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HAPS-EDucator is the official publication of the Human Anatomy and Physiology Society (HAPS) and is published four times per year. Major goals of the Human Anatomy and Physiology Society are to promote communication among teachers of human anatomy and physiology in colleges, universities, and related institutions; to present workshops and conferences, both regional and national, where members can obtain information about the latest developments in the health and science fields; and to encourage educational research and publication by HAPS members.

SUBMISSIONS TO HAPS-EDucator
Papers for publication, requests for information, submission of advertisements, and letters to the editor are welcomed. Articles should be submitted to the editor in a Word document as an e-mail attachment. If references are included, please follow the methods in Scientific Style and Format: The CSE Manual for Authors, Editors, and Publishers, 7th edition, 2006. Examples of reference formatting and additional information on formatting the text and figures are provided on the HAPS-EDucator page of The HAPS website (hapsweb.org). Although the HAPS-EDucator is not a peer-reviewed journal, the Editor and the Editorial Advisory Committee reserve the right to determine whether an article is suitable for publication and to make minor editorial changes to the content and style of submitted articles. It is the policy of the Human Anatomy and Physiology Society (HAPS) that any advertising appearing in its publication(s) must be related to the teaching of anatomy and physiology. The HAPS-EDucator Editor and HAPS-EDucator Editorial Advisory Panel jointly determine whether an advertisement meets the criteria of HAPS. Any advertisement that is deemed not to meet the needs of the organization will not be printed, and the advertisement plus any monies collected from the advertiser will be returned. The opinions reflected in advertising that appear in this publication do not necessarily represent the opinions of HAPS. Advertisement of a product in the HAPS-EDucator does not represent endorsement of that product by HAPS. Contact the Editor for information on advertising rates, advertisement size and the procedure for submitting an advertisement to HAPS-EDucator for publication.

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The Cover art: is the work of Sharon K Horstman, Technical Specialist in the Biology Department at Anne Arundel Community College. The hand model was Valerie Washington, Laboratory Assistant. Richard Faircloth, Professor Emeritus at Anne Arundel Community College and long-time leader in HAPS, conceptualized the project.
Greetings HAPSters!

I am composing this column in the midst of the cold weather and gray skies so typical of Ohio in winter. As I watch the snowflakes fall, I am reflecting on, and thankful for, the incredible work being accomplished by the HAPS Board, Steering Committee, and all of the HAPS members who give so freely of their time and talents to ensure a successful and dynamic organization.

The fall was a busy time for the HAPS Board and Steering Committee. Following monthly e-meetings, we had very productive face-to-face meetings in October. A portion of these meetings involved preliminary examination of our organizational chart and committee structure, in part due to the fact that we have charged our Executive Director Larry Spraggs with additional duties. Some of these proposed structural changes will require a vote by HAPS members at our Annual Meeting in Victoria.

The Board and HAPS Committees continue to work on HAPS’ Strategic Plan (see our website for details on the Strategic Plan). Transitioning some committee and administrative duties to our Executive Director is allowing us to concentrate more on the “big picture” of our Strategic Plan.

With the guidance of Larry Spraggs, the HAPS-Institute developed its own Strategic Plan. This plan provides HAPS-I with achievable goals for the foreseeable future. We are all excited to watch the transformation and potential growth of HAPS-I.

Examination of HAPS’ position statements revealed that updates are needed and the appropriate committees are addressing those. With the guidance of Larry Spraggs and Steering Committee Chair Tom Lehman, a Leadership Training Program and a Training Guide for Committee Chairs are in development. These will be invaluable instruments for ensuring smooth transitions in HAPS’ leadership. Speaking of leaders…we welcome Margaret Weck as the new chair of Partner Associations Committee and thank outgoing chair Betsy Ott.

HAPS Foundation Chair Valerie O’Loughlin continues to lead the charge in obtaining $500,000 for the foundation. Even though economic times may be tough, I encourage all of you to participate in the foundation drive. We appreciate all giving (small, medium, or large!) for this worthy cause.

By the time this newsletter is published, the HAPS Regional Conference in Sarasota, Florida, will have taken place. They expected a large turnout with a program guaranteed not to disappoint. Thanks to Jeff Laborda for organizing this conference.

On a larger scale, Peggy Hunter and her committee are busy putting together an outstanding program for our 25th Annual Conference in Victoria, Canada. I know I can’t wait to participate in all they have planned for us as well as to enjoy the beauty of Canada!

During the next few weeks, the Nominating Committee, under the direction of chair Don Kelly, will be developing a slate of candidates for officers for 2011-12. Information will arrive through email describing the process. Be on the lookout!

Have a great spring semester/quarter!
Caryl Tickner
President, Human Anatomy and Physiology Society
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Another great conference is being planned for May 28th to June 2nd in Victoria, B.C. Peggy Hunter and her committee have worked hard to offer an outstanding conference for our 25th Annual Meeting. I hope you are all going to take advantage of this excellent benefit of your membership in HAPS. While our Annual Conference is one of the most notable offerings of HAPS, there are many other membership benefits.

- Regional conferences are being offered for a taste of the annual conference closer to home and as an economical conference option for members.
- Our HAPS Institute is another opportunity for members. This excellent program allows members to undertake professional development that also gives graduate credit that may help with promotion and tenure.
- You can find curriculum standards and learning outcomes for A&P at our website to help you in course design.
- You will find position statements on various issues related to the teaching of A&P, and standards for things like lab safety at our website as well.
- Go to our website to find out what’s new in A&P from legal issues to the latest news in relevant fields of study.
- Join the HAPS listserv as a resource to use when you need quick help with an A&P topic or teaching technique.
- The publication you are reading now, the HAPS EDucator, offers articles on A&P. As a member you also have access to an archive of past issues.

Most of all, as a HAPS member, you are part of a community of over 1600 educators, including faculty from high schools to med schools, all interested in promoting excellence in the teaching of human anatomy and physiology. Take advantage of these excellent benefits to grow and excel in our profession. Please contact me if I can be of any assistance.

Learn, Discover, Share with HAPS

Sincerely,

Larry

Dr. Laurence Spraggs
Executive Director
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FROM THE EXECUTIVE DIRECTOR
Annual Conference Update

Peggy Hunter, Conference Coordinator
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Join us May 28 – June 2, 2011
for the 25th annual
Human Anatomy and Physiology Society conference
at Camosun College in Victoria, British Columbia, CANADA.

Hotel rooms at the historic Fairmont Empress Hotel http://www.fairmont.com/empress, are now available at the conference rate of $139 per night (+ taxes). These rooms are limited in number and excellent value for a stay in this iconic hotel. To book these rooms, you can link to https://resweb.passkey.com/Resweb.do?mode/welcome_ei_new&eventID=2588931&convbr=9299.

Update speakers convene at the Victoria Conference Centre http://www.victoriaconference.com/ for two days of seminars, May 29 and 30. Three of the speakers are confirmed.

Dr. Brad Nelson, PhD, is a native of Vancouver BC and the founding Director of the BC Cancer Agency’s Deeley Research Centre in Victoria BC. He is an Associate Professor of Medical Genetics at the University of British Columbia and holds adjunct appointments in the Departments of Biology and Biochemistry/Microbiology at the University of Victoria.

Dr. Nelson’s lab studies the immune response to cancer, with an emphasis on ovarian, breast, and lymphoid cancers. His team is developing a clinical trials program that will investigate the use of immune-based strategies for the treatment of cancer.

Dr. Ben Sporer, PhD, a graduate of the University of British Columbia (PhD) and the University of Victoria (MSc, BSc), is the physiologist responsible for overseeing the Performance Preparation division at Canadian Sport Centre Pacific. His areas of interest include asthma and exercise, performance optimization, athlete monitoring, and exercise in hypoxia.

Dr. Bayla Schecter, BSc, MDCM, AAFP, has worked in the field of addiction medicine for 19 years. She has an extensive background in the area of addiction research, with a particular focus on the effects of alcohol, marijuana, cigarettes, and stimulants (cocaine, methamphetamine and Ecstasy) on the adolescent nervous system.

Bring your dancing shoes and get ready to swing in the Crystal Ballroom May 30. Enjoy an evening of fine dining and learn how to transform yourself into a superhero. Our keynote speaker is Dr. E. Paul Zehr, PhD. Dr. Zehr is the Director of the Centre for Biomedical Research at the University of Victoria and author of the book Becoming Batman: The Possibility of Becoming a Superhero.

Workshops will take place at Camosun College, a short bus ride from the downtown conference centre. More than 60 workshop applications have been submitted for 2 days of teaching focused inspiration.

