabbing in your mouth, anal regions or other moist surfaces – any infections in those locations can be contagious!

Chapter 15: The Evolution of Microbial Life, *continued*

CHARACTERISTICS OF PROKARYOTES

1. single-celled organisms
2. smaller in size than eukaryotes
3. lack a true nucleus
4. lack membrane-bound organelles
5. reproduce by binary fission (as quickly as 20 minutes by dividing in half)
6. _____
7. _____

HOW DO WE CLASSIFY BACTERIA?
DOMAINS vs. KINGDOMS

1. **Domain Bacteria**: common bacteria
2. **Domain Archaea**: These archaebacteria are classified into a separate kingdom because recent biochemical studies have shown that they are as different from other bacteria as they are from eukaryotes (the nuclei are membrane-bound). Some research shows they may be more similar to eukaryotes than to other bacteria.

   Examples of Archaebacteria

   Extremophiles

   1. **Halophiles** are "salt lovers" live in extreme salt environments (such as the Great Salt Lake)
   2. **Thermophiles** are "heat lovers" that live in very hot water (such as hot springs)

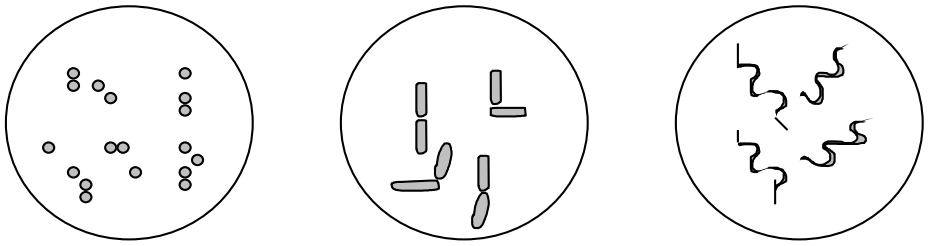
   Methanogens are anaerobic methane producers that live in anaerobic environments and give off methane as a waste product. Thrive in mud at the bottoms of lakes and swamps. Produce methane from carbon dioxide and hydrogen. Also the cause of marsh gas. Aid digestion in cattle that depend on cellulose.

KINGDOMS

In the five kingdom system, bacteria occupy one kingdom known as **KINGDOM MONERA.**

BACTERIAL SHAPES

Nonphotosynthetic bacteria can be classified based on their morphology (shape). Identify the following shapes of bacteria, below using these terms: coccus, bacillus, or spirochetes (plural = cocci, bacilli).

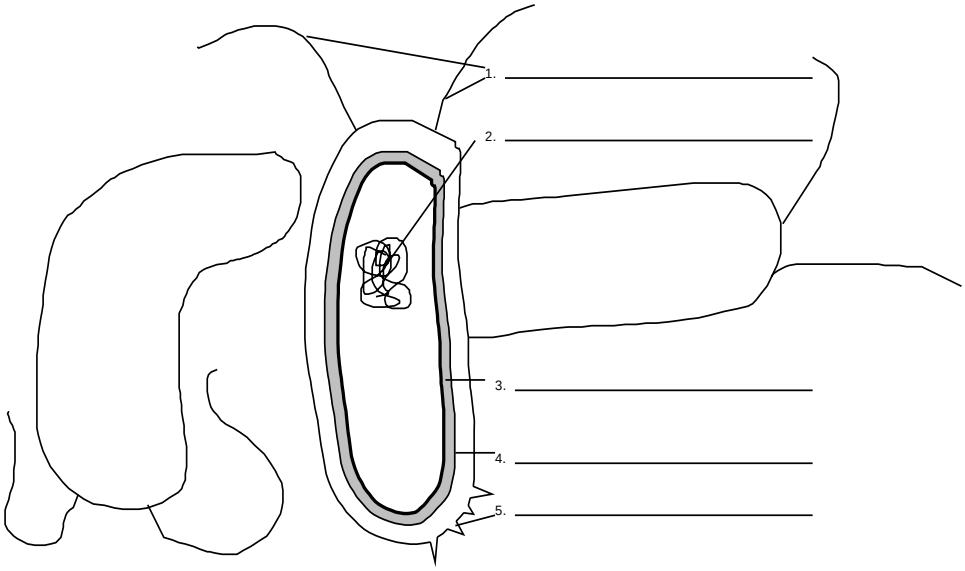


Singular = _____ _____ _____
Plural = _____ _____ _____

Chapter 15: The Evolution of Microbial Life, *continued*

PARTS OF A TYPICAL BACTERIAL CELL

1. **Flagellum** (plural = flagella) whip-like tail. Not all bacteria can move, but the mobile ones are generally propelled by whiplike appendages—flagella—that may project from all over the cell or from one or both ends, singly or in tufts.
2. **No nucleus**, but there is a DNA-region, no nuclear envelope
3. **Plasma membrane** is composed of a phospholipid bilayer like other eukaryotic organisms.
4. **Cell wall** is situated on the outside of the plasma membrane and composed of polysaccharides.
5. **Pilus** (plural = pili) extensions of cytoplasm through cell membrane which help bacteria stick to each other and to surfaces, assists with mating.



6. **Endospore** is an outer layer produced to act as a thick protective coat when the bacterium enters a dormant stage. The cytoplasm is dehydrated and the cell does not metabolize. During this dormant period, the bacterium can withstand heat, cold, trauma, and poisons. The endospore enables the bacterium to survive for centuries. To kill bacteria in food, we must use a steam pressure cooker to 250° F. Steam pressure cookers are used in the food industry to prevent **botulism**, a toxin produced by the soil bacteria called *Clostridium botulinum* (ever heard of **Botox**?).

BACTERIAL NUTRITION

4 modes of nutrition

1. **Photoautotrophs** (*light-self-feeder*) Nourish themselves via photosynthesis, a process that converts the sun's energy into chemical energy as glucose.
2. **Chemoautotrophs** (*chemical-self-feeder*) Transform carbon dioxide (CO_2) and another inorganic chemical such as hydrogen sulfide or ammonia into food. Deep sea vent bacteria utilize this process.
3. **Photoheterotrophs** (*light-other-feeder*) Use light to make ATP but still need to obtain their carbon from organic forms by consuming.
4. **Chemoheterotrophs** (*chemical-other-feeder*) Consume organic molecules for energy and carbon (common).

Chapter 15: The Evolution of Microbial Life, *continued*

Review of Bacteria

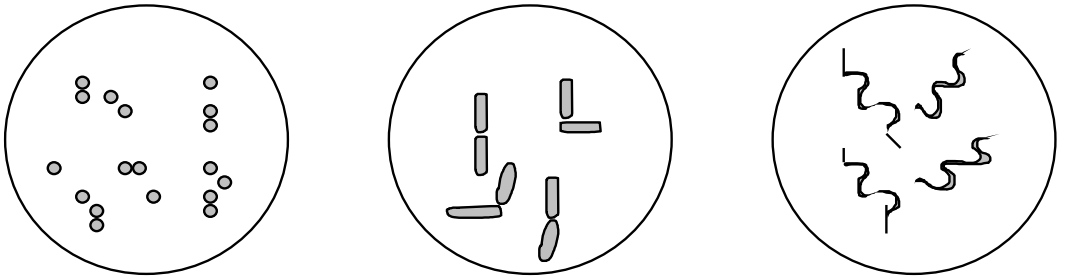
1. What makes bacteria different from other forms of life? _____

_____

2. What are the characteristics of prokaryotes? _____

_____

3. Do bacteria have membrane-bound organelles? _____
4. By what method do bacteria reproduce? _____
5. How long does it take for typical bacteria to divide in half? _____
6. List the 3 examples of bacterial shapes _____
7. Identify these shapes of bacteria:



_____ _____ _____

8. What is an endospore? _____
9. Describe the difference between chemosynthesis and photosynthesis. _____

_____

10. Describe the different methods in which bacteria can feed themselves. _____

_____

_____

11. Compare and contrast the two domains of bacteria. _____

_____

_____

Think about these questions; if you have any trouble answering them, come see me!

Chapter 15: The Evolution of Microbial Life, *continued*

CHARACTERISTICS OF EUKARYOTES

1. possess a true nucleus (nuclear envelope surrounding DNA)
2. larger than eukaryotes
3. have membrane-bound organelles
4. reproduction is sexual or asexual

KINGDOM PROTISTA

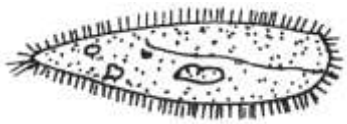
CHARACTERISTICS OF PROTISTS

1. eukaryotic (have a *true* nucleus)
2. mostly single-celled organisms…some, however, are multicellular
3. typically live in aquatic environments (lakes, rivers, ponds, ocean)
4. have some means of movement (to propel themselves through the watery environment)
5. have the ability to sense changes in the environment and respond to them (makes them more advanced than bacteria)

PROTIST MOTILITY

- _____: short hair like extensions covering the cell; useful for propelling cell through a watery environment.
- _____: a "false foot" used by the unicellular protist to extend the cytoplasm against one part of the plasma membrane like a foot.
- _____: a long tail-like whip that allows the protist to move through the watery environment.

Label the modes of movement in these protist cells:



Paramecium

_____

Amoeba

_____

Euglena

_____

Chapter 15: The Evolution of Microbial Life, *continued*

CLASSIFICATION OF PROTISTS

- **Protozoans** (*proto* = first; *zoion* = animal) are animal-like protists. These protists live in aquatic environments. Since they are animal-like, they eat other organisms for nutrition.
  - **Flagellates** move by flagella and are types of protozoans that are non-parasitic (free-living). Example is *Giardia*, which causes the disease giardiasis. Giardiasis is an infection from *Giardia*. How can you catch giardiasis?_____
  - **Amoebas** move by pseudopods and live in ponds, lakes and creep along surfaces.
  - **Apicomplexans** are all parasitic and are named for the *apex* on their cell used to penetrate the host. *Plasmodium*, the protist that causes malaria, belongs to this group. Malaria is transmitted to humans using mosquitoes; people who have the genetic disorder known as sickle cell anemia are someone immune to malaria.
  - **Ciliates** move by cilia and are free-living (non-parasitic). *Paramecium* is an example of this group.
- **Slime Molds** resemble fungi, but actually are not related at all. These live in moist environments such as leaf litter or decaying organic matter. They get their nutrition by consuming dead organic matter.
  - **Plasmodial slime molds** are an amoeboid mass called a plasmodium. They have one single cell with many nuclei. Live among leaf litter on forest floors; consuming bacteria and dead organic matter.
  - **Cellular slime molds** are strange organisms: they consist of single amoeboid cells when feeding, yet they migrate around as a slug-like colony of cells when the food supply is gone.
- **Phytoplankton or Unicellular Algae** are plant-like protists. (*phyto* = light)
  These live in aquatic environments, too, but these organisms photosynthesize using sunlight energy.
  - **Dinoflagellates**: the word means "whirling tails," these unicellular protists have tails known as flagella. Dinoflagellates has plates reinforced by _____. Their population numbers can soar, causing an "algal bloom;" toxins can cause fish kills in oceans, lakes, and rivers.
  - **Diatoms**: have glassy cell walls containing _____. Store their food as oil which also keeps them afloat—a benefit since these organisms photosynthesize. When they die, they sink to the bottom creating a layer called diatomaceous earth. Ever wonder where the grit comes from in *toothpaste* and *silver polish?*
  - **Green algae (unicellular)**: are named for their chloroplasts which help them photosynthesize. These live in lakes and ponds. The colonial form of green algae called *Volvox*.
- **Seaweeds or Multicellular Algae** are also plant-like protists. However these have more than once cell, thus are called multicellular. These live in aquatic environments, too. They get their nutrition by photosynthesis.
  - **Green Algae (multicellular)** is called "sea lettuce" or *UIva*. It's edible and lives in the intertidal zone.
  - **Red Algae** is abundant in warm waters; they have other pigments to make them appear red.
  - **Brown Algae** is also called "kelp" and can grow to over 60 meters in length! Kelp forests are vital for many sea organisms; they contain floaters to keep the seaweed close to the surface—and near light.

Chapter 15: The Evolution of Microbial Life, *continued*

Review of the Characteristics of Protists

Determine if each of the following statements about protists is True *or* False.

_____1. All protists are single-celled prokaryotes.
_____2. Protist cells have a nucleus.
_____3. Protist cells can contain membrane-bound organelles such as chloroplasts and mitochondria.
_____4. All protists are heterotrophic.
_____5. Most protists can sense light, touch, and chemicals.
_____6. All protists are autotrophic.
_____7. Protists can be either heterotrophic or autotrophic.
_____8. Some protists are multicellular.
_____9. Slime molds are autotrophs.
_____10. Protists use various methods of movement such as cilia, flagella, and pseudopods.
_____11. The diatoms are plant-like protists that photosynthesize.
_____12. Protists are prokaryotes.

Answers: 1. False; some are multicellular; 2. True; 3. True; 4. False; some are autotrophic; 5. True; 6. False; some are heterotrophic; 7. True; 8. True; 9. False; they are decomposer; 10. True; 11. True; 12. False; only the bacteria are prokaryotes

Heterotrophic Protists

Match the protist with its description.

_____1. These protists move by cilia
_____2. *Giardia* is a type of ____
_____3. *Plasmodium*, the cause of malaria, is a type of ____
_____4. These protists move by flagella
_____5. These protists move by pushing cytoplasm against their cell membranes.
_____6. These protists are all parasitic
_____7. All free-living (non-parasitic)
_____8. The *Paramecium* is a type of ____.

A. Amoebas
B. Apicomplexan
C. Ciliates
D. Flagellates

Answers: 1C, 2D, 3B, 4D, 5A, 6B, 7D, 8C

Autotrophic Protists

Match the protist with its description.

_____1. Live as kelp forests
_____2. Have glasslike shells sometimes used to make detergents or fertilizers
_____3. Cause the red tides that are poisonous to fish
_____4. Found floating near the surface because they require light
_____5. *Volvox* is a colony of single-celled protists living in a ball.
_____6. These single-celled organisms have silica in their cell walls.
_____7. Type of seaweed have pigments to make them appear red.
_____8. Live in the intertidal zones as a type of seaweed.
_____9. Stores food as a droplet of oil; helps keep them afloat.
_____10. These single-celled organisms have cellulose in their cell walls.

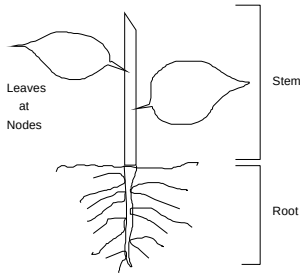
A. Diatoms
B. Red algae
C. Green algae
D. Dinoflagellates
E. Brown algae

Answers: 1E, 2A, 3D, 4A, C, D, 5C, 6A, 7B, 8C, 9A, 10D

Chapter 16: Plants, Fungi, and the Move onto Land

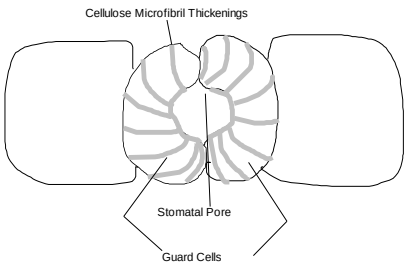
COLONIZING LAND – TERRESTRIAL ADAPTATIONS FOR PLANTS

1. **Stiffening** in the forms of **lignin** in stems. Stems hold the leaves up in the air.



2. **Cuticle** is a covering that helps keep the plant from drying out. It is often made of a waxy substance and is found on the leaves. Dessication (drying out) occurs as water evaporates from the surface of the leaf.
3. **Vascular tissue** transports both fluids and sugars.
   - **Xylem** allows a plant to transport water and fluids. In which direction do the fluids travel?

     _____
   - **Phloem** is a type of tissue that plants used to transport sugars.
     - Where does sugar come from in a plant?_____
     - In which direction do sugars travel? _____
4. **Gametangia** are ways for the plant to reproduce without a need to be near water. Sperm usually swim through water to the egg. But, by having gametangia, the plant's egg and sperm will not dry out in the air. Gametangia are literally jackets around the gametes.
5. **Leaves** are solar collectors for the plant.
   - What is the main function of leaves? _____
   - What do you notice about how leaves are oriented to the sun? _____
6. **Roots** provide two functions for the land plant: 1) anchoring and 2) water absorption from the soil.
7. **Stomata** are opening on the surfaces of leaves which allow gas exchange to occur.
   - Why do plants need gas exchange to occur? _____
   - These pores can be opened and closed to regulate the amount of water lost and gases allowed in.



Chapter 16: Plants, Fungi, and the Move onto Land, *continued*

KINGDOM PLANTAE - FOUR PHYLA

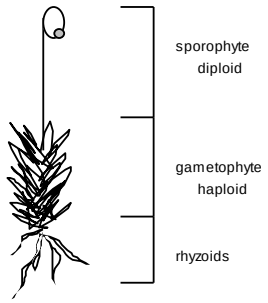
Phylum Bryophyta

Mosses: These primitive plants are the predominant members of Phylum Bryophyta. They are dependent on water and thus must live nearby – for 2 reasons. So, they do not have a good method for conducting water throughout their bodies.

Characteristics of Mosses

- Lack vascular system (must live near water)
- Have rhizoids that are similar to roots and pull water up from the ground
- Also lack seeds, cones, flowers, or fruits (advancements seen in other plants)
- Reproduction is via spores (2N) and gametes (1N). Fertilization of gametes takes place because the haploid sperm swim to the haploid egg (water is necessary here).

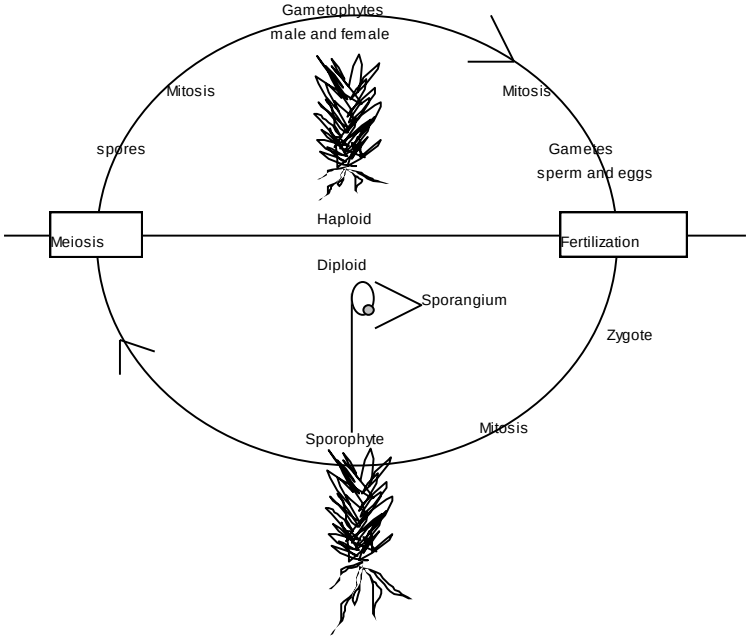
A Moss, member of Phylum Bryophyta



Moss Life Cycle

All plants undergo a process called Alternation of Generations between a sporophyte (spore producing plant) stage and a gametophyte (gamete producing plant) stage. On the life cycle, below, indicate which structures are haploid (N) and diploid (2N).

Life Cycle of a Moss, a member of Phylum Bryophyta



Chapter 16: Plants, Fungi, and the Move onto Land, *continued*

KINGDOM PLANTAE - FOUR PHYLA

Phylum Pterophyta

Ferns: These plants are a bit more advanced than mosses. Ferns still require water for fertilization to take place, plus, their vascular tissue is not very advanced.

Characteristics

- Possess _____ tissues to conduct water and food (this is a first!)
- Have rhizoids, root-like structures that pull water into the plant from the ground
- Lack seeds, pollen, cones, flowers, and fruit
- Reproduction is via spores and gametes. Ferns produce "sori" on the backs of their fronds.

Major advancement over the mosses: _____

Phylum Pinophyta *or* Coniferophyta

Gymnosperms: Gymnosperm literally means "naked seed." These plants take a large evolutionary step over the ferns.

Characteristics

- Have _____ tissue (xylem and phloem) to grow tall
- Possess true roots rather than rhizoids
- **Reproduction** uses _____, _____, and _____. However, they lack the flowers and fruits that attract pollinators and animals to eat and disperse seeds.
    - Female Pine Cone: is woody and bears many scales and ovules.
        - Ovule: a reproductive structure in a seed plant that will become the "seed."
    - Male Pine Cone: are smaller, soft, short-lived. Appear in spring. Each scale produces spores which contain pollen grains.
        - Pollen grains: spore from sporophyte generation; carries sperm to the egg.
    - **Pollination**: occurs when a pollen grain lands on and enters an ovule. Meiosis then occurs.
        - A haploid spore begins to develop into the female gametophyte.
        - Eggs develop later in the ovule.
        - Sperm develops later in the pollen grain.

Major advancement over the mosses and ferns:_____

_____

Examples: pines, firs, cedars

Chapter 16: Plants, Fungi, and the Move onto Land, *continued*

KINGDOM PLANTAE - FOUR PHYLA

Phylum Magnoliophyta *or* Angiophyta

Angiosperms: Angiosperms are flowering plants. Angiosperm literally means "*vessel seed*." The seeds of angiosperms are enclosed in a "*vessel*" called an ovary; ovaries develop into fruits. These are the **most advanced of all plants** because they have vascular tissue, roots, seeds, pollen, fruits, and flowers. They do not need cones, like the gymnosperms, because they protect their seeds in "vessels" or fleshy ovaries.

