

**CENTRAL TEXAS COLLEGE
SYLLABUS FOR BIOL 2402
ANATOMY & PHYSIOLOGY II (BIOL 2402)**

Semester Hours Credit: 4

INSTRUCTOR: SANDRA WHISLER

E-MAIL ADDRESS: sandra.whisler@ctcd.edu

Office 1021 (in the Science department)

Phone: (254) 526-1502

I. INTRODUCTION

- A. Human Anatomy and Physiology II is designed for students entering health care fields (nursing, EMT, dental, MLT medical etc.) or biological sciences. It is an advanced course that builds on basic knowledge gained in general biology, general chemistry, and Human Anatomy and Physiology I.
- B. The main focus of this course is the biochemical function of the body and the interrelationships between body systems that exist to maintain homeostasis.
- C. The body systems emphasized in this course are those most important in homeostatic regulation. These include: nervous system, endocrine system, cardiovascular system, respiratory system, and urinary system.
- D. Major topics covered include osmolarity (water and ion balance), pH balance, blood flow regulation (blood pressure, cardiac output, vascular regulation of blood flow), blood glucose regulation, and other metabolic regulation.
- E. Anatomy & Physiology II (BIOL 2402) requires a **prerequisite of Anatomy & Physiology I (BIOL 2401)** or comparable course work to be approved by the instructor. Background in general biology/basic chemistry is necessary (for example, Biology 1406 would provide sufficient background in both areas). Advanced and recent high school biology and chemistry courses would also meet the background requirements.

II. LEARNING OUTCOMES

Upon successful completion of BIOL 2402, the student will be able to:

- A. Use vocabulary related to human physiology and express terms in a professional and knowledgeable manner.

- B. Display behaviors such as self-discipline, courtesy and consideration for others, and eagerness for knowledge, which are essential components of effective functioning in the health sciences.
- C. Demonstrate self-reliance in using laboratory facilities, completing laboratory activities, and evaluating collected data related to human physiology.
- D. Evaluate the principles of body homeostasis in the healthy state in order to have background necessary for analyzing the diseased state.

III. INSTRUCTIONAL MATERIALS

- A. Required text: Silverthorn, Dee, Human Physiology: An Integrated Approach. Fifth edition, San Francisco, Benjamin Cummings, 2010.
- B. Required Laboratory Manual: Hidy, Patrick, Lab Manual for Human Physiology, Killeen, Texas, 2007. Available at CTC bookstore.
- C. Optional: Hidy, Patrick, Medical Prefixes Suffixes and Abbreviations, Killeen, Texas, Available at CTC Bookstore.
- D. Required: Whisler, Sandra. Supplementary Lab and Lecture materials for A & P II. Fall 2010. Available at CTC Bookstore.
- E. Laboratory materials as provided by the instructor. You will often serve as your own experimental subject during lab.
- F. Library and Internet. Excellent sources of outside readings and resources needed for researching concepts and projects. Videotapes will be provided in the library and viewed in the laboratory environment when applicable. Additional copies of other A & P text books and general biology textbooks are available in the lab room for checkout. The text book comes with an associated web site and CD ROM that have both been praised by students as helpful for gaining background and for reinforcing concepts studied in class.

IV. COURSE REQUIREMENTS

- A. To receive transferable credit for this course, you must earn a grade of "C" or better. All students with grades of "D" or less on exams are to immediately make arrangements to conference with the instructor to ascertain the reason(s) for their low performance. It is recommended that the student volunteer for this counseling when he/she first encounters the decline in scores. If the student does not volunteer for counseling, a counseling meeting may be initiated by the instructor. It is the responsibility of the student to seek help and ask questions when concepts presented in lecture or the textbook are not clear.

If you are having a problem understanding, it is preferable to ask questions in class. Generally, if one student is confused, so are others—they will benefit from your question. If you do not wish to ask in class, make an appointment with the instructor.

You will be provided with a copy of your instructor's schedule including office hours. These will also be posted on the office (NS-1021) door. **The purpose of office hours** is to provide a time for you to have individual or small group access to the instructor. You can generally count on finding me in my office during these times. If you are making a special trip to campus to see me, it is best to contact me to set up an appointment so that I will have enough time to assist you. Meeting times outside office hours may be arranged if the normal office hours do not fit your schedule.

- B. You begin this course the **FIRST** day of class and your evaluation at the end of the course will be indicative of the effort exerted during the semester. This course is technical and the terminology involved requires **frequent** study and much attention to meaning. Memorization of some facts will be necessary, but a **functional understanding** must result as the final product. Your attitude about this course will determine a large part of how you perform in the class. If you choose to be interested in the subject, successful study will come more easily for you. In the sciences, we recommend 3 hours of outside study for each hour of class time. Do the math: 3 hour of lecture each week + 3 hours of lab each week = 6 hours in class → $6 \times 3 = 18$ hours of additional study each week. Make a schedule for yourself that sets aside these hours for study in a quiet, private place.
- C. You are expected to read the assigned textbook chapters, paying particular attention to the pages indicated for you in the course schedule provided on the first day of class. You should also bring your textbook to class and to lab. **NOTE- Make sure you have your name written on the inside of the front cover.** These are not inexpensive books to lose. If your name is in the book, it will make it easier to return.
- D. Your notes are an essential study tool. The majority of the exam questions will be derived from the lecture notes. The note taking strategy I recommend for college level classes is as follows:
- **READ the chapter** before you attend the corresponding lecture. At the very minimum, review the topic headings, basic vocabulary and chapter figures and captions prior to class.
 - Answer all of the concept check questions and graph questions **as you read**.
 - Take good notes in class.
 - Ask questions during lecture if you do not understand something. The best time to get a question cleared up is during lecture. If you don't understand, there are undoubtedly others who do not understand either.

- Go to a quiet place to study and **re-write your notes** adding in colors, outline organization, and additional information from your text. Do this the same day you hear the lecture, preferably as soon as possible.
- **Answer the questions** at the end of the chapter and any review questions provided by your instructor. If you cannot answer these without returning to your notes to find the answer then you are insufficiently prepared for the exam and additional study is needed.

If you are absent, you need to arrange for one (or better yet two) of your classmates to either tape the lecture and/or make their notes available to you when you return. As with the textbook notes, you must be sure to put the transcribed notes in your own words, and if the notes do not make sense ask the instructor for clarification.

- E. **Student participation** in class is essential. When you actively participate, you give yourself the opportunity to process and grasp information. You also give the instructor an opportunity to help you learn when you ask questions about material that you do not understand. The instructor cannot read your mind and know that you are confused. You must seek the assistance that you need.

Active class participation is not only beneficial to learning, but is reflected in “fudge points” at the end of the semester. These are points which are added to the overall grade if only a few are needed to attain the next highest grade. (e.g. have 626 points; need 630 points for an A. Result, 626 + “fudge points” = A) However, the “fudge points” will not exceed 3 percentage points. **You are not entitled to these points. They will only be given to students who in the instructor’s opinion have demonstrated substantial effort and/or improvement. Effort includes but is not limited to: attending class regularly, participation in lecture and in lab activities, asking relevant questions and general civility in class (see below). To earn these points you must clearly demonstrate to the instructor a positive learning attitude, consistent effort and the ability to work with and support lab partners and other class members. Improvement over the course of the semester will also be considered when I allocate any additional points.**

V. EXAMINATIONS

- A. Always contact the instructor immediately if you know you will be missing an exam. This is both a courtesy to the instructor and to your advantage as the instructor may suggest an alternative time to take the exam that would be acceptable to the instructor. **Make-up examinations will not be given following the testing date.** If prior knowledge of an absence is obtained, the test may be taken early, if the situation warrants. If you are not present for an exam, the missed grade will be computed as your lowest grade and dropped from the averaging process (the drop grade does not apply during summer semester).

If you miss in excess of one exam, a grade of zero will be recorded and averaged into the final grade.

- B. The exams will be structured to include both subjective and objective questions. Question types will include, multiple choice, short answer, and fill in type questions. Calculation/evaluation type questions will also be common. There may be “bonus questions” on the exam. Bonus questions are constructed so that students who have studied “above and beyond” will have a definite advantage to answering them correctly.

VI. SEMESTER GRADE COMPUTATION

The semester grade will reflect, in addition to examination grades, homework/quiz grades and up to 3 percent “fudge points” (see above).

16 week semester grading format

<u>Examination</u>	<u>Points</u>	<u>Total Grade Points</u>	<u>Grade</u>
Three lecture exams	300	720-800	A
Three Lab Exams	300	640-719.....	B
Quiz, single concept maps and other lab points	100	560-639.....	C
Fourth lecture exam and Final Exam (taken on the day of the final exam)	200	0 - 479	F

900 - 100 (dropped lowest regular exam grade) = 800 possible points.

You should bring a scantron (100AS form) to each lab and lecture exam. Answers to some test questions will be recorded on the scantron.

In addition to the “drop exam”, either of the two projects listed below may be used to substitute for ONE of the exam grades. They may not be used to substitute for the final exam grade. They may not be used to substitute for exams that were missed. Details about these projects will be provided in class.