Planning to explore Victoria? We want your input. An activities brochure for conference attendees is in the works. Go to http://www.surveymonkey.com/s/P2GJX2K or link to the survey on the HAPS website and complete the 10 multiple choice questions survey as soon as possible and let us know what you want to do while you are in Victoria for HAPS 2011.

photo courtesy of Tourism Victoria
Developing Viable Alternatives to Lecture

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There are laws in almost all areas of science: the law of conservation of matter, the laws of thermodynamics, Newton’s laws, and more. Many of these laws put variables into equations, such as force equals mass times acceleration. Education has no equations, but we do have some strong generalities, such as high ACT / SAT score = excellent potential student, or low ACT / SAT score = increased risk of not graduating. One proclamation in education that is close to “law” is “we teach the way we were taught.” Most all of us have sat through thousands of hours of classroom lectures, some good, some entertaining, some totally worthless. Now most of us are continuing that tradition; we lecture to our students, and rarely deviate from that mode of instruction. We may think of trying something new, but it’s so much more convenient to lecture – and besides – it worked for us!

Research in teaching and learning shows that some students do indeed learn in lecture, but then they are the ones who can learn in almost any learning environment. Many anatomy and physiology instructors have heard of the alternatives to lecture: problem-based learning, case studies, etc. Few of us, however, have time to actually learn new teaching techniques or have time in our course schedules to implement new and unique activities for our students.

This summer, forty to fifty anatomy and physiology instructors will be developing and learning to use curriculum materials that are truly an alternative to lecture. They will be attending a workshop to learn a teaching and learning philosophy titled Process Oriented Guided Inquiry Learning (POGIL). POGIL has been in existence for about 15 years and has been used in both the classroom and lab setting. Though it has been researched primarily in chemistry and other physical sciences, is also has been used in the life sciences. Its use within anatomy and physiology is new, but preliminary work done by Patrick Brown, from King’s College in Tennessee, shows good promise (Brown 2010).

From a theoretical point of view, POGIL is a combination of constructivist learning theory and cooperative group learning. Constructivism is a view of learning that asserts that learners build, or construct, their own understanding of the world – and that all new knowledge is learned in relation to prior knowledge. For example, your knowledge, or lack of knowledge, of chemistry greatly affects your ability to learn cell respiration. Additionally, if students have misconceptions in their prior knowledge, then new learning is often skewed to accommodate those misconceptions. A key element within constructivism is the notion that “knowledge is social.” This phrase underlines the importance of the learners’ ability to put knowledge into action – to be able to explain what they know, convince others that their ideas are true or plausible, or put their ideas into action. “Prove it” and “convince me” are two good phrases that describe the social nature of learning. And it is this social component where cooperative group learning comes into the POGIL approach.

For many instructors, the phrase “cooperative learning” brings up thoughts of one student doing all the work on an assignment while the others go along for the ride and still reap full credit. No doubt about it, cooperative group learning takes practice to orchestrate and there will be difficult days. But there are strategies to help promote the two key components to successful cooperative groups: positive interdependence between group members and individual accountability for learning. Any successful student group must require effort on the part of all members, and each individual in a team must eventually be accountable for his or her own learning. POGIL activities address these two important group dynamics.

A POGIL curriculum module is completed in groups of two or three students and starts with content of some type, for example: a graph; a section from a textbook, newspaper, or website; a data table; or even instructions for setting up equipment and collecting data in a lab. This content is read, or described, by one of the group members. After reading the content, or “model” as it is called in POGIL lingo, the group is next prompted to answer convergent and divergent questions. Convergent questions are most frequently knowledge or fact-based and require students to look back to the model, or into their prior knowledge, to answer correctly. (Example: What is normal body temperature? What is the formula for calculating cardiac output? Or even, draw a diagram that shows blood flow to the brain.) The intent of the convergent questions is to ensure that students have indeed read the model and can describe the content.

(Continued on next page)
Divergent questions require students to use creativity, imagination, or what is sometimes called “higher order thinking skills” to answer. Divergent questions frequently do not have only one correct answer, as is the case with most convergent questions, but rather prompt students to brainstorm multiple answers and to synthesize ideas into new concepts. After students have listed a multiple number of answers, often by writing on a white board that the whole class can see, students are then encouraged to work as a group to discuss strengths and weakness of each. After a given period of time the course instructor brings the whole class together and calls on individual groups for answers, which often promotes large group discussions.

During a POGIL activity the classroom instructor moves from group to group listening and asking questions to promote doubt and deeper thought in students answers – and thus stimulating critical thinking. Very rarely does a POGIL instructor simply give an answer – but more often they say “that information is in your text” or sometimes even, “I think you could Google that.” This role is close to the opposite of lecturing; whereas the instructor used to be the source of information and answers, in the POGIL method the teacher is the source of questions and doubt! He is an academic troublemaker, if you wish.

One key to success in any POGIL activity is the quality of the curriculum. The materials must fit the academic level of the students, and the questions must be of interest and promote brainstorming. Too many easy questions and students are bored. Too many difficult questions and students are confused and lost. Like in any classroom, it is the instructor’s responsibility to match curriculum to the students’ ability, goals, and interests.

POGIL Workshop at the University of Minnesota

During the last week in July, 2011, there will be a POGIL workshop at the University of Minnesota for 40 anatomy and physiology instructors who are willing to be adventurous and try a new teaching and learning strategy. The workshop will focus on first, what is POGIL; second, how to use POGIL; and third, developing a POGIL activity for anatomy and physiology.

Unique to this workshop will be the collection of instructors attending. Our goal is to gather instructors from all academic levels—from high school to graduate school.

Anatomy and physiology is most frequently taught at the college level, but there are increasing numbers of programs in high schools. In Minnesota, 18 high school programs work together in a program called College in the Schools. All schools in this program will be sending instructors to the workshop. Additionally, we are hoping to secure funding from the Minnesota State College and University System to attract anatomy and physiology instructors from two- and four-year colleges, technical colleges, and universities within Minnesota. By gathering many different levels of instructors, we will be able to share ideas, problems, and solutions, and hopefully generate some useful and creative curriculum. If we do not fill the forty slots with instructors from Minnesota, a call will be put out on the HAPS listserv looking for more participants. An important point here is that we are not making housing or entertainment plans for the participants, but we are also hoping not to charge registration fees.

All attendees of the workshop will be required to generate one POGIL activity that could be used in either a classroom or laboratory setting. The curriculum writing process will be a team effort in that we will have groups of instructors working together to proof and brainstorm ideas for the activities. At the end of three days, every participant will be responsible for submitting one POGIL activity with an accompanying teacher’s guide. We intend to publish all 40 POGIL activities on a web site for use by all attendees. Additionally, after some revision and review from the POGIL office, we hope to open the web page to any anatomy and physiology instructor willing to try a POGIL activity with his or her students – free of charge.

This summer at the HAPS Conference in Victoria, we will be presenting a one-hour introduction to POGIL and a more thorough description of our POGIL workshop. If you’re tired of lecture, or maybe a bit bored with giving too much power to PowerPoint, then you might want to attend our workshop and think about breaking the old “you teach the way you’ve been taught” law.

For more information, contact Murray Jensen at msjensen@umn.edu

Reference:

In the early history of anatomy there were two great men, separated from each other in time by almost 1500 years. One man cloaked his academic brilliance in showmanship and self-aggrandizement. He enjoyed enormous fame during his lifetime and well beyond. The other man, diligent and determined, produced a single, astonishing piece of work and then left the limelight to pursue a comparatively quiet private life. What did these two men have in common? What was the nature of the thread that bound them together across the centuries? The answers to these questions marked the birth of the academic discipline we know as anatomy and established the scientific underpinnings of the study of medicine.

The story of medicine begins with Hippocrates in the 5th century BC. More is known of him through myth than through fact but he is celebrated as the Father of Medicine. In his day medicine was very personal. There were no formal schools of medicine and no medical licenses. The Hippocratic physician lived with the knowledge that there was very little he could do for his patients other than to encourage them and to track the course of their illness. Consequently physicians of the day became experts in the symptoms of disease and many were extremely skilled at providing a prognosis. The cautionary phrase for medical practitioners we know today as "first do no harm" originated during this period and was an outgrowth of the knowledge that the body often healed itself and that sometimes the interference of a physician could be detrimental to the process (Nuland 2008).

The Greeks believed that bodily health was governed by humors that were moved by, and mixed with, a life force called “innate heat”. They thought that innate heat was a type of energy that was generated in the heart and traveled to the rest of the body with the blood. The humors were blood, which was judged to have hot, wet characteristics; yellow bile, which was believed to be warm and dry; black bile, which had cold, dry characteristics and phlegm, which was believed to be cold and wet. Because of the association of humors with temperature and moisture content, the Greeks believed that the body’s equilibrium could be affected by the seasons and by changes in ambient temperature and humidity. Disrupting the equilibrium could bring on disease so they believed it was necessary to treat the whole patient and to prescribe changes in the external environment with respect to diet and exercise. The patient’s general constitution and mental state were also carefully evaluated before a working diagnosis was formulated (Nuland 2008).