Characteristics

- Have vascular tissue, roots, seeds, pollen, fruits, flowers
- Do not have rhizoids, cones, like their less advanced relatives

Major advancement over the mosses, ferns, and gymnosperms: _____

_____

Examples: all of our fruits and vegetables, nuts, flowers, hardwoods come from this phylum

Reproduction: The flower is the sporophyte (2N) generation which produces _____ (like pollen). Inside certain structures produced by the flower, the gametophyte generation exists. The gametophyte produces (1N) haploid gametes like _____ and _____.

Parts of a Flower

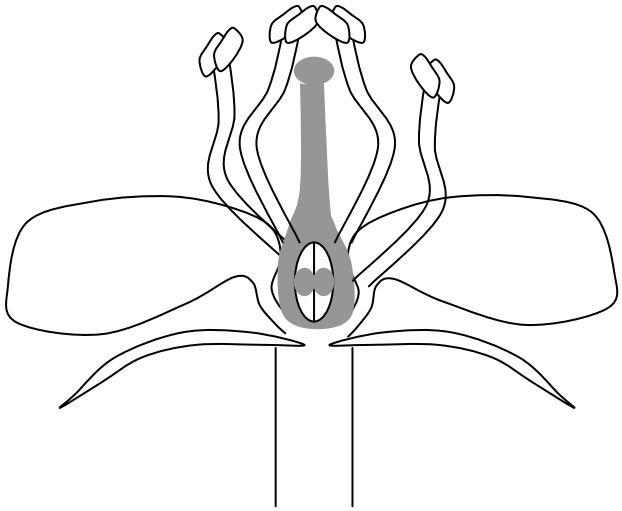
- **Sepal:** the outermost whorl of a flower; *usually* green
- **Petal:** the whorl of a flower located inside from the sepals; *usually* colored; they are actually modified leaves (look for the veins, that's how we know)
- **Stamen:** the male reproductive portion of a flower; where the pollen grains are produced.
  - **anthers:** the specific portion of the anther where pollen grains are produced
  - **filament:** the stalk which holds up the stamens of the anther
- **Pistil:** the female reproductive portion of a flower; where the eggs are produced
  - **stigma:** the specific portion of the pistil where a pollen grain will land for pollination
  - **style:** the stalk which holds up the stigma of the pistil (not always present)
  - **ovary:** the specific location of the egg; where fertilization will take place when sperm arrive from the pollen grain

Chapter 16: Plants, Fungi, and the Move onto Land, *continued*

PHYLUM MAGNOLIOPHYTA

LABEL THE FLOWER

Identify the parts of the flower using the bold terms from above. Also, indicate male and female structures, where pollination occurs, where pollen is produced, where the egg is housed.



POLLINATION AND DOUBLE FERTILIZATION

Pollination: In plants, the process of **pollination** occurs when a _____ lands on a sticky stigma. This may occur when a bee transfers a pollen grain or when wind blows a pollen grain onto the stigma. Once the pollen grain has landed on the stigma, it starts to grow down the style to the ovary. When the pollen grain has arrived at the ovary, _____ sperm are released.

Double Fertilization: The process of **double fertilization** now takes place. _____ sperm fertilizes _____ egg; another sperm fertilizes two polar nuclei.

- The union of the sperm and egg forms a zygote which will grow into an embryo. This zygote has ____ sets of chromosomes and is called _____. This zygote eventually grows into a new plant (called a sporophyte).
- The union of the sperm and two polar nuclei forms the endosperm which has _____ sets of chromosomes and is called triploid. **Endosperm** is a nutrient source that aids in the growth of new plants. Coconut milk is a classic example of endosperm.
- What does the ripened ovary become? _____
- What does the new plant grow from? _____

Chapter 16: Plants, Fungi, and the Move onto Land, *continued*

Review Kingdom Plantae

Complete the Plant Comparison Chart

Indicate "yes" or "no" for each of the following questions and phyla.

	Mosses	Ferns	Gymnosperms	Angiosperms
Alternation of Generations?	yes			
Vascular System?				
Rhizoids?		yes	no	
Roots?		no		yes
Pollen?				
Seeds?			yes	
Cones?				
Flowers?		no		yes
Fruits?	no			

Plant Phyla

Determine if the following descriptions are for:

A. Mosses (Phylum Bryophyta)
B. Ferns (Phylum Pterophyta)
C. Pines (Phylum Coniferophyta)
D. Angiosperms (Phylum Magniolophyta)

_____1. Lacks vascular tissue, true roots, stems, leaves; needs water for fertilization
_____2. Has flowers and fruits, vascular tissue, seeds
_____3. Reproduces using cones, has seeds, vascular tissue
_____4. Lacks seeds, but has vascular tissue, reproduces via sori on the back of frond
_____5. Dominant generation is the gametophyte in these small plants that need to be near water
_____6. Has pollen, cones, vascular tissue and examples include pines

Answers: 1A, 2D, 3C, 4B, 5A, 6C

Flower Parts

Determine if which portion of the flower is described.

_____1. Male portion of the flower where the anthers and filament are found
_____2. Outermost whorl of the flower; usually green and found outside the petals
_____3. Female portion of a flower where the seeds form from ovules
_____4. Colored leaves which are found inside the sepals
_____5. Location where pollen is produced
_____6. Collective term for stigma, style, and ovary

A. stamen
B. petal
C. sepal
D. pistil

Answers: 1A, 2C, 3D, 4B, 5A, 6,D

Chapter 16: Plants, Fungi, and the Move onto Land, *continued*

KINGDOM FUNGI

CHARACTERISTICS OF FUNGI

Fungi are unique because of their mode of nutrition and physical structure.

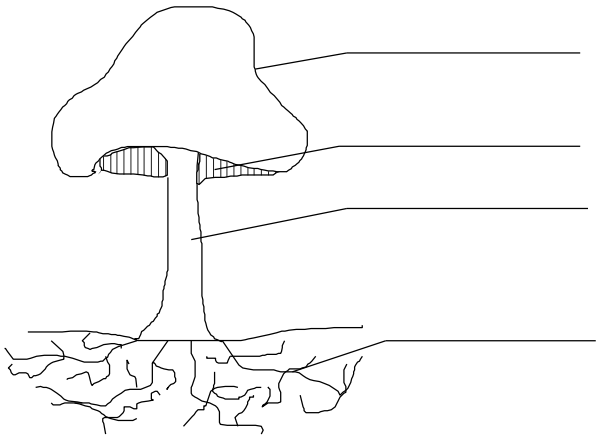
- **Basic Characteristics**
  - eukaryotic
  - multicellular
  - heterotrophs
- **Plant-Like Features**:
  - alternation of generations
  - cell walls
  - lack of motility
  - spore production
- **Animal-Like Features**:
  - chitin, a "crunchy" polysaccharide (like in insects) in cell walls
  - heterotrophic nutrition

Fungal Nutrition: Fungi are _____ that digest their food via extracellular _____. They digest their food by extending the hyphae in and around food sources (dead trees, soil, manure, living tissues). Enzymes are secreted into the substance to digest it and then the hyphae grows into them to absorb the nutrients.

Phylum Basidiomycota (mushroom fungi) reproductive structure:

- _____: cells that form a netlike mass of filaments.
- _____: bunches of hyphae which are strands of cells that make up the body of the fungus. Production of asexual spore on sporangia.
- _____: the fruiting body which is made of packed hyphae. If a mushroom is growing on a log or on dead leaves, pull the organic matter apart. The white mass of "strings" is the mycelium. That is the actual fungus; picking that fungus is not going to harm the fungus or kill it.

Mushroom, member of the Fungi Kingdom



Label the parts of the mushroom
pileus (cap), gills, stipe (stalk), mycelium

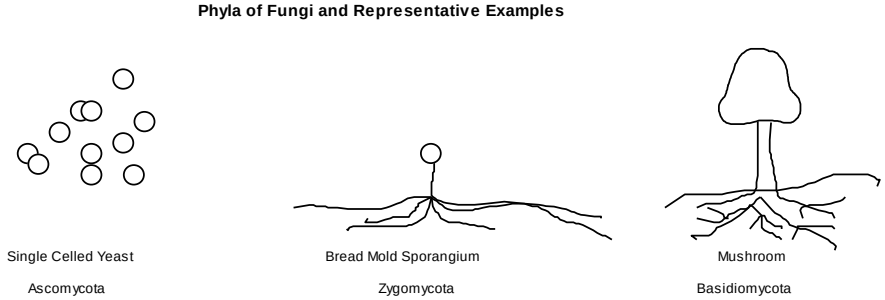
Chapter 16: Plants, Fungi, and the Move onto Land, *continued*

FUNGAL REPRODUCTION

- **Asexual Reproduction** is most common.
  - Fragments of hyphae give rise to new individuals.
  - Hyphal cells can divide or bud; or a fungus can produce asexual spores that disperse, divide mitotically, and develop into new fungi.
- **Sexual Reproduction** requires two different "strains" of fungal cells.

EXAMPLES OF FUNGI

- Phylum Basidiomycota
  - mushrooms (Shiitake, edible mushrooms)
- Phylum Zygomycota
  - molds (making cheese, bread molds, penicillin)
- Other fungi:
  - plant parasites (grape vines, rust on wheat, Dutch elm disease, corn smut, ergot (LSD))
  - animal parasites (yeast infections, ringworm, athlete's foot)
  - truffles
  - yeasts (brewing beers, wines, bread-making)
- _____: fungus lives with plant roots in a symbiotic relationship. Some plants cannot live without these fungi. Helps the plant get extra nutrients. Fungi lives either on the inside or the outside of the plant roots.
- _____: mutualistic associations where both species benefit from the relationship. Occurs between a fungi and an algae. The alga receives protection and water from the fungus, while the fungus is nourished by the photosynthetic products of the alga. Live in low-pollution areas.



ECOLOGICAL IMPACTS OF FUNGI

Industrial Use

- **Commercial Products**

  Organic acids: citric acid (flavoring ingredient, detergent, antioxidant of fats); Alcohols: ethyl alcohol (industrial solvent), glycerols (solvent, plasticizer); Antibiotics: Cephalosporins (antibiotic), ergot alkaloids (vasoconstrictors); Plant growth factor: Giberellic acid (growth-promoting hormone, regulate fruit setting)
- **Nutritional Supplements and Enzymes** for items such as vitamin B, enzymes such as lactose and protease
- **Food Processing** (Yeast) used to make bread, wine, beer, and cheeses

Chapter 16: Plants, Fungi, and the Move onto Land, *continued*

Review of Fungi

Part I

Match the term with the correct words:

_____1. mycorrhiza	A. this carbohydrate composes the cell walls of fungi
_____2. mycelium	B. reproductive structure of some fungi which is made of hyphae
_____3. hyphae	C. mutualistic, symbiotic associations between fungi and algae
_____4. chitin	D. fungus lives with plant roots in a symbiotic relationship
_____5. mushroom	E. tangled mass or network of hyphae which make up the body of the fungus
_____6. lichens	F. these filamentous cells constitute the fungus
_____7. spores	G. reproductive cells released from a fungus to carry on the next generation

Answers: 1D, 2E, 3F, 4A, 5B, 6C, 7G

Part II

Match each of these descriptions of fungi with the correct word.

_____1. Single cell of a fungus is known as:	A. eukaryotes
_____2. This mass of hyphal cells constitutes the body of the fungus	B. heterotroph
_____3. Fungi are classified as ____ because they're made of many cells	C. hyphae
_____4. The fungi are called ____ because they consumer other organisms.	D. lichens
_____5. A symbiotic, mutualistic relationship between fungi and algae is called:	E. multicellular
_____6. Fungi contain organelles and a nucleus, so they are ____.	F. mycelium

Answers: 1C, 2F, 3F, 4B, 5D, 6A

For Discussion

1. Describe how plants and fungi are similar.
2. Describe how plants and fungi are different.
3. Why do you think that plants and fungi should be placed into different kingdoms? Cite some reasons or characteristics to support your answer.
4. Describe how nutrition differs for plants and fungi.
5. Do fungi have roots and stems just like the plants? Explain.

Think about these questions; if you have any trouble answering them, come see me!

Chapter 17: The Evolution of Animals

CHARACTERISTICS OF ANIMALS

What is an animal?

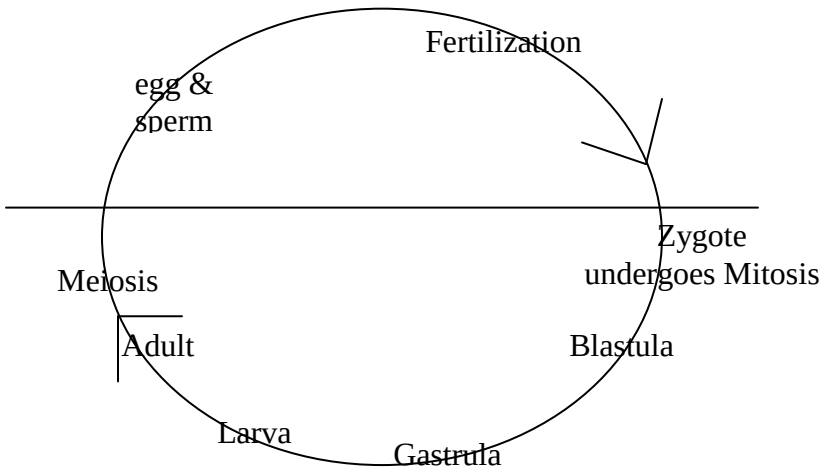
- eukaryotic: means that the animal has a true _____ and _____
- multicellular: in most, cells form tissues that are arranged as organs and organ systems
- _____: must obtain carbon and energy by consuming other organisms; most take food into their bodies and digest it there
- requires _____ for aerobic respiration
- most are _____ at some point in the life cycle; some spend their lives as sessile
- most have a digestive tract (internal cavity or tube where enzymes are secreted & digestion occurs)
- all lack cell _____ that are found in plants, some protists, and fungi
- most are _____ (2N), no alternation of generations, sexual reproduction occurs mostly
- life cycle includes embryonic development

  zygote → blastula → gastrula → larva → adult

  - egg and sperm fuse to form **zygotes**, which undergo mitosis
  - **blastula**: early stage of development; hollow ball of cells. In some, such as sea star and other animals, one side of the blastula will fold inward, forming a gastrula
  - **gastrula**: looks like an indented blastula; after the gastrula, many animals develop into adults; however some go through larval stages
  - **larva**: an immature individuals that looks very different from an adult; the larva metamorphoses and becomes an adult

BASIC ANIMAL LIFE CYCLE BASED ON SEA STAR DEVELOPMENT

Indicate which cells are diploid or haploid on this animal life cycle.



Chapter 17: The Evolution of Animals, *continued*

FOUR KEY EVOLUTIONARY TRENDS IN ANIMAL DEVELOPMENT AND EVOLUTION

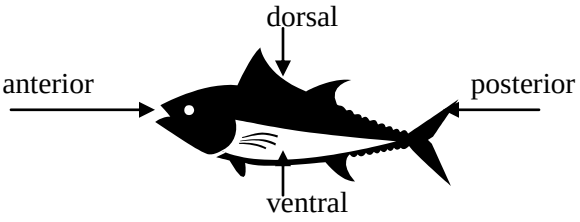
1. **Structural complexity**: presence of complex _____ and organs.

2. **Body symmetry** progresses through lower order animals to higher order animals from:

no symmetry → radial → bilateral

less highly evolved → more highly evolved

- **Radial Symmetry**: the body parts are arranged like pieces of a pie around an imaginary central axis, spokes of a wheel. This is a primitive arrangement of the body.
- **Bilateral Symmetry***:* Mirror images on the right and left sides. Allows for the creation of regions of the body as well as a distinct head region:



1. head, or **anterior**
2. tail, or **posterior**
3. back, or **dorsal** surface
4. bottom, or **ventral** surface
5. sides, or **lateral** surfaces
6. along with trend to bilateral symmetry goes **cephalization** (formation of a head).

3. **Coelom** (pronounced "see-lum") is a fluid-filled cavity & an important evolutionary step.
   - The coelom provided space for organ systems to develop or to operate more efficiently.
   - A **pseudocoelom** ("false coelom") has a body cavity but no membrane

   Advantages of Coeloms
   - flexibility
   - internal organ growth, movement, development, cushioning
   - prevention of internal injury

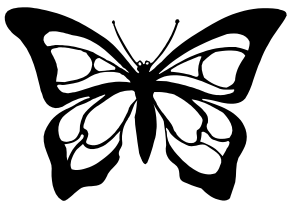
4. **Method of Embryonic Development**:
   - **Protostomes**: mouth develops _____.

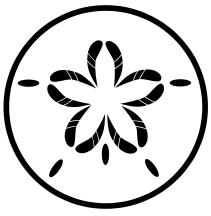
     Examples: _____
   - **Deuterostomes**: mouth develops _____.

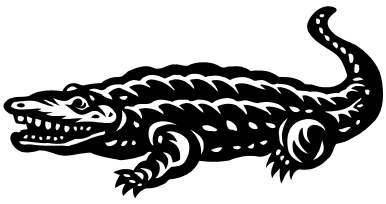
     Examples: _____

Determine which animals, below, have no symmetry, radial symmetry, or bilateral symmetry.

For the alligator, identify the anterior, posterior, dorsal, and ventral surfaces.







Chapter 17: The Evolution of Animals, *continued*

KINGDOM ANIMALIA

Invertebrates are animals without _____

Phylum Porifera: Sponges

Characteristics and Body Plan

1. Sessile = _____, filter feeders
2. Most have three loosely associated layers of cells; lack specialized tissues
3. **Specialized Cells**

   a. Motile cells called **amoebocytes** which move by pseudopods. These cells can: 1) digest and distribute food; 2) transport oxygen; 3) dispose of wastes; 4) manufacture skeletal elements; 5) even change into other cell types

   b. Skeletal elements composed or protein or mineral-containing particles composed of **spongin** fibers and **spicules** of calcium of silica provide support and protect the sponge

   c. Flagellated cells, called **choanocytes** or collar cells, to propel water through the body and strain food particles.

      1. at the base of the choanocyte is a collar-like ring surrounding the base of the flagellum
      2. water is expelled through the _____ (opening)

Feeding and Method

1. Filter feed food particles such as bacteria in the water through the osculum (opening) which leads to a central cavity
2. Choanocyte traps bacteria in mucus on its collar, then engulfs the food by phagocytosis (food engulfing)
3. The amoebocytes pick up food packaged in food vacuoles from the choanocytes. They digest it and carry the nutrients to other cells.

What makes the sponges a primitive, simple organism?

1. _____
2. _____
3. _____
4. lack a gastrula stage of development
5. 3 cells layers are not homologous to other animals

Additional Notes: _____

_____

Chapter 17: The Evolution of Animals, *continued*

KINGDOM ANIMALIA
Invertebrates, *Continued*

Phylum Cnidaria: Jellyfish, Corals, Sea Anemones, Hydra

Characteristics and Body Plan

1. Radial symmetrical carnivores with 2 body forms.
2. Body plan takes two forms:
   a. **polyp** body form is stationary with tentacles
   b. **medusa** body form is like the jellyfish; still radial symmetry, but can move freely about in water
3. **Tissues**: nerve cells detect stimuli and activate responses
4. Special stinging cells known as **cnidocytes** (**nematocysts**): are stinger cells found on tentacles of both polyps and medusa.

   Structure

   a. fine thread coiled within a capsule
   b. when discharged, it can sting or entangle prey

   Function

   a. defense
   b. prey capture (sea anemone catch fish)

Feeding Method: Carnivorous, use tentacles to capture prey. In both forms, the mouth leads to a digestive compartment. Digestion is extracellular. Undigested food and other wastes also exit through the mouth; there is no anus; making an incomplete digestive system

Advancements over sponges

1. _____
2. _____
3. _____
4. Radial Symmetry first seen in Cnidarians

Additional Notes: _____
_____

Chapter 17: The Evolution of Animals, *continued*

KINGDOM ANIMALIA
Invertebrates, *Continued*

Phylum Platyhelminthes: Flatworms, *Planaria*

Characteristics and Body Plan

1. Development of true organs (two or more tissues functioning as a unit) as well as the presence of a head (cephalization). Cephalization leads to bilateral symmetry.
    a. **Digestive Organs**: incomplete digestive tract; has a mouth but lacks an anus
    b. **Muscle**: layers of contractile muscles below the epidermis together with cilia--function in locomotion in planaria (flatworms).
    c. **Nervous**: brain, nerve cords, lateral nerves, light-sensitive eye spots

3 Main Classes

1. **Flatworms**: flat, ribbon or leaflike animals such as *Planaria*
    Free-living flatworms, such as planarian, live on the undersurfaces of rocks in freshwater
2. **Flukes**: *Schistosoma*, called Trematoma
    Parasitic: lives on or in a living organism. Blood flukes can infect humans and cause a disease called schistosomiasis (blood fluke disease). Suckers attach to the host, such as the blood vessels near the host's intestines
3. **Tapeworms**
    Parasitic: of vertebrate intestines (reptiles, birds, mammals). They have no digestive tract of their own. Absorb nutrients across the body surface from the host's partially digested food in the intestines.