Concept map project	Maximum points : 80	Due during the first half of the course.
Poster project	Maximum points: 80	Due during the second half of the course.

Note on the drop grade. I will drop one lecture or lab exam. I will not drop the 100 point exam for the comprehensive final. If your quiz and homework average is lower than any of your exam grades, I will drop that grade instead. Thus, if you are satisfied with your exam average, you do not need to feel obliged to do all of the homework if you do not need it to prepare you for the exams.

You should bring a scantron (100AS form) to each lab and lecture exam. Answers to some test questions will be recorded on the scantron.

VII. NOTES AND ADDITIONAL INSTRUCTIONS

- A. Course Withdrawal: It is the student's responsibility to officially withdraw from a course if circumstances prevent attendance. Any student who needs to officially withdraw from a course after the first scheduled class meeting must file a Central Texas College Application for Withdrawal (CTC Form 59). **The withdrawal form must be initiated and signed by the student.**

CTC form 29 (withdrawal form) will be accepted at any time prior to Friday of the 12th week of classes during the 16-week fall and spring semesters. The specific last day to withdraw is published each semester in the Schedule Bulletin.

A student who officially withdraws will be awarded the grade of "W" provided the student's attendance and academic performance are satisfactory at the time of official withdrawal. **Students** must file a withdrawal application with the College before they may be considered for withdrawal.

A student may not withdraw from a class for which the instructor has previously issued the student a grade of "F" or "FN" for nonattendance.

- B. Administrative Withdrawal: An Administrative withdrawal may be initiated when the student fails to meet College attendance requirements, as defined in the current Central Texas College Catalogue and/or other amendatory documentation (in excess of 4 class + lab meetings). In such cases, the student is dropped from the course with the grade of "F". (Each case will be assessed individually)
- C. Incomplete (IP) Grade - May be given only in those cases where the student has completed the majority of the coursework but, because of personal illness, death in the immediate family or military orders, the student is unable to complete the final requirements for a course. Prior approval from the instructor is required before the grade of "IP" is recorded. A student who merely fails to show for the final examination will receive a zero for the final and "F" (FN) for the course. (see student handbook).

Because of the unpredictable nature of the military and its obligations, students who are soldiers or dependents occasionally are uprooted and transferred prior to the end of a semester. It is imperative that these students petition for a grade of "IP" and subsequently notify the instructor of his or her new duty station (i.e. address, e-mail address, phone number, etc.) Also, the individual should contact the education officer at the new duty station so that arrangements can be made for faxing or mailing the final exam to that office so that the student might complete the course requirements and obtain a grade for the course.

- D. Cellular Phones and Beepers: Cellular phones and beepers **will be turned off** while the student is in the classroom or laboratory.

- E. Americans with Disabilities Act (ADA): Students requiring accommodations for disabilities are responsible for notifying the instructor. Reasonable accommodations will be granted in full compliance with federal and state laws and Central Texas College policy.
- F. Instructor Discretion: The instructor reserves the right of final decision in course requirements.
- G. Civility: Students are expected to conduct themselves with civility at all times in the college environment. Failure to do so can result in disciplinary action up to and including expulsion.

Minimal civility includes:

1. Turn off your beeper or cell phone before you enter the room. Put it out of sight.
2. Arrive at class on time.
3. Stay in class for the entire period. Do not leave to go to the rest room, take a phone call, or for any other non-emergency reason.
4. If it is unavoidable that you must leave early one day, inform the instructor of the situation prior to the start of class and position yourself in class near the door so that you do not disrupt others when you leave.
5. Talking, sleeping, reading, texting or working on other material during class time is inappropriate. You will be asked to leave if you engage in these activities.
6. Use socially acceptable language in class.
7. Children and guests do not belong in class. Children are never allowed in the lab, even during open lab times.
8. Cellular phones and beepers WILL BE TURNED OFF during lecture and lab. Repeat violators will leave the classroom and not be permitted to return.

H. Cheating or plagiarism will not be tolerated. The consequences for cheating will be related to the severity of the act. **At minimum**, the student will earn zero points for the assignment/exam involved in the first incident. The consequence of any act of cheating or plagiarism may include expulsion from the course and/or from CTC. Presence of visible or audible electronic devices during the exam will be considered cheating. All electronic devices will be placed out of sight and hearing prior to the start of the exam.

I. Students with disabilities who wish to have special accommodations made must get approval and documentation through the Disabilities office. It is the responsibility of the student to obtain approval through the office of disabilities, provide documentation of necessary accommodations to the instructor, and make any necessary special arrangements directly with the instructor. The office of disabilities does not contact the instructor.

J. Student resources:

Learning resources center: 526-1344

Provides self-paced developmental math and English instruction

Provides assistance in reading and math for nursing students

Project Pass: 526-1580

Limited textbook lending library

Tutoring

Library: 526-1237

There is a copy of the text, supplement materials and Dr. Hidy manual on closed reserve.

The library has many hours available including weekends and Fridays. Check on-line or call for hours.

VIII. COURSE OUTLINE

The objectives of all the chapters below include the development of a working knowledge of the concepts and vocabulary. This course builds on the information presented in A & P I and also builds on itself throughout the term. Long term retention is a key to success in this course. Instructor review questions will be provided for each topic. The learning activities at the end of each chapter also serve as a review for exams. Do the review questions for each chapter as noted in the course lecture and lab schedule.

Read the preface for the philosophy of the textbook and the useful hints section. Note the website to be used for additional help: (<http://www.physiology-place.com>). Explore the links found within this webpage. In this preface section note the “themes & special features” which are designed to help you find your way around the textbook. People constantly ask me how to study this subject... this section should give you a few helpful hints. Here are some more:

Basic study strategies for science courses include:

1. Read the text assignments and your notes. It is your responsibility to preview the material being covered in lecture before you attend the lecture. Without substantial preview, you handicap yourself in understanding the lecture material.

2. Preview for lab is absolutely critical. Quizzes may be given at the start of lab to encourage you to be consistent about preview before lab.

3. Re-write a summary of the text or lab manual information combining it with class notes. Be sure to use your own words. This is not simply copying over neatly what you wrote in class or writing down a chapter outline. It is combining your understanding of the reading, lecture and other study information in a way that creates a condensed study tool.

4. Find a compatible group of people to study with. Teach the members of your study group what you have just learned. When you explain something to someone else, the information will become clearer to you.

Specific Course Objectives by chapter:

A. Introduction to Physiology: Chapter 1

1. Learning Outcomes: Upon successful completion of this lesson, the student will:
 - a. Review the anatomy and basic physiology of all body systems.
 - b. Review the concept of homeostasis and give examples.
 - c. Identify the fluid compartments within the body and describe the basic pathways by which materials and energy are exchanged between the body and the outside environment.
 - d. Create and read graphs related to physiologic data.
 - e. Evaluate descriptions of scientific experiments identifying experimental variables (independent and dependent), controlled variables, number of replicates, data, results, and conclusions.
 - f. Distinguish between the terms hypothesis, theory and fact.
 - g. Identify factors that increase the difficulty of experimentation with human subjects above and beyond those affecting typical scientific experiments.
 - h. Explain the importance of placebo and nocebo effects in relation to experimental design. Explain the features of typical experimental designs used with human subjects including blind studies, double blind studies and crossover studies.
 - i. Discuss the importance of peer review to scientific integrity. Explain how the process of peer review works and therefore how information published in peer-reviewed journals differs from information published in books and magazines.
 - j. Apply the citation formats described in the text to assignments submitted for this course.
 - k. Create and use concept maps as a study tool.
2. Learning Activities:
 - a. Answer concept checks, graphing and figure questions and end of the chapter questions.
 - b. Construct concept maps that clearly and succinctly summarize the major anatomy and physiology of body systems.
 - c. Evaluate, interpret and make a variety of graphs.
 - d. Correctly cite information obtained from scientific sources.

B. Chemistry: chapter 2 (Consider this a review chapter to reacquaint you with terms. If this material is new to you, you will need to put in concerted effort to learn much of it on your own. This material is covered in A & P I at CTC.)