Making a diagnosis based on humors required an extensive physical examination. Writings from the period indicate an exceptionally close doctor-patient relationship that encouraged physicians to smell and taste virtually all body secretions and discharges including "blood, urine, skin secretions, ear wax, nasal mucous, tears, sputum, and pus" (Nuland 2008). They smelled the stool of sick patients and even noted the degree of stickiness of their sweat in an effort to gain a clear picture of what was wrong. We can only imagine how much these ancient men of medicine would have appreciated today’s high tech laboratory testing equipment. There was, overall, an empirical quality to the process of diagnosis that encouraged developing excellent powers of observation and note taking, both of which laid the groundwork for the modern application of the scientific method to medicine. Doctors of today would be comfortable with Hippocratic teaching methods because bedside teaching was stressed along with keeping careful case records. Attendance at clinical lectures was encouraged and experienced physicians frequently performed demonstrations for their students. The role of the physician was to determine what was wrong with the patient and to assess when, or if, it was appropriate to intervene. In the writings contained in what today is called the Hippocratic Corpus it is clear that Hippocratic physicians firmly rejected supernatural powers as a cause of disease. They believed that disease was caused by disequilibrium of the four humors and that each disease symptom had a specific cause. Treatment was therefore designed to be very specific (Nuland 2008).

Galen, heir to the Hippocratic tradition, was born in AD 130 in Pergamon, which is today the city of Bergama in Turkey. The son of a wealthy landowner and architect, Galen was accustomed from birth to the blessings of good fortune. He received an excellent education that included extensive traveling throughout the Roman Empire and when he returned home to Pergamon he was appointed as surgeon to the

(Continued on next page)
pneuma and mixed with blood in this manner became “vital pneuma” which exited at the top of the liver by way of a large vein. The liver produced “vegetable pneuma” with which the body could be nourished. Galen was convinced that the body operated on a three-part system in which the veins provided nourishing blood, the arteries provided the life force and the nerves provided movement and sensation. As a clinician, Galen favored bleeding or venesection for almost all disorders and he provided careful directions with regard to where and when the bleeding should be done and how much blood should be taken. For very severe conditions he recommended bleeding the patient twice a day. At the first bleeding of the day physicians were directed to stop the bleeding before the patient fainted but at the second bleeding physicians were told to continue the bleeding until the patient was unconscious. Galen’s teachings on venesection were still followed by many physicians, and accepted as sound medical practice, until the beginning of the 19th century (Nuland 2008, Porter 1999).

In his studies Galen systematically recorded all of his observations. He brought to his laboratory the equivalent of the accessories any modern laboratory investigator would like to have. His writing details the presence of research assistants, scribes who were skilled in note taking, in-house printing capabilities, and a willing publisher. The sheer volume of his life’s output of writing is staggering. He started writing in his teenage years and never stopped until his death at seventy years of age. More of his writing survives from antiquity than from any other ancient writer. At least 350 authentic titles are known, as much as the collective total of all other Greek writers combined. At least part of his enduring fame can be attributed to his prolific writing, which has to be counted as one of his major strengths (Porter 1999).

Incredibly, Galen’s reputation lasted intact and he was venerated for a thousand years after his death. So huge was his reputation at the time of his death that during the following millennium, to study medicine was synonymous with studying Galen. He had convinced his contemporaries that he had the correct explanation for everything. He stated and frequently wrote, “It is I, and I alone, who have revealed the true path of medicine” (Nuland 2008). His message to posterity was that further investigation on any medical subject was totally superfluous. Among his contributions to anatomy, he is credited with dividing the bones of the body into long bones and flat bones. He coined the terms epiphysis, diaphysis (though this term was not used by Galen in the modern way), apophyses, trochanter, diarthrosis,
synarthrosis, suture, and symphysis pubis. He was very familiar with the bones of the skull and it is well documented that he performed cranial trepanations on humans (Bataille et al. 2007). He wrote extensively on the number and design of the vertebrae including the sacrum and coccyx and he gave a great deal of attention to the ribs, the clavicle, and the bones of the appendages. He described seven of the twelve pairs of cranial nerves and his work on the muscles is considered exemplary. He described fetal development and the reproductive organs. He proved that arteries carry blood instead of air, and by his extensive experimentation, he introduced physicians of his time to physiology. Over his lifetime he produced a treasure of anatomical works, all of which were based on hundreds, if not thousands, of animal dissections. Due to governmental prohibitions against human dissection, it is believed that Galen never dissected a human though no one would understand the extraordinary implications of this for another 1500 years (Singer 1957, Toledo-Pereyra 2008). Unfortunately for Galen’s reputation in the modern world of medicine there is no pneuma in the human body, no humors, no innate heat, and no rete mirabile. Equally unfortunately, the extent of his accomplishments and the power and mystique of his personality, effectively and in retrospect astoundingly, prevented new anatomical and medical advancement for over a thousand years (Nuland 2008, Toledo-Pereyra 2008).

When the power of the Roman Empire declined in the 4th century, the Eastern Empire, centered in Constantinople, gained ascendancy. During the millennium that followed, science did not advance at all. Fortunately, the birth of the Moslem nation in the 8th century marked the formation of a culture that was interested in translating the old Greek texts into Arabic. These Arabic translations became the repository of the work of the ancients, which saved Greek science and medical writings for later generations. Physicians of the Renaissance eventually found a great deal in Galen to criticize, though initially they criticized the master only with the greatest of reluctance (Nuland 2008, Porter 1999, Toledo-Pereyra 2008).

Andreas Vesalius was born Andreas van Wesele in Brussels in 1514. His father, a pharmacist to Emperor Charles V, was descended from a family of physicians and pharmacists who had a long history of involvement with the royal courts. His great-grandfather had been an instructor at the medical school of Louvain. Vesalius’s father encouraged his interest in medicine and in 1533 Vesalius enrolled in medical school at the University of Paris, which was still teaching anatomy according to the dictates of Galen (Benini and Bonar 1996).

It was difficult to acquire bodies for dissection when Vesalius was in medical school. The 14th and 15th centuries had witnessed an increased acceptance of human dissection following a decree by Louis d’Anjou in 1376 that allowed surgeons in Montpellier, France, to dissect the corpse of one executed criminal per year and a similar decree in 1478, which allowed the l’Ecole de Paris to perform a limited number of public dissections. By the 16th century a small but measurable amount of progress had been made in terms of allowing dissections for medical study but Vesalius still had to rely primarily upon bodies he stole from places of execution in order to obtain an adequate number of specimens to satisfy his growing interest in anatomical investigation (Bataille et al. 2007). It is estimated that during the three years Vesalius spent studying medicine at the University of Paris he saw no more that three or four formal dissections. Human skeletons, however, were readily available and Vesalius had reconstructed several from the bodies he salvaged following executions. Consequently, much of his early work in anatomy was done in osteology (Benini and Bonar 1996, Nuland 2008).

Vesalius had to leave the University of Paris in 1536 without receiving a diploma because war had been declared between the French King and Emperor Charles V. He entered the University of Padua in 1537 and in the same year he earned his Doctor of Medicine degree from that University. The next day he was appointed Professor of Surgery at the University of Padua which carried with it the responsibility of teaching human anatomy to medical students. He was just 23 years of age (Zimbler 2001, Nuland 2008, Porter 1999).

Like other medical students of his day, Vesalius had learned anatomy the old fashioned way, through reading the works of Galen. When dissections were performed, they were lead by a professor, seated in a chair high above the students, reading a translation of Galen. It is doubtful if the professor, could even see the dissection that was taking place beneath him. Poorly trained barber-surgeons attempted to follow the directions read out by the professor and it was the job of the demonstrator, who usually had even less training than the barber-surgeons, to point out the body parts to medical students (Benini 1996, Nuland 2008, Porter 1999). In his new faculty position at the University of Padua, Vesalius immediately began to set up a ground-breaking curriculum in anatomical studies that encompassed a multidimensional, innovative approach. The biggest break with tradition was that Vesalius himself undertook to do the dissection demonstrations for his students. He kept a skeleton handy for reference during his dissection, and he regularly sketched an outline of the bones on the skin of the cadaver before he made the first cut into the body. He made large anatomical charts for students to follow during the dissection process, and he often did comparative dissections or vivisections on other animals as companion demonstrations. His students loved the new format (Nuland 2008).
As a learning aid for his anatomy students, Vesalius published six anatomical charts in April of 1538. Titled *Tabulae anatomicae sex* the six charts were keyed with reference letters identifying anatomical structures and sized so that students could take them to their own rooms for further study. These charts are among the first known anatomical illustrations specifically designed as student study guides. Vesalius himself drew the first three charts, which were representations of the liver and its blood vessels. These early illustrations still retained a few of Galen’s errors, showing the liver with five lobes and depicting the heart of an ape. The other three charts were diagrams of the male and female reproductive systems, the veins, and the arteries. Again, Galen’s influence is still evident as Vesalius included the *rete mirabile* among the arterial illustrations. The *Tabulae* is seen as a transitional work for Vesalius and stands today as the first hint that anatomy might be liberated from Galen’s influence.