Advancements over sponges and cnidarians

1. Bilateral Symmetry
2. Cephalization
3. _____

Additional Notes: _____

_____

Chapter 17: The Evolution of Animals, *continued*

KINGDOM ANIMALIA
Invertebrates, *Continued*

Phylum Nematoda: Roundworms

Characteristics and Body Plan

1. Bilateral Symmetry
2. Cuticle covers the body to resist drying out and crushing.
3. Coelom is a fluid-filled space between the inner and outer tissue layers; acts as a hydroskeleton. Internal space is in direct contact with the wall of the digestive tract. Outer edge contacts a muscle layer part of the body wall.
    a. the development of a coelom in more complex animals follows
    b. allowed the development of a closed circulatory system
    c. provided a fluid-filled cavity in which organs could be suspended.
4. Complete digestive tract but no circulatory system

Examples

1. One species that infects humans produces thin, serpentlike ridges at the surface of skin. For thousands of years, healers removed the "serpents" by winding them out slowly, painfully, around a stick. Thus, the symbol of the medical profession continues to be a serpent wound around a staff.
2. *Trichonella*, causes trichonosis. Contracted from eating uncooked pork with juvenile worms which can penetrate heart muscle (heart transplant may be necessary!)
3. *Wuchereria bancrofti*, a roundworm that causes elephantitis

Advancements over previous phyla

1. Pseudocoelom: _____
2. _____
3. _____

Additional Notes: _____

_____

Chapter 17: The Evolution of Animals, *continued*

KINGDOM ANIMALIA
Invertebrates, *Continued*

Phylum Mollusca: "soft-bodied" snails, octopuses, clams, slugs, squids, scallops, oysters

Characteristics and Body Plan

1. bilaterally symmetrical body plan
2. muscular head-foot for locomotion
3. Mantle
   a. Mantle covers the body, may secrete a shell in clams, snails
   b. Mantle functions in respiration, waste disposal, and sensory reception
   c. Creates mantle cavity, which houses a gill in some mollusks
4. The _____extracts oxygen dissolved in water and may dispose of wastes
5. _____is a rasping organ used to scrape up food (algae)
6. Mollusks are the first to have a _____ (consists of 3 small cavities)
7. Mollusks are the first to have a **true** _____ **system**-an organ system that distributes nutrients and water throughout the body

3 Main Classes

1. **Class Gastropoda**: "belly-foot": snail, sea slug, slug
   Live in fresh, salt water and terrestrial environments; the only mollusks that live on land. Have a well-defined head, tentacles, and elongated flattened foot
2. **Class Bivalves**: "folding door": clams, oysters, mussels, scallops
   Live in marine and freshwater sedentary in sand or mud. Feed as filter feeders. The body is flattened between two valves of a hinged shell. Foot is used for digging and anchoring. Mucus-coated gills trap food particles in water.
3. **Class Cephalopoda**: "head-foot": octopus, squid
   Built for speed and agility; so the shell is mostly small and internal (squid) or missing (octopus). Beaklike jaws for predation and radula to crush or rip prey apart. All have large brains and developed sense organs--most complex nervous system among invertebrates. Foot is modified into 8 or 10 arms, each studded with suckers, and terminates in a funnel, or siphon.

Advancements over previous phyla

1. Coelom
2. _____
3. _____

Additional Notes: _____

_____

Chapter 17: The Evolution of Animals, *continued*

KINGDOM ANIMALIA
Invertebrates, *Continued*

Phylum Annelida: Segmented Worms like earthworms, leeches

Characteristics and Body Plan

1. Coelom and presence of organ systems.
2. Segmented body which allows for the repetition and presence of nerve cells in each segment and excretory organs are repeated in each segment.
3. Bilateral symmetry
4. Cephalization
5. Complete gut tube with _____ and _____

Reproduction: sexual reproduction. Marine worms shed sperm and egg into sea water. Earthworms and leeches are hermaphrodites; pairs reciprocally fertilize each other by swapping sperm.

3 Main Classes

1. **Class Oligochaeta:** earthworms

   Presence of _____--these are bristles on each segment used in moving the earthworm. Setae are important in carrying top soil to the surface
2. **Class Polychaetes**: "many-hairs;" includes the fireworms, clam worms, feather dusters

   Colorful marine worms that burrow into the mud or sand
3. **Class Hirudinea:** leeches

   Live as free-living carnivores or parasites on worms and mollusks; some parasitize large animals and suck their blood; can go 9 months between meals. They have razorlike jaws and saliva containing a strong anesthetic and anticoagulant. So, they can make a painless bite through the skin.

Advancements over previous phyla

1. Segmentation
2. Closed Circulatory System

Additional Notes: _____

_____

Chapter 17: The Evolution of Animals, *continued*

KINGDOM ANIMALIA
Invertebrates, *Continued*

Phylum Arthropoda ("*jointed foot*"): crayfish, lobsters, crabs, barnacles, spiders, ticks, insects

Characteristics and Body Plan

1. Exoskeleton made of _____, a polysaccharide + proteins
2. Distinct segments
   a. head
   b. thorax (usually bearing 3 pairs of legs and 2 pairs of wings)
   c. abdomen

Four Main Groups

1. **Arachnids:** scorpions, spiders, ticks, mites; related to horseshoe crab

   Have specialized pairs of legs: 1) first pair is modified into chelicerae, poison fangs, for defense or prey; 2) pedipalps, the second pair, holds the prey while the spider injects poison or enzymes; 3) spinnerets are silk-spinning organs at the rear of the abdomen; these threads that are size for size, stronger than steel

2. **Crustaceans:** lobsters, crayfish, crabs, shrimp, barnacles

   Almost all of these organisms have an exoskeleton, called a carapace, hardened with calcium salts.

3. **Millipedes and Centipedes**

   These organisms have segments like earthworms, but jointed legs classify them as arthropods.
   Millipedes: wormlike, eat decaying plant matter; 2 pairs of legs per segment; slow-moving.
   Centipedes: terrestrial carnivores; pair of poison claws for defense or prey; 1 pair of legs per segment.

4. **Insects**: grasshopper, cricket, locust, cockroach, mantis, dragonflies, damselflies, bedbugs, plant bugs, water striders, beetles, moths, butterflies, fruit flies, houseflies, gnats, mosquitoes, ants, bees, wasps

   Most successful class of animals on earth because it is the largest group. For most insects (butterflies, flies, beetles), the embryo develops into:

   1. larva
   2. transitional stage, or pupa, sometimes in a cocoon
   3. metamorphosis takes place in the body within the pupal exoskeleton
   4. mature adult, nonmolting, appears

   Insects that metamorphose have larva and adults that eat very differently and are adapted to different environmental conditions; may make it successful in climate changes.

Advancements over previous phyla

1. _____
2. Jointed Appendages

Additional Notes: _____

_____

Chapter 17: The Evolution of Animals, *continued*

KINGDOM ANIMALIA
Invertebrates, *Continued*

Phylum Echinodermata: sea urchins, sea stars, and sea cucumbers

Characteristics and Body Plan

1. Rough or spiny skin come from plates or spines which are parts of internal _____ of calcium carbonate.
2. _____ is unique to echinoderms. It's a network of water-filled canals that branch into tube feet. There are suction cup tube feet for locomotion, gas exchange.
3. Starfish/sea star's mouth is centrally located on undersurface. When feeding, the stomach is pushed out through the mouth.

Relationship to Vertebrates

More closely related to vertebrates than invertebrates based on studies of embryonic development.

Not closely related to cnidarians or other animals that never show bilateral symmetry

Primitive characteristics

1. Lack body segments, therefore they have no _____ with no _____
2. Pentaradial symmetry as adults; _____ symmetry as larvae

Additional Notes: _____

_____

KINGDOM ANIMALIA
Phylum Chordata • The Vertebrates

Characteristics and Body Plan: Features present at some stage in chordate's life history

1. Dorsal hollow nerve cord
2. Notochord: a flexible rod that is extended between digestive tract and nerve cord
3. Pharyngeal slits (_____ structures around the throat)
4. Post-anal _____.

Vertebrate Characteristics

Vertebrates retain the characteristics of the chordates, with a few distinguishing characteristics:

1. Vertebral column which replaces the notochord. Composed of an endoskeleton is made of cartilage, or hard bone and cartilage.
2. Possess well-defined organs and some degree of segmentation
3. Pronounced cephalization with sense organs and brain at front end.

Chapter 17: The Evolution of Animals, *continued*

KINGDOM ANIMALIA
Vertebrates, *Continued*

Phylum Chordata

Three Classes of Fishes {Agnatha, Chondrichthyes, Osteichthyes}

1. **Class Agnatha:** Jawless Fish like agnathans or lampreys

   Lampreys: Feed by boring a hole in the side of a fish and sucking the blood. A toothed, sucking disk is an unhinged, circular mouth outgrowth. Agnathans gave rise to two groups of jawed fishes: 1) Chondrichthyes (cartilaginous fish) and 2) Osteichthyes (bony fish)

2. **Class Chondrichthyes**: (Cartilaginous Fishes) sharks, sting rays, skates. General features:
   1. Gills: extract oxygen from water
   2. Hinged jaws
   3. Paired forefins and hindfins: maneuver body when swimming
   4. Cartilaginous skeleton
   5. Sharks have a _____ sensory organs running along each side of the body. Used to sense pressure changes and detect minor vibrations in the water.

3. **Class Osteichthyes**: (Bony Fishes) trout, goldfish, tuna, mackeral, bass. General features:
   1. Stiff skeleton reinforced by calcium salts
   2. Also have a lateral line system
   3. Keen sense of smell, sight
   4. _____ on each side of head covers a chamber housing the gills. The movement of operculum allows fish to breathe without swimming. Sharks lack opercula and must swim to move water over gills.
   5. _____ is a gas-filled sac which helps keep them buoyant and allows them to adjust the swimming depth.

4. **Class Amphibia** ("double-life"): frogs, salamanders, toads, newts. General features:
   1. Amphibians require _____ for reproduction and embryonic development (eggs).
   2. **Larva**, a tadpole resembles fish, versus the **Adult** which lives on land:

1) gills	1) lungs
2) no legs	2) 4 legs
3) algae-eaters	3) insect-eaters
4) lateral line system	4) no lateral line system
5) long, finned tail	5) external eardrums

   Need to solve some problems for life on land:
   1. Dehydration – amphibians have moist skin
   2. Lack of buoyant support (no water to support your body's weight) – amphibians have legs
   3. Fertilization – amphibians lay their eggs in water

Chapter 17: The Evolution of Animals, *continued*

KINGDOM ANIMALIA
Vertebrates, *Continued*

Phylum Chordata

4. **Class Reptilia**: lizards, snakes, turtles, alligators, and crocodiles

   Advances over Amphibians

   1. Reptilian skin is covered with scales waterproofed with protein, _____

   2. Eggs are covered with tough shells that retain water in a sac called the amnion. The eggs have a yolk sac to nourish the embryo during its development.

   General Characteristics

   1. _____: embryo develops within a drought-resistant, protective, fluid-filled sac called the amnion. Now, reptiles do not have to lay eggs in water.

   2. Cold-blooded: _____ means that the organism does not use metabolism to control body temperature.

5. **Class Aves**: birds

   General Characteristics

   1. More similar to _____ because of these characteristics:

      amniotic eggs — scales on legs

      toenails containing keratin — general body form

   Innovations for Flight

   1. Feathers

   2. Other modifications for light weight:

      lack teeth — tail is supported by only a few small vertebrae

      wings — lack claws

      feathers have hollow shafts, some bones are hollow and contain air sacs

      large flight (breast) muscles anchored to keel-like breastbone

   3. Requirements for flight:

      energy-have a high rate of metabolism

      _____ feathers and body fat help maintain body temperature

      highly efficient circulatory system

      lungs are efficient at extracting oxygen from air; they have air sacs

Chapter 17: The Evolution of Animals, *continued*

KINGDOM ANIMALIA
Vertebrates, *Continued*

Phylum Chordata

6. **Class Mammalia**: kangaroo, human, dog, bat, mouse

   General Characteristics

   1. Endothermic: high rate of metabolism
   2. Hair is made of keratin
   3. Mammary glands produce milk to nourish young

   - **Three Classes of Mammals**

   1. **Monotremes**: duck-billed platypus and spiny anteater

   _____-laying mammals warm the eggs till they hatch; the young suckle the mother's milk

   2. **Marsupials**: pouched mammals: kangaroos, opossums, koala bears

   Give birth to tiny, embryonic offspring that complete development in the _____. Housed in a _____, a pouch on mother's abdomen

   3. **Placentals**: embryos are nurtured inside the mother by an organ called the _____. Most mammals have this reproductive structure. A placenta consists of embryonic and material tissues that joins the embryo to the mother within the uterus.

Chapter 17: The Evolution of Animals, *continued*

Review of Invertebrates

Use the textbook to help match these characteristics with the correct phylum.

_____1. Jointed appendages first appeared in this phylum
_____2. Phylum with stinging cells called nematocysts
_____3. Most simple invertebrate group with no organs
_____4. Phylum with animals that secrete 1, 2, or no shells
_____5. Segmentation of parts first appeared in this phylum
_____6. First to have an appearance of a true coelom
_____7. Radial symmetry first appeared in this phylum
_____8. Spiny-skinned organisms with a water vascular system for movement
_____9. Phylum with a mixture of primitive and advanced characteristics
_____10. Phylum with four major characteristics including a post-anal tail, gill slits, dorsal hollow nerve cord.

A. Annelida
B. Arthropods
C. Chordates
D. Cnidarians
E. Echinoderms
F. Flatworms
G. Mollusks
H. Roundworms
I. Sponges

Answers: 1B, 2D, 3I, 4G, 5A, 6G, 7D, 8E, 9E, 10C

Examples

Match each group of examples to its phylum, using the Letters A-I, above.

_____1. tapeworms, blood flukes
_____2. grasshopper, cricket
_____3. *Planaria*
_____4. jellyfish
_____5. starfish, sea urchin, sand dollar
_____6. earthworm, leeches
_____7. snail, slug, octopus
_____8. bee, wasp, fly
_____9. clam, oyster
_____10. shrimp, spider, mite,tick
_____11. sponges
_____12. roundworms
_____13. corals, hydras
_____14. moth, butterfly

Answers: 1F, 2B, 3F, 4D, 5E, 6A, 7G, 8B, 9G, 10B, 11I, 12H, 13D, 14B

For Discussion

1. Describe the three classes of mollusks.
2. Describe how segmentation is considered an advantage for animal development.
3. List and describe the four characteristics of Phylum Chordata.
4. What major feature differentiates invertebrates from vertebrates?
5. Discuss the four evolutionary advancements seen in animals and apply these advancements to the phylum in which they first appear.
6. Compare the different classes of arthropods.
7. Explain why sponges are considered to be so simple.
8. Do any invertebrates have a skeleton? If so, describe these simple skeletons.

Think about these questions; if you have any trouble answering them, come see me!

Chapter 17: The Evolution of Animals, *continued*

Review of Phylum Chordata: The Vertebrates

Use the textbook to help match these characteristics with the correct class.

_____1. Class which contains the first endotherms
_____2. Class which contains the ectotherms
_____3. Type of fish with skeleton made of cartilage
_____4. Spend part of life on water; part on land
_____5. First to lay eggs in shells on land
_____6. Placentals, marsupials, and monotremes
_____7. Jawless fish
_____8. Warm blooded, hair, mammary glands
_____9. Modifications for flight include lighter bones, no teeth, no claws
_____10. First to have legs to walk on land
_____11. First appearance of jaws
_____12. Lateral line system, air bladder, operculum

A. Agnathans
B. Amphibians
C. Birds
D. Bony Fish
E. Cartilaginous Fish
F. Mammals
G. Reptiles

Answers: 1C, 2G, 3E, 4B, 5G, 6F, 7A, 8F, 9C, 10B, 11E, 12D

Examples

Match each group of examples to its class, using the Letters A-G, above.

_____1. turtles and lizards
_____2. sharks and stingrays
_____3. pigs, dogs, cows
_____4. lampreys
_____5. goldfish, tuna, flounder
_____6. finches, robin, eagle, sparrow
_____7. frogs and toads
_____8. crocodiles and alligators
_____9. humans and gorillas
_____10. newts and salamanders
_____11. kangaroos and opossum
_____12. hawk, ostrich
_____13. bats, sloths, monkeys
_____14. duck-billed platypus

Answers: 1G, 2E, 3F, 4A, 5D, 6C, 7B, 8G, 9F, 10B, 11F, 12C, 13F, 14F

For Discussion

1. Describe the adaptations reptiles needed for life on land to be successful.
2. Why are fish, birds, reptiles, and mammals classified into the same phylum?
3. Compare and contrast the three groups of mammals.
4. Describe the modifications in birds for flight.
5. Explain how being an endotherm affects an animal's life.
6. Discuss why birds seem to be more closely related to reptiles.
7. Compare amphibians' larval stage to bony fish.
8. Describe the amniotic egg and explain what it allows animals to do.

Think about these questions; if you have any trouble answering them, come see me!

Chapter 21: Unifying Concepts of Animal Structure and Function

ANATOMY AND PHYSIOLOGY

Define anatomy:_____

_____

_____

- **Gross or Macroscopic Anatomy**: the "big picture" of the body; anatomy seen with the naked eye
- **Microscopic Anatomy**: need microscope or other device to view the cells or tissues of the body

Examples: structure of a muscle, layers of the stomach, components of compact bone

Define physiology: _____

_____

_____

Examples: how the kidney regulates what enters the blood stream, the physiology of muscle contraction

What is the relationship between anatomy and physiology?_____

_____

_____

TISSUES

Remember the organizational scheme of the body:

cells→tissues→organs→organ system→organisms

Tissues are a cooperative unit of many very similar cells that perform a special function. Latin, "to weave." Tissues are composed of cells. Tissues compose organs; which in turn compose organ systems; organ systems compose the organism.

Histology = study of tissues.

Four Major Tissue Groups

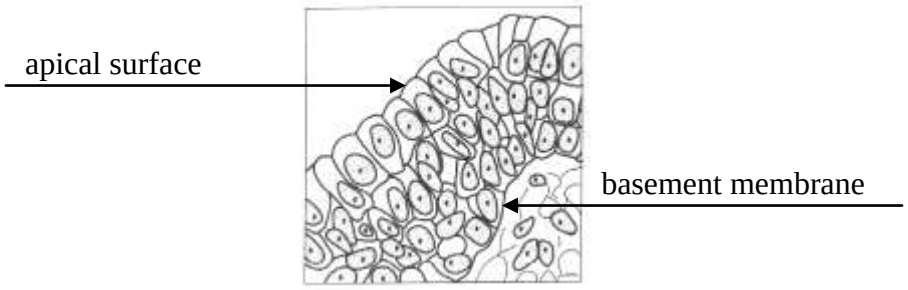
1. Epithelial Tissue
2. Connective Tissue
3. Muscle Tissue
4. Nervous Tissue

Chapter 21: Unifying Concepts of Animal Structure and Function, *continued*

EPITHELIAL TISSUE

a. **Structure (Morphology):** Epithelial tissue occurs in sheets of cells.

- Upper free surface, is called the _____.
- Deeper surface is attached to tissue beneath, called a _____.



- *Avascular* – because there are **no** blood vessels…blood supply reaches these cells by diffusion.
- *Innervated* – a nerve runs through the tissue (notice how your arm hairs stand on end when cold!)