1. Learning Outcomes: Upon successful completion of this lesson, the student will:

- a. Explain the structure of the atom and how the structure is modified to form ions, isotopes and bonds.
- b. Distinguish between elements, compounds and molecules and give examples of each.
- c. Use electron dot (Lewis dot) or orbital diagrams to indicate sharing of electrons in covalent molecules. Write structural formulas of common molecules such as water, oxygen, carbon dioxide, glucose, amino acids, fatty acids etc. Explain why atoms form covalent bonds with each other and how polar and non-polar covalent bonds differ.
- d. Explain how ions form. Describe the types of forces that hold charged ions or molecules together.
- e. Diagram the structure of a water molecule including shape and partial charges. Explain how the partial charges in water molecules result in hydrogen bonding between water molecules. Explain how the forces created by hydrogen bonds in water result in surface tension, adhesion, cohesion and the ability of water to act as a solvent.
- f. Name and diagram the major functional groups found in biomolecules including carboxyl, hydroxyl, amino, phosphate, sulfhydryl, carbonyl.
- g. List the four categories of biomolecules and give examples of their building blocks or monomers.
- h. Distinguish between monosaccharides (both 5 carbon and 6 carbon), disaccharides, and polysaccharides and give examples of each group.
- i. List the major classes of lipids. Give examples of each class. Describe the major subunits of triglycerides and phospholipids.
- j. Describe the levels of organization of proteins. Explain the forces that hold proteins together at each level of organization. Diagram the process of connection between two amino acids. Use correct terminology to describe the interaction between the functional groups and reactions involved in peptide bond formation.
- k. Describe the components of a nucleotide. Explain the specific structure of ATP and relate it to the generalized structure of a nucleotide.
- l. Compare and contrast the structure of DNA and RNA and explain how they are related to nucleotide structure.
- m. Explain which bases pair during replication, transcription and translation and what forces hold the base pairs together.
- n. Apply the terminology related to aqueous solutions (solute, solvent, solution, solubility, suspension) to examples of specific combinations of ions and molecules with water.
- o. Determine the molecular mass of a molecule using the periodic table.

- p. Make a solution of a given molarity, molality, osmolarity or percentage using common solutes used to make IV solutions: sodium chloride and dextrose.
- q. Explain the structure of the pH scale. Give examples of body fluids and common household materials that are representative of various points of the scale. Explain the relationship between hydrogen ion concentration and hydroxide ion concentration in aqueous solutions. Define and relate acids, bases and salts.
- r. Explain the action of buffers and give examples from the body.
- s. List the major functional categories of proteins.
- t. Explain the concepts of specificity, affinity and competition in relation to protein structure.
- u. Explain why many proteins are produced by a cell in an inactive form and the typical ways by which the proteins will be activated.
- v. Compare and contrast the effect on protein function of chemical modulators including antagonists (inhibitors), agonists, competitive inhibitors, allosteric modulators and covalent modulators.
- w. Discuss the physical factors that impact protein activity. Discuss the up and down regulation of proteins, and saturation.

2. Learning Activities:

- a. Answer concept checks, graphing and figure questions and end of the chapter questions.
- b. Make sodium chloride and dextrose solutions of various concentrations.
- c. Observe demonstrations of the properties of water and describe how hydrogen bonds cause these effects.
- d. Use molecular model kits to form models of simple molecules including oxygen, carbon dioxide, methane, water, glucose, fructose, sucrose, and various amino acids. Use molecular model kits to form models of functional groups and explain/illustrate the properties of functional groups using molecular models.
- e. Use molecular model kits to form a model of a short polypeptide chain and to form nucleotides and connect them into a short polymer.

C. Compartmentalization, cellular junctions and epithelial functions: Chapter 3(Consider this a review chapter to reacquaint you with terms. If this material is new to you, you will need to put in concerted effort to learn much of it on your own. Most of this material is covered in A & P I at CTC.)

1. Learning Outcomes:

- a. Describe the major compartments of the human body and the importance of fluid compartmentalization.

- b. Compare and contrast mucous membranes, serous membranes and cell membranes. Give examples of serous and mucous membranes and describe their specific locations.
 - c. Give the major functions of cell membranes and describe the composition of the cell membrane.
 - d. Classify the components of the cell membranes in terms of structure and function.
 - e. Describe compartmentalization within the cell. Distinguish between inclusions and membranous organelles. Give examples of each.
 - f. List the major types of organelles and important cellular inclusions and give the function of each.
 - g. Describe the structure of the mitochondrion in detail.
 - h. Describe various cellular junctions (gap, tight, and anchoring) and list typical locations and functions of cellular junctions.
 - i. List the epithelial tissue types that line the following organs or structures: mouth, small intestine, proximal convoluted tubule, sudoriferous gland, urinary bladder, fallopian tubes, bronchi, paranasal sinuses.
 - j. What are the special characteristics of transporting epithelia? Between what body compartments are these epithelial layers found? Which organs/structures on the above list are lined with transport epithelia? Which organs above have ciliated epithelial layers?
 - k. What connective tissue type(s) form the following structures: the femur, the Achilles tendon, the anterior cruciate ligament, the subcutaneous layer of the skin, the fascia of the gastrocnemius muscle?
 - l. How are neurons and muscle cells similar to each other, but different from all other cell types?
 - m. Distinguish between necrosis and apoptosis. Give examples of each process.
 - c. Students will explain the cell cycle and the process of mitosis. Students will recognize the various stages of mitosis under the microscope.
2. Learning Activities:
- a. Answer concept checks, graphing and figure questions and end of the chapter questions.
 - b. Identify cell structures (nucleus, nucleolus, cell membrane) microscopically.
 - c. Identify stages of mitosis microscopically and describe the processes occurring at each stage.

D. Cellular Metabolism: Chapter 4

1. Learning outcomes:

- a. Explain how photosynthesis and cellular respiration help transfer energy throughout the environment.
- b. Write the summary equations for photosynthesis and cellular respiration and describe the forms of energy that are transferred during these processes.
- c. Describe the types of work performed using cellular energy.
- d. Distinguish between potential and kinetic energy. Classify the following energy in cells as potential or kinetic: energy used to move a vesicle to the cell membrane, energy used to move a flagellum, energy in glycogen or fat, energy in ATP, energy used to change the shape of a protein to move an ion across a membrane, energy stored in a difference in ion concentrations on two sides of a membrane.
- e. List the two laws of thermodynamics and explain their relevance to energy in living organisms.
- f. Given a sample reaction, identify the reactants, products, enzyme involved and whether the reaction is reversible or not based on the reaction notation.
- g. For a system of coupled reactions, identify which is endergonic and which is exergonic. Identify whether oxidation, reduction or phosphorylation is involved in the reaction system based on changes to the reactants and products.
- h. Evaluate graphs of endergonic and exergonic reaction progression to determine the free energy changes involved in the reaction, the activation energy, and the energy of the reactants and products.
- i. Explain the purpose of activation energy in terms of both the ball and hill model and the actual types of changes to bonds likely to occur during a chemical reaction.
- j. Define enzymes. Discuss the necessity for enzymes in cellular reactions. Discuss modulation, inhibition, allosteric effects, coenzyme effects, pH and temperature effects on enzyme activity.
- k. Given examples of chemical reactions, evaluate whether the reactions are oxidation/reduction reactions, hydrolysis/dehydration synthesis reaction, addition/subtraction/exchange reactions or ligation reactions.
- l. Define metabolism, catabolism, anabolism. Distinguish between a simple reaction and a metabolic pathway. Determine if a single reaction or a pathway is anabolic or catabolic.
- m. Explain how cells regulate metabolic pathways.
- n. Explain how feedback inhibition regulates metabolic pathways. Explain the other factors that are important in regulating metabolic pathways.
- o. Explain why compartmentalization in cells is important in light of your understanding of metabolic pathways and enzyme activity.
- p. List the major sub-reactions of aerobic cellular respiration.
- q. For each major sub-reaction of cellular respiration, summarize the reactants, products and energy storage molecules produced by the

- pathway. In what part of the cell or specific part of an organelle does each sub-reaction occur?
- r. Identify the sub-reaction of aerobic cellular respiration that also occurs during anaerobic (fermentation) processes.
 - s. Given any single step of glycolysis as illustrated in figure 4-14, explain in detail what chemical changes (addition or loss of H, CO₂, phosphate etc.) and energy changes (endergonic or exergonic) occur during the step.
 - t. What is the net energy production of each (of 4) major subreactions of aerobic respiration?
 - u. Explain the mechanism of the electron transport chain during cellular respiration. Explain how the transport chain creates a hydrogen ion concentration gradient and how the gradient is used to drive ATP synthesis.
 - v. Define glycogenolysis and explain how it relates to body energy balance and to cellular respiration.
 - w. Compare and contrast the energy storage of lipids, proteins and carbohydrates.
 - x. Describe the breakdown processes for lipids and proteins. Explain how breakdown products of these processes are potentially harmful to the body and how the body disposes of them.
 - y. Explain the importance of gluconeogenesis to normal body function. Describe the sources of energy used to form new glucose.
 - z. Explain the sources of building block molecules for lipid synthesis when there is insufficient lipid intake from food.
 - aa. Describe the major steps required for the production of proteins based on DNA nucleotide sequence.
 - bb. Given a DNA or RNA codon, use a chart of the genetic code to determine the amino acid the codon codes for. Decode a DNA sequence to mRNA. Decode an mRNA sequence to an amino acid sequence.
 - cc. Name the most important enzyme involved in RNA formation from DNA.
 - dd. Describe the process of transcription (overview).
 - ee. Describe the process of translation (overview).
 - ff. Explain how proteins are modified after translation into the final, active, form of the protein.
 - gg. Explain how proteins formed on cytoplasmic ribosomes differ from those formed on the Rough Endoplasmic reticulum.