In this work, some relatively minor tenets of Galen were amended and Vesalius pointed out that there were a few apparent discrepancies between Galen’s descriptions of certain bones and his own findings. For instance, he observed that the human jawbone consists of only one continuous bone, not two, as Galen had professed and is typical of many animals. From this time on, as Vesalius became more and more familiar with human dissection, he became more critical of Galen and more convinced that Galen had based his anatomical knowledge only on animals. Little by little he became certain that Galen had never dissected a human cadaver (Bataille et al. 2007, Benini and Bonar 1996, Nuland 2008, Porter 1999).

In 1539, Vesalius began a project that was to become the major accomplishment of his academic life. Convinced that Galen was wrong in many of his conclusions, he began dissecting humans in earnest with a large supply of cadavers of executed criminals made available to him by the Paduan authorities. By now Vesalius’s reputation had spread from the University into the community and so great was the collective interest in his continuing work that in some cases it is believed that executions were postponed until Vesalius was ready for his next subject.

The work in progress would become a series of books titled *De Humani Corporis Fabrica*. The *Fabrica* marks a watershed in the understanding of human anatomy and the incorporation of anatomical expertise into the study of medicine (Nuland 2008).

An artist from the Netherlands named Jan Stephan van Calcar, perhaps working in conjunction with the master painter Titian and his assistants, is believed to have done the illustrations for the *Fabrica* (Saunders 1973). He worked closely with Vesalius and beautifully captured the stunning details of Vesalius’s meticulous dissections. Intricate, detailed woodcuts of the illustrations were made in Venice and Vesalius had the woodcuts carried by mules over the Alps to Switzerland where the best printing press in the world was located.

The world famous printer Joannes Oporinus did the printing in Basel, Switzerland, in June and July of 1543, and the printing itself was a hallmark in the art of bookmaking. The completed *Fabrica* volumes included 663 folio pages, 11 large plates of illustrations and close to 300 smaller illustrations that are scattered throughout the work. The text of the *Fabrica* is a classic in pedagogy. It is well organized and speaks directly to the needs of anatomy students. Modern anatomy textbooks that combine clear, comprehensive text with numerous illustrations are patterned after the *Fabrica*. The completed *De Humani Corporis Fabrica* went on sale in August of 1543. It was the first text of its kind to be created with such exactitude and the first medical text whose parts were so well integrated. The dissected bodies are seen in graceful life-like poses, similar to those that can be seen today rendered in different medium, in a traveling exhibit called Body Worlds. The “muscle men” drawings contained in the *Fabrica* depict muscles in motion and display each muscle as if it is functioning in a living system. To further capture the feeling of form and motion, which Renaissance painters like Leonardo DeVinci pioneered, Calcar’s drawings are done with real backgrounds so that when the drawings are placed side by side in proper sequence they show a continuous scene of the Euganean Hills of Padua. It has been said that anatomy as a separate discipline began with the *Fabrica*, and with its publication in 1543, the modern scientific study of medicine came into being. Measured by any ancient or modern criteria, it was an astounding accomplishment (Nuland 2008, Zimblar 2001). Sadly the priceless woodcuts were destroyed in the bombing of Munich, which occurred during the Second World War. Fortunately a final printing from the original woodcuts, which created a work known as the *Icones Anatomicae*, had been struck and published jointly by the New York Academy of Medicine and the Library of the University of Munich prior to the war in 1934 (Saunders 1973).

A smaller summary volume for use in the classroom, the *Epitome*, was published immediately after the *Fabrica*. The *Epitome* was originally intended as a laboratory guide for students. It was largely pictorial with a minimum of text and, since it was much smaller than the *Fabrica*, it could easily be transported from place to place. Vesalius designed it to be “used as a pathway along the highway of the major work” (Saunders 1973). When the two books were used together they would constitute a complete course in anatomy accompanying the anatomy student from a beginning exploration of the subject to advanced learning in the field. A German translation of the *Epitome* came out two weeks after the original publication, making the essence of the *Fabrica* available to the common man. The *Epitome* would prove to be more popular and considerably less expensive than the *Fabrica*. It was more in tune with the needs of the general public since the *Fabrica* was clearly written for an audience with

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extensive anatomical knowledge. As a learning aid to anatomy students, the Epitome included pictures of internal organs that could be cut out and pasted on a representative male or female figure. When the cutouts were fastened to a representative figure according to the instructions written by Vesalius, the organs could be revealed in the correct superficial to deep sequence by lifting or moving the layers of cutouts aside (Saunders 1973).

The De Humani Corporis Fabrica consists of seven books, each of which deals with a separate system or group of organs. Book I describes the bones of the body and includes several amendments to Galen’s bone work. Book II covers the muscles. Book III describes the vascular system. This book is considered to be less accurate than the others because it is based partly on animal material in the manner of the work of Galen. Book IV is a description of the nervous system, which still includes Galen’s numbering of seven pair of cranial nerves rather than twelve pair. Book V covers the abdominal and reproductive organs. In this book Vesalius pointedly corrects Galen’s assertion that the liver has five lobes but accepts Galen’s description of the liver producing blood from chyle. Where Galen believed that the inferior vena cava originated in the liver, Vesalius stated that his dissections could not support that assertion. Book VI describes the thorax. In this book Vesalius questioned Galen’s belief that blood passed through unseen holes in the interventricular septum of the heart. His careful analysis made it easier for those who came after him to discover the pulmonary system. Book VII covers the brain and in it Vesalius denied the existence of the rete mirabile in human dissections, while at the same time he accepted its presence, as per Galenic doctrine, in his written commentary. It is reminiscent of a present day anatomy student who, having been told by his instructor to find an elusive structure in his dissection, labors mightily to find it and would rather pretend he sees it than admit defeat. Vesalius solved this problem by simultaneously dissecting the brain of a sheep along with a human brain. This enabled him to point out the rete mirabile in the sheep’s brain and contrast this with its apparent absence in the human brain. Galen’s views on the rete mirabile are believed to have been based on dissections of apes, oxen and pigs, animals that have a rete mirabile, which is a collection of tiny arterial blood vessels near the entrance of the internal carotid artery into the cavernous sinus (Bataille 200, Porter 1991).

The Fabrica contained a very elaborate system of cross-references between the illustrations and the written text, which was unique in the historical development of printed texts. This cross-reference system eliminated the ambiguity that can develop when language falls short of describing the details of anatomical systems that are being studied without the aid of an accompanying cadaver. It is clear in looking at the juxtaposition of illustrations and text in the Fabrica that Vesalius intended to weave the two together. It is not as if a picture is worth a thousand words in this case; it is as if the words and the pictures have been blended into a seamless whole (Saunders 1973).

In an interesting article written in 2006 in Neurosurgery, Bataille et al. describe dissecting a sheep’s brain, using Vesalius’s dissection techniques from Book VII of the Fabrica, to expose the rete mirabile of the sheep’s brain. They conclude that it is possible that Vesalius, and Galen before him, may have “committed an error of interpretation or observation” during their dissection of the cavernous sinus. They may have “inadequately differentiated” the arteries and veins existing in the region of the cavernous sinus but Bataille et al. maintain that the rete is always obvious in sheep and can never be observed in human dissections. The authors of this article went so far as to translate the Latin text of the original edition of the Fabrica to be sure they followed Vesalius’s dissection directions exactly as he gave them. It was not until 1546 that Vesalius was finally ready to declare that he totally denied the existence of the rete mirabile in humans. In the conclusion of their article Bataille et al. quote Vesalius in the Fabrica, “I myself cannot wonder enough at my own stupidity and overly great trust in the writings of Galen and other anatomists; yes I, who so much labored in my love for Galen that I never undertook to dissect a human head in public without that of a lamb or ox at hand, so as to supply what I could in no way find in that of man, and to impress it on the spectators, lest I be charged with failure to find that plexus so universally familiar by name. For the soporal (internal carotid) arteries quite fail to produce such a plexus reticularis (rete mirabile) as that which Galen recounts” (Bataille et al. 2007).

The De Humani Corporis Fabrica was very well received by the medical and scientific community of Vesalius’s day, but there were still some diehard Galen traditionalists who refused to accept it and the criticism of Galen it contained. Jacobus Sylvius, trusted mentor and close friend of Vesalius, was one of those who openly criticized the Fabrica. Sylvius and a few others tried to account for the differences between what Vesalius had discovered with his dissections and the dogma of Galen by saying that the anatomy of humans had degenerated since classical times. There is conflicting evidence cited in the literature about the effect this may have had on Vesalius. Some say it was the reason he gave up his teaching position in 1544 and left the University of Padua. Others say he left because he had always wanted to be a practicing physician. What is known is that prior to leaving Padua Vesalius burned his personal papers, which included a priceless annotated edition of Galen’s works and his notes for more publications in anatomy and medicine. He married, settled down and became the court physician to Charles V of Spain. Twenty years after leaving Padua, in 1564, a series of unusual events

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seem to mark a pathway to Vesalius’s death. A Spanish nobleman who was being treated by Vesalius died and Vesalius was asked to perform an autopsy on the man. When he opened the chest cavity in the presence of autopsy witnesses, Vesalius saw to his horror that the man’s heart was still beating. Vesalius was denounced to the Spanish Inquisition and fortunately managed to receive dispensation from the Inquisition from King Phillip II of Spain on the condition that he travel on a pilgrimage to Jerusalem. The return voyage from the Holy Land was interrupted by a major storm and the passengers were shipwrecked on the Greek Island of Zante. Vesalius died there, most likely as a result of sickness related to the severe conditions on the Island and lack of proper food and shelter. He is buried on the island (Benini and Bonar 1996, Loriaux 1993, Nuland 2008).