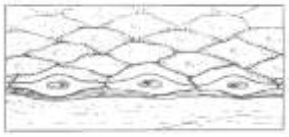
b. **Where would you find this tissue?**

- Dry areas, such as covering outside of body = _____
- Moist areas, such as lining internal cavities that open to the outside = respiratory system, urinary system, digestive system (mouth to anus), female's reproductive system
- Lining both endocrine and exocrine glands

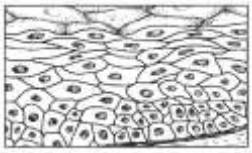
c. **Function:** cover and line body surfaces; built for secretion, absorption, filtration, and diffusion

d. **How is epithelial tissue named and classified?**

1. Number of cell layers (1 or more)
   a. _____ epithelium has 1 layer of cells



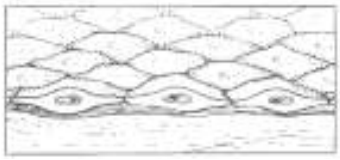
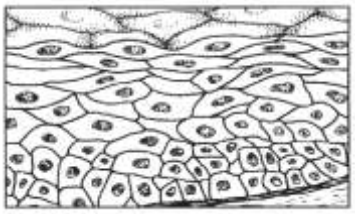
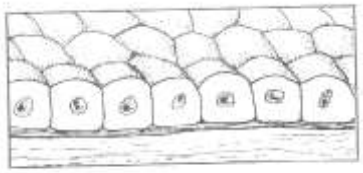
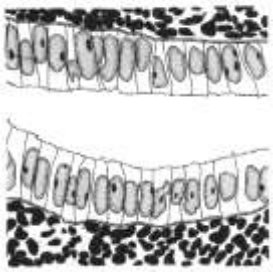
   b. _____ epithelium has 2 or more layers of cells



2. Shape of most of the cells composing them
   a. _____: (shaped like floor tiles) 
   --nucleus is **flattened**
   b. _____: (shaped like dice) 
   --nucleus is **round**
   c. _____: (shaped like bricks or cones on end) 
   --nucleus is **oblong**

Chapter 21: Unifying Concepts of Animal Structure and Function, *continued*

EPITHELIAL TISSUE, *continued:* Specific Epithelial Tissue Types

	# Cell Layers	Characteristics	Function	Location
Simple Squamous 	_____	**Squamous** cells regenerate rapidly by division of the cells at its attached surface—true for both simple and stratified!	filtration, diffusion, and secretion	lung air sacs, capillaries, serous membranes, and blood vessels
Stratified Squamous 	_____	**Keratinized** (waterproofing protein, keratin) stratified squamous = areas such as the skin **Nonkeratinized** stratified squamous = esophagus, nose, mouth, anal canal, & vagina	covers and lines surfaces subject to abrasion	skin, esophagus, inside nose, mouth, anal canal, vagina
Simple cuboidal 	_____	Found frequently in **glands** (salivary, thyroid, pancreas) where it functions in secretion.	secretion and absorption	_____ _____ _____ _____
Simple columnar 	_____	Has **goblet cells** which produce mucus. Has modifications known as **villi** cells which help to increase surface area.	secretion and absorption	stomach, small intestine, large intestine, fallopian tube (ciliated)

Chapter 21: Unifying Concepts of Animal Structure and Function, *continued*

CONNECTIVE TISSUE

a. **Structure**: sparse cells scattered through a nonliving substance called a _____; the cells synthesize the matrix, usually a web of fibers embedded in a liquid, jelly, or solid matrix.

b. **Function**: connect, protect, and provide structure/support for the body

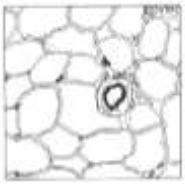
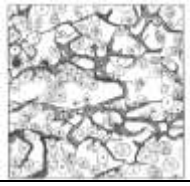
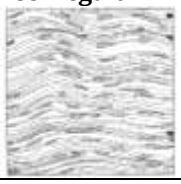
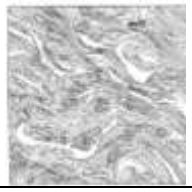
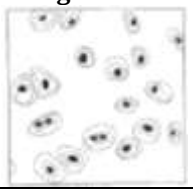
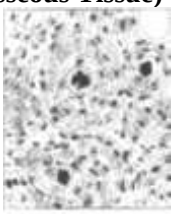
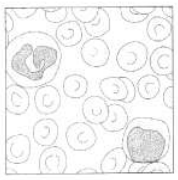
- connects: ligaments and tendons connect muscle to bone and bone to bone
- protects: bones protect delicate organs such as the brain, spinal cord, and heart/lungs
- structure: cartilage provides flexible support for the ear, nose, and between vertebrae

c. **Types of Connective Tissue**

- **Loose Connective Tissue Types**
  - loose aerolar
  - loose adipose
  - loose reticular
- **Dense Connective Tissue Types**
  - dense regular
  - dense irregular
- **Cartilage**
  - hyaline cartilage
  - elastic cartilage
  - fibrocartilage
- **Compact Bone**
- **Blood**

Chapter 21: Unifying Concepts of Animal Structure and Function, *continued*

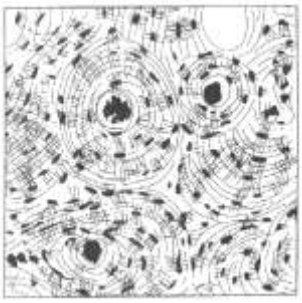
CONNECTIVE TISSUE, *continued*: Specific Connective Tissue Types

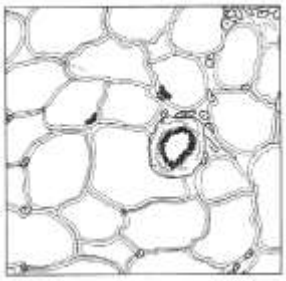
	Function	Location
Loose Areolar 	binding and packing material; holding other tissues and organs in place	directly under the skin, binds skin to muscle
Loose Adipose 	contains lipids (fat); cell swells when fat is stored; shrinks when fat is used as fuel	_____ _____
Loose Reticular 	acts as a "tissue skeleton"	liver, lymph nodes, bone marrow, spleen
Dense Regular 	forms tendons (holds muscles to bone) and ligaments (join bones together)	in joints as tendon and ligaments
Dense Irregular 	_____ _____	dermis of skin (also called fascia)
Cartilage 	forms a strong, flexible skeletal material; lacks nerves and is avascular	ears, between the vertebrae, ribs, nose, embryonic skeleton
Compact Bone (Osseous Tissue) 	protection, support, movement, hematopoesis (blood cell formation)	bones
Blood 	transportation of blood gases, nutrients, wastes, hormones, amino acids, proteins, etc.	traveling in the blood vessels of the cardiovascular system

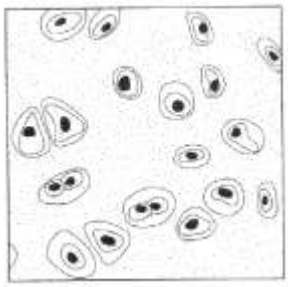
Chapter 21: Unifying Concepts of Animal Structure and Function, *continued*

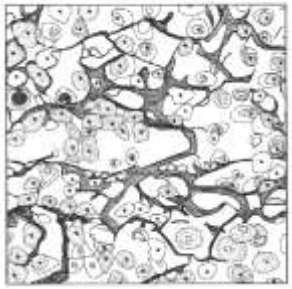
IDENTIFY THESE CONNECTIVE TISSUES

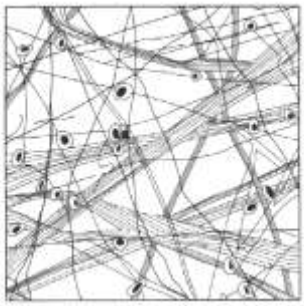
Label each specific type. For example, say: "hyaline cartilage connective tissue"

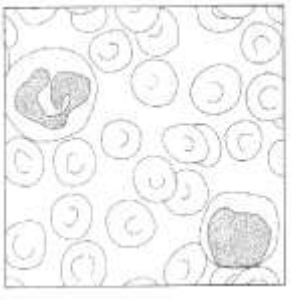










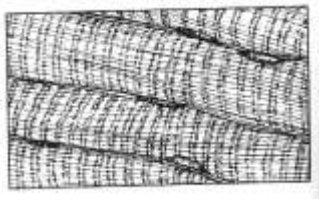
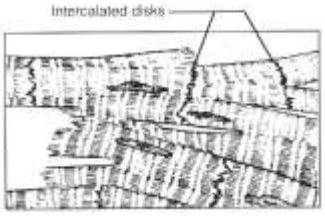
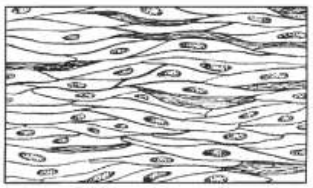


Chapter 21: Unifying Concepts of Animal Structure and Function, *continued*

MUSCLE TISSUE

a. **Structure**
   1. bundles of long, cylindrical cells called muscle fibers
   2. most abundant tissue in a typical animal

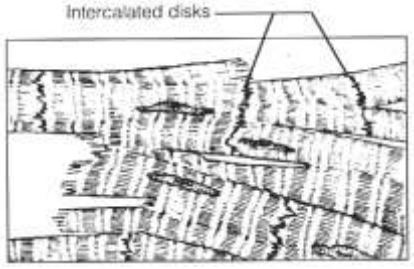
b. **Function**
   1. movement of…
      a. the skeleton (skeletal muscle)
      b. substances such as blood, urine, food, etc. (smooth muscle)
      c. blood through the heart (cardiac muscle)
   2. generate heat through the conversion of glucose and oxygen into ATP

	Control?	Characteristics	Function	Location
Skeletal Muscle 	voluntary	**striations** due to light and dark banding patterns **cylindrical cells** **multinucleate**	move bones, & make facial expressions	attached to bones
Cardiac Muscle 	involuntary	**striations** **branched cells** separate fibers that are bound end to end with **intercalated disks**	contract the heart to pump blood through vessels	heart
Smooth Muscle 	involuntary	**NO striations** **spindle-shaped cells** **uninucleate**	contract to push substances through the tubes of the body	walls of hollow organs of digestive tract, bladder, vessels

Chapter 21: Unifying Concepts of Animal Structure and Function, *continued*

IDENTIFYING MUSCLE TISSUE

Label each specific type: For example, say: "skeletal muscle tissue"



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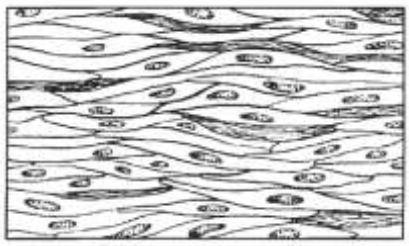

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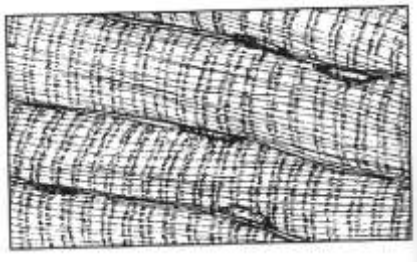
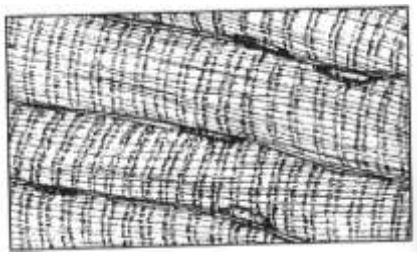


_____

Identify the **striations** *in this muscle tissue. Identify the* **nuclei.**



Chapter 21: Unifying Concepts of Animal Structure and Function, *continued*

NERVOUS TISSUE

a. **Structure**

1. _____ are nerve cells which conduct nerve signals

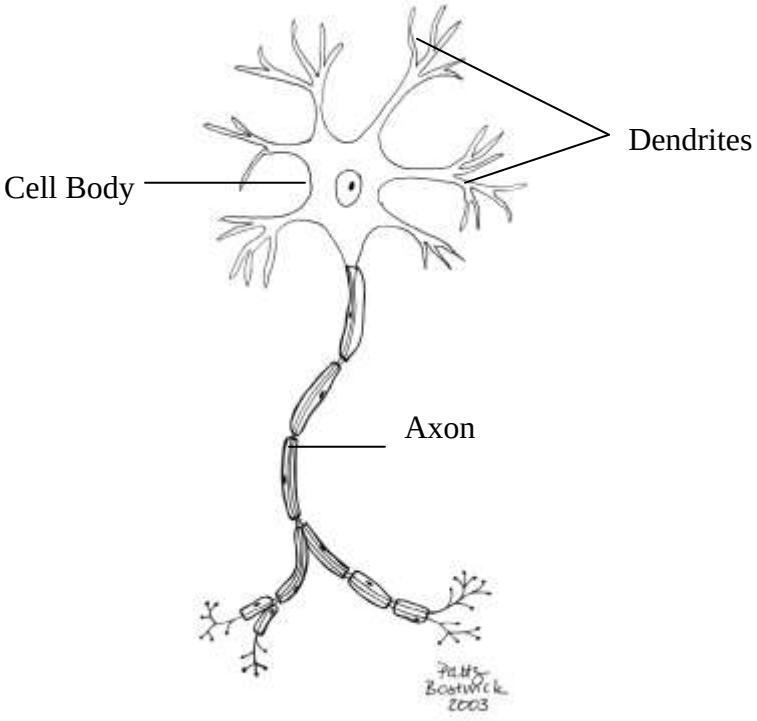
   a. _____ is the portion of the neuron which conducts messages away from the cell body.

   b. _____ are the portions of the neuron that conduct messages toward the cell body.

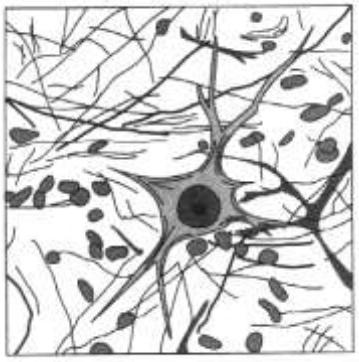
   c. The cell body is the site of the nucleus and metabolic center of the nerve cell.

b. **Function**: can be summarized by these two functional characteristics: _____ and _____

1. senses stimuli
2. determines and directs responses
3. enables body's parts to function as a whole
4. transmits nerve signals from 1 part of the body to another via neurons



Motor Neuron (Nerve Cell)



Nervous Tissue

Chapter 21: Unifying Concepts of Animal Structure and Function, *continued*

Review of the 4 Tissue Types, *Continued*

Identify each of these descriptions as epithelial, connective, muscle, or nervous tissue or the specific type.

_____1. general type of tissue that has a matrix

_____2. general type of tissue that has a basement membrane and apical surface

_____3. general type of tissue that conducts electrical impulses

_____4. general type of tissue that moves the body, propels substances through the organs, moves the skeleton, and contracts the heart

_____5. general type of tissue that is described as cuboidal, squamous, columnar

_____6. general type of tissue that can be described as skeletal, cardiac, smooth

_____7. general type of tissue that can be described as simple or stratified

_____8. general type of tissue that has several different types: bone, blood, cartilage, adipose, tendons, ligaments

_____9. general type of tissue that contains neurons

_____10. general type of tissue that connects and protects

_____11. general type of tissue that lines body surfaces (both inside and outside)

_____12. general type of tissue that lines inside of digestive tract, skin

_____13. general type of tissue that connects epithelial tissue to underlying layers

_____14. specific type of connective tissue that binds skin to underlying muscle

_____15. specific type of connective tissue that stores fat

_____16. specific type of muscle tissue that moves the skeleton and bones

_____17. specific type of muscle tissue that is found only in the heart

_____18. specific type of connective tissue that forms the skeleton

_____19. specific type of connective tissue that has a rubbery or jelly-like matrix

Answers: 1. connective tissue, 2. epithelial tissue, 3. nervous tissue, 4. muscle tissue, 5. epithelial tissue, 6. muscle tissue, 7. epithelial tissue, 8. connective tissue, 9. nervous tissue, 10. connective tissue, 11. epithelial tissue, 12. epithelial tissue, 13. connective tissue, 14. areolar, 15. adipose, 16. skeletal , 17. cardiac, 18. bone, 19. cartilage

Review of the 4 Tissue Types: For Discussion

1. Explain how epithelial and connective tissues different in both structure and function.
2. Compare and contrast muscle and nervous tissues.
3. Compare and contrast the different types of epithelial tissues.
4. Describe how the three types of muscle tissue are different based on their structure and function.
5. Describe the role of nervous tissue in the body.
6. Explain the role of the matrix in connective tissues.

Think about these questions; if you have trouble answering any of them, come see me!

Chapter 21: Unifying Concepts of Animal Structure and Function, *continued*

ORGAN SYSTEMS OF THE HUMAN BODY

Outer Protection: Integumentary System

Protect the inside of the body from the outside world. Another boundary is created by the plasma membrane around the substances inside of cells. This system contains the _____

Support and Movement: Muscular and Skeletal Systems

Not only do these systems allow us to move, walk, and run, but these systems propel substances through our blood vessels and digestive tracts as well.

- The muscular system contains 3 types of muscle: 1) cardiac 2) skeletal and 3) smooth.
- The skeletal system protects body parts, and consists of bones and cartilage.

Controlling the Body: Nervous and Endocrine Systems

These two systems also control **metabolism** which is defined as the sum of all chemical reactions in the body.

- The nervous system has sense organs (like the eyes and ears); we detect outside stimuli that is processed by our brain. Responsiveness is the ability to sense changes in the environment.
- The endocrine system produces chemical messengers known as _____ that help to coordinate and regulate the body's functions. The endocrine system is composed of glands such as the pancreas, adrenals, thyroid, ovaries, testes, pituitary, pineal…

Maintaining Homeostasis: Circulatory, Lymphatic, Respiratory, Digestive, and Urinary Systems

- The function of the circulatory system is to: _____ .
  The circulatory system contains these organs: _____
- Escaped fluids are returned to circulation by the lymphatic system. This system also produces cells that participate in the immune response.
- The function of the respiratory system is to: _____
  The respiratory system contains these organs: _____
- The function of the digestive system is to break food down into nutrients and disperse it via the blood. The digestive system contains the following organs: _____
  _____
- The function of the excretory (urinary) system is to: _____
  The urinary system contains these organs: _____

Reproduction: Reproductive System

- The function of the reproductive system is for males' _____ to produce sperm while females' _____ produce eggs.

Chapter 21: Unifying Concepts of Animal Structure and Function, *continued*

Review of the 11 Organ Systems

1. Name two organ systems responsible for support and movement of the body: _____

_____

2. Name the organ system that provides the outermost protection for the body: _____
3. Name two organ systems responsible for controlling the body: _____
4. Name three organ systems that take part in excreting wastes from the body: _____

_____

5. Name the organ system responsible for exchanging blood gases (oxygen and carbon dioxide): _____

_____

6. Name the organ system that moves the bones: _____
7. Name the organ system that serves as a storage site for calcium: _____
8. Name the organ system that produces eggs in females and sperm in males: _____
9. Identify the function of the cardiovascular system: _____

_____

10. Identify the function of the digestive system: _____

_____

11. List at least four organ systems that try to maintain homeostasis in the body: _____

_____

12. Describe how the nervous system and endocrine system are different in the ways they control our bodies: _____

_____

_____

13. Name the organ system that propels substances through blood vessels and the urinary tract: _____
14. Identify the system to which the heart and blood vessels belong: _____
15. Identify the system to which the lungs and trachea belong: _____
16. Identify the system to which the stomach, liver, intestines, pancreas, and mouth belong: _____
17. Identify the system to which the brain and spinal cord belong: _____
18. Identify the system to which the glands (pituitary, thyroid, pancreas) belong: _____
19. Identify the system to which the kidneys and bladder belong: _____
20. Identify the system to which the ovaries and testes belong: _____
21. Identify the system to which skin belongs: _____

Answers: 1. muscular and skeletal systems, 2. integumentary system, 3. nervous and endocrine systems, 4. urinary removes wastes from metabolism; digestive removes wastes from digestion; respiratory removes wastes from cellular respiration (carbon dioxide), 5. respiratory system, 6. muscular system, 7. skeletal system, 8. reproductive system, 9. circulates blood with blood gases, nutrients, 10. break down food and extract/absorb the nutrients into the blood stream, 11. circulatory, lymphatic, respiratory, digestive, and urinary (there are a total of 5), 12. nervous system is faster because it sends nerve impulses down nerves; the endocrine system is slower since is distributes hormones into the bloodstream to a target area, 13. muscular system, 14. circulatory system, 15. respiratory system, 16. digestive system, 17. nervous system, 18. endocrine system, 19. urinary system, 20. reproductive system, 21. integumentary system

Chapter 21: Unifying Concepts of Animal Structure and Function, *continued*

HOMEOSTASIS AND CONTROL MECHANISMS

Homeostasis ("*same, standing still*") is defined as the maintenance of a constant internal environment within the body; it's a dynamic equilibrium. The body tries to maintain its values such as temperature, blood pressure, & blood pH within a narrow range of values. To maintain proper homeostasis we need:

- nutrients
- oxygen
- water
- body temperature of 98.6 ° F

Define Negative Feedback Loop: _____ inhibits _____. The release of a product inhibits any further production to reach homeostasis. In other words, the role of the effector in negative feedback is to **cancel** the original stimulus (shut off the system).

Negative Feedback Mechanism

- **stimulus** (= input) can be either internal or external
- **sensory receptor** carries the message to the brain or spinal cord
- **regulatory center** (brain) interprets the information and turns on an effector
- **effector** (= output) glands or organs bring about a response that cancels the original stimulus

Describe an example of a Negative Feedback Loop: _____

_____

_____

_____

Other Examples:

- most hormones
- maintenance of body temperature, blood pressure

Define Positive Feedback Loop: _____ enhances _____. The effects trigger more change until homeostasis is reached. The response intensifies or enhances the original stimulus; the feedback is "positive" since you get the same action as the original stimulus. Positive feedback does not maintain homeostasis within a narrow range of values as does negative feedback. The effector **enhances** the stimulus to restore homeostasis.

Describe an example of a Positive Feedback Loop: _____

_____

_____

_____

Other Examples:

- blood clotting using platelets
- oxytocin
- chronic heart failure (CHF)

Chapter 21: Unifying Concepts of Animal Structure and Function, *continued*

Review of Negative and Positive Feedback

1. Describe how scratching an itch is an example of negative feedback._____

_____

_____

_____

2. Describe how negative and positive feedback are different. _____

_____

_____

3. Describe how sweating and shivering are ways to maintain your body's temperature via negative feedback. _____

_____

_____

4. Describe an example of positive feedback. _____

_____

_____

5. Negative and positive feedback are similar in that they are both mechanisms for maintaining _____ in the body.

6. Describe homeostasis. _____

_____

7. Describe how a thermostat illustrates the negative feedback mechanism._____

_____

_____

8. Oxytocin is an example of a _____ feedback loop because the contractions (change in the body) triggers more change (release of oxytocin by the pituitary gland) until the baby is born.

9. The regulation of blood sugar is an example of a _____ feedback loop because once the blood sugar has been restored to normal levels by insulin, the production of insulin is inhibited.