2. Learning Activities:

- a. Answer concept checks, graphing and figure questions and end of the chapter questions.
- b. Use models to demonstrate the major principles of DNA transcription and translation.
- c. Create and evaluate graphs of enzymatic reaction progress.

E. Reproduction and Genetics (chapter 26)

1. Learning Outcomes

- a. Define: gonads, gametes, internal genitalia, external genitalia, autosomes, sex chromosomes.
- b. Explain how sex is determined in humans.
- c. Explain how a karyotype is produced and what information can be obtained from a karyotype. What type of genetic information cannot be determined from a karyotype?
- d. Compare and contrast the purpose and processes of meiosis and mitosis.
- f. Discuss the production and feedback mechanisms of the major hormones involved in reproductive control in males and females.
- k. Which hormones are involved in control of sperm production? What are their functions?
- l. Distinguish between primary and secondary sexual characteristics.
Name the hormones involved in development and maintenance of secondary sexual characteristics in males and females.
- n. Explain how hormones coordinate the release of the oocyte and the changes to the endometrium. Consider both pituitary and gonadal hormones.
- o. Outline the major events of fertilization from sperm maturation and capacitation to production of the zygote.
- p. As the zygote moves from the site of fertilization to the endometrium, what events occur? Through what structures does the developing zygote pass?
- q. Describe the function of the placenta. What hormones maintain the placenta during pregnancy?
- r. Explain how the parturition process represents positive feedback.
- s. List the hormones that control milk production and milk letdown. Name the locations where these hormones are produced and to what hormonal classes (peptide, steroid or amine) each belongs. Explain how sensory information plays a role in milk production and letdown.

2. Learning Activities:

- a. Answer concept checks, graphing and figure questions and end of the chapter questions.
- b. Given a photograph of human chromosomes, make a karyotype and determine the sex of the individual and any chromosomal abnormalities of the individual.

F. Membrane Dynamics: Chapter 5

1. Learning Outcomes:

- a. Explain how materials enter and leave the body.
- b. Distinguish between the idea of homeostasis and equilibrium.
- c. Explain how sodium, potassium, chloride, bicarbonate and large anions and proteins are distributed in the three major body compartments.
- d. Identify which transport processes depend on ATP energy and which depend solely on molecular movement due to heat energy. Identify which transport processes require membrane proteins.
- e. List the properties of diffusion and discuss the factors that typically influence diffusion rate in cells.
- f. Explain how membrane composition, folding, and thickness affect diffusion.
- g. Explain how molecular size, lipid solubility, charge and concentration affect diffusion rate.
- h. Explain how temperature and distance affect the rate of diffusion.
- i. Classify membrane proteins in terms of both structure and function.
- j. Distinguish between channel proteins and carrier proteins. Distinguish between open and gated channel proteins.
- k. Distinguish between membrane carrier proteins that require ATP for shape change and those that do not.
- l. Give specific examples of molecules/materials that are transported across membranes by the following processes: simple diffusion, diffusion through a pore protein, facilitated diffusion, active transport using membrane proteins, endocytosis, exocytosis.
- m. Classify carrier proteins as uniport, antiport, symport and cotransporters.
- n. Explain how metabolically active cells maintain a concentration gradient of glucose that allows glucose to enter the cell by passive transport.
- o. Distinguish between primary and secondary active transport and give examples of molecules that are transported by each process.
- p. Classify the following transporters according to the categories in objective “m” and “o” above: sodium-potassium ATPase, GLUT transporters, SGLT transporters.
- q. Explain how the terms specificity, competition, and saturation relate to both enzyme activity and carrier protein activity.
- r. Give examples of molecules transported by phagocytosis, pinocytosis, receptor mediated endocytosis and exocytosis. Categorize these processes as active or passive processes.
- s. Explain how membrane recycling is involved in receptor-mediated endocytosis.
- t. Diagram a transport epithelial layer indicating the apical surface with microvilli, the basolateral surfaces, and tight junctions.

- Explain how the structure of the transport epithelial cells creates a polarized cell.
- u. Explain how the presence of microvilli affects the ability of the membrane to move materials between lumen and ECF.
 - v. Explain in detail the transepithelial transport of glucose between the lumen of the kidney or intestine and the ECF. Include a discussion of all of the types of transporters involved, where ATP energy is required and what drives movement of molecules where ATP is not used directly.
 - w. Define transcytosis and give a specific example of where it occurs in the body and for what purpose it occurs.
 - x. Compare and contrast the concepts of osmolarity and tonicity.
 - y. Discuss how sex and age affect body water content. When the body maintains homeostasis, how does the osmolarity of the 3 major body compartments compare? Explain how the volume of water in the three compartments compares.
 - z. Define osmosis. What conditions cause water to move by osmosis?
 - aa. Given the molarity of a solution, calculate the osmolarity of the solution. Give the normal osmolarity range for the human body. Given information on solute concentration, determine the relative osmolarity and tonicity of two solutions. Determine how cells will change when placed in solutions of varying osmolarity or varying tonicity.
 - bb. Explain how penetrating and non-penetrating solutes have differing effects on solution tonicity and cell size.
 - cc. Describe the resting distribution of ions across a living neuron, muscle cell or other body cell. What factors help to maintain the resting ion distribution?
 - dd. Define the term electrochemical gradient. Explain how membrane potential can be measured.

2. Learning activities:

- a. Answer concept checks, graphing and figure questions and end of the chapter questions.
- b. Perform experiments that demonstrate the effect of solute concentration on cell size.
- c. Observe the effects of phase and temperature on rate of diffusion.
- d. Set up experiments and collect data on the effect of solute type, size and charge on diffusion across a semipermeable membrane.
- e. Graph the results of the above experiments and draw conclusions about the effect of solute concentration and type on cell osmolarity.
- f. Given hypothetical cell/solution systems, determine the osmolarity and tonicity of the solution relative to the cells.

G. Communication, Integration & Homeostasis: Chapter 6

1. Learning Outcomes:
 - a. Describe the basic modes of communication between cells and give specific examples of each mode. Modes include: Gap junctions, contact dependent signals, Autocrine signals, chemical long distance signals and electrical long distance signals.
 - b. Distinguish between paracrine and autocrine signals.
 - c. Distinguish between neurotransmitters, neurohormones and hormones.
 - d. Make a flow chart showing the major components of a signal pathway.
 - e. Distinguish between the receptor locations, signal mechanisms, and rates of action for lipophilic (hydrophobic) signal molecules and lipophobic (hydrophilic) signal molecules.
 - f. List the 4 categories of membrane receptors and explain how each creates a change within the cell
 - g. Define transduction. Give an example of transduction of radio waves. Give an example of transduction in a special sense organ and give an example of transduction during cell signaling.
 - h. Explain the functions of G-proteins, Adenyl cyclase, cAMP, and tyrosine kinase in cell signaling.
 - i. Explain how ion channels create electrical signals and chemical signals within cells.
 - j. Give examples or recognize examples of primary and secondary messengers in examples of signaling systems.
 - k. Give examples of typical cellular responses to signal molecule binding. Categorize the following specific examples into the major types of cellular responses: exocytosis, vesicle transport, muscle contraction, phosphorylation, channel opening, transport of new receptors to membrane surface, new production of mRNA, production of a new protein.
 - l. Compare and contrast leukotrienes and prostaglandins.
 - m. Discuss the properties of saturation, specificity, and competition in relation to receptors.
 - n. Explain how agonists and antagonists work with receptors to determine cell response.
 - o. Compare tonic control of blood vessel diameter to the action of epinephrine during a flight or flight response.
 - p. Distinguish between tonic control mechanisms and antagonistic control mechanisms. Give examples.
 - q. Explain the components of the reflex arc (reflex control pathway).
 - r. Define the term set point. Explain the importance of a set point in maintaining homeostasis.
 - s. Compare and contrast negative and positive feedback pathways. Give examples of each.
 - t. Given a diagram of a neural, endocrine or neuroendocrine reflex, Identify the components of the reflex arc.

2. Learning Activities:
 - a. Answer concept checks, graphing and figure questions and end of the chapter questions.
 - b. Make flow charts for reflex arcs involving the nervous and endocrine systems.

H. Endocrine Control of Metabolism & Growth: Chapter 7, Chapter 23

1. Learning Outcomes:
 - a. Define the term hormone in detail. Give examples of several other types of communication chemicals produced in the body and how they are similar to and different from hormones.
 - b. Identify the locations of the major endocrine glands in a picture or by giving an anatomical description of the location.
 - c. Identify the hormones, targets and actions of the hormones produced by the following endocrine glands: pineal, pituitary, thyroid, parathyroid, thymus, adrenal, pancreas, testes and ovaries.
 - d. Classify the hormones produced by the above glands as steroid, amine or peptide hormones.
 - e. Describe the process of production and transport of peptide hormones. Where do most peptide hormones act at the target cell?
 - f. Describe the process of production and transport of steroid hormones. Where do most steroid hormones act at the target cell?
 - g. Explain the phrase 'half life of a hormone'.
 - h. Name the two amino acids from which amine hormones are derived.
Name the specific hormones are derived from each amino acids.
 - i. Explain the endocrine reflex for rising or falling glucose levels.
Explain the endocrine reflex for falling blood calcium levels.
 - j. Which hormones are necessary for blood calcium regulation?
How does each affect blood calcium?
 - k. Describe in detail the structure, location, and blood flow to the pituitary gland.
 - l. Which hormones are produced by the posterior pituitary? How do these chemicals differ from typical hormones? What are the targets of these hormones?
 - m. Which hormones are produced by the anterior pituitary? Which of these have both a releasing and inhibiting hormone produced by the hypothalamus?
 - n. What are the targets of the anterior pituitary hormone? Which

of

Anterior pituitary hormones are tropic and which are direct-acting?