Anatomists who came after Vesalius corrected his work as he had corrected Galen but anatomy would never again be based on anything other than independent observation. The human cadaver became the test of truth and fact-finding became the goal of dissection. After Vesalius, anatomists worked for the privilege of attaching their name to a newly discovered structure and the 17th century was the heyday of body part naming. To mention just a few from this period: Graafian follicles, Haversian canals, Circle of Willis, Eustacian tube, Aqueduct of Sylvius, and Tulp’s valve. It was an extraordinary time of discovery. It is important to remember that even though the Renaissance sparked an anti-Galen reaction, the great men who came after Galen were still following Galen’s precepts of dissection and his traditional three part view of physiological function. No Renaissance anatomist opposed the Galenic three-part order of venous blood for nourishment, arterial blood for the life force, and the brain for sensory and motor activities, even when dissection was discrediting some of the main tenets of the scheme. Galen’s emphasis on dissection paved the way for the stunning accomplishment that was the De Humani Corporis Fabrica (Nuland 2008).

Renaissance anatomists greatly elevated the standing of anatomy in science and medicine. Its status had been very low, stigmatized by its association with barber-surgeon guilds, underhanded methods of procuring bodies for dissection and the use of untrained laborers. Anatomy had not even been listed among the ancient divisions of medical study (Nuland 2008). After Vesalius, both anatomy and surgery were incorporated into medical education and physicians were taught to use their own hands in the process of dissection and to integrate this laboratory experience with textbook learning. After Vesalius, the study of anatomy became the method by which medicine was taught and learned.

References


Saunders JBdeCD, O’Malley CD. 1973. The Illustrations from The Works of Andreas Vesalius of Brussels with Annotations and Translations, A Discussion of the Plates and Their Background, Authorship and Influence, and a Biographical Sketch of Vesalius. New York (NY): Dover Publications, p 9-42. (This Dover edition, first published in 1973, is an unabridged and unaltered replication of the work originally published in 1950 by The World Publishing Company, 2231 West 110th Street, Cleveland, Ohio. The text is reprinted by special arrangement with the original printer.)


Abstract
Small-group learning improves student understanding of lecture material. When introduced into the laboratory, it improves students’ ability to apply physiological concepts to design and implement research protocols, then to critically analyze the collected data. Traditional instructor-directed laboratory exercises are conducted to familiarize students with the equipment, vagaries of experimental design, data collection, statistical analysis, and awareness of Institutional Review Board (IRB) and Institutional Animal Care and Use Committee (IACUC) requirements. Given this foundation, student teams then examine a problem of their own interest. In the past, team projects have been limited to ten weeks. In this time period, small student groups performed a literature search, put forth a research proposal, conducted the experiments and presented their findings. Innovative student-generated research projects demonstrated the ability of students to adapt traditional experiments to embrace their specific research projects. Anecdotal feedback from course evaluations and attitudes expressed on student surveys indicated that this approach fostered increased confidence in understanding physiological principles and in designing and conducting experiments in accordance with the scientific method. One of the limitations expressed was the lack of time available for design and implementation of their projects. Consequently, the laboratory component will be restructured increasing the time available for students to design, conduct, analyze and interpret their own findings.

Introduction
Physiology laboratories have dual emphases: first to support and reinforce the lecture material and second to foster development of student capabilities in experimental design and analysis. Small-group learning improves students’ abilities to design science-based research projects and analyze data critically (Kibble 2009, Saunders and Sievert 2002). At Ohio Northern University (ONU), medical physiology courses have traditionally consisted of didactic lectures, scenario-based activities to improve critical thinking skills (Abraham et al. 2004), and classical laboratory experiments that unfortunately used antiquated technology or involved demonstrations using single pieces of equipment. Curricular approaches to incorporating inquiry-based physiology laboratory experiences differ. In one approach, traditional teacher-directed classes are presented for the first third of the semester and small-group research projects thereafter (DiPasquale et al. 2003); in another, inquiry-based projects are implemented to the exclusion of teacher-directed classes throughout the course (Casotti et al. 2008). However, Tufts and Higgins-Opitz (2009) question the effectiveness of problem-based learning in the absence of teacher-centered learning experiences. To address equipment and time limitations, our approach has been to use out-of-class time to incorporate student-generated inquiry-based learning into the laboratory component of the medical physiology courses. Small student groups have conducted their own research projects, analyzed the data, and presented their findings in a podium style presentation to culminate their physiology lab experience.

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Although the inquiry-based portion of our medical physiology courses has evolved over multiple years, it was only formally assessed this year as part of the planning strategy for the restructuring of these courses in preparation for the university conversion to a semester based calendar. The success of our current program was assessed by instructor evaluation of the student-generated experiments and via a survey. This IRB (Institutional Review Board) approved survey asked students to rank whether the laboratory learning objectives were being met. The successes and failures of our current laboratory teaching practices in reaching our learning objectives, as assessed in this study, form the basis for the redesign of the physiology laboratories described herein.

Methods

Our strategy for medical physiology laboratories under the current quarter-based system includes teacher-directed laboratories which demonstrate important physiological concepts and out-of-class team-based research to foster student creativity, scientific inquiry, and data analysis. Teams of 3-4 students are formed in the first week of class and project expectations are discussed. By the third week of each quarter, students are required to submit a brief outline indicating the hypothesis to be addressed and the protocol to be followed. Students are required to complete the necessary paperwork to obtain ONU IRB or IACUC (Institute of Animal Care and Use Committee) approval prior to commencement of any experiment involving out-of-class participants or animal models. Students then conduct their experiments, collect and analyze the data, and present their findings by the tenth week of the quarter.

As part of the overall determination of their final grade, the portion of the grade pertaining to student-generated projects is derived by summing the scores obtained from four different assessors: instructor assigned scores for their research proposal evaluated on a 5 point scale, their formal written report based on a 34 point scale (abstract: 4 pts, introduction: 6 pts, materials and methods: 6 pts, results: 6 pts, discussion: 6 pts, proper citations, grammar and spelling: 6 pts), peer assigned scores for teamwork on a 10 point scale, and oral presentation evaluated on a 16 point scale (presentation organization: 3 pts, delivery technique: 3 pts, visual aids: 2 pts, scientific content: 4 pts, response to questions: 3 pts, references: 1 pt).

To determine student perception of the effectiveness of this teaching strategy and evaluate its flaws, an ONU IRB-approved survey (Table 1) was designed to obtain quantitative data pertaining to laboratory specific learning objectives. These objectives (assessed on a 5 point scale where 1 was strongly disagree and 5 was strongly agree) included (a) developing proficiency in the safe use of laboratory equipment, (b) using appropriate statistical tests and graphical representations to assist in presentation and

Table 1. Formative Course Design Survey for Medical Physiology

This survey is being used to determine student attitudes toward lab experiences to aid the faculty in redesigning the Bio 324-326 Medical Physiology series for semester conversion.

For each of the following statements circle the number that indicates if you:
Strongly Disagree (1), Disagree (2), Neither Agree nor Disagree (3), Agree (4), Strongly Agree (5)

1. My understanding of the course material has been greatly improved by the laboratory component of the course.
2. Teamwork activities (scenarios, labs) increased my level of understanding of the course material.
3. I learned most from the labs:
   a. where the a single setup of equipment was used as a demo
   b. where each group of students performed experiments on their own equipment setup
4. I learned most from labs:
   a. where I was given an explicit set of directions and performed step-by-step experiments
   b. where a small group of students was allowed to design and run their own experiments
5. I would prefer that:
   a. all labs had explicit directions and expected outcomes
   b. we were given equipment each week and allowed to design our own experiment
   c. we were given some directed experiments to learn the equipment and the major principles and were then allowed to design some experiments
6. The laboratory portion of this course increased my confidence and competency in:
   a. designing a laboratory experiment
   b. critically reviewing scientific literature
   c. safe and proper collection of data
   d. proper analysis of data
   e. using critical thinking to interpret data with respect to the literature
   f. writing up laboratory results in an approved scientific format
   g. presenting experimental findings orally
   h. working as an effective team member in a small group
7. The quality of the available equipment was adequate for me to learn the necessary principles:
   a. for teacher-directed labs
   b. for student-generated lab projects
8. The number of available lab setups was adequate for me to learn the necessary principles:
   a. for teacher-directed labs
   b. for student-generated lab projects
9. I think I would benefit most from a laboratory portion of the course that meets:
   a. Weekly
   b. Biweekly
   c. Just a couple of times

Please feel free to add any comments you feel would be helpful on the back of this paper.