10. Explain the role of the effector in the negative feedback mechanism. _____

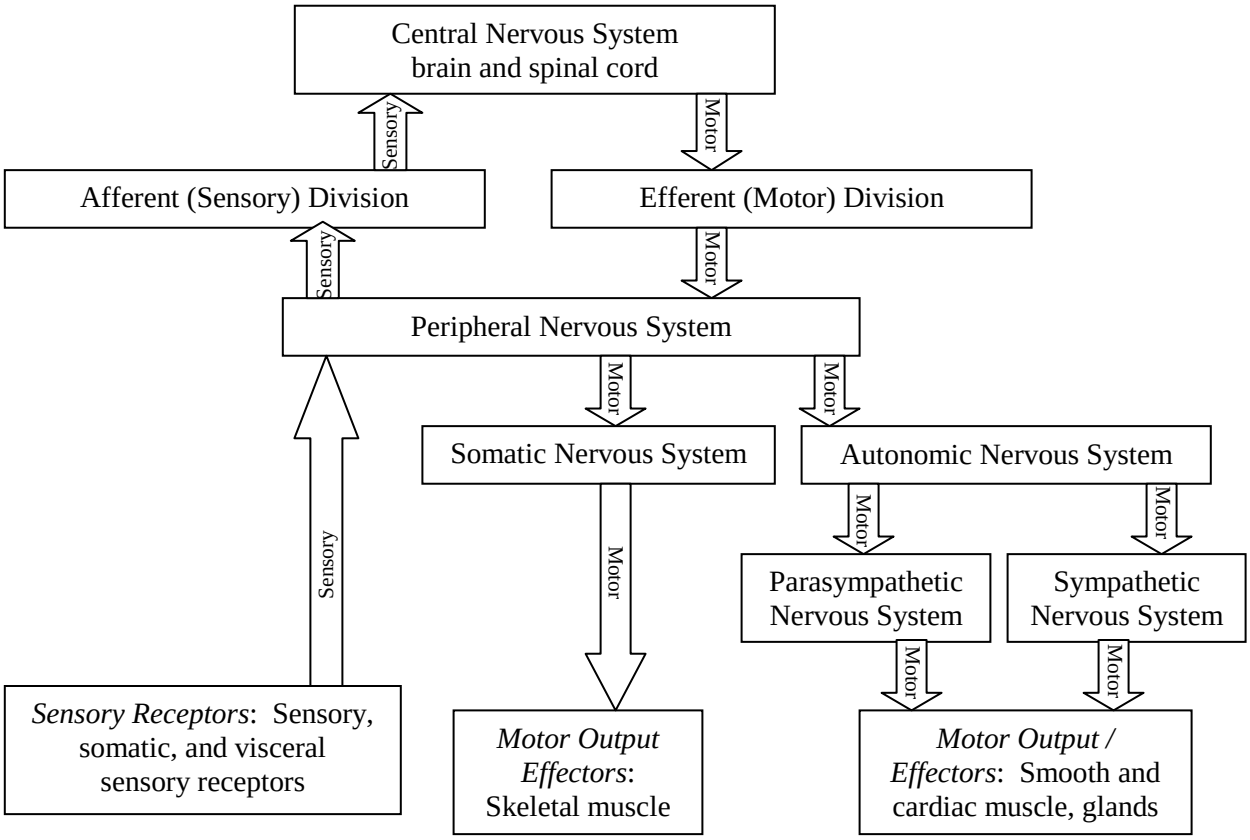
_____

_____

Think about these questions, if you have trouble answering any of them, please see your instructor!

Chapter 27: Nervous, Motor, and Sensory Systems

NERVOUS SYSTEM



	The Central Nervous System (CNS)	**The Peripheral Nervous System (PNS)**
Function	Central control; receives incoming sensory information, makes decision, and dictates motor output.	Sends sensory information to the CNS and carries out motor function received from the CNS.
Organs	Brain and spinal cord	Cranial nerves and spinal nerves
Protection	Skull and vertebrae provide bony protection. Three layers of membrane, known as meninges, also serve as protection for the brain and spinal cord. • Skull forms the **cranial** cavity; houses the brain • Vertebrae form the **spinal** cavity; house the spinal cord	No bony protection.
Subudivisions? **If so, what are they, and what are their functions?**		

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

FUNCTIONS OF THE NERVOUS SYSTEM

1. **Sensory input**: receptors in _____ and _____ send information to the brain and spinal cord in the CNS. Gather information about the internal environment of the body and external stimuli (touch, taste, sound, sight)
2. **Performs integration**: The CNS processes all incoming sensory input and sends out nerve impulses to effector organs: muscles and glands.
3. **Stimulates motor output**: The CNS sends out nerve impulses to _____ and _____. So, the muscles contract and the glands secrete.

CELLS FOUND IN NERVOUS TISSUE

A. **Neuroglial Cells**: "nerve glue," these cells support, protect, nourish neurons; do not conduct nerve impulses, never lose the ability to divide.

B. **Neurons:** conduct nerve impulses, lose the ability to divide

1. **Motor Neurons (or Efferent Neuron)**: have short dendrites and long axons. Conduct nerve impulses from interneurons and _____ the CNS to effector organs (muscles or glands) so they are said to "innervate" these structures. Motor neurons cause muscles to contract and glands to secrete.
2. **Sensory Neurons (or Afferent Neuron)**: conduct nerve impulses from the body's sensory receptors _____ the CNS. Gather information from receptors that detect information from skin, muscles, joints, or internal organs.
3. **Interneuron (or Associated or Integration Neuron)**: found only within the _____. Conducts nerve impulses between various parts of the CNS (such as from one side of brain to the other side). Has short dendrites and either a long or short axon.

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

NEURON STRUCTURE

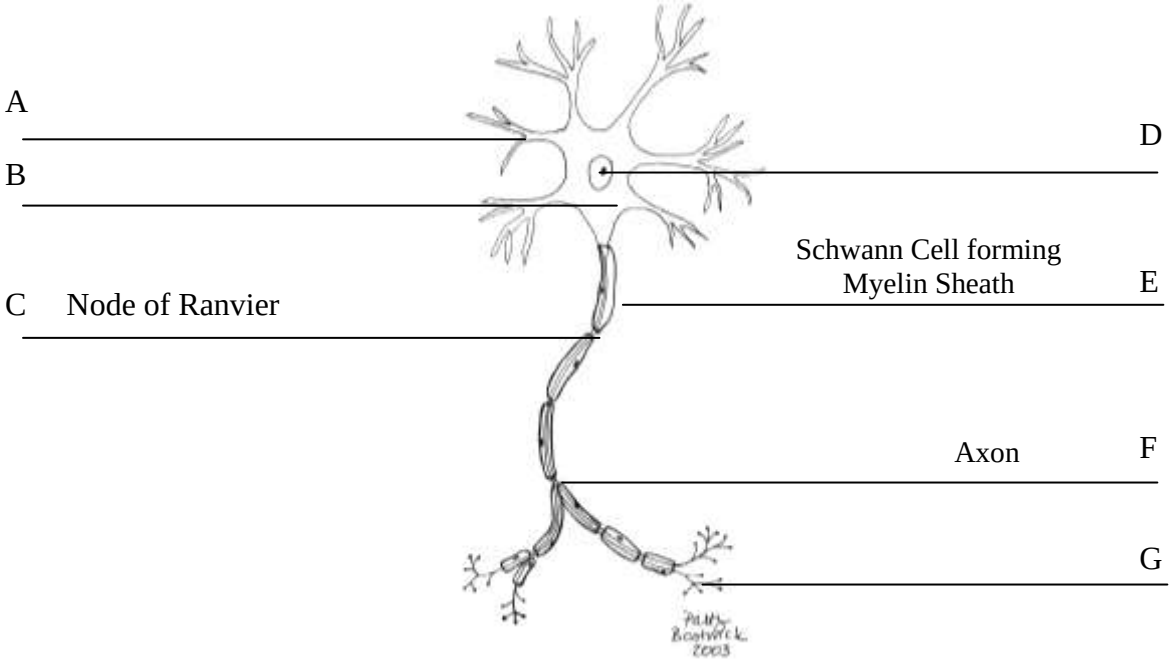
1. **Cell Body** (B): contains the _____ (D) and other organelles; metabolic center of the cell.
2. _____ (F): a type of fiber that conducts nerve impulses _____ the cell body.
   - Usually only _____ per neuron.
   - Can be 3-4 feet in length (such as length of leg)
   - Branches at the end are called _____ (G)

   Functions
   - Conduct nerve impulses away from the cell body & help create a new one in neighboring neuron
   - Action potential causes the axon terminals (synaptic knobs) to release a chemical called _____ in order to excite / inhibit other nearby neurons.
3. _____ (A) : a type of fiber that conducts nerve impulses _____ the cell body.
4. **Myelin Sheath** (E): a whitish, fatty protein covering on long axons

   Function: wrap, insulate, and protect the axons of the nerve fibers. Speeds up the nerve impulse because nerve impulses jump from one node to the next node of Ranvier!

   Structure: _____: form the myelin sheaths around nerve fibers that are found in the **PNS**. They are specialized supporting cells that wrap themselves tightly around the axon.
   - A myelin sheath is formed from the wrappings of _____ cells around the _____ .
   - _____ (C): gaps between Schwann cells (myelin sheaths). Nerve impulses (action potentials) jump from one node to the next node.
   - _____ Matter: myelinated axons in the CNS
   - _____ Matter: unmyelinated axons, dendrites, and cell bodies in the CNS

Multipolar Neuron



Review of Nervous Systems Basics

Types of Neurons

Match the correct letter with the description.

_____1. Another name for an afferent neuron is:
_____2. Cause muscles to contract and glands to secrete.
_____3. These neurons are found only within the CNS.
_____4. Conduct nerve impulses from interneurons away from the CNS.
_____5. Conduct nerve impulses from sensory organs to the brain or spinal cord.
_____6. Conduct nerve impulses between parts of the CNS.

A. interneuron
B. motor neurons
C. sensory neurons

Neuron Anatomy and Function

Match the correct letter with the description.

_____1. Portion that releases neurotransmitters
_____2. Part that conducts electrical currents toward the cell body
_____3. Substance that increases speed of impulse transmission
_____4. The portion of the nerves in the CNS that lack myelin sheaths are:
_____5. Part that generally conducts impulses away from the cell body
_____6. The part of the neuron that can be myelinated
_____7. Typically only one of these on a neuron
_____8. There are usually many of these processes on a neuron
_____9. Forms the myelin sheath by wrapping the axon
_____10. Another name for the axon terminals is:
_____11. The portion of the nerves outside the CNS that have been myelinated are:
_____12. Location of the nucleus and metabolic center of the nerve cell
_____13. Collections of these in the CNS are called tracts.
_____14. Collections of these in the PNS are called ganglia.

A. axon
B. axon terminal
C. cell body
D. dendrite
E. gray matter
F. myelin sheath
G. Schwann cell
H. synaptic knobs
I. white matter

Answers for Types of Neurons: 1C, 2B, 3A, 4B, 5C, 6A

Answers for Neuron Anatomy and Function: 1B, 2D, 3, F/G, 4D, 5A, 6A, 7A, 8D, 9G, 10H, 11A, 12C, 13C, 14C

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

NERVE IMPULSE TRANSMISSION

How to Transmit a Nerve Impulse Along an Unmyelinated Axon

A. Resting Potential

1. The plasma membrane of a resting neuron is "polarized."
2. *Polarized* means ions (atoms with charges) are unequally distributed on either side of the cell's membrane.
   a. Potassium has the symbol of _____ and a _____ charge.

   Potassium is found _____ the membrane. There are _____ potassium ions.

   b. Sodium has the symbol of _____ and a _____ charge.

   Sodium is found _____ the membrane. There are _____ sodium ions.
3. Cell remains inactive in **Resting Potential** as long as inside is more **negative** than the outside.

Do you know why the inside is more negative than the outside when we're dealing with two positively charged ions?

Draw the Polarized Nerve Cell

S odium
O utside
P ositive
P otassium
I nside
N egative

B. Action Potential = Conducting a Nerve Impulse

1. A nerve impulse (stimulus in the form of a neurotransmitter) changes the permeability of the cell's plasma membrane for a brief moment.

2. Normally, _____ ions _____ diffuse through the plasma membrane, but the stimulus allows _____ to enter through gates in the membrane.

3. The entry of sodium ions into the cell changes the polarity of the nerve cell. *What does polarity mean?* Now, the inside of the cell is positively charged while the outside is negatively charged.

4. If the stimulus is strong enough, the action potential is generated and the nerve impulse is sent along the nerve cell.

Draw the Depolarized Nerve Cell

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

NERVE IMPULSE TRANSMISSION

C. Repolarization

1. **Repolarization** is the restoration of the resting potential. Repolarization occurs in the same direction as depolarization.

2. As soon as sodium ions rush into the membrane, the permeability changes again and it becomes impermeable to sodium ions. Our problem is that we have a positively charged interior as well as ions in the wrong place. Here's how we fix these problems:

3. Potassium ions diffuse out, restoring the _____ on the inside of the membrane and the _____ on the outside surface.

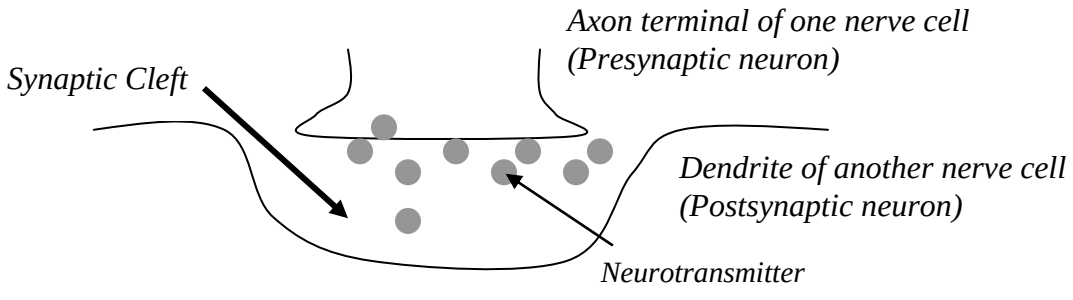
4. A protein pump on the plasma membrane known as the sodium-potassium pump completely restores the resting state condition. What this means is _____ ions diffuse out first to restore the negative charge on the inside of the cell. Sodium ions are left inside. Then, the sodium-potassium pump moves the _____ ions back inside and returns the _____ ions back outside.

5. Propagation occurs much faster in **myelinated nerves** because the nerve impulse jumps from node to node along the length of the fiber.

Draw the Repolarized Nerve Cell

D. Synapse

1. **How does the electrical impulse travel from one neuron to the next?**
   - The nerve impulse travels to the end of the neuron, into little endings called **axon terminals.**
   - The small gap between the axon terminal and dendrites is called the: _____
   - So, when the nerve impulse travels to the end of the axon terminals, the message travels to the next neuron via a chemical called: _____ .



Review of Nerve Impulse Transmission

Complete the following chart for the nerve impulse transmission

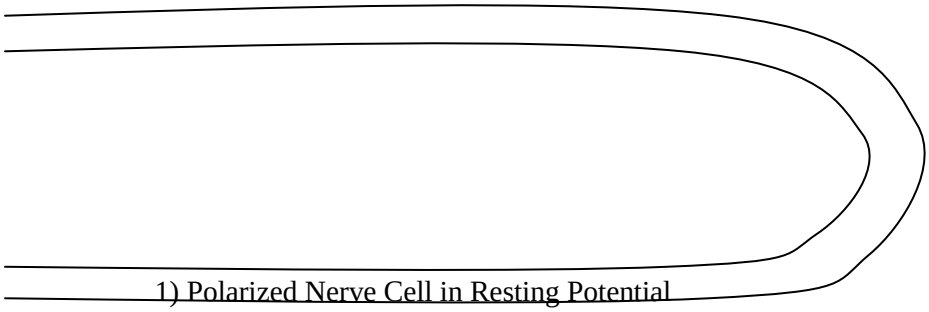
	Where are the ions?	Where are the charges?
Resting Potential	• sodium is 1. _____ the cell • potassium is 2. _____ the cell	• the outside has a 8._____ charge • the inside has a 9._____ charge
Depolarization and the Action Potential	• the membrane becomes more permeable to 3._____ ions due to a stimulus. • so, the 4._____ ions rush into the cell • now, both potassium AND sodium are inside the cell	• once the sodium ions enter, the inside of the cell now has a 10._____ charge and the outside has a 11._____ charge • during the action potential, a flow of 12._____ charges are propelled down the length of the axon
Repolarization	• to restore the proper charges, the 5._____ ion is the first to leave the cell • then, the sodium-potassium pump removes 6._____ from the cell and replaces 7._____ to the inside of the cell	• when the potassiums leave, the 13._____ charge is restored on the inside of the cell and the 14._____ charge is restored on the outside of the cell • the charges remain the same after the sodium-potassium pump works

Answers

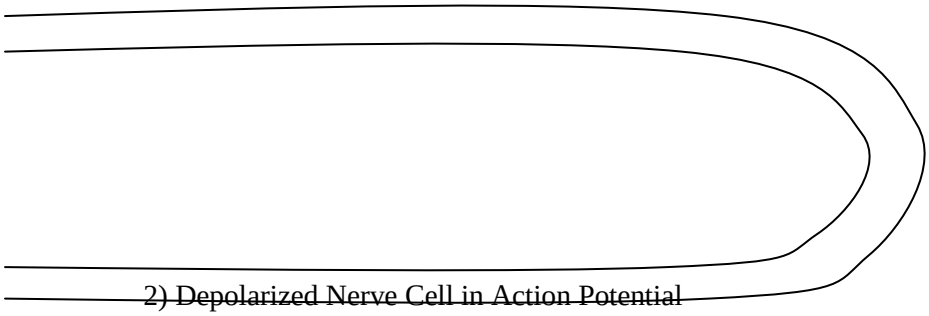
1. outside
2. inside
3. sodium
4. sodium
5. potassium
6. sodium
7. potassium
8. positive
9. negative
10. positive
11. negative
12. positive
13. negative
14. positive

Review of Nerve Impulse Transmission, *Continued*

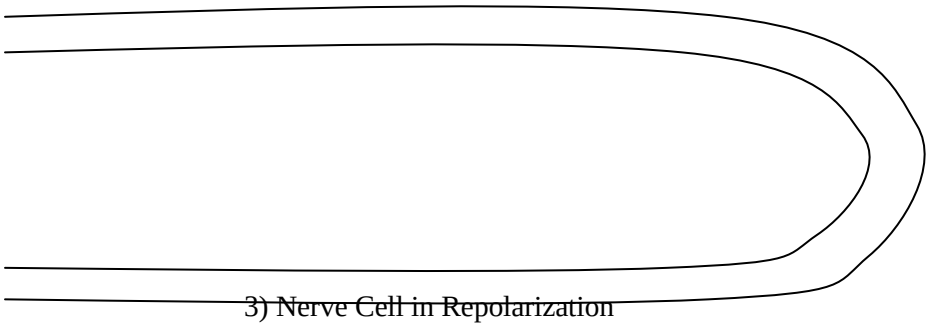
For each of the cells 1) Resting Potential 2) Action Potential and 3) Repolarization, indicate the location or movement of sodium and potassium ions, the location or movement of positive charges, whether the cell is permeable to sodium ions, etc.



1) Polarized Nerve Cell in Resting Potential



2) Depolarized Nerve Cell in Action Potential



3) Nerve Cell in Repolarization

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

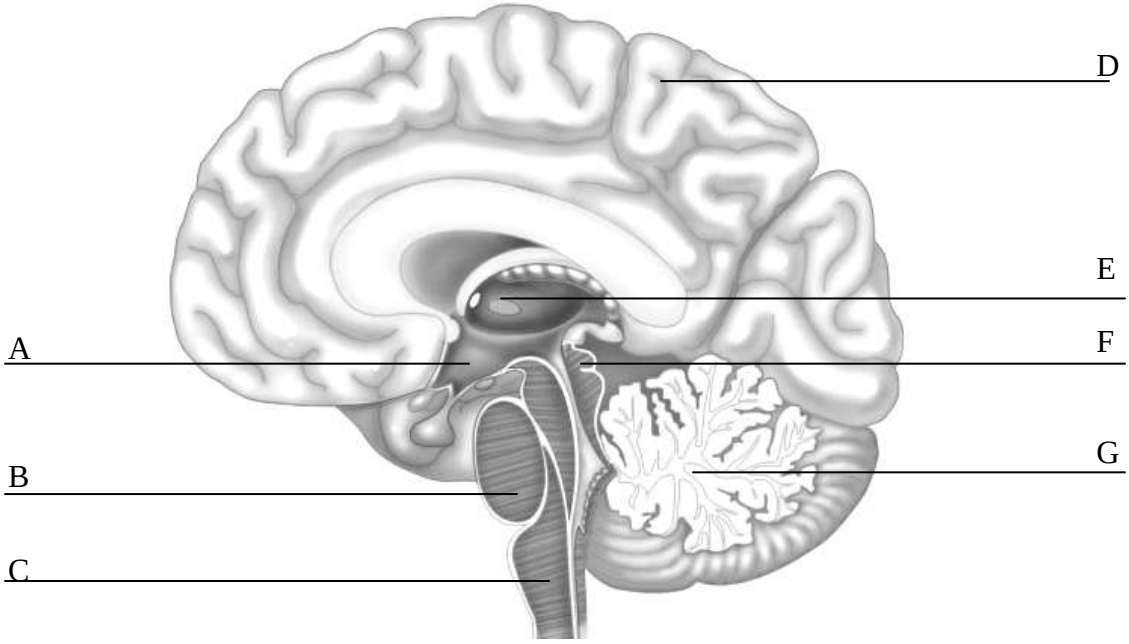
CENTRAL NERVOUS SYSTEM (CNS)

Brain and Spinal Cord are the two main organs of the CNS

Protection of the CNS:

- **Bones** (skull bones such as the frontal, parietal, occipital, and temporal)
- **Membranes = Meninges**
  - Function: covers and protects the brain and spinal cord; contains the cushioning cerebrospinal fluid (CSF), and secures brain to the skull.
  - Structure: there are three layers, detailed below:
    - **Dura Mater** ("tough mother") outermost double-layered structure
    - **Arachnoid Mater** ("spidery mother") threadlike extensions connecting it to the pia mater
    - **Pia Mater** is the thin layer directly connected to the brain (shrinkwrap!)
- **Cerebrospinal fluid (CSF)** is a fluid that circulates around, cushions, and nourishes the brain and spinal cord.