- o. Explain why two loop feedback systems are common for the anterior pituitary hormones?
- p. Distinguish between synergism, antagonism and permissiveness as mechanisms for hormonal control.
- q. Use reflex pathways to help diagnose endocrine pathologies.
- r. Describe the structure of the adrenal gland in relation to the major classes of hormones produced by this gland.
- s. Describe the reflex pathway for control of cortisol secretion. List the major effects of cortisol. Name and describe the condition that results if cortisol production is excessive. Name and describe the condition that results if cortisol production is low.
- t. Name the amino acid and the micronutrient used to produce T4 and T3. How do these two thyroid hormones differ in structure?
- u. Describe the common pathologies of thyroid dysfunction.
- v. Make a flow chart of the feedback pathway for thyroid hormone control.
- w. Make a flow chart of the feedback pathway for growth hormone control. List the major targets of growth hormone and its effects.
- x. Describe the major pathologies of growth hormone dysfunction.
- y. Discuss the regulation of calcium balance in the body including the organs involved, hormones involved and specific cell types that are targets for calcium regulating hormones.

2. Learning Activities:

- a. Answer concept checks, graphing and figure questions and end of the chapter questions.

I. The Nervous System (Chapter 8, 9, 10)

1. Learning Outcomes:

- a. Summarize the organization of the nervous systems in terms of afferent and efferent pathways and integrating centers.
- b. Draw and describe the structure of a typical multipolar neuron.
- c. Describe the major functions of each of the structures.
- d. Compare and contrast the structural and functional classifications of neurons.
- e. Explain the necessity for both slow and fast axonal transport.
- f. Classify the various types of glial cells and describe their functions.
- g. Compare and contrast Schwann cells and oligodendrocytes.
- h. List and summarize the action of the three types of ion channels.
- i. Distinguish between graded and action potentials in terms of cellular location, ion channel activity, and rate and distance of transmission.

- j. Explain why graded potentials decrease in strength with distance from the stimulus while action potentials do not decrease in strength.
- k. Draw a graph of a typical action potential in a neuron axon. Relate the phases of the graph to the changes in ion movement across the cell membrane.
- l. Describe the purposes of the activation and inactivation gates on sodium and potassium channels in the axon membrane.
- m. Distinguish between the relative and absolute refractory periods in the neuron action potential.
- n. Explain how all-or-none action potentials in the axon can cause variable amounts of neurotransmitter release.
- o. Explain the conduction of action potentials from the trigger zone (axon hillock) to the axon terminal.
- p. Describe the structural factors that influence rate of transmission in the axon.
- q. Explain how myelination influences conduction.
- r. Describe the structure of the synaptic end bulb (axon terminal) at the neuromuscular junction and the events that occur at the synapse when an action potential reaches the axon terminal.
- s. Distinguish between chemical and electrical synapses.
- t. List the major neurotransmitter groups.
- u. Describe in detail the production, breakdown and recycling of acetylcholine.
- v. Discuss the various types of cholinergic receptors and their locations.
- w. Describe the various ways neurotransmitters may be broken down after release into a synapse.
- x. Compare and contrast spatial and temporal summation of graded potentials. Explain how summation affects the initiation of an action potential in the axon hillock.
- y. Explain why axons of peripheral neurons may be able to regenerate, while those in the central nervous system cannot.
- z. Describe the layers of protection around the central nervous system.
- aa. Explain how cerebrospinal fluid (CSF) is produced, circulates and is reabsorbed. Give the major functions of CSF.
- bb. Explain the structural components of the blood-brain barrier and why boundary is important to normal CNS function.
- cc. Describe the structure of the spinal cord and explain how a typical spinal reflex arc is arranged within the spinal nerves and cord.
- dd. Name the cranial nerves and give their major types (sensory, motor or mixed) and specific functions.
- ee. List the major brain regions and describe the major functions of each region.
- ff. Distinguish between a sensory neuron and a sensory receptor.

- gg. Give several specific examples of transduction of signals by sensory neurons into graded potentials.
- hh. Discuss how arrangement of primary and secondary sensory neurons contributes to the variation in two point discrimination at the body surface.
- ii. Outline the major sensory pathways for the special sense organs.
- jj. Compare the amount of surface on the somatosensory cortex to the sensitivity of the body part received by a specific cortical region.
- kk. Give the names and functions of the major touch receptors in the skin including those that detect pain and itching.
- ll. Give several examples of referred pain areas for internal organs. Explain a likely cause for referred pain.
- mm. Explain in detail the transduction of sound by the ear.
- nn. Explain which portions of the ear function in equilibrium and the basic mechanism by which they transduce motion into neural signals.
- oo. Describe the neural pathway for vision.
- pp. Explain how the process of accommodation alters the lens shape and thus the focal point for both normal and common abnormal vision patterns.
- qq. Describe the layers of the retina and the functions of the major types of photodetection cells.

2. Learning Activities:

- a. Answer concept checks, graphing and figure questions and end of the chapter questions.
- b. Students will perform a variety of tests of skin receptors including two point discrimination, referred pain, adaptation of receptors, afterimage, and pressure sensitivity on
- c. Students will perform tests of hearing, vision, olfaction and equilibrium.

J. The Nervous System (Chapters 11, 13)

1. Learning Outcomes:

- a. Outline the efferent (motor) division. Give the major functions of each branch.
- b. Explain the function of the sympathetic division during a fight or flight response.
- c. Explain how the autonomic divisions fine tune the body to maintain homeostasis. Give examples of functions that are primarily controlled by the parasympathetic division and of functions primarily controlled by the sympathetic
- d. List the major brain regions involved in the coordination of

examples
division.

- e. autonomic functions, endocrine control and behavioral functions. Diagram a general autonomic neural pathway and compare and contrast it with a typical somatic neural pathway.
- f. Compare and contrast the anatomic structure of the sympathetic and parasympathetic divisions.
- g. Compare and contrast the neural pathways and neurotransmitters of the parasympathetic and sympathetic divisions.
- h. List the organs innervated by the vagus nerve. Which specific division has many fibers within the vagus nerve?
- i. Compare and contrast the effectors of the autonomic and somatic divisions. Explain how the synapses between autonomic neurons and their effectors differ from the synapses between somatic neurons and their effectors.
- j. Give a detailed description of the release, action, and recycling of norepinephrine.
- k. Explain how the adrenal medulla relates to the sympathetic nervous system. List the hormones it produces and their major actions.
- l. Explain how autonomic agonists and antagonists are important in research and medicine.
- m. Discuss how the variability of receptors in the autonomic division leads to great variability in cellular response to autonomic stimulation.
- n. Discuss in detail the events that occur at the neuro-skeletal muscle junction. Discuss the specific action of Ach at nicotinic receptors and the results of Ach binding on these receptors.

2. Learning Activities:

- a. Answer concept checks, graphing and figure questions and end of the chapter questions.
- b. Describe the components of a reflex arc and apply the understanding of these components to various reflexes commonly tested in clinical settings.
- c. Students will perform tests of various somatic and autonomic reflexes.

K. Muscles (Chapter 12)

1. Learning Outcomes:

- a. Compare and contrast the structure and location of smooth, cardiac and skeletal muscle.
- b. Describe in detail the anatomy of a skeletal muscle fiber.
- c. Describe in detail the structure of a sarcomere and the changes that occur to sarcomere structure during contraction.
- d. Discuss the importance of sarcoplasmic reticulum, mitochondria, and glycogen to skeletal muscle contraction.

- myosin,
- e. Explain the molecular basis of contraction in detail (actin, ATP cycle).
 - f. Explain excitation contraction coupling in skeletal muscle.
 - g. Compare the time frame for neuron membrane potentials, muscle fiber potentials and skeletal muscle contraction cycle.
 - h. List the three main sources of energy for skeletal muscle contraction in order from first used to last used. Explain how phosphocreatine is created and recycled in skeletal muscle cells.
 - i. Compare and contrast the three types of skeletal muscle fibers in terms of both structure, metabolism and function.
 - j. Graph and explain how summation of contractions results in maximum tension and fatigue.
 - k. Explain how variation in motor unit composition leads to differences in strength of contraction.
 - l. Explain why there has historically been less study of smooth muscle than of skeletal or cardiac muscle.
 - m. Compare and contrast single unit and multiunit smooth muscle in terms of location and contractile activity and coordination.
 - n. Explain how the neuromuscular junction for smooth muscle differs from that for skeletal muscle.
 - o. Explain how smooth muscle actin and myosin filaments are arranged within the cell. Explain how this arrangement causes the cell to change shape during contraction.
 - p. List the sources of Calcium needed for smooth muscle contraction. How does muscle stretch affect calcium entry into smooth muscle cells?
 - q. Explain the regulation of smooth muscle contraction.