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interpretation of data, (c) applying literature-based information and scientific process to the creation and design of a research project, (d) conveying the plan and significance of the research project in both oral and written formats, and (e) developing the ability to work together collaboratively. The significance of student participation and careful consideration of their survey responses was explained prior to administration of the survey at the end of the quarter (November, 2009).

Analysis of the responses to each item on the survey included the calculation of the mean and the percent of respondents who agreed or strongly agreed versus those who disagreed or strongly disagreed.

Results
Over the last nine years, numeric achievement pertaining to inquiry-based student-generated projects graded on the aforementioned parameters has resulted in all student groups obtaining grades of 75% or higher (n=96 projects). This indicates that students were able to effectively design and perform experiments which addressed issues of interest to them. Student projects ranged in sophistication from simple repetition of the lab experiments as performed in the teacher-directed labs (with minor alterations in the data collected or a superimposition of a gender, physical condition, or age bias) to fully designed laboratories which simply used the equipment available.

The following three examples demonstrate varying levels of design prowess and indicate how, at each level, the students were able to harness their knowledge of physiology and the usage of laboratory equipment to design valid inquiry-based experiments and analyze the resultant data.

The first example of a student project was based on a teacher-directed laboratory experiment where students were instructed to (a) examine the effects of motor unit recruitment on the electromyogram (EMG), (b) determine the effects of fatigue on the EMG, c) examine the relationship between tetanus and movement, and (d) study the activity in antagonistic muscles during normal movement. To accomplish the fourth objective, the students were instructed to use two sets of recording electrodes to measure the antagonistic activities of biceps and triceps (EMG). In the student-directed laboratory, “Use of EMG to analyze quadriceps and hamstring muscles use during a grand battement devant movement in ballet”, a dance instructor’s claim that the grand battement devant movement required the contraction of both the quadriceps and hamstring muscle groups was tested. To accomplish this IRB-approved protocol, twelve female students (six with dance training and six without) performed three repetitions of the movement which consisted of flexing the leg at a 45° angle and holding it straight (Fig. 1).

Results indicated that both dancers and non-dancers used their quadriceps muscles but not the hamstring

![Fig. 1 Student demonstrating the leg position and corresponding placement of electrodes on the quadriceps muscles in order to record muscle activity during the performance of the grand battement devant movement.](image)

![Fig. 2 A comparison of mean EMG (v) of the hamstrings and quadriceps muscles recorded during the grand battement devant movement in ONU female dancers (n=6) and non-dancers (n=6). The asterisks indicate a significant difference between the quadriceps EMG and corresponding hamstrings for each test group (p < 0.05).](image)
muscles \((p < 0.05)\) to perform this movement (Fig. 2). The discrepancy observed in muscle use was interpreted to indicate that dancers had been trained to know specifically which muscles were needed whereas non-dancers were less sure of the movement. Although not particularly creative, this student-generated research project demonstrated an effective use of the equipment to conduct a well thought out experiment. Student analysis of the data incorporated appropriate statistical methods and good use of the literature to interpret their findings.

A second example of a student-generated project capitalized on a teacher-directed respiratory laboratory where students used a flow meter transducer to (a) measure and compare the gravitational effect on breathing parameters \((V_T, IRV, ERV, VC)\), and (b) measure and compare the metabolic effect on breathing parameters obtained at rest and following exercise. In the same lab, they also measured (c) vital capacity \((VC)\) with a hand-held spirometer and compared this to the calculated VC using predictive equations based on height and age, (d) calculated residual volume, (e) determined the forced expiratory volume in 1 second, and (f) learned how to correct expired volumes collected at ambient temperature and pressure to the saturated volumes that would be present in the body at 37°C. The student-directed project “Deviations in Vital Capacity Resulting from Temperature and Humidity Differences among Various Environments” used the hand-held spirometer to assess the effect of changing temperature and humidity on measured VC. Students measured temperature and humidity in the classroom, outdoors (December in Ohio) and in two areas in the ONU sports facility: the pool and the sauna. They measured the VC of 12 students, over a 15 minute period, in each of the four environments to show changes in VC (Fig. 3) and compared the VC at the 15 minute time point for each of the four environments (Fig. 4). Students selected a piece of equipment used only briefly during the teacher-directed lab and were able to apply their knowledge of the effects of temperature and humidity on respiratory physiology to design a simple but elegant experiment showing not only a difference in VC in environments at different temperatures and humidities but also a time course change in VC. The negative relationship seen in winter weather was interpreted by students to indicate that as exposure to cold winter weather increased VC decreased, whereas the positive relationship seen in the sauna environment indicated that as exposure to sauna conditions increased VC increased. The students clearly outlined a hypothalamic reflex mechanism resulting in respiratory center vagal output causing bronchoconstriction in the cold and sympathetic bronchodilation in response to heat, indicating that thermal stress is directly proportional to VC, and cited appropriate references to support their viewpoint.

![Fig. 3 Linear relationship of mean vital capacity of students under varying temperature and humidity conditions over time \((n=12)\). Using a hand-held spirometer, vital capacity was recorded every 5 min for 15 min (A) outdoors in winter \((24°F, \text{relative humidity } 44%)\), and (B) in the sauna at the gym \((190°F, \text{relative humidity } 92%)\).]

![Fig. 4 Mean vital capacity of students after 15 minutes of exposure in each environment \((n=12)\). The * indicates significant difference from the classroom environment by post-hoc least squared difference analysis \((p<0.05)\).]
In a third teacher-directed laboratory, rings of fresh bovine renal artery, either intact or with the endothelium denuded, were suspended in organ chambers containing aerated (95% O₂, 5% CO₂) Krebs Henseleit bicarbonate buffer maintained at 37°C. Students were directed to add adrenergic and cholinergic neurotransmitters (as well as their agonists or antagonists) to the bath to (a) examine the effects of cholinergic and adrenergic agonists on vascular smooth muscle, (b) determine the receptor types that mediated contraction and relaxation of vascular smooth muscle, (c) determine the effects of non-receptor mediated depolarizing and hyperpolarizing factors on vascular dynamics, and (d) determine the contribution of endothelium to vascular tone. The student-directed laboratory, “Herbal Effects on GI Motility”, examined the individual effects of three herbs: chamomile, lemon balm, and fennel, purported to collectively reduce GI upset by decreasing gut motility. Using the organ chamber system, the student experimental design tested the efficacy of each herb individually on relaxing smooth muscles in strips of bovine duodenal tissue (n=4 strips of tissue from a single animal per treatment group). They added single, double, and triple infused extracts of the three herbs and observed a dose dependent trend in relaxation by lemon balm (Fig. 5), and mild relaxation by chamomile, but found that fennel actually increased contractility (Fig. 6). Thus, the students concluded that the lemon balm and chamomile were effective in reducing GI motility but that fennel was not. However, they did not take into account any synergistic activities of the herbs. Furthermore, due to time constraints, their study was restricted to multiple segments obtained from a single animal. This project demonstrated the team's ability to adapt a protocol creatively and use the literature to design a valid scientific experiment.

Survey responses (n= 20) aimed at determining the students’ attitudes to our laboratory approach indicated that the majority of students (75%) said small group activities (scenarios/labs) increased their understanding of course material (Fig. 7). They also indicated that the labs increased their confidence and ability in working effectively as a team member (85%) and in experimental design and data collection (65%), but none expressed a preference for running their own student-directed experiment every week.
Students felt that an increased number of setups would make the teacher-directed labs more effective (70%). Less than half of the students reported that the laboratory experience had increased their confidence in reading scientific literature critically (45%). Furthermore, the laboratory experience neither increased their confidence in critically interpreting their results with respect to the literature (40%) nor increased their confidence in writing up the lab results in an appropriate scientific format (45%). Only 55% of students indicated that the laboratory experience had increased their confidence in statistical analysis; however, a gratifying 80% said the lab experience had increased their confidence and competency in orally presenting material.

Discussion
This study set out to determine the effectiveness of the laboratory component of the medical physiology courses as currently employed in the quarter system. We determined that the laboratory approach had a positive impact on overall student learning but was not without limitations.

Whereas we consider this out-of-class student-directed research component to our program to be a resounding success, student surveys revealed areas in which we are not meeting our stated goals. On a positive note, our laboratory approach reinforced understanding of the course material. This is consistent with the findings of others (Cassoti et al. 2008, Saunders and Sievert 2002, and Springer et al. 1997) that small group learning is an effective complement to lecture. Students rated group co-members highly and this cooperative spirit was also evident during teacher-directed laboratories indicating effective teamwork. Furthermore, students indicated greater confidence in oral communication following completion of the course.

