1. An Introduction to Anatomy and Physiology

Introduction to the Chapter

Students typically enter into their studies of Anatomy and Physiology (A&P) with a combination of anticipation and anxiety. On one hand, opening up this book is one of their first steps toward exploring the detailed workings of their bodies, and might quite possibly begin their journey down the road toward a career in the health sciences. On the other hand, students might know of A&P's reputation for intense memorization and vocabulary building, and might be concerned regarding their level of preparation for such a class. Students' experience with Chapter 1 will set the tone for the remainder of their studies of A&P. With an overview of all the organ systems, a discussion on homeostasis, and an introduction to anatomical terminology, it would be easy for students to confirm their preconceptions of A&P as a subject open only for rote memorization. However, all of these topics play critical roles in the applied health sciences. Consider framing the subject matter using examples from medical imaging, surgical procedures, or examinations of patients' bodies. Put a face to the naming of body parts, and provide a historical perspective by discussing the origins of anatomical terminology. Use student "actors" to model feedback loops, and employ peer discussions to get students active and to build community. The sections that follow provide specific tips for doing all of the above. These techniques and your own engaging presentation style will help set the tone for the course as a relevant, interesting, and highly applicable survey of human A&P.

Chapter Learning Outcomes

1-1 Explain the importance of studying anatomy and physiology.

1-2 Define anatomy and physiology, describe the origins of anatomical and physiological terms, and explain the significance of *Terminologia Anatomica* (*International Anatomical Terminology*).

1-3 Explain the relationship between anatomy and physiology, and describe various specialties of each discipline.

1-4 Identify the major levels of organization in organisms, from the simplest to the most complex, and identify major components of each organ system.

1-5 Explain the concept of homeostasis.

1-6 Describe how negative feedback and positive feedback are involved in homeostatic regulation, and explain the significance of homeostasis.

1-7 Use anatomical terms to describe body regions, body sections, and relative positions.

1-8 Identify the major body cavities and their subdivisions, and describe the functions of each.

Teaching Strategies

1. Encouraging Student Talk

a. Prior to beginning Chapter 1, consider using a pair discussion/activity about surgical procedures to help students understand the importance of anatomical terminology. Give each student a different small piece of paper showing the initial incisions for a common surgical procedure. Below are a few examples.

Appendectomy
http://www.nlm.nih.gov/medlineplus/ency/presentations/100001_3.htm

Cesarean section
http://www.nlm.nih.gov/medlineplus/ency/presentations/100191_4.htm

Cardiac bypass surgery
http://www.nlm.nih.gov/medlineplus/ency/patientimages/000310.htm

Instruct students not to share their papers with their neighbors (neighbors will likely have different procedures on their cards). Now tell students they need to talk their neighbor through the surgical incision on their card without the assistance of any visual cues. They cannot point or gesture, only describe with words how to make the incisions indicated on their paper. Their partner can then point to her/his own body to try to demonstrate how they think the incision should go. Provide a few minutes so that each student can try to describe their procedure to a partner, then randomly select a few students to share how the exercise went. What words did they use to describe their incision? How accurate was their partner when it came to understanding the incision on the paper? What was tricky? Obviously, precision is very important in making surgical incisions, so the language used by health professionals must also be precise. In the absence of good communication, medical errors can – and often do – happen. Tell students to hold on to their slips of paper until the end of class, at which point they should have all the information necessary to accurately and precisely describe their incision to their partner using the language of anatomy!

2. Lecture Ideas and Key Points to Emphasize

a. Discuss some examples to stress the relationship between anatomy (structure) and physiology (function). For example, show a diagram of a frontally sectioned heart. Ask students what they notice about the structure of the heart and what that implies about how it functions. You could direct students to specifically compare the structure of the right vs. left ventricle walls and hypothesize about what those structural differences imply about the different jobs of those chambers. At the cellular level, point out that the function of mitochondria is to produce ATP and that liver cells are abundant in mitochondria. What might that imply about the activities and needs of liver cells?

b. Use a variety of examples to demonstrate different types of feedback loops. Begin with the examples in Sections 1-5 and 1-6; then expand to discuss how negative vs. positive feedback is demonstrated at multiple scales in the human body (for example, blood sugar regulation, childbirth, bone growth/resorption based on levels of pressure applied to the bone, cancerous cell division, and so on). Ask students whether they think these examples show negative or positive feedback. Emphasize that the response in a feedback loop directly influences the original stimulus.

c. Note that homeostatic set points change from moment to moment and throughout life. Ask students how they think various internal set points might change when we exercise or when we contract an infection.

d. Providing a historical perspective in the study of A&P can help engage students and provide a context for the content discussed. In fact, one of the main recommendations to faculty following a recent, large-scale study on student success was to "Offer ways for students to incorporate and honor their own culture, history, and traditions [in classes]" (RP Group 2013. Student Support (Re)defined). Sections 1-1 and 1-2 provide a first chance to introduce this historical perspective. See also the "Incorporating Diversity & the Human Side of A&P" sections in each chapter of this Instructor's Manual for additional ideas on introducing these historical and cultural contexts.

e. Discuss the need for a common language of anatomy by pointing out the impacts of communication on the outcomes for patients. Show news articles or other reports discussing the correlation between poor communication and medical errors (e.g., http://www.pbs.org/newshour/bb/health/july-dec99/errors_11-30.html). Tell students they will begin practicing this new language right away, so that they can try to avoid miscommunications in their careers.

f. Sectional anatomy is challenging for students to visualize. It is wise to explicitly acknowledge this difficulty. Start by stating that the process of sectioning reduces a three-dimensional object to a two-dimensional artifact. Have students do several drawing exercises to reinforce the visualization process. Elaborate on Figure 1–9c, pointing out how it takes thought and imagination to identify familiar organs in this unfamiliar horizontal section. Radiologists struggle with this sort of anatomical problem on a daily basis. Encourage students to work in groups in order to understand how each of the various planes of the body show different images and organs. Have students explain to each other that a sagittal section produces a right and a left piece, a transverse section produces a superior and an inferior piece, and a frontal section produces an anterior and a posterior piece. Use these terms to give students practice in hearing and using these directional tags.

g. Body cavities are lined with membranes that secrete a *serous* (watery) fluid. Draw an example on the board, such as the heart in the pericardial cavity or the lung within the pleural cavity. Label and describe the difference between the *parietal* and *visceral* membranes. Illustrate that the parietal membrane lines the cavity that contains the organs, while the visceral membrane covers the surface of the organs (*viscera*, organs within a body cavity), and the cavity is the space between the visceral and parietal membranes. Ask students to guess what function the watery fluid might serve. Help them to understand its function of facilitating movement of the organs by getting them to visualize the vigorous motions a beating heart within the thoracic cavity surrounded by the slowly moving lungs. In addition, be mindful that the concept of "dorsal cavity," which was commonplace in many earlier A&P textbooks, has been dropped from contemporary anatomical thinking. Only the ventral cavity, derived from the embryonic *coelom*, is a true cavity.

h. When discussing the organization of the text, point out that the major section headings are complete sentences. This makes them easy to understand, and they prepare the reader for the information that follows.

i. Share tips that former students have given for succeeding in your class. Note that there are many different ways to succeed in an A&P course, and that students should experiment with a wide variety of study techniques and memorization strategies to find the tools that are most useful to them. Many students continue employing ineffective study strategies because they have never been encouraged or taught how to

develop other tools. Point out that many resources are available to help them develop study strategies that work for them. They can use coloring books, YouTube videos,

mnemonic associations, analogies, concept mapping, diagramming, and any other techniques that produce the results they desire. Numerous books exist specifically to help A&P students study the material (for example, *Get Ready for A&P*). Note that trying to explain the material to others (classmates, friends, family members, coworkers) is a technique that enhances comprehension and retention for almost every student.