2. Learning Activities:

- a. Answer concept checks, graphing and figure questions and end of the chapter questions.

L. Cardiovascular Physiology (Chapter 14)

1. Learning Outcomes:

- a. Beginning at the right atrium, list the structures through which blood passes in the pulmonary circuit and in any specific systemic circuit of your choice. Follow the blood until it returns to the right atrium. In which regions of the circuit is the blood fully oxygenated? In which regions is it deoxygenated?
- b. Explain how blood pressure is created in the cardiovascular system.
- c. Compare and contrast arteries, veins and capillaries in terms of structure and function.
- d. List the major materials transported by the cardiovascular system and explain which blood component transports each material.

- e. Explain how blood pressure changes as blood passes from the aorta through the systemic circuit and back to the right atrium.
- f. Explain what causes fluid (blood to flow). Explain how blood vessel diameter affects flow.
- g. In addition to vessel diameter, what other factors affect resistance to flow?
- h. Discuss the factors that determine flow velocity. Distinguish between flow rate and velocity of flow.
- i. Describe the structure of the heart. Include the following terms in the discussion: pericardium, myocardium, endocardium, cardiac muscle tissue, connective tissue, names of all chambers, names of all valves, control of blood flow through the heart, coronary arteries, coronary veins.
- j. Make a concept map describing the myocardial tissue using the following terms: autorhythmic cells, pacemakers, sinoatrial node, atrioventricular node, interatrial conduction fibers, contractile muscle fibers, atria, ventricles, intercalated discs, desmosomes, gap junctions, calcium.
- k. Compare and contrast the action potentials of cardiac muscle contractile cells and cardiac autorhythmic cells.
- l. Diagram the voltage changes during an action potential in cardiac muscle contractile cells. Compare and contrast this action potential diagram with that of a skeletal muscle cell. Explain the role of calcium in extending the time of the action potential.
- m. Explain why cardiac muscle cells cannot experience tetany.
- n. Diagram a heart showing the conduction pathway. What is the function of each portion of the conduction pathway? Explain the significance of the AV node delay.
- o. Diagram a typical electrocardiogram. Name the major waves and segments. Relate each wave on the electrocardiogram to electrical conduction and blood ejection in the heart itself.
- p. Relate the mechanical events of the cardiac cycle to the electrical events of the cycle.
- q. Relate the heart sounds to the mechanical cycle of the heart.
- r. Define stroke volume. Calculate cardiac output and give typical values for cardiac output, stroke volume and heart rate.
- s. Explain how the autonomic nervous system modulates heart rate. Why is the word 'modulate' used here instead of 'determines'?
- t. Explain the factors that cause blood to return to the heart through the venous system. How does venous return influence stroke volume?
- u. Summarize the factors that affect cardiac output.

2. Learning Activities:

- a. Answer concept checks, graphing and figure questions and end of

- the chapter questions.
- b. Students will use an electrocardiogram to produce an electrocardiograph.
 - c. Students will interpret electrocardiographs of normal and several abnormal individuals.

M. Chapter 15 – Blood Flow and the Control of Blood Pressure

1. Learning Outcomes:
 - a. Trace the path of blood from the heart through various circuits including the pulmonary circuit, coronary circuit, renal circuit, or other specific body part like the hand or foot.
 - b. Discuss the factors that control arteriole diameter. Include a discussion of the muscular and nervous control of these vessels, and factors that change resistance. Discuss the importance of tonic control of arteriolar diameter.
 - c. Compare and contrast the structure of arteries, veins, capillaries and lymphatic vessels.
 - d. Name the vessels in which blood pressure and pulse are typically taken.
 - e. Discuss the changes in blood flow and sounds that occur during determination of blood pressure. Determine blood pressure, pulse pressure and mean arterial pressure of a subject. Describe the sounds heard and changes in the sphygmomanometer during evaluation of blood pressure. Explain why these changes occur.
 - f. Explain why mean arterial pressure is not a simple mean of diastolic and systolic pressures.
 - g. Relate the pressure changes occurring in the arteries to the pressure changes occurring within the heart.
 - h. Explain the relationships between pressure gradients, flow and resistance of blood through the circulatory system and air through the respiratory pathway. Distinguish between flow and flow velocity.
 - i. Discuss the changes in blood pressure, and flow velocity as blood moves away from the heart, into capillary beds and back to the heart through veins. Explain the significance of elastic recoil in arteries to maintaining pressure.
 - j. Explain what processes help return blood to the heart through veins. Name the branch of the nervous system which controls venous diameter. Explain how venous diameter relates to cardiac output.
 - k. Discuss the major factors that determine mean arterial pressure.
 - l. Explain the processes that cause exchange at capillary beds. Relate these to changes in blood pressure and flow velocity through the capillary bed. Discuss the forces that determine whether fluid moves out of capillaries or into them.
 - m. Explain how excess fluid is removed from the interstitial space.
 - n. List the three functions of the lymphatic system.

- o. Describe the structure of the lymphatic system.
 - p. Describe the structure of lymph nodes, the cell types found in them and the fluid movement through them.
 - q. Define edema and discuss the factors that disrupt the normal balance between capillary filtration and absorption.
 - r. List the components of the baroreceptor reflex arc. Give details about the specific neurotransmitters and receptors located on the effectors of this arc. Relate this reflex to orthostatic hypotension.
 - s. Explain the interplay between vascular disease (athero/arterosclerosis), blood pressure and heart damage (heart attack) and stroke.
2. Learning Activities:
- a. Answer concept checks, graphing and figure questions and end of the chapter questions.
 - b. Participate in lab activities involving blood pressure.

N. Chapter 16 and Chapter 24 (p. 787-791) – Blood (the bulk of this topic will be covered in laboratory exercises) Fundamentals of the immune system.

1. Learning Outcomes:
- a. Describe the composition of blood including the composition of plasma and the functions of the cellular elements found in blood.
 - b. List the typical volume of blood for the standard 70kg man and the volumes of plasma versus cellular elements for this individual.
 - c. List and Discuss the importance of the various categories of plasma proteins and explain where each is produced in the body.
 - d. Categorize the leukocytes on the basis of structure and function and give their typical values in blood as a percentage (white cell differential).
 - e. Evaluate a white cell differential and determine what type of infection/reaction has occurred based on the differential count.
 - f. Perform a white cell differential count on a prepared blood slide.
 - g. Discuss the site of production, differentiation and maturation of the various types of cellular elements including hormonal control of development.
 - h. Collect the students own blood in a capillary tube, centrifuge it and determine a hematocrit.
 - i. Explain the significance of a hematocrit and relate this test to tests of complete blood count (CBC), and total hemoglobin.
 - j. Discuss the transport, storage and use of iron in the production of erythrocytes.

- k. Discuss the production, maturation, and breakdown of erythrocytes including the fates of the pigments produced by breakdown and the organs involved.
 - l. Discuss possible causes of anemia.
 - m. Recognize important root words related to blood disorders including: anemia, penia, hemo, lysis, poly, cythemia, micro, cytic, cytosis,.
 - n. Compare the production of platelets to that of other formed elements.
 - o. Define hemostasis and relate this name to homeostasis.
 - p. List and briefly describe the 3 main steps of hemostasis.
 - q. Define coagulation cascade and name the 3 coagulation cascades that lead to clot formation.
 - r. Compare and contrast a clot and a platelet plug.
 - s. Explain why platelet plugs form at a damaged site in a blood vessel, but not on the undamaged endothelium of the vessel.
 - t. Explain the steps and result of the common pathway (cascade) of clot formation.
 - u. Explain the major steps of fibrinolysis.
 - v. Name a natural anticoagulant and describe its mode of action. Name an anticoagulant drug and describe its mode of action.
 - w. List the 6 basic types of leukocytes. Note which are granular, which are phagocytic, which are cytotoxic and which may act as antigen presenting cells.
 - x. Compare and contrast mast cells and basophils. What chemicals do they contain and what functions do they have?
 - y. List several activities of phagocytic cells.
2. Learning Activities:
- a. Answer concept checks, graphing and figure questions and end of the chapter questions.
 - b. Perform a white cell differential count on a prepared blood slide.
 - c. Make a concept map relating to the process of blood clotting.

O. Chapter 17 Respiratory Physiology

1. Learning Outcomes:
- a. List the major functions of the respiratory system.
 - b. Explain the general causes of air movement through the respiratory system.
 - c. Define the following processes related to respiration: ventilation, inspiration, expiration, internal respiration, gas transport, external respiration, cellular respiration.
 - d. Explain which of the processes listed above are diffusion processes.