Identify the cerebrum, cerebellum, brain stem (medulla oblongata, pons, midbrain), and diencephalon (hypothalamus and thalamus).



Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

CNS: BRAIN AND SPINAL CORD

1. **Brain Stem**

Medulla oblongata

- Function: regulates heart beat and blood pressure (_____ center), breathing (_____ center), swallowing, coughing, sneezing

Pons

- Function: regulates breathing rate and has reflex centers for visual and auditory stimuli.

Midbrain

- Function: reflex centers for visual, auditory, and tactile responses

2. **Diencephalon**

Hypothalamus

- Function: maintains homeostasis (maintenance of a constant internal environment), to include the following regulating centers for the Autonomic Nervous System (ANS):
    - hunger
    - sleep
    - thirst
    - body temperature
    - water balance
    - blood pressure
    - the pituitary gland (link between endocrine and nervous systems)

Thalamus

- Function: relay station for incoming sensory information on the way to the _____ for interpretation. So, all sensory information (except smell) goes to the thalamus first.

3. **Cerebellum**

- Location: posterior to the cerebrum; separated from the brain by the 4th ventricle; it's two masses of tissue connected in the middle by the vermis; has outer gray matter and inner white matter (arbor vitae).
- Function: integration center for _____ coordination to smooth out voluntary movements. Receives inner ear information for balance.

4. **Cerebrum**

- Location: larger, outermost, wrinkly portion of the brain
- Function of the Cerebrum: consciousness: perception, communication, understanding, and voluntary movement. Contains interneurons for motor, sensory, and integration of decision-making functions.
- Structure of the Cerebrum:
    - **Two Hemispheres** (right and left)
    - **Five Lobes** (frontal, parietal, temporal, occipital, insula)
    - **Cerebral cortex** is the outermost region of the brain. Gyri (_____) and Sulci (_____).

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

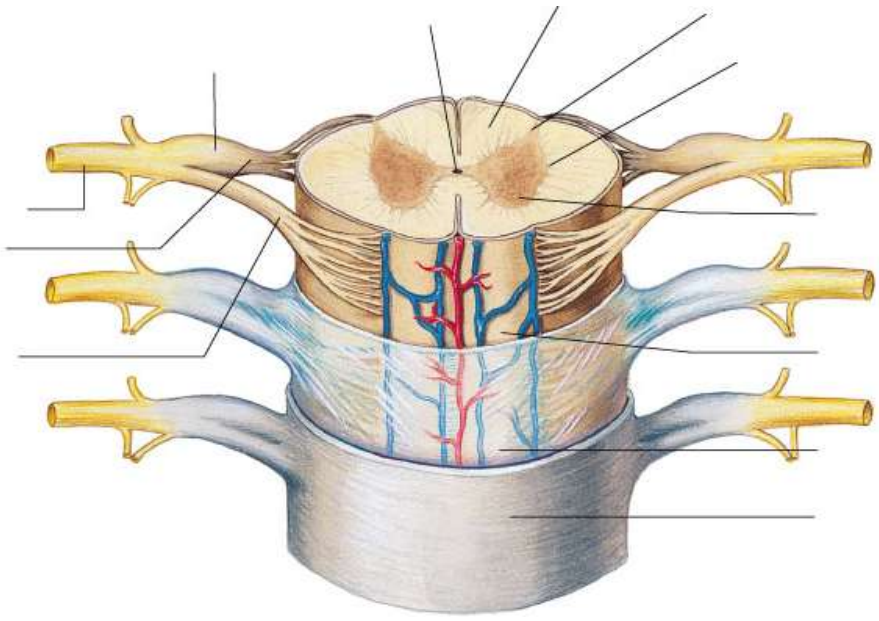
CNS: BRAIN AND SPINAL CORD

Spinal Cord

Structure

- Runs from the foramen magnum of the skull to the first or second lumbar vertebrae. It is found in the _____ foramen, a hollow area of the vertebrae.
- **Three parts of the spinal cord:**
  - 31 pairs of spinal nerves
  - gray matter
  - white matter
- **Gray matter** contains cell bodies, dendrites, and unmyelinated axons. It's shaped like a letter H or a butterfly.
- **White matter** is around the gray matter. It contains bundles of _____ fibers that form columns.

Identify the horns of the gray matter, white matter, & the central canal on this spinal cord cross section. Also, can you locate the pia mater and dura mater?



PERIPHERAL NERVOUS SYSTEM (PNS) SUBDIVISIONS OF MOTOR CONTROL

- **Somatic Nervous System (SNS)**: carries signals to the _____ muscles; you have voluntary control over this portion of the PNS.
- **Autonomic Nervous System (ANS)**: is involuntary and controls the actions of smooth muscles and glands.

Review of 4 Major Divisions of the Brain

Identify each division of the CNS based on its function or description.

_____1. Integrates the functioning of the ANS
_____2. Regulates heart rate and respiration
_____3. Coordinates voluntary movement
_____4. Responsible for thinking and memory
_____5. Regulates body temperature and eating
_____6. Regulates muscle tone and equilibrium
_____7. Suppresses unimportant sensations
_____8. Regulates secretions of the pituitary gland
_____9. Regulates blood pressure
_____10. Regulates coughing and swallowing

A. Cerebellum
B. Cerebrum
C. Hypothalamus
D. Medulla Oblongata
E. Midbrain
F. Pons
G. Thalamus

Answers: 1. C, 2. D, 3. A, 4. B, 5. C, 6. A, 7. G, 8. C, 9. D, 10. D

For Discussion

1. Describe the role that a neurotransmitter plays in transmitting a nerve impulse.
2. Describe the movement of sodium and potassium ions in transmitting an action potential.
3. Explain the difference in electrical states inside & outside the neuron during action & resting potentials.
4. Explain the difference between a motor and a sensory neuron.
5. Explain why myelination helps to speed a nerve impulse.
6. Discuss the role of the Schwann cell in transmitting nerve impulses.
7. Describe the different functions of a motor nerve and a sensory nerve.
8. Describe the protective coverings of the brain and spinal cord.
9. Differentiate between the function and structure of the axon and dendrites.
10. Describe the difference between the CNS and the PNS both in structure and function.
11. Discuss the protective layers on the brain and spinal cord.
12. Identify the different parts of the brain and their functions.

Think about these questions, if you have any trouble answering them, please see your instructor!

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

SKELETAL SYSTEM

FUNCTIONS OF THE SKELETAL SYSTEM

1. _____
   - Bones form the internal framework that supports and anchors all soft organs.
2. _____
   - Bones protect soft body organs such as the skull protects the brain.
3. _____
   - Skeletal muscles attached to bone allows for movement. Tendons are attached to bones which use the bones as levers.
4. _____
   - Fat is stored in internal cavities called marrow cavities.
     - This fat is specialized to create blood cells through a process known as hematopoesis
   - Minerals such as calcium and phosphorus are also stored
     - Calcium is used in muscle contraction and nervous system to transmit messages.
     - Stored as calcium salts in the bones
     - When the body is low on calcium, it can get more calcium ions from the bones
5. _____
   - **Hematopoesis** is the process of blood cell formation. Occurs in bone marrow cavities of certain bones (such as skull, ribs, sternum, ends of long bones, vertebrae)

ORGANIZATION OF THE SKELETON

How many bones are in the human body? _____

Appendicular versus Axial Skeleton

- **Axial**_____

  _____

  Name bones found in the Axial Skeleton: _____

  _____

- **Appendicular**_____

  _____

  Name bones found in the Appendicular Skeleton: _____

  _____

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

LEARN THE BONES

- Learn the bones listed below – be able to identify them on a skeleton.
- Spellings counts – so be sure to practice how to write these names.
- Start by marking the appendicular and axial skeleton portions on this skeleton (next page)

Axial Skeleton

- frontal bone
- parietal bone
- temporal bone
- occipital bone
- mandible
- cervical vertebrae (C_1-C_7)
- thoracic vertebrae (T_1-T_{12})
- lumbar vertebrae (L_1-L_5)
- sacrum
- coccyx
- true ribs (rib pairs 1-7)
- false ribs (rib pairs 8-12)
- floating ribs (rib pairs 11, 12)
- sternum

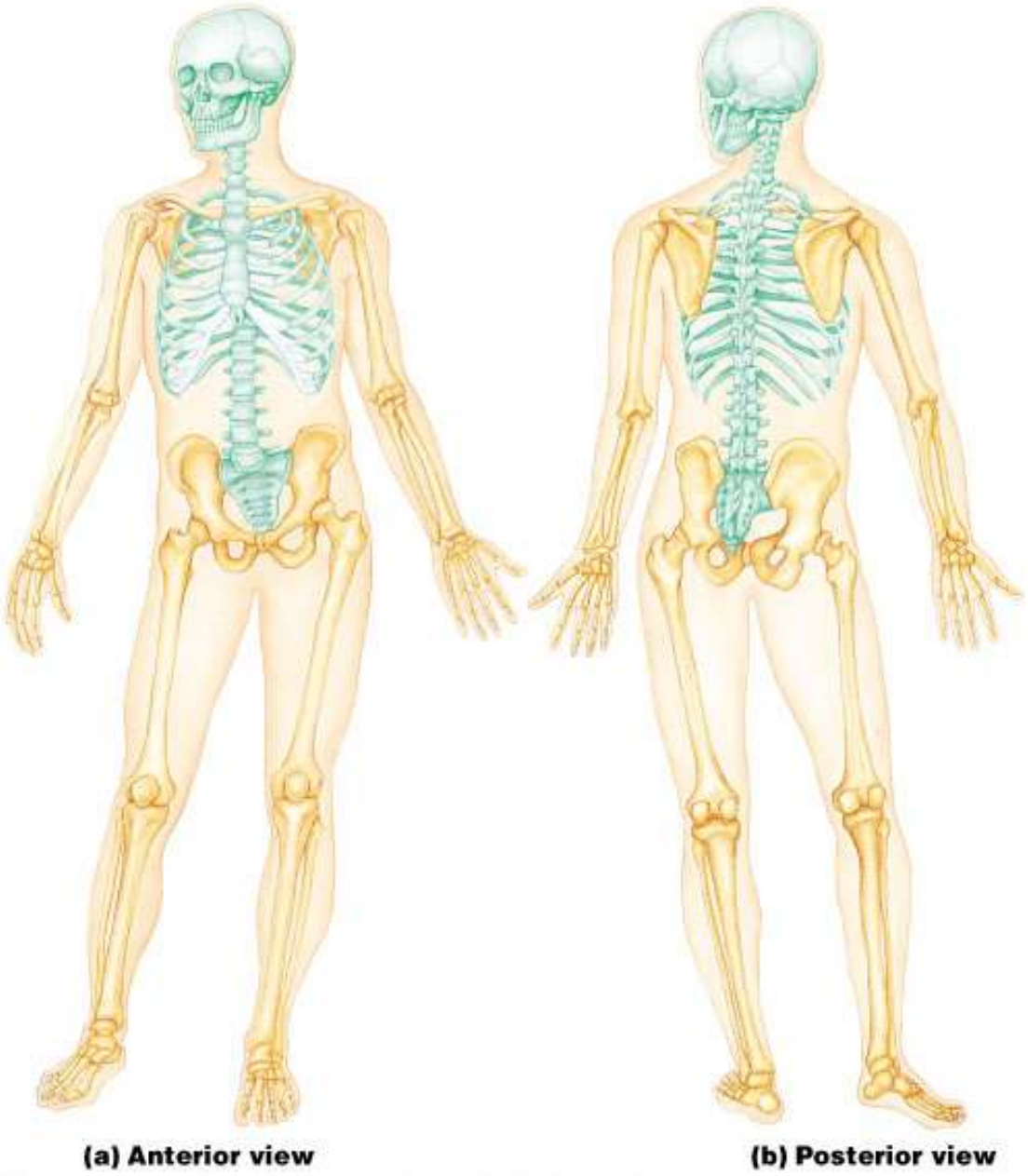
Appendicular Skeleton

- clavicle
- scapula
- humerus
- ulna
- radius
- coxal bones
- femur
- fibula
- tibia
- carpals
- metacarpals
- phalanges (of hand)
- tarsals
- metatarsals
- phalanges (of foot)

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

Mark the axial and appendicular skeletons.

Can you identify the bones from the previous page?



(a) Anterior view **(b) Posterior view**

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

Axial Skeleton

Identify these bones of the skull

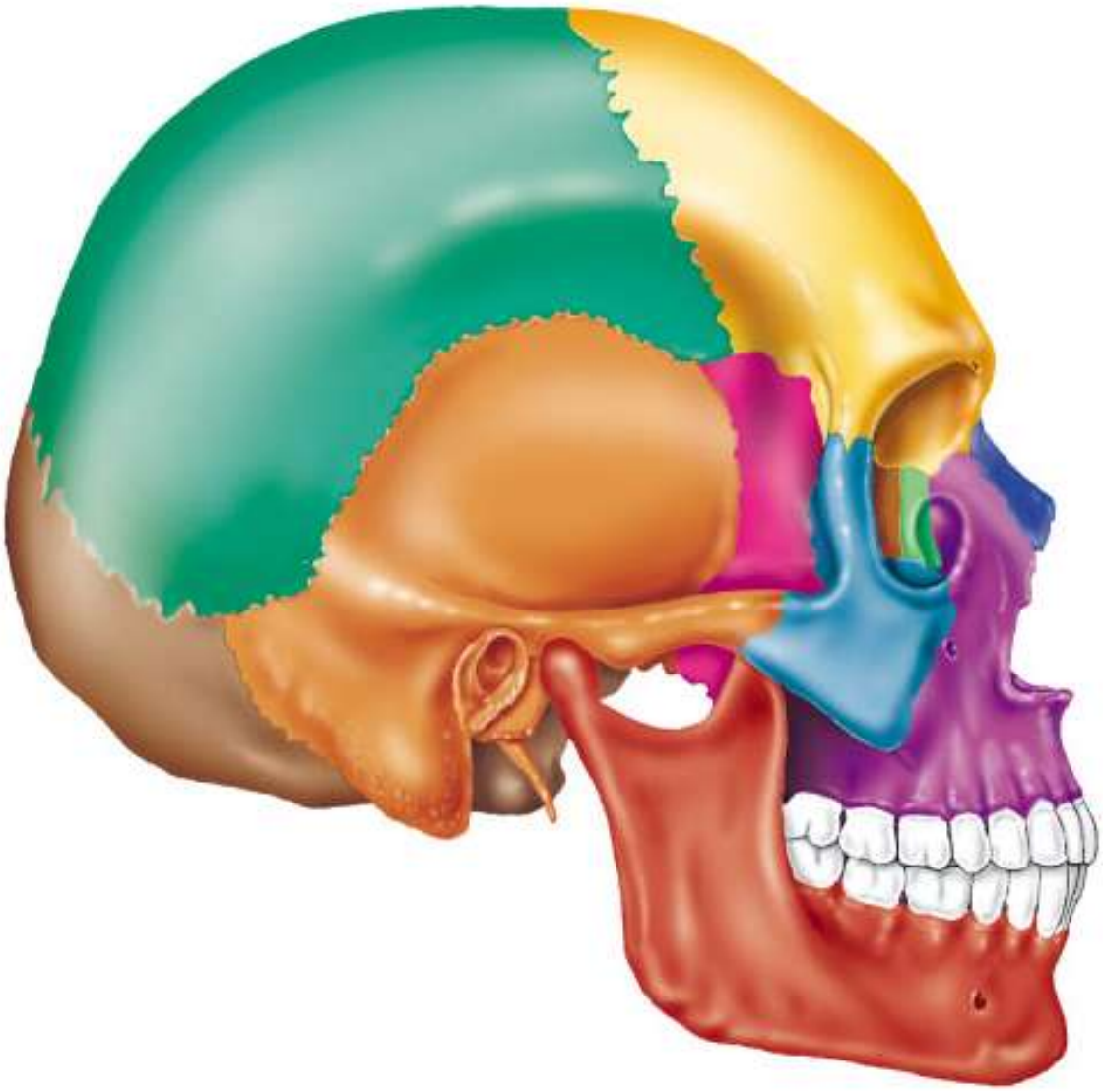
frontal bone

parietal bone

temporal bone

occipital bone

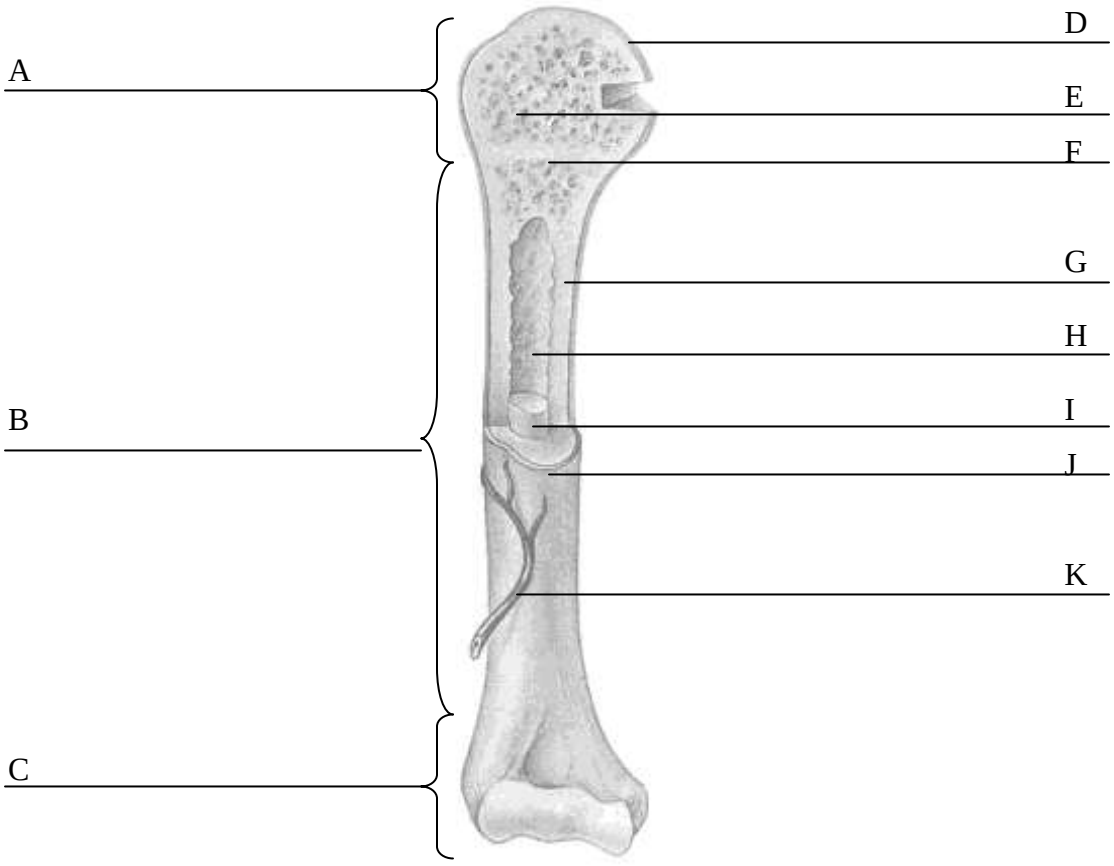
mandible



Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

LONG BONE STRUCTURE

1. _____(B): the shaft which makes up the bone's length; composed of compact bone.
   a. This **medullary** (marrow) **cavity** (H) contains **yellow bone marrow** which is a storage area for _____(I)
   b. The medullary cavity is lined with _____(G), a thin layer of squamous epithelium tissue.
2. _____(J): covers the diaphysis and the bones (except at joints). It's a fibrous, connective tissue. Hundreds of connective tissues, called *perforating (Sharpey's) fibers* connect the periosteum to the underlying bone. Tendons and ligaments are bonded through these perforating fibers and anchors them to the bone. The periosteum is associated with two cell types:
   a. **Osteoblasts** form bone through a process called **ossification**. Osteocytes develop from osteoblasts that have become completely surrounded by bone matrix.
   b. **Osteoclasts** are giant cells whose job is to break down bone. They raise blood calcium levels.
3. _____(A, C): the ends of the long bone. Consists of a thin layer of compact bone enclosing an area filled with spongy bone (E).
4. _____(D): covers the external surface of the epiphysis rather than periosteum.
5. _____(F): in adult bones, there is a thin line of bony tissue spanning the epiphysis that is a remnant of the epiphyseal plate.
6. _____: a flat plate of hyaline cartilage seen in young, growing bone.



Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

TWO TYPES OF BONE TISSUE

Compact Bone

1. _____: mature bone cells which account for most of the cell population in a bone. They cannot divide and can no longer secret matrix materials. Osteocytes are located in a **lacuna**.

2. The _____ of bone tissue is made of **calcium salts**. The layers of the matrix are called **lamellae** which contain:

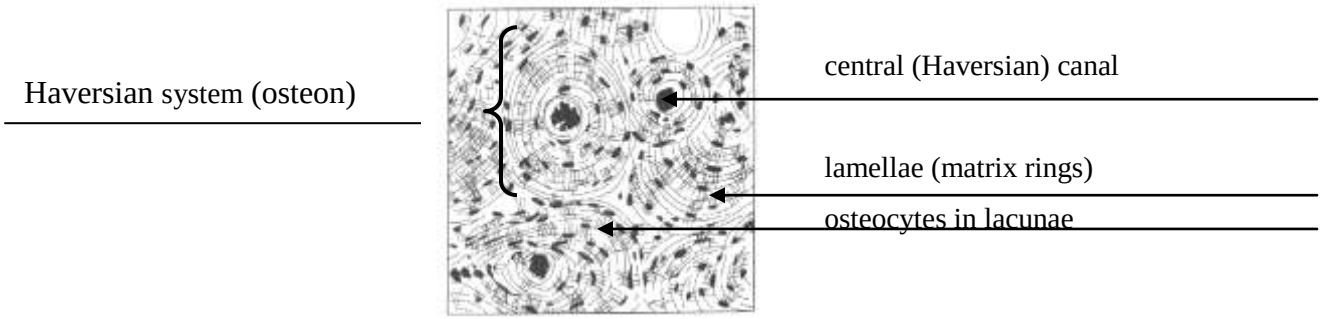
3. Canals:

   a. The matrix is arranged in concentric circles (called lamellae) around **central** or **Haversian canals**, which carry blood vessels and nerves. These central canals are in the center of one **osteon (Haversian system)**.

   b. **Perforating (Volkmann's) canals** run perpendicular to the surface and connect together central canals.

4. Each complex of central canal and the lamellae (matrix rings) is called a **Haversian system** or an **osteon.**

Compact bone covers the exterior of all bones. Osteon = lamellae + central canal



Spongy (Cancellous) Bone

1. Composed of _____, bony bars designed to take stress and for strength.

2. **Red bone marrow** is located between trabeculae of spongy bone in long and flat bones. Red bone marrow makes blood cells. Spongy bone may also contain **yellow bone marrow** which is adipose tissue used for energy reserves.

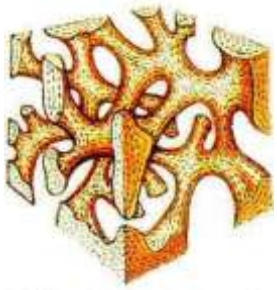


Image from health-pictures.com

Review of Bone Macroanatomy and Microanatomy

Bone Physiology

Fill in the blank the following descriptions about bones.

_____1. the articular cartilage is consumed and this creates an area where yellow ____, an adipose tissue, is found.

_____2. the marrow of a bone is the location of red ____ cell formation

_____3. the pull of ___ can reshape a bone

_____4. blood cell formation is called:

_____5. lengthwise bone growth occurs at the epiphyseal ___.

_____6. blood cell formation is called:

Gross Anatomy of a Long Bone

Identify each of the following parts of a long bone.

_____1. connective tissue found covering of the diaphysis

_____2. shaft of a long bone

_____3. the location of spongy bone

_____4. the location of compact bone

_____5. ends of a long bone

_____6. connective tissue found covering the epiphysis

_____7. the marrow cavity contains this type of storage connective tissue

_____8. the process of bone formation

_____9. the process of blood cell formation

_____10. the location where blood cell formation occurs

_____11. evidence of lengthwise growth in an adult is found at…

Microanatomy of Compact Bone

Identify each of these parts of a Haversian system.

_____1. an alternate name for a Haversian system

_____2. mature bone cells are called ____.

_____3. the canal where a blood vessel travels through the bone

_____4. the nonliving/inorganic portion of the compact bone

_____5. a Haversian canal contains…

_____6. the space in an osteon where osteocytes are located

Answers to Bone Physiology: 1. marrow, 2. blood, 3. gravity, 4. hematopoesis, 5. epiphyseal plate, 6. hematopoesis
Answers to Gross Anatomy of a Long Bone: 1. periosteum, 2. diaphysis, 3. epiphysis, 4. diaphysis, 5. epiphysis, 6. articular cartilage, 7. adipose tissue, 8. ossification, 9. hematopoesis, 10. marrow cavity, 11. epiphyseal line
Answers to Microanatomy of a Compact Bone: 1. osteons, 2. osteocytes, 3. Haversian canal, 4. matrix of calcium salts, 5. blood vessels and / or nerves, 6. lacunae

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

MUSCULAR SYSTEM

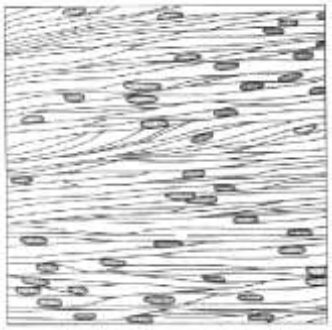
FUNCTIONS OF SKELETAL MUSCLES

1. **Movement:** muscles move bones and provide for facial expressions.
2. **Posture**: the ability to support the body against gravity.
3. **Stabilize Joints:** muscles (and tendons and ligaments) help to stabilize poorly articulating joints.
4. **Generate Heat**: mitochondria make ATP from glucose and oxygen; skeletal muscles use ATP for contractions and create heat as a bi-product. *How is excess heat removed?*

IDENTIFY THESE TYPES OF MUSCLE TISSUE

Identify each of the following as skeletal, smooth, *or* cardiac *muscle.*

involuntary
location: heart
striated
unique features:
- branching pattern
- intercalated discs
- muscle fibers are separate



involuntary
location: walls of hollow organs
lacks striations

spindle-shaped

voluntary
location: attached to bones
striations

cylindrical-shaped
multinucleate
muscle fibers are close together

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

ANATOMY OF SKELETAL MUSCLE

Macroscopic Anatomy of a Skeletal Muscle

1. **_____:** the connective tissue that covers the outside of the entire muscle.

2. **_____:** several muscle fibers bundled together are called a fascicle. This type of connective tissue wraps the fascicles.

3. **_____:** each individual muscle cell in the fascicle is also wrapped by this connective tissue. Think of this as the "membrane layer on the inside (endo)."

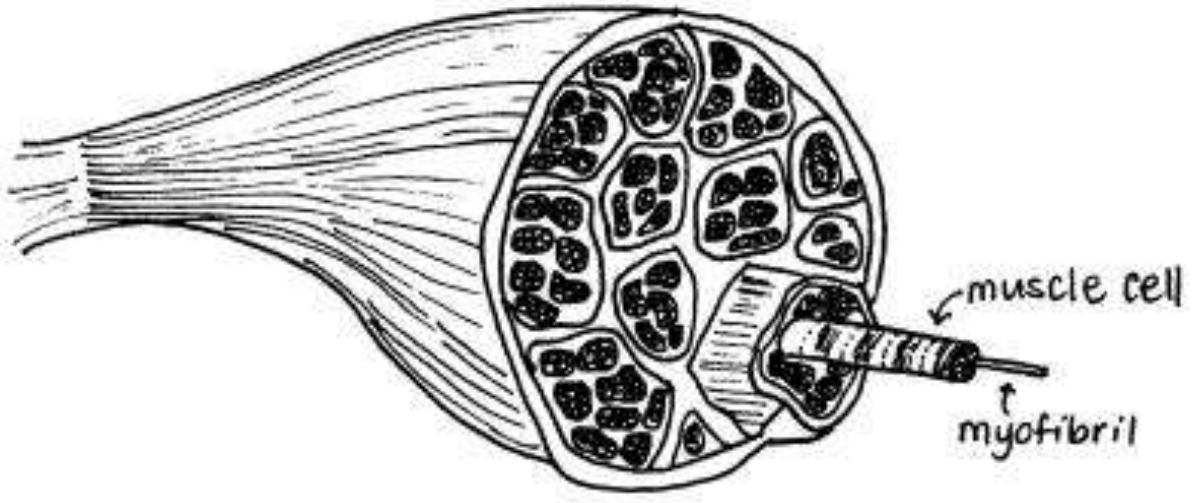
Microscopic Anatomy of a Skeletal Muscle

1. **_____:** "flesh husk"—the plasma membrane of a muscle cell

2. **_____:** long organelles found inside the muscle cell. These are the tiny contract units that help to shorten the muscle during muscle contraction. The myofibrils have a banding pattern (= striations).

On this picture of a skeletal muscle, below, be able to identify the following:

- **Epimysium**
- **Endomysium**
- **Perimysium**
- **Muscle Cell**
- **Sarcolemma**
- **Myofibril**
- **Fascicle**



Review of Muscles

Types of Muscle Tissue

Identify each of these descriptions as skeletal, smooth, *and/or* cardiac.
More than one answer may be appropriate for some of these.

_____1. striated
_____2. lacks striations
_____3. one nucleus
_____4. more than one nucleus
_____5. branched
_____6. unbranched
_____7. voluntary
_____8. involuntary
_____9. branched, involuntary, striated
_____10. multi-nucleate, striated, voluntary
_____11. one nucleus, involuntary, lacks striations
_____12. intercalated disks
_____13. contracts to beat the heart and pump blood
_____14. lines the walls of blood vessels, digestive organs, urinary tubes
_____15. contracts to move bones of skeleton

Membranes covering a Muscle

Identify each of these descriptions as epimysium, perimysium, *or*, endomysium.

_____1. Wraps an entire muscle (say, for example, the biceps brachii)
_____2. Wraps the individual muscle cells
_____3. Wraps fascicles (bundles) of muscle cells

Answers: Types of Muscle

1. skeletal, cardiac
2. smooth
3. smooth, cardiac
4. skeletal
5. cardiac
6. smooth, skeletal
7. skeletal
8. smooth, cardiac
9. cardiac
10. skeletal
11. smooth
12. cardiac
13. cardiac
14. smooth
15. skeletal

Answers: Membranes covering a Muscle

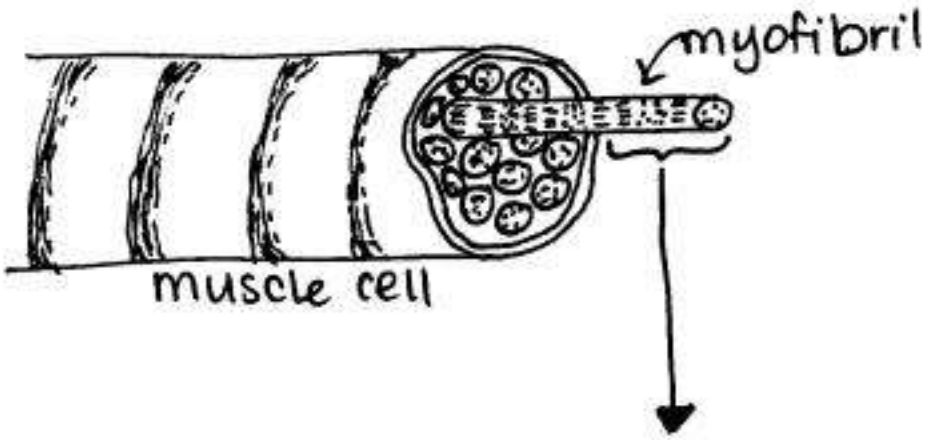
1. epimysium
2. endomysium
3. perimysium

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

IDENTIFYING DETAILS OF THE MYOFIBRIL

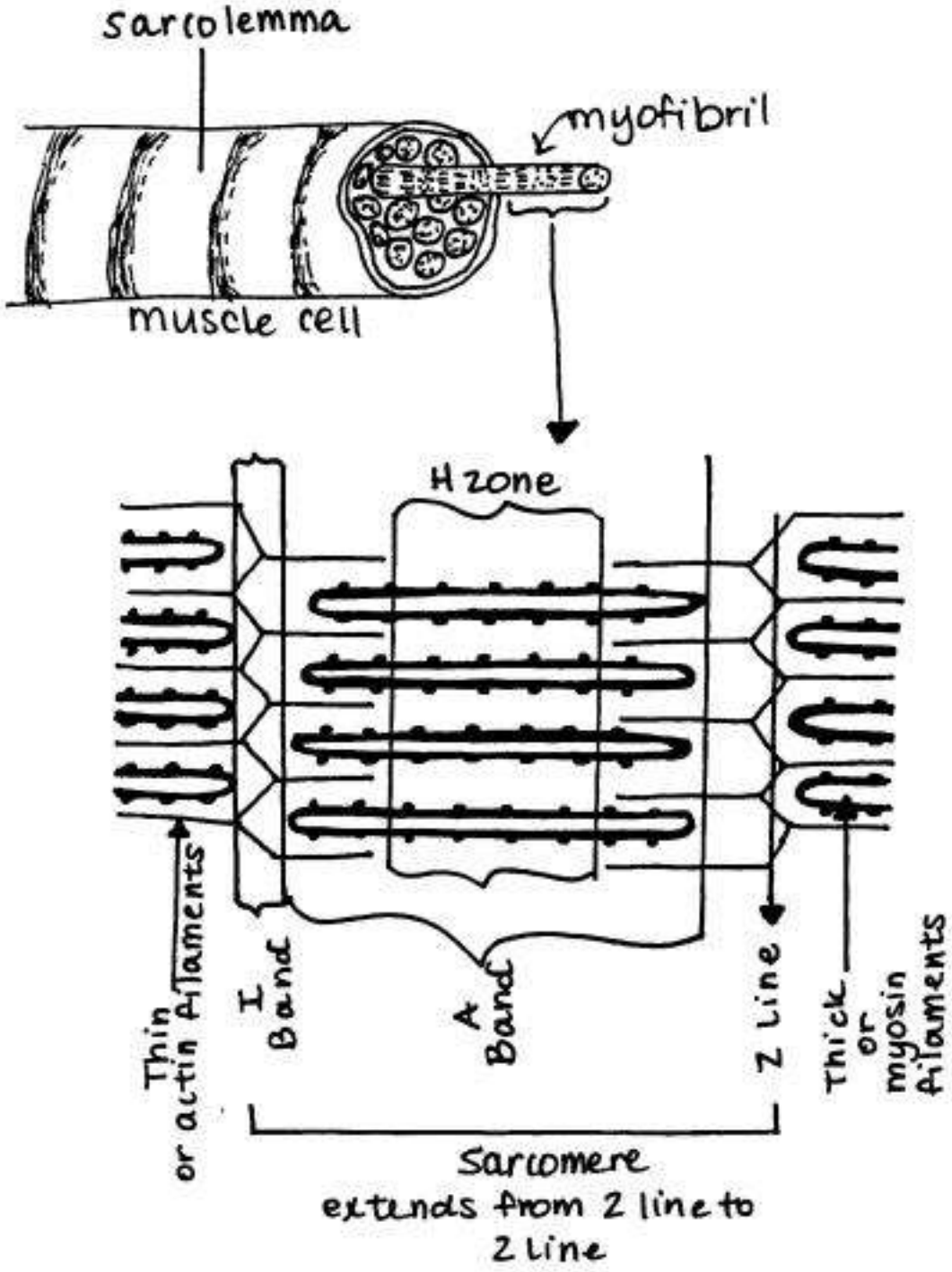
Locate and label the following structures on the muscle cell:

Sarcolemma
H zone
Myosin filaments
Thick filaments
Sarcomere
A band
Myosin heads
I band
Z line (disc)
Actin filaments
Thin filaments
Myofibril
Muscle Cell
Myofibril



Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

Identifying Parts of a Muscle Cell—Labeled



Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

MICROSCOPIC ANATOMY OF SKELETAL MUSCLE

1. **Sarcomere:** this is a portion of the myofibril. It's a unit that runs from one ___ line to the next ___ line.
    - *During muscle contraction (sliding filament theory), what happens to the sarcomere?*_____
    _____

2. **Parts of the sarcomere**

    a. **A band (DARK band):** a portion of the sarcomere which contains all of the _____ filaments and only a portion of the _____ filaments.

    b. **I band (LIGHT band):** a portion of the sarcomere which contains the _____ line and only the _____ filaments.
    - *During muscle contraction (sliding filament theory), what happens to the I band?* _____
    _____

    c. **H zone:** a portion within the A band which contains only the _____ filaments. No thin filaments are found in this zone.
    - *During muscle contraction (sliding filament theory), what happens to the H zone?*_____
    _____

    d. **Z line (disc):** this zig-zag shaped line is a membrane where the _____ are attached.
    - *During muscle contraction (sliding filament theory), what happens to Z line (disc)?* _____
    _____

3. **Myofilaments**: these are long proteins made either of actin or myosin.

    a. **thick filament/myosin filament:** these thick filaments possess heads which are crucial for muscle contraction. The thick filaments are made of the protein **myosin**. Myosin heads are part of the myosin filaments. These heads are made of proteins which attach to a particular portion of the thin filaments during muscle contraction.
    - *During muscle contraction (sliding filament theory), what is the role of the myosin heads?* _____
    _____

    _____

    b. **thin filament/actin filament:** these thin filaments are anchored to the Z line (disc). The myosin heads of the thick filaments attach to certain sites on the thin filaments so that muscle contraction can occur. These thin filaments are made of the protein **actin**.

4. **Sarcoplasmic reticulum:** this organelle is wrapped around the _____. It reabsorbs _____ ions after muscle contraction to help the muscle relax.

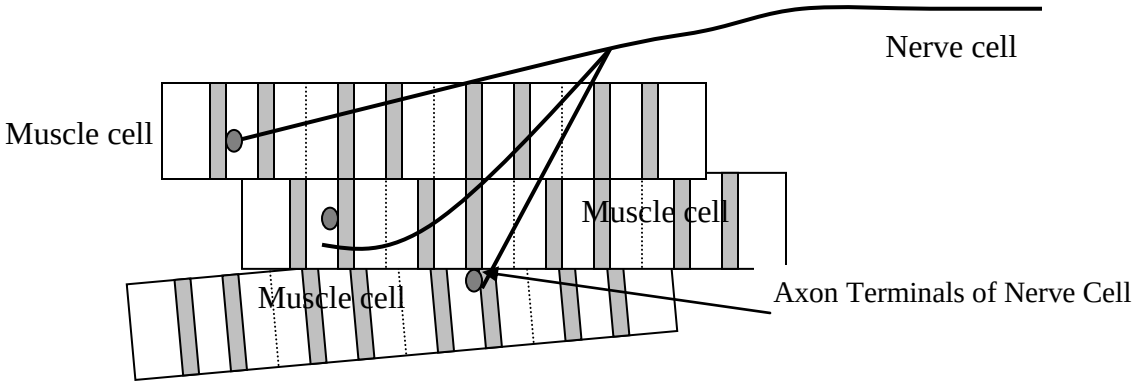
Label the drawings on the next page using your new muscle microanatomy vocabulary. Be prepared to identify or describe these parts in relation to muscle contraction.

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

INNERVATION OF MUSCLE

How Does a Nerve Impulse Trigger the Contraction of a Muscle?

On the drawing below, circle the
Neuromuscular Junction and the Motor Unit



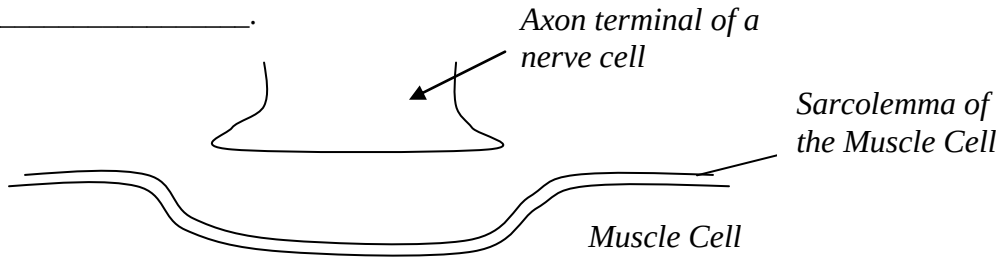
SEQUENCE OF EVENTS TO PROMOTE A MUSCLE CONTRACTION

Excitation of the Muscle

1. Skeletal Muscle is stimulated by a nerve cell. The nerve cell and all the skeletal muscle cells it stimulates are called a _____.

2. The location where individual axon terminals stimulate ONE muscle cell is called a _____ _____. This neuromuscular junction is where the nerve cell nearly comes into contact with the sarcolemma of the muscle cell.

3. The gap between the sarcolemma of the muscle cell and the axon terminals (synaptic knobs) of the nerve cell is called the _____.



Identify where the neurotransmitter is released into the synaptic cleft.