3. Making Learning Active

a. As an alternative to a traditional lecture on feedback loops, have students demonstrate the components and actions of positive vs. negative feedback loops in front of the class. Use string to connect a thermometer, a thermostat from a hardware store, a hand fan, and a matchbox. Randomly select a student to hold each prop. Call on other students to help label the props as receptor, control center, effector, afferent pathway, and efferent pathway. Introduce an external stimulus (e.g., heat), and have students in the audience determine which of the "actors" detect, process, and act on that stimulus. Once the effector (the fan) creates its response, take the stimulus away to show how the response directly eliminated the stimulus. Run the activity again, this time asking students to pretend it is a positive feedback loop. This time show the stimulus becoming more prominent as a result of the response. Finally, simulate a change in set point by having the thermostat/control center adjust the temperature setting. Ask students how this will affect the feedback loop and the conditions. When might such a change in set point actually happen in our bodies? Have students try to identify the anatomical parts that correspond to the props in the play. Use Figures 1–2, 1–3, and 1–4 to recap and expand on these concepts.

4. Analogies

a. As an analogy for homeostasis, imagine a circus performer perched on a board that is balanced on a ball. As the performer balances, he never holds perfectly still; his outstretched arms are continuously moving up and down, and his weight is continuously shifting from one leg to the other. He relies on input from several senses (the sensors) to stay upright (the set point) by using his muscles (the effectors) to remain balanced. That is, he uses his feedback control system to *negate* the balancing errors; thus, this constitutes a negative feedback loop. If his muscles were fatigued and the compensating movements occurred too late, this would work against him. The weakness of the effectors would lead to a *positive* feedback loop: his efforts to keep things in balance lead to the opposite outcome, a worse disturbance, and a fall. Often, this is the course of disease.

b. The analogy used in the text of the thermostatic control of room temperature is an excellent illustration of the component parts or pathway involved in homeostatic regulation. Draw this scheme on the board:

thermometer	✯	thermostat	✯	air conditioner/furnace
sensor	✯	control center	✯	effector

Point out the parallels. For example, note that the thermostat compares the actual temperature to the set point and turns on effectors that add or subtract heat. Ask them what the anatomical and physiological equivalents are. Point out that fever is caused by bacterial toxins in the blood acting on the hypothalamus to raise the thermal set point, which we then respond to by generating heat. Let students recognize that this concept explains shivering when they have a fever.

c. As an analogy to the internal environment for cells (interstitial fluid), have students imagine fish living in an aquarium. State that fish are living units like cells, complex on the inside, but helpless on the outside. They need certain things in their environment

to be held within a satisfactory range by external mechanisms. Review what these factors are, and relate them to body function—for example, adding oxygen and removing carbon dioxide, pumping fluids, making nutrients available, keeping osmotic pressure right, holding the pH in range, removing ammonia (nitrogen waste), suppressing bacterial growth, and so forth. Of course, the keeper of the fish is the sensor, the control center, and the effector, all in one.

5. Demonstrations

a. Ask students to consider the changes that would happen to their muscles if they participated in a weightlifting exercise program. Have them try to identify the components of a feedback loop in that situation and determine whether it is positive or negative feedback. See if students can appropriately relate the stimulus to the response. Students might say the stimulus is "exercise" and the eventual response is "bigger muscles." However, this description doesn't clearly demonstrate a response counteracting a stimulus. A more accurate, but still very simplified, description might be that the stimulus is "muscle fatigue" and the eventual response is "stronger muscles." In this example, the response clearly counteracts the stimulus, making this easy to identify as negative feedback.

b. To demonstrate the importance of a common anatomical language, ask students how many different ways they can think of to describe the location of the fingers compared to the location of the belly button, or the location of the spine compared to the heart. Similarly, you can place a dot on an outline of the human body and ask students to describe its location. Students should realize that many common terms are ambiguous (below, above, up, down) depending on the position of the body and each individual's interpretations of those words. Similarly, colloquial terms for the body cavities (gut, chest, stomach, and so on) can lead to confusion. This means we must have a common vocabulary and means of positioning the body in anatomy.

c. The ability to infer function from form (or form from function) is a useful skill for A&P courses. To demonstrate this, you can show pictures of antique devices or surgical tools that students are likely unfamiliar with. Though they might not know exactly what the items are used for, students will still be able to guess many reasonable functions for those devices/tools. Point out that students should take a similarly creative stance when examining a new organelle, tissue, or organ. They can make predictions about form and function from the outset and then use the book to check their predictions against the actual forms and functions of cells or body parts.

d. When discussing body cavities, it may help students to see them on torso models. Put out as many torso models that you have and use them continuously in both lecture and lab. Students can better understand the membranes associated with a cavity if they can see the wall of the cavity and the organs. When set up like this, it is possible to see the small space between the parietal and visceral membranes and where the serous fluid is located.

e. If possible, have some x-rays, MRIs, and CT scans in the classroom for students to look at. The films should show the identifiable organs and/or structures. Also, point out the differences between the three images and why you would use one over the other to see a structure or organ in the body.

f. Have zip-lock bags and food dye in class. Fill a bag about ¼ full of water and add a dye color to it. Hold the closed bag in front of you and explain that the outer part of the bag is the parietal membrane and the inner part of the bag is the visceral part of

the membrane, and the colored water is the serous fluid. Hold the bag while you bend, walk, sit, and go about various tasks to show how the fluid and membranes allow body parts to slide smoothly past one another.

g. Using the plastic bag set up as in (f) above to show the pericardial cavity. You can push it in with your fist to show the parietal and visceral membranes. Clench and unclench your fist to mimic heartbeats. Now have a student work with you. Using a straw, ask the student to slowly add more colored water to the bag. Keep moving your fist in a pumping motion. Soon the bag will be very full, and you will not be able to push against it well. Talk about pericarditis and how it slows the heartbeat. What is the logical thing to do to release the pressure?

6. Applications

a. Eastern medicine is gaining more prominent recognition among the general public, so you might want to have a discussion with your students on the similarities between Eastern and Western medicine. The Eastern system emphasizes the flow of "chi" through the body; and if the "chi" is pushed out of alignment, the body veers away from health to disease. Most of Eastern medicine is focused on the restoring the proper flow of "chi" necessary for health. Western medicine has the same general concept, except that it is called homeostasis.

b. Almost any disease or condition would provide an excellent opportunity to apply basic concepts of homeostasis and feedback loops. Without delving into the detailed physiology of specific organ systems, students could discuss the general physiological dilemmas involved in diabetes, hypothermia, cancer, and other problems. In those contexts, students could try to identify whether receptors, control centers, or effectors might be malfunctioning and how those malfunctions lead to inappropriate positive feedback. Such an exercise could be discussed in class or could be assigned out to students to extend their knowledge.

c. Using several colors of string, have groups use the colors to "mark up" a volunteer to show the planes and directional terms. You might suggest students work in same-sex groups if that makes the exercise more comfortable. Student groups can "grade" each other and make helpful suggestions.

7. Common Student Misconceptions and Problems

a. Students should understand that homeostasis is a dynamic process, one that is constantly fluctuating within normal limits. The literal meaning of homeostasis is "staying the same," but we never are physiologically in a state of "unchanging sameness" unless we're dead! For this reason, it is important that students be aware of "normal range" when learning physiological parameters like pH of blood, RBC count, or heart rate. Only when a controlled variable moves out of range will a compensatory response be made.

b. Students similarly often assume that any sustained deviation from a "normal" set point or range must involve positive feedback or a harmful alteration to the body's internal environment. Fever, in particular, is assumed to be positive feedback, since it involves an increase in body temperature beyond the normal range. In fever, though, the set point changes, and the body performs negative feedback around that new, higher set point. Should the fever continue to go inappropriately higher and higher, that would indeed represent unhealthy positive feedback. Point out the many reasons set points might have to change from moment to moment or throughout the life of an individual, and explain how negative feedback still tends to be used at those altered set points.

c. Given the informal uses of the words "positive" and "negative," it is often difficult for students to identify positive vs. negative feedback when given an applied scenario.

Some students assume positive feedback is good for us and negative feedback is bad. Even more commonly, students think positive feedback involves an increase in some variable in the body while negative feedback involves a decrease in a variable. Provide specific examples where uninterrupted positive feedback is quite harmful to the body (e.g., excessive clotting of blood). Similarly, explicitly describe examples of negative feedback where the responding variable changes to be higher (e.g., when our body temperature drops and we must raise it to maintain homeostasis). Finally, you can directly confront students with these misconceptions on assessments and ask them to provide examples of feedback loops that contradict the misconceptions above.

d. Students sometimes confuse the ways we use the names of body cavities and surface regions with the ways we use directional terms. If asked to describe the location of the navel using anatomical terms, they might refer to Figures 1–5 and 1–7 and describe it as "gluteus to the neck" or "ventral of the medial." Give students plenty of opportunities to practice these unfamiliar terms by describing various points on the body using a directional term in relation to a body region.

e. The mediastinum is not a cavity, but rather a region within the thoracic cavity. The mediastinum contains the pericardial cavity and is flanked by the pleural cavities.

8. Terminology Aids

a. Note that a variety of online glossaries provide in-depth coverage of anatomical roots (e.g., http://www.anatomy.usyd.edu.au/glossary/). These glossaries are a great resource when studying new vocabulary, since the word roots from one term are likely to reappear over and over in the study of anatomy.

b. Encourage students to find anatomical landmarks and regions *on their own bodies* while they study the terms in the text.

c. The word *parietal* (the wall side) sounds like (but doesn't come from) *peri*meter (outer boundary). Contrast this with *visceral*, related to viscera, the "guts."

d. *Serous* sounds like "serum"—the watery component of blood.

e. Point out that the combining form–*stat* in thermo*stat* is also found in the word homeo*stat*ic. It means "stands" or "stays" fixed or constant.

f. Use the examples of "inferior" and "superior" to make the point that often in anatomy and physiology, common words are used in a specialized sense, different from their commonsense meaning.

9. Incorporating Diversity & the Human Side of A&P

a. Efforts to name and describe the parts of the human body have spanned thousands of years and crossed continents. Such efforts, which continue through today, demonstrate the fundamental need for a common anatomical language in the medical sciences. In introducing anatomical nomenclature, you might reference the long arc of human history devoted to the language of anatomy. African papyri dating to the 16th century BC provide some of the first written lists of anatomical terms. Egyptian healers made early accounts of anatomical features, ailments, and treatments. Additional major works came between the first few centuries BC–AD from Greek physicians, like Herophilus and Galen. Many Greek physicians borrowed from Egyptian knowledge and in fact performed their studies in Egypt due to cultural prohibitions on dissections and other such studies in Greece. Numerous Middle Eastern physicians, like Avicenna and Ibn al-Nafis, contributed works in the following centuries. In modern times, health scientists have attempted to standardize terminology in works such as *Nomina Anatomica* and *Terminologia Anatomica*, which reported terminological updates as recently as

1998. As knowledge of A&P has changed, new discoveries have inspired debate over the terms used to describe the body. Certainly many more names and publications

could be added to the list above, which could provide the backdrop to this content or form the basis for further student research.

References/Additional Information:

http://www.nlm.nih.gov/onlineexhibitions.html
http://www.nlm.nih.gov/dreamanatomy/da_timeline_anatomy.html
http://puffin.creighton.edu/museums/greiner/
http://www.med.wayne.edu/imsa/Islam%20and%20Medicine.html