Explain which are due to total air pressure differences and which are due to partial pressure differences. Explain which of these processes creates the need for oxygen in the body.

- e. Name the serous membranes that surround the lungs. Describe the exact location of each of these membranes. Discuss the two major functions of these membranes.
- f. List the structures of the airway in the order that air moves OUT of the respiratory pathway.
- g. Name three major cartilages of the larynx and give the function of each.
- h. Relate the number of primary bronchi to the number of lobes in the right and left lungs.
- i. Describe the structure of an alveolus with its surrounding capillaries. List the two cell types found in the wall of the alveolus and give the function of each.
- j. Compare the flow rate and pressure in the pulmonary circulatory pathway with the flow rate and pressure in the systemic circulatory pathway. Compare the volume of blood flow through the lungs with the volume of blood flow in the systemic circuit.
- k. Explain the mechanisms that maintain low interstitial volume in the lung. Explain the importance of low interstitial volume in the lung.
- l. Explain how congestive heart failure (right heart failure) leads to problems with lung function.
- m. Explain the relationship between total pressure of a mixture of gases and partial pressures of the gaseous components.
- n. Explain how partial or total pressure differences lead to gas movement.
- o. Explain the relationship between pressure and volume of a gas.
- p. Explain the effect of temperature on gas volume and/or pressure.
- q. Give the normal atmospheric pressure at sea level for dry air. How does moisture affect partial pressures of gases in the air?
- r. What is the effect of expansion of the thoracic cavity on lung volume? How does this expansion affect the air pressure within the alveoli?
- s. Use a spirometer to determine vital capacity, expiratory reserve volume and tidal volume.
- t. Describe the action that must be performed in order to use a wet spirometer to determine the following: tidal volume, inspiratory reserve volume, vital capacity, expiratory reserve volume, expiratory capacity. List the normal volume for residual capacity. List the normal tidal volume.
- u. Explain which muscles are used for inspiration and how these muscles change the volume of the thoracic cavity.
- v. Explain the process of normal, relaxed expiration including the forces that cause air to move out of the respiratory system during relaxed expiration.

- w. Explain which muscles are used for forced expiration and how these muscles change the volume of the thoracic cavity.
- x. Compare and contrast graphs of intrapleural pressure and alveolar pressure during the breathing cycle.
- y. Explain why intrapleural pressure must always be negative relative to the external air pressure.
- z. Define/explain pneumothorax and hemothorax. Why do these conditions impair breathing?
- aa. Distinguish between lung compliance and lung elastance and explain how each plays a role in ventilation. If elastance is impaired, how will breathing change? If compliance is impaired, how will breathing change?
- bb. What is the function of lung surfactant? Which cells produce it? Compare and contrast the role of surface tension in the intrapleural cavity and alveolar spaces.
- cc. Explain the effect of bronchoconstriction and bronchodilation on air movement through the respiratory pathway. How does the immune chemical histamine affect the bronchiole diameter? How does it affect blood vessel diameter? How does epinephrine affect bronchiole diameter?
- dd. Compare and contrast total pulmonary ventilation with alveolar ventilation. Relate these differences to anatomic dead space.
- ee. Explain how deeper and shallower breathing affect alveolar ventilation. Explain how breathing rate affects alveolar ventilation.
- ff. Define the following types/patterns of ventilation: eupnea, hyperpnea, hyperventilation, hypoventilation, tachypnea, dyspnea, apnea.
- gg. How do partial pressures of oxygen and carbon dioxide in the alveoli change during normal ventilation? Explain why these changes are small.
- hh. How is blood flow altered when air flow to a given area of the lung is impeded? By what mechanism does this occur?

2. Learning Activities:

- a. Answer concept checks, graphing and figure questions and end of the chapter questions.
- b. Use a spirometer to measure tidal volume, vital capacity, and expiratory reserve volume. Calculate the remaining capacities and volumes.
- c. Calculate, compare and contrast total pulmonary ventilation, and alveolar ventilation for different individuals or situations.

P. Chapter 18: gas exchange in lungs and tissues.

1. Learning Outcomes:

- a. Discuss the relationship between diffusion rate and surface area,

- concentration gradient, membrane permeability and membrane thickness. Explain how the following diseases relate to these factors: asthma, pulmonary edema, emphysema, fibrotic lung disease.
- b. Explain how the solubility of gases (oxygen, carbon dioxide and nitrogen) compare to the solubility of salts and sugars? How do the solubility of oxygen and carbon dioxide compare to each other?
 - c. Compare and contrast the concentration of gases (oxygen and carbon dioxide) in liquid and air with the partial pressures of gas in liquid and air.
 - d. List the normal partial pressures of oxygen and carbon dioxide in the following locations: airspace of the alveolus, arterial blood, venous blood, resting tissue, active tissue.
 - e. Discuss how differences in partial pressures drive gas exchange in the tissues and in the alveoli.
 - f. Define hypoxia and hypercapnea. Explain why these conditions are usually related.
 - g. Explain the effect of low partial pressure of oxygen on oxygen uptake by the blood. Why might this condition exist.
 - h. Explain how loss of alveolar surface area, fluid accumulation in the lung interstitial space, loss of lung compliance and loss of lung elastance, constriction of bronchioles, scar tissue in the lung, and accumulation of fluid in the alveolar space affect gas exchange. Which diseases are related to each of these conditions?
 - i. In what two ways is oxygen transported by the blood? What percent of oxygen is transported by each process?
 - j. Evaluate how destruction of red blood cells could lead to loss of consciousness and brain death. You may wish to make a process map to help you organize your thoughts.
 - k. Describe the structure of hemoglobin.
 - l. Discuss the factors that determine how much oxygen will be bound to hemoglobin at any given time.
 - m. Diagram an oxyhemoglobin dissociation curve indicating the typical partial pressure of oxygen and percent saturation of hemoglobin for blood in lung capillaries, blood in resting tissue capillary beds and blood in active muscle capillary beds.
 - n. Explain how the oxygen binding capacity of hemoglobin illustrates the idea of reserve capacities in the body. Give at least one other example illustrating reserve capacity.
 - o. Explain why it is advantageous for hemoglobin to unload extra oxygen when pH is low, carbon dioxide partial pressure is high and/or 2,3 DPG is high.
 - p. Explain why maternal and fetal hemoglobin curves differ. What structural feature of hemoglobin leads to these functional differences?
 - q. Describe the factors that influence the amount oxygen dissolved in plasma. Then discuss the factors that determine how much oxygen is bound to hemoglobin.

- r. Explain the three ways carbon dioxide is transported in the cardiovascular system.
 - s. Write the carbonic acid equilibrium. Why is it important that this reaction be reversible?
 - t. Explain how the carbonic acid equilibrium affects the ability of hemoglobin to transport oxygen.
 - u. Explain the regulatory control of ventilation including inputs to regulation, receptors for regulation, output pathways for ventilation and muscle groups involved in ventilation.
 - v. Describe the mechanism of action of the chemoreceptor cells (glomus cells) of the carotid body.
 - w. Discuss the mechanism of action of central chemoreceptors used for control of respiration.
- 2 Learning Activities:
- a. Answer concept checks, graphing and figure questions and end of the chapter questions.

Q. Chapter 19– Urinary system

1. Learning Outcomes:
- a. List the functions of the urinary system.
 - b. Define reserve kidney capacity and explain why it is important. What other body capacities also have large reserves?
 - c. Diagram the major organs of the urinary system and list their functions.
 - d. Describe control of the two urethral sphincters in an infant and in an adult.
 - e. Explain the micturition reflex
 - f. Define retroperitoneal. Which organs of the urinary system are retroperitoneal?
 - g. What % of total blood volume passes through the kidneys at any time?
 - h. Name the two types of nephrons. Where are they located? Compare and contrast them in terms of structure and function.
 - i. Describe blood flow to and around the nephron.
 - j. Describe filtrate flow through the nephron (order of the path of flow).
 - k. Define juxtaglomerular apparatus. What two structures are involved? What specialized cell types are found in each?
 - l. List the three processes which occur in the nephron. In which regions of the nephron does each occur?
 - m. Distinguish between secretion and excretion.
 - n. Compare and contrast filtration and secretion.
 - o. How much filtrate is produced by the Bowman's capsules every day? How does this compare to total body fluid, total blood in

- the body and total plasma volume?
- p. List specific materials that are moved in each region of the nephron and explain the mechanisms by which they are moved.
 - q. Discuss the changes in volume that occur as fluid enters and passes through the nephrons to become urine.
 - r. Compare the proportion of water and solute reabsorbed by the LOH and PCT.
 - s. List the normal urine osmolarity range.
 - t. How does the filtering system work in the Bowman's capsule? Include a discussion of the pressure (forces) that determine the amount of filtration.
 - u. Define GFR. What affect does increased GFR have on urine output? What affect does increased BP have on GFR? What affect does increased blood volume have on GFR?
 - v. Explain how tubuloglomerular feedback helps maintain a constant GFR within normal mean arterial blood pressure. How does angiotensin II play a role in this process?
 - w. List the autoregulatory mechanisms controlling GFR.
 - x. What neural controls and hormones help regulate GFR?
 - y. Discuss the driving forces of renal reabsorption in the PCT.
 - z. Diagram sodium reabsorption and sodium-linked glucose reabsorption in the PCT.
 - aa. Explain the necessity for and process of transcytosis in the PCT.
 - bb. Explain why glucose appear in the urine of someone who is hypoglycemic.
 - cc. Define: renal threshold, transport maximum.
 - dd. Give examples of at least 3 materials that are secreted in the nephron. Why is each secreted?
 - ee. Where does most secretion occur?
 - ff. What is meant by the following statements:
 glucose clearance = 0 ml/min; urea clearance = 50 ml/min
 creatinine clearance = 100 ml/min; penicillin clearance = 150 ml/min
 - gg. Name the main extracellular ion. Discuss the importance of regulation of this ion in relation to water balance.
 - hh. Name the main intracellular ion. Discuss the consequences of fluctuation in the extracellular concentration on intracellular levels, cardiac and other muscle function and neuron function.