4. A chemical, called a neurotransmitter, is released into the synaptic cleft. The specific neurotransmitter we're dealing with is called acetylcholine (Ach).

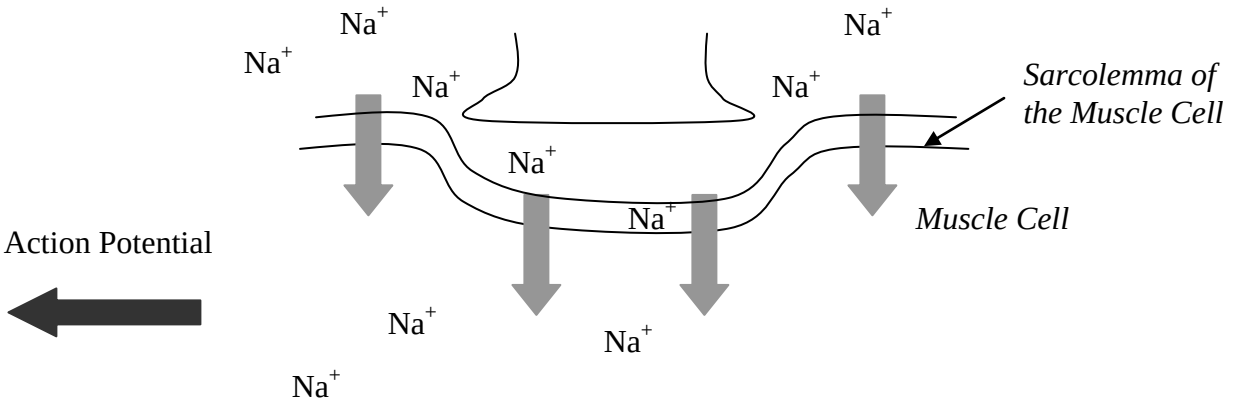
5. Acetylcholine causes the sarcolemma to become temporarily permeable to _____ ions that rush _____ the muscle cell.

Chapter 27: Nervous, Motor, and Sensory Systems, *continued*

SEQUENCE OF EVENTS TO PROMOTE A MUSCLE CONTRACTION

Contraction of the Muscle

6. Both potassium and sodium ions are involved in the transmission of this nerve impulse along the length of the muscle cell. Sodium ions have a positive charge, which creates an electrical impulse. This influx of positive ions into the muscle cell causes a flow of electrical current. This electrical current is called the _____.



7. The action potential flows along the muscle cell causing contractions of the myofibrils.

8. **Sliding filament theory of muscle contraction:** the myosin heads of the thick filaments attach to the thin filaments to cause a muscle contraction through the shortening of the muscle. The filaments slide past one another. The myosin heads attach, detach, and reattach to the binding sites on the thin filaments--pulling the thin filaments toward the sarcomere's center.

9. Muscle contraction stops when the stimulus from the nerve cell stops. Potassium ions move out of the cell via activation of the sodium-potassium pump. Sodium ions return to the interior of the cell.

Review of Microanatomy of a Muscle: *Match the following descriptions with the letters at right.*

____1. Zone of the A band that contains only thick filaments	A. A band
____2. Plasma membrane of the muscle cell	B. I band
____3. Heads of the thick filaments attach to receptors sites on the ___.	C. H zone
____4. Contractile unit of a myofibril, running from Z line to Z line	D. Z lines
____5. These filaments contain "heads" made of the protein myosin	E. myofibril
____6. Long, filamentous organelle found in muscle cells; banded appearance	F. sarcolemma
____7. Band containing thick/myosin filament and some thin filaments	G. sarcomere
____8. Band containing only thin filaments and the Z line	H. sarcoplasmic reticulum
____9. Organelle which stores and releases calcium for muscle contraction	I. thick (myosin) filament
____10. These membranes move closer together during the sliding process	J. thin (actin) filament
____11. These filaments are anchored to the Z lines	

Answers: 1. C, 2. F, 3. J, 4. G, 5. I, 6. E, 7. A, 8. B, 9. H, 10. D, 11. J

For Discussion

1. Explain what is responsible for the light and dark banding pattern seen in skeletal muscle cells.
2. Describe the role of the myosin heads in muscle contraction.
3. Explain and list the events that occur during the sliding filament theory.

Microanatomy of a Muscle: *Identify each of these descriptions about the parts of a muscle cell or myofibril.*

_____1. band containing the Z line and thin filaments
_____2. organelle that performs contractions in a muscle cell
_____3. plasma membrane of a muscle cell is also called this
_____4. organelle found storing and releasing calcium ions
_____5. contractile unit running from one Z line to the next Z line
_____6. membrane where the thin filaments are attached
_____7. another name for thin filaments
_____8. another name for thick filaments
_____9. only these myofilaments have "heads" for sliding
_____10. band containing all the thick filament and some thin filament

Neuromuscular Junction & Nerve Impulse: *Identify these steps or parts of a neuromuscular junction.*

_____1. one nerve cell and all the muscle cells it stimulates is called a ___
_____2. axon terminals of one nerve cell and its muscle cell
_____3. space or gap where the nerve and muscle cells nearly meet
_____4. chemical released into the synaptic cleft
_____5. specific neurotransmitter released in muscle contraction
_____6. these two types of ions are necessary for muscle contraction
_____7. the influx of sodium ions causes a change in the charge, called a ___
_____8. these ions rush into a cell during the change in the sarcolemma
_____9. action potential causes the Z lines to move ____
_____10. Z lines move closer together cause myosin heads attach to ___ filaments.

Answers: Microanatomy of a Muscle

1. I band
2. myofibril
3. sarcolemma
4. sarcoplasmic reticulum
5. sarcomere
6. Z line
7. actin filaments
8. myosin filaments
9. myosin (thick) filaments
10. A band

Answers: Neuromuscular Junction & Nerve Impulse

1. motor unit
2. neuromuscular junction
3. synaptic cleft
4. neurotransmitter
5. acetylcholine
6. potassium, sodium
7. action potential
8. sodium
9. closer together
10. actin (thin) filaments

BIOLOGY 100 FINAL EXAM STUDY GUIDE

Advice for the Final Exam:

1) Study your old tests and old quizzes (or course competencies for internet class).
2) Start **1 week before the final exam** date. Every night, set aside an hour and do 3 chapters of this study guide. Use your coursepack and/or textbook to answer the questions. Either write out the answers to this study guide or explain them out loud. Mark the items you have difficulty with…call, email, or come see me for help!
3) Don't stay up late the night before the final exam. Get a good night's rest and come refreshed and prepared for the test.

Chapter 1: Introduction: Biology Today

- Define biology.
- Name the 3 domains. What makes each domain different from the others? What kinds of organisms will you find in each domain?
- Who is Charles Darwin and what is his contribution to science?
- Describe the peppered moth experiment. Why is it a good example of evolution and natural selection?
- List and describe the steps of the scientific method.

Chapter 2: Essential Chemistry for Biology

- Trace the hierarchy of life from atoms, molecules, cells . . . to ecosystem.
- Name the four major elements found in organisms. Write their symbols.
- Name the seven trace elements found in organisms. Write their symbols.
- Define: compound, atom, molecule, isotope, element.
- Describe the structure of an atom; list the charge and location of each subatomic particle.
- How do you figure out the atomic number for an atom? The mass number?
- How many electrons fill the innermost orbital? The next orbital?
- What's the difference between ionic and covalent bonds?
- Define ion, polar, nonpolar.
- What's the difference between single and double bonds?
- Define monomer, polymer, reactant, product.
- Identify in a reaction the reactants and products.
- What are the four inorganic compounds?
- List the properties of water…such as cohesion, polarity, etc.
- What makes acids different from bases?
- Give some examples of electrolytes.
- What is a neutralization reaction?
- Identify where you'd find acids, bases, and neutral compounds on the pH scale.
- On the pH scale, 4 is ____ times more acidic than a pH of 6.
- What are some examples of acids? Bases?

Chapter 3: The Molecules of Life

- What are functional groups? What organic compound groups is each group typically associated with?
- Describe what happens in a dehydration synthesis reaction…what happens in a hydrolysis reaction? How is water involved in each reaction?
- Which type of reaction is described: "monomers joining to form polymers by the removal of water"?
- What are the four organic compound groups? List the building block, function, and examples of each.
- All organic compounds contain the element ____.

Chapter 4: A Tour of the Cell

- What makes prokaryotes and eukaryotes different? What types of organisms are prokaryotes? Eukaryotes?
- Describe the plasma membrane, cytoplasm, and the nucleus of a eukaryotic cell.
- Define "organelle".

- Briefly describe the function and structure for: plasma membrane, nucleus, cytoplasm, ribosomes, smooth ER, rough ER, Golgi apparatus, lysosomes, vacuoles, mitochondria, chloroplasts, cytoskeleton, cilia, and flagella.
- What's the relationship between the nucleus, smooth and rough ER, and Golgi apparatus?

Chapter 5: The Working Cell

- What 3 items make up ATP?
- What is ATP used for?
- Define: metabolism, enzyme, substrate, active site, activation energy.
- Explain how an enzyme binds with its substrate.
- Basically, how is "passive transport" of a substance across a membrane different from "active transport?"
- Diffusion is the movement of particles from ___ to ___ concentration across a membrane.
- What is the diffusion of water called?
- How is facilitated diffusion different from diffusion?
- Explain what happens to a cell if it is placed into a hypertonic, hypotonic, and isotonic solution.
- What type of membrane transport does a cell use to move a substance against its concentration gradient?
- Explain when a cell would use endocytosis rather than active or passive transport.

Chapter 6: Cellular Respiration: Harvesting Chemical Energy

- Write the overall equation for aerobic cellular respiration in words and in chemical symbols.
- What are the reactants of cellular respiration? The products?
- In what organelle does this reaction occur?
- How many ATP can be made as a result of aerobic cellular respiration? As a result of anaerobic cellular respiration?
- Explain what happens to the reactants and products that enter each reaction during the three steps of aerobic cellular respiration: glycolysis, Krebs cycle, and the electron transport chain.
- How are lactic acid fermentation and alcohol fermentation different from aerobic cellular respiration?

Chapter 8: The Cellular Basis of Reproduction and Inheritance

- Explain how sexual and asexual reproduction differ.
- What is binary fission? What types of organisms use binary fission?
- What is a basic definition of mitosis? What types of organisms reproduce using mitosis?
- What is a chromosome?
- There are two phases to a cell's life: Interphase and Mitosis. Explain what you might see happening to a cell and its nucleus during each phase.
- List the four phases of mitosis and describe what's happening in the cell.
- How do meiosis and mitosis differ as reproductive processes?
- Explain some problems that can result from meiosis: Down's, Klinefelter's, and Turner's Syndromes.

Chapter 9: Patterns of Inheritance

- Who was Gregor Mendel and what is his contribution to science?
- Define: heredity, genes, alleles, dominant, recessive, phenotype, genotype.
- For a trait such as hair color in which dark hair is dominant over light colored hair, what would your phenotype be if you are homozygous dominant? What is your phenotype if you're homozygous recessive? Or heterozygous?
- What is a Punnett Square used for?
- Sex-linked disorders are carried on the ____ (or Y) chromosome.
- Autosomal traits are carried on chromosomes # ____ - ____.
- For the ABO blood groups, which two alleles are dominant?
- Work a monohybrid autosomal Punnett Square. Here's an example: Mrs. A is heterozygous for the ability to taste PTC, a chemical. The ability to taste this chemical is carried on the dominant allele. Mr. A cannot taste PTC. What's the probability that they have a child who can taste PTC?
- Work a sex-linked disorder Punnett Square: Here's an example: Male-pattern baldness is a recessive, sex-linked disorder. Mr. B is bald and his wife is a carrier for this disorder. Is it possible for them to have a boy who is normal for this disorder?

- Work an ABO blood group Punnett Square. Mr. C has AB blood, Mrs. C has O blood. List the possible phenotypes of their children.
- Define with examples: incomplete dominance, multiple alleles, codominance, pleitropy, and polygenic inheritance.

Chapter 10: Molecular Biology of the Gene

- Describe the basic structure of DNA using these terms: double-stranded, nucleotides, purine, pyrimidine, adenine, thymine, guanine, cytosine, helix.
- What organelle in the eukaryotic cell stores DNA?
- What are the base-pairing rules for adenine, thymine, cytosine, guanine?
- List the three items that make up a nucleotide.
- Describe the steps of DNA replication using these terms: DNA helicase, DNA polymerase, base-pairing.
- Replicate DNA. Here's an example:

  CTGCTCAATATG
  GACGAGTTATAC

- List three differences between DNA and RNA.
- What are the two main steps of protein synthesis? Describe what happens in each step.
- How is initiation, elongation, and termination part of translation?
- What do the start and stop codons tell the tRNA to do?
- What would you expect to find in a virus? What would you expect NOT to find in one?
- Describe the steps to viral reproduction.

Chapter 13: How Populations Evolve

- Define evolution and natural selection.
- List and describe the evidences for evolution.
- What are some sources for variation that can cause evolution? Define: genetic drift, gene flow, nonrandom mating, mutation.

Chapter 14: How Biological Diversity Evolves

- Define "species."
- What causes allopatric speciation? What causes sympatric speciation? Give examples of each.
- Define: taxonomy and phylogeny.
- What is the Binomial System of Nomenclature invented by Karl von Linne? Explain the proper way to write an organism's scientific name.
- List the classification scheme for organisms…start with kingdom and take the scheme to species.
- What are analogous and homologous structures? Give examples of each.
- What are the kingdoms found in each domain?

Chapter 15: The Evolution of Microbial Life

- List the characteristics of a prokaryote (bacteria).
- Identify the two domains into which bacteria can be classified. Why do you think there needs to be two domains?
- List the different shapes bacteria can have. List and describe the parts of a bacterial cell.
- Identify the four methods of bacterial nutrition (such as photoautotroph).
- How do bacteria reproduce?
- List the characteristics of protists.
- Identify the different ways that protists can move themselves.
- Differentiate the animal-like protists (protozoans) from the plant-like protists (algae, diatoms, etc.).

Chapter 16: Plants, Fungi, and the Move onto Land

- Describe the advancements necessary for plants to live on land.
- List the characteristics of the mosses, ferns, gymnosperms, and angiosperms.
- Describe the moss life cycle using the sporophyte and gametophyte generations.

- For each plant phylum, tell the advancements each group has over the primitive group. For example, the mosses were primitive. They lacked vascular tissue, roots, etc. They were dependent on water for reproduction. The advancements seen in the ferns was a development of vascular tissue.
- Identify the four major parts of a flower. Explain where pollination and double fertilization occur in a flower. Briefly tell what happens during each of these processes.
- Describe the characteristics of fungi.
- Explain the mode of nutrition for fungi.
- Describe the basic structure of a fungus. Define: hyphae and mycelium.
- What are lichens and mycorrhiza?

Chapter 17: The Evolution of Animals

- List the characteristics of animals.
- Explain a generic life cycle for an animal.
- Identify the four key evolutionary trends in the body structure of animals. Define symmetry, coelom, and embryonic development.
- List the invertebrate animal phyla.
- Identify the basic characteristics and advancements of the invertebrate animal phyla.
- What makes an animal a "chordate?"
- List the vertebrate (chordate) animal phyla.
- Identify the basic characteristics and advancements of the vertebrate animal phyla.

Chapter 21: Unifying Concepts of Animal Structure and Function

- Define anatomy and physiology. Give examples of each type of study.
- Define tissue and list the four major tissue groups.
- For each of the four major tissue groups, identify the structure and function and any examples.
- List the 11 organ systems. What organ(s) will you find in each system? What is the primary function of each system?
- Define homeostasis. Explain how the negative and positive feedback loops work to maintain homeostasis. Give examples of each feedback loop type.

Chapter 27: Nervous, Motor, and Sensory Systems

- Describe the organization of the nervous system and explain the functions of the nervous system.
- What is the function of a sensory neuron? A motor neuron?
- Explain the function of the different parts of the neuron (such as axon, dendrites, myelin sheath, Schwann cell).
- Explain how a nerve impulse transmission occurs. For resting potential, action potential, and repolarization, know where the ions and charges are.
- What is a synapse and what happens at the synaptic cleft?
- What is the role of the neurotransmitter in nerve impulse transmission?
- What are the functions of the skeletal system?
- Identify the bones (page 607) of both axial and appendicular skeletal systems.
- Describe the macroanatomy (big picture structure) of the long bone.
- What are the functions of the muscular system?
- Name the 3 types of muscle…include several characteristics of each type.
- Describe the macroanatomy of a skeletal muscle.

List #1 of Vocabulary Words for Quiz 1

	Word Root	**Definition**
1.	aero–, aer–	*air*
2.	a–, an–, in–	*without, negative*
3.	–ase	*suffix for an enzyme*
4.	bio–	*life*
5.	cili–	*small hair*
6.	co–, com–, con–	*with, together*
7.	cyte–	*cell*
8.	end–	*within*
9.	eu–	*good*
10.	exo–	*outside*
11.	eury–	*broad, wide*
12.	glyc–, glu–	*sugar*
13.	hydro–, hydra–	*water*
14.	hypo–	*under, below*
15.	hyper–	*over, above*
16.	inter–	*between*
17.	intra–	*within*
18.	iso–	*same*
19.	kary–	*nucleus, nut*
20.	lip–	*fat*
21.	–logy	*study of*
22.	–lysis	*breakdown, dissolve*
23.	mono–	*single*
24.	nucle–	*kernal*
25.	–pepsia	*digestion*
26.	–phobia	*abnormal fear*
27.	poly–	*much, many*
28.	pro–	*before*
29.	–soma, –some	*body*
30.	syn–, sym–	*with, together*

List #2 of Vocabulary Words for Quiz 2

	Word Root	**Definition**
1.	allo–	*other*
2.	ana–	*apart*
3.	chrom–	*color*
4.	de–	*away from*
5.	diplo–	*double, twofold*
6.	dis–	*apart*
7.	gen–	*precursor of*
8.	heter–	*different*
9.	home–, hom–	*same*
10.	kin–	*move*
11.	macr–	*large*
12.	meta–	*after*
13.	micr–	*small*
14.	multi–	*many*
15.	–oid	*resembling*
16.	osis–	*condition of*
17.	peri–	*around*
18.	phag–	*swallow, eat*
19.	pheno–	*show, appear*
20.	–philia	*love, attraction*
21.	pino–	*drink*
22.	plasm–	*substance*
23.	poly–	*many, much*
24.	post–	*after*
25.	pre–	*before*
26.	quadri–	*four*
27.	re–	*back, again*
28.	telo–	*end*
29.	tri–	*three*
30.	zyg–	*a yoke, twin*

List #3 of Vocabulary Words for Quiz 3

	Word Root	**Definition**
1.	adip–	*fat, lipid*
2.	anti–	*against*
3.	auto–	*self*
4.	bi–	*two*
5.	carn–	*flesh*
6.	chem–	*chemical*
7.	chlor–	*green*
8.	cyano–	*blue*
9.	dia–	*through*
10.	epi–	*upon*
11.	morph–	*form, shape*
12.	nom–	*name*
13.	peri–	*around*
14.	photo–	*light*
15.	pil–, trich–	*hair*
16.	–plasia	*formation*
17.	–plasty	*make, shape*
18.	pod–	*foot*
19.	pseud–	*false*
20.	–scopy	*visualization*
21.	–stasis	*stop, control*
22.	super–, supra–	*above*
23.	tax–	*order, arrange*
24.	–trophy, –trophic	*development*
25.	vacc–	*cow*

List #4 of Vocabulary Words for Quiz 4

	Word Root	**Definition**
1.	amphi–	*both sides, surrounding*
2.	angi–	*vessel*
3.	arbor–	*tree*
4.	arthr–	*joint*
5.	blast–	*immature cell form*
6.	cephal–	*head*
7.	coel–	*hollow, cavity*
8.	cutan–, cut–	*skin*
9.	derm–	*skin*
10.	di–	*double*
11.	duct–	*carry*
12.	echino–	*prickly, spiny*
13.	gamet–	*married, spouse*
14.	gastr–	*stomach*
15.	gnath–	*jaw*
16.	hydro–	*water*
17.	myc–	*fungi*
18.	oo–	*ova, egg*
19.	phyte–	*plant*
20.	para–	*to bear*
21.	rhiz–	*root-like*
22.	stomat–	*mouth*
23.	sub–	*under*
24.	therm–	*heat*
25.	vert–	*turn*

List #5 of Vocabulary Words for Quiz 5

	Word Root	**Definition**
1.	adren–	*toward the kidney*
2.	chondr–	*cartilage*
3.	crani–	*skull*
4.	encephal–	*brain*
5.	erythr–	*red*
6.	flex–	*bend*
7.	gon–, gono–	*seed, offspring*
8.	hist–	*tissue*
9.	hormon–	*hormones*
10.	lact–, galact–	*milk*
11.	leuk–, leuc–	*white*
12.	my–	*muscle*
13.	myel–	*spinal cord, marrow*
14.	neur–	*nerve*
15.	ocul–	*eye*
16.	oste–, oss–	*bone*
17.	pect–	*chest*
18.	physi–	*nature*
19.	pneum–	*air, breath*
20.	pulmon–	*lung*
21.	sarc–	*flesh*
22.	scler–	*hard*
23.	stasis–	*standing still*
24.	vas–	*vessel*
25.	veni–	*vein*