Table 2. Highlights of Semester-Based Student-Centered Activities in Medical Physiology Courses

Semester 1: Emphasis on experimental design
- Student teams search the literature to guide them in designing an experiment. There will be a dedicated lab to teach students how to evaluate student data with respect to the literature.
- All students will complete paperwork pertaining to IRB or IACUC approval whether or not approval is required for the specific experiment. Completion of forms will help students recognize the importance of ethical considerations when conducting physiological research on living organisms (Kibble 2009).
- Students will generate written proposals for inquiry-based research projects.
- Oral podium presentation of their proposals will prepare students to present at a meeting in podium format.

Semester 2: Implementation of their Research Proposals
- Students will perform the experiment and collect data as designed by the student team.
- Statistical analysis of data. There will be a lab exercise dedicated to statistical representation of data: addition of this lab exercise addresses the issue that only 55% of current students indicated that the laboratory experience increased their confidence in statistical analysis.
- Development of discussion points and conclusion with respect to the literature.

Faculty-team meetings during dedicated project lab times will facilitate teaching students how to correlate their research findings with the literature and will help to develop student confidence in reading and writing critically.

While the out-of class projects addressed the goals of reinforcing lecture material, fostering creative thinking and working effectively as team members, survey results revealed areas in which there was a failure of our approach to develop student confidence in reading scientific literature critically, to interpret results with respect to the literature and to write in a scientific format.

As currently taught, the teacher-directed medical physiology laboratories demonstrate important physiological concepts that correspond with information presented in lectures. However, due to the equipment limitations, most of these laboratories allow only one or two repeats of the exercises and the lack of repetition fails to show students that variability is inherent to all biological processes. Thus students come to expect a single narrow outcome for each exercise as has been noted by FitzPatrick and Campisi (2009). This, in turn, decreases discussion, problem-solving, and teaching moments that can occur when an outcome is obtained that lies outside normal expectations and it also limits student creativity and scientific inquiry and data analysis. The currently employed out-of-class team-based research (that was introduced to address equipment shortages) would have permitted multiple repetitions of the protocol had not equipment sharing and time constraints prevailed. Although student-driven research can be a valuable learning experience, under the quarter system, the students had to be highly organized in order to conduct their experiments, collect and analyze the data, and present their findings by the tenth week of the quarter. The need for students to obtain IRB or IACUC approval (which take a minimum of two weeks) prior to commencement of any experiment which involves out-of-class participants or animal models severely restricted the types of experiments which could be conducted, generally forcing students to conduct experiments that did not involve animals or humans (other than classmates).

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In 2011, ONU will convert from a quarter to a semester system providing an ideal opportunity to redesign our medical physiology courses. We plan to capitalize on the positive impact of our out-of-class study by bringing the principles and techniques of experimental physiology into scheduled class time. The redesign of medical physiology labs under the semester system will address the recognized deficiencies of the current laboratories. However, full implementation of the proposed improvements is contingent upon access to a sufficient number of modern user-friendly computerized data acquisition systems. Furthermore, the curricular changes to our medical physiology courses (Table 2) will satisfy three out of the seven newly-adopted university student learning outcomes (effective communication; critical and creative thinking; scientific and quantitative literacy) and will partially address a fourth learning outcome (informed and ethical responses to personal, civic, and global needs).

The proposed changes for the laboratory component of the medical physiology sequence under the semester system will include many novel and creative learning strategies that will set it apart from other semester based programs. Instead of three small, rushed, out-of-class projects as under the quarter calendar, the full year of physiology will have a single small-group in-class research project which will be designed in the first semester and conducted in the second semester. In previous years, students were not provided a priori with well delineated grading rubrics; clearly defined grading rubrics have been developed for the semester based curriculum for all project-related parameters and will be available on-line for students to reference at any time (Table 3). This should provide additional direction and greater feedback to students as well as increase grading standardization.

The proposed first semester will begin with an introductory laboratory period setting forth laboratory expectations and serving as a dedicated lab session run jointly by the faculty and the library staff to teach students how to conduct literature searches and determine the relevance of a paper to the topic being investigated. Two instrumentation labs will introduce students to the proper use and capabilities of the equipment while allowing concurrent collection of data for use in the discussion of appropriate statistical analyses. Eight teacher-directed laboratories will highlight specific physiological concepts.

The quiz questions will ask them to identify the controls in the experiment, the type of data they will be collecting and how it will be handled.

Three laboratory periods will be dedicated to development of student team-based research proposals. During these labs, group consultations with the teacher will be used to help identify potential problem areas and refine experimental designs. The expectation is that these research proposals will be derived through critical review of the literature and will be hypothesis-driven. Each student team will submit a written draft of their research proposal and will receive feedback from the teacher prior to submission of the final written proposal. In addition to the written proposal, students will be required to complete all paperwork pertaining to IRB or IACUC approval whether or not such approval is required (e.g. experimentation involving invertebrate animals does not require such approval).
not require IACUC or IRB approval). Completion of this paperwork will help students recognize the importance of ethical considerations when conducting physiological research on living organisms regardless of the legal requirements for such documentation (Kibble 2009). We believe that the increased time allotment, consultation opportunities, and feedback afforded to the students will allow them to produce sound research proposals and will enlighten them to the importance of good experimental design.

A final laboratory period will be used for oral presentations of these proposals. A gratifying 80% of students surveyed said that the lab experience had increased their confidence and competency in orally presenting material. The maintenance of the oral presentation of their project proposal at the end of the first semester and the introduction of a poster presentation (at the end of the second semester) should enhance their communication skills and expose students to the two communication formats most frequently encountered at scientific meetings.

In the second semester, we are planning eight teacher-directed laboratories pertaining to didactic lecture material; five open laboratory periods during which students can conduct their approved experiments, analyze their results, and consult with the teacher should the need arise; and a laboratory period for compiling their research reports and poster presentation during which faculty will be meeting with each group to provide feedback and clarification. A final laboratory period for poster presentations of the team-based research projects which will be open to the ONU community at large. Additionally, faculty-team meetings during dedicated project lab times will facilitate teaching students how to correlate their research findings with the literature. Since only 55% of students indicated that the laboratory experience had increased their confidence in statistical analysis, the new curriculum will include a lab on statistical representation of data.

We have written a grant for the purchase of a sufficient number of user-friendly data acquisition systems which, if funded, will alleviate two of the problems associated with the current laboratory series. In teacher-directed labs, multiple stations will allow increased student participation as well as simultaneous collection of data by multiple groups of students. The latter will allow comparison of results and discussion of similarities and differences among the different trials. Furthermore, following the example of FitzPatrick and Campisi (2009), a data base will be created so that data obtained during teacher-directed labs in one academic year can be compared with data from previous years affording greater statistical power and allowing additional questions to be addressed.

The dedication of specific laboratory periods for student-based projects and the additional data acquisition systems will alleviate the issues of time constraints and competition for limited resources and increase the availability of the instructor to serve as consultant to student investigative groups. This will allow more trials to be conducted, thereby increasing both the sample size and the level of confidence in the validity of the results.

The year-long student-based inquiry will make our approach truly unique, affording our students not only a complementary lab experience corresponding to physiology lectures but a legitimate research experience. The experimental component of the first semester is focused on project design with teacher mentoring experimental design, writing effectiveness, and presentation skills. The experimental component of the second semester is dedicated to implementation of the project design that was proposed (and approved) in the first semester and statistical analysis and presentation of the data obtained. Instructor consultation during collection and analysis of data will be geared toward improving the quality and strength of the student-based research projects. Furthermore, progression of the students through the two-course sequence should provide them with a greater appreciation of the scientific method. Students completing worthy projects during the two-course sequence will be encouraged to submit their findings for presentation at scientific meetings such as the Ohio Academy of Sciences Annual Meeting.

Assessment of the revised inquiry-based two semester course will include a survey administered in the first week of the first semester and again in the last week of the second semester. It will include both objective and subjective questions addressing student ability to design an experiment and analyze data as well as assessing student attitudes toward laboratory experiments and their current competence in: a) designing a laboratory experiment, b) critically reviewing scientific literature, c) collecting scientific data, d) analyzing scientific data, e) using critical thinking to interpret data with respect to the literature, e) writing up laboratory results in an approved scientific format, f) presenting experimental findings orally, and g) working as an effective team member in a small group.

Conclusion
The use of out-of-class time to supplement the curriculum in the physiology labs was very effective in meeting several of our goals, such as enhancing instruction of course material and improving written and oral communication skills. However, time constraints due to student and faculty schedules and lack of equipment hampered student development of critical thinking and analytical skills to their fullest potential.

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The stated course revisions, which will be put into effect in the semester based calendar, will allow us to bring the experimental design component into the scheduled laboratory time and address the current weaknesses in the laboratory component of the course. In order to effectively institute the changes outlined herein we will need to modernize and continually update our equipment. With these additions, we believe the shift to the two-tiered inquiry-based laboratory learning strategy holds great promise for physiology education.

References


As graduate student instructors teaching an undergraduate anatomy lab (Anatomy A215: Basic Human Anatomy), we consistently come across students who seem as though they just don’t get it. They don’t know how to structure their time in class, how much to study outside of class, and more importantly, they don’t know how to study the large volume of information covered in class. As instructors we try to suggest mnemonics and other ways to tackle the material. Even so, this just doesn’t seem to sink in for many of our students. We (JK and AS) participate in weekly seminars with other graduate students in anatomy to discuss educational research, both our own projects and studies completed by others. In these seminars we have discussed a range of topics, including expert versus novice learners and metacognition. Discussing these topics led to our own introspection about our individual learning processes. We both saw improvements in our study techniques and overall learning. If thinking about thinking was this helpful for us, we could only imagine what it could do for our students. We thought it was important that our students learn a few new methods for studying, but we especially wanted to help students become more aware of their cognitive processes.

This led both of us (JK and AS) to the idea of setting up a 1-credit course to teach anatomy students how to study. We hoped to help them better monitor their study habits, so that they could accurately determine if their current study techniques were working or if they should try something else. In other words, we wanted to introduce our students to metacognitive techniques and achieve a better understanding of how they learn. Although our proposed course focused on how to help students better learn anatomy, we felt that their experiences in this course also could be applied to future coursework. With support from our advisor, we began the process of developing the course.

The first big step for us was to get departmental approval to offer our course. It was an interesting process for us to begin putting our thoughts down on paper. There were so many factors that hadn’t even crossed our minds. What if only one person signed up? What’s the maximum number of students we can handle? What exactly are our goals, and what are we going to do in class to reach them? After many visits with our advisor, we had a proposal for our course that included our goals and expected outcomes, along with our plan for class activities. Our proposal was presented to our program’s Undergraduate Education Committee, which provided us with feedback on our proposal and ultimately approved our plan. Our work had paid off, as our department felt as though our course had potential, and many faculty members were excited to see how it turned out. We were set to teach MSCI M100: Improving Learning Skills in Anatomy for the first time during the summer 2010 session. Students were told that MSCI M100 should be taken concurrently.

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with our Anatomy A215 class, and that it was expected that MSCI M100 would help them do better in Anatomy A215.

Now, we were excited to receive the go-ahead to teach our class, but it suddenly hit us, we had a lot of work to do! Writing a syllabus was a new project for both of us, and even with our course proposal completed, we found more and more details to iron out. Many emails were sent back and forth with revised copies of the syllabus. Many bagels were consumed in meetings about assigning point values to class assignments and finalizing exactly what the expectations were for class assignments.

The two regular assignments we decided upon were weekly online journal entries and weekly quizzes. Each was worth five points and due by 8pm the evening prior to class. Since we were teaching during the summer and the semester was condensed, we actually met in class twice per week, increasing the number of journal entries and quizzes per week to two. We provided a topic for each journal entry, typically pertaining to what material in Anatomy A215 students found difficult and how they were attempting to understand it. The journal entries were accessed and stored on Oncourse (our online learning platform software, similar to Blackboard). Each quiz was five multiple choice questions covering Anatomy A215 material that was set up online and made available immediately after class (expected to be done by the night before the next class meeting).

This entire process of developing the course elicited a rollercoaster of emotions. One week we felt as though we had no idea what we were doing. We couldn’t believe we’d been given permission to teach our own class and didn’t think anyone would sign up. The next week we were confident. We had clear ideas about what we would do and how we’d do it, and we were definitely going to make a difference in these students’ habits. Lucky for us, we have an advisor who managed to reel us in whenever we seemed to be drowning. (Thanks Valerie!) As it got closer and closer to the end of the spring semester we got more and more planning finished, and students actually started signing up for our class! We began the summer with five students enrolled in our class, and we ended it with all five still in it.

The summer began without a hitch. We put our plan in motion and our students seemed receptive and excited for the class. We had a very friendly atmosphere. Since we were young women and all the students in our class were also women, we all clicked together and it was an atmosphere open to discussion. Although the classroom environment was welcoming, there were many times throughout the summer that we felt like what we were trying to accomplish wasn’t coming through. We also felt that there were instances where our activities fell short of their purposes. For example one day we took the students to a computer lab and asked each student to set up her own histology questions from the virtual microscope used in Anatomy A215. After everyone had their questions set up, the students rotated through each computer to quiz themselves. At the end we walked through each question with all of the students to discuss the answers. When class ended we got no reaction from the students about this activity, and while we thought it would be useful, we really doubted whether or not the students saw any value in it. However, when the next exam was approaching, our students requested to do this activity again. We also received feedback from the students in their online journals, stating that they found this activity to be very helpful.

At the conclusion of our pilot run we were forced to take a step back and examine the effectiveness of our course. Throughout the semester we asked our students whether they believed MSCI M100 was helping them understand anatomy and the overwhelming answer was yes. But what did our students’ “yes” mean in regards to our ultimate goal of the course? Our goals were to increase their awareness of their learning habits while simultaneously increasing longer retention of the information they were learning. Part of our plan as we developed this course was to include steps to methodically assess its effectiveness. If it proved to be successful we wanted to be able to share our results with other educators, so we applied for and received IRB approval to review and report on the results of our class (IRB Study #1007001530).

Through their journal entries we were able to see that a few of our students actually grasped, in part, what we were trying to achieve. One student wrote “I am really glad I took this course because it forces me to study and taught me a lot about how I learn” and another wrote “It truly taught me how to study, but also how to recognize when a study technique doesn’t work for me”. The students who responded in this way were three students who were active participants in every class, both in MSCI M100 and the anatomy course. All three ended up with great grades in the Anatomy A215 course. Though we should take pride in having reached some of our students, our efforts fell flat for others.

There are many distractions as an undergraduate student; we all know that. Half of the battle is getting students to realize and admit that their study habits are detrimental to their own success. Two of our students struggled to overcome their own bad habits with Anatomy A215 and MSCI M100. It was clear that the metacognitive concepts were somewhat lost on these two students. Even so, we did manage to help these students conclude that some of the problems they had...
with the course were personal willpower-related issues. We asked our students to discuss what they thought their “bad” study habits were and the best times for them to study the material. One student, who struggled to do the required work for our class and to be an active participant in anatomy, stated that she waited ‘until the last minute’ to study for an exam and did not study the material every day because she felt like she had already done enough by just being in class that day.

As an educator, this student’s revelation may not be surprising. If many students feel the same way, then how do we get students like her to study each day after class? Do multiple quizzes a week help her to do that? Or do we just put students like her in the bottom 20% of our nice neat bell curve and walk away? As both Associate Instructors (AI) for Anatomy A215 and primary instructors for MSCI M100 we have torn feelings. We want to do everything to help her, such as planning activities worth points to force her to study and stay on top of the material. But at the same time, this is college. Succeeding in college involves working to develop the skills needed to succeed. The students who don’t care to put in the time and effort may never care, regardless of the incentives we try to provide.

We realize that much of our course was just forcing our students to study for 2 more hours a week, and adding more out of class assignments that directly caused them to read lecture materials and textbooks. These are things that some of our students may not have done on their own. Even with this extra push we, in a class of five, had two students who still struggled. It is truly up to students to decide how they make their college experience. For some it may take not getting into a professional program they want or not being able to succeed in a competitive field for them to become more motivated and goal-driven.

For future MSCI M100 classes we plan to be more aware of students who have trouble maintaining a study schedule outside of class. We will also try to implement more group work outside of class. Many undergraduate students may not study in groups because finding group members is a difficult task. As an associate instructor it is easy to walk around a laboratory and see that the students who actively work in groups are more likely to find the correct answer, and that these student groups help each other in ways that AIs and professors cannot. Through our experiences with MSCI M100 we have also learned that sometimes students must be pushed outside their comfort zone and basically be forced to try something new. In doing something new, which they may have otherwise dismissed as unnecessary additional work, students are able to experience the benefits first-hand.

We plan to offer this class again in the Spring 2011 semester. During the spring semester, nearly 450 students enroll in Anatomy A215, so we anticipate a robust enrollment for MSCI M100. By having a larger student base we will be able to draw more solid conclusions regarding whether or not students enrolled in MSCI M100 became more self aware of their strengths and weaknesses in learning anatomy. We will also be able to see whether class size affects success in M100 – would a smaller class (like in the summer, where student-teacher interaction was great) be better for a course like ours?

Overall, we are happy with our pilot run of MSCI M100. We enjoyed setting up the course and implementing activities that we believed would help students in these and future courses. We were not immune to frustration; we were amazed and dismayed as two students in a class of five were still able to fall behind. Sometimes the most interesting thing that comes out of teaching is learning more and more about the different complexities of the human spirit.
**Powerful Points