2 Learning Activities:

- a. Answer concept checks, graphing and figure questions and end of the chapter questions.

R. Chapter 20 and Fluid & Electrolyte Balance

1. Learning Outcomes:

- a. What are the main mechanisms by which the cardiovascular system detects blood pressure changes?
- b. What are the mechanisms by which the cardiovascular system

- increases or decrease blood pressure?
- c. Where is the cardiovascular control center located?
 - d. List the three mechanisms by which the kidneys regulate water loss.
 - e. Explain how behavior helps regulate water gain.
 - f. Discuss the main inputs/outputs to body water balance.
 - g. Trace water through the nephron indicating where it **may** be reabsorbed, and where it **must** be reabsorbed and what controls water reabsorption.
 - h. Explain the mechanisms that create the steep concentration gradient in the medulla.
 - i. Compare and contrast the membrane permeability and materials transported in the descending LOH and the ascending LOH.
 - j. Name the two hormones that directly affect reabsorption of sodium and water by the kidney tubule? Where do these act?
 - k. Discuss the importance of countercurrent flow to nephron function. Diagram the location in the nephron where countercurrent flow occurs including osmolarity values for filtrate and blood.
 - l. Discuss ion transport across the ascending LOH.
 - m. Given a diagram of a transport system showing ion channels, active transporters and passive transporters, evaluate what processes are occurring and what classes of transporters are involved.
 - n. Discuss the processes which must occur in order for the loop of Henle to produce a filtrate that is more dilute and of lower volume than the filtrate that entered it from the proximal convoluted tubule.
 - o. Compare blood osmolarity, urine osmolarity and filtrate osmolarity in various regions of the nephron.
 - p. Discuss the following for vasopressin: 1) factors that trigger release 2) location of release 3) location of receptors 4) mechanism of action at cells with receptors 5) results of action of hormone.
 - q. Discuss the following for aldosterone: 1) factors that trigger release 2) location of release 3) location of receptors 4) mechanism of action at cells with receptors 5) results of action of hormone
 - r. List the major hormones involved in the RAAS pathway.
 - s. Explain the overall effect of the RAAS pathway.
 - t. Describe the pathways that lead from low blood pressure to renin production.
 - u. Explain how the cardiovascular system influences renin production.
 - v. Name the organ and specific cells within the organ which produce renin.
 - w. Renin is sometimes called a hormone and sometimes called an enzyme. Explain why.
 - x. Describe the pathway of production of angiotensin II. Begin with protein precursor production and discuss the sources and locations for both enzymes involved in conversion of the precursor(s) to angiotensin II.

- y. What are the 4 pathways by which angiotensin II acts? Explain how each affects blood pressure.
- z. List two behaviors directly involved in maintaining blood pressure. How are these behaviors triggered?
- aa. Define ACE as related to blood pressure regulation. Discuss the effect of ACE inhibitors.
- bb. In general, how do natriuretic inhibitors affect blood pressure?
Which cells produce atrial natriuretic peptide?
Which cells produced brain natriuretic peptide?
- cc. Discuss the effects of natriuretic peptides on:
GFR, sodium reabsorption, water reabsorption, secretion of aldosterone, vasopressin, renin, cardiovascular center, blood vessels, heart rate, stroke volume, cardiac output, parasympathetic activity
- dd. Describe the location and action of baroreceptors.
- ee. For each situational example, evaluate what might lead to the condition and what effects the condition will have on blood volume, blood pressure, blood osmolarity, cell volume, GFR, thirst, vasopressin production, aldosterone production, renin production, angiotensin II production.
DEHYDRATION
HEMORRHAGE
EXCESSIVE WATER INTAKE W/O SOLUTE
- ff. Give the normal range of pH in the blood. When ECF pH changes, what happens to intracellular pH?
- gg. Give examples and pH for lumens in the body that have pH very different from the blood. Explain why the pH differs in each case.
- hh. Discuss the effects of pH disturbance on cellular function.

- ii. What are some acidic food inputs? What are some acidic metabolic inputs? What is normally the most important metabolic acidic input?
- jj. How does circulatory failure or severe pulmonary dysfunction affect pH? Why?
- kk. How does diabetes affect pH? Why?
- ll. Write the carbonic acid equilibrium. Where does this reaction occur? In which cells does it occur fastest? Why is it fastest in these locations?
- mm. Give specific examples of cells that contain carbonic anhydrase.
- nn. What three systems or processes are involved in pH homeostasis? Which works fastest? Slowest?
- oo. What effect do buffers have on pH? What are the main buffers in plasma? What are the main buffers in urine? When the carbonic acid equilibrium occurs in RBC's passing through systemic tissues, what happens to the products of the equilibrium?
- pp. What is the significance of chloride shift?
- qq. Why are fluctuations in bicarbonate ion much less noticeable than fluctuations in hydrogen ion?

- rr. For each of the following circumstances, show using up/down arrows and equilibrium arrows the effect of the change on the carbonic acid equilibrium equation.
 - hypoventilation due to partial airway blockage
 - increased hydrogen ion concentration due to ketoacidosis
 - decreased bicarbonate ion due to severe diarrhea
 - hyperventilation during a panic attack
 - decreased hydrogen ion in blood due to persistent vomiting of stomach contents
 - increased hydrogen ion in blood due to kidney failure
 - ss. What is meant by respiratory compensation for acidosis/alkalosis? Which form of acidosis/alkalosis can the respiratory system compensate for?
 - tt. What is meant by renal compensation for acidosis/alkalosis? Which compensatory mechanism is more rapid renal compensation or respiratory compensation?
 - uu. By what mechanisms can the kidney compensate for excess H⁺?
 - vv. By what mechanisms can the respiratory system compensate for excess H⁺?
 - ww. Explain why the shift in bicarbonate levels indicates whether a person is in respiratory or metabolic acidosis.
 - xx. How does acidosis affect potassium homeostasis? what are the consequences of potassium imbalance?
 - yy. Discuss the importance of water to cellular function, transport and temperature homeostasis.
 - zz. Name the specific factors that contribute to total osmolarity. Which of these materials are found within each of the major body fluid compartments (plasma, intracellular and interstitial)? How do changes in osmolarity impact ion balance, pH balance and blood pressure regulation?
- AA. Name the two ions primarily controlled by the body to maintain acid-base balance. Which organ is most important in maintaining acid base balance? Which body systems/tissue types are most impacted by acid/base balance?

2 Learning Activities:

- a. Answer concept checks, graphing and figure questions and end of the chapter questions.

S. Chapter 22--Glucose metabolism

1. Learning Outcomes:

- a. Which two hormones affect glucose homeostasis on a short term basis? Where are they produced? From which specific cell types? Under what circumstances is each produced?

- b. Discuss specific mechanisms by which insulin promotes anabolism.
 - c. Distinguish between the main mechanism of type I and type II diabetes.
 - d. Explain how absence of insulin leads to each of the following symptoms of type I diabetes: Tissue loss, Hyperglycemia, polyphagia, osmotic diuresis and polyurea, polydipsia, low blood volume, low blood pressure, circulatory failure, coma or death, metabolic acidosis, increased respiration.
 - e. Discuss the interaction of the major hormones that affect blood glucose: insulin, glucagon, epinephrine, and cortisol.
- 2 Learning Activities:
- a. Answer concept checks, graphing and figure questions and end of the chapter questions.

T. FINAL EXAM.

5 week summer semester grading format

<u>Examination</u>	<u>Points</u>	<u>Total Grade Points</u>	<u>Grade</u>
Four exams (150 pts each)	600	810-900	A
Concept map assignment	100	720-809.....	B
Quiz and lab points	100	630-719.....	C
Final exam 100 points	100	540-629.....	D
		0 – 539.....	F

Summer exams include both a lecture and lab component.

No exams will be dropped during summer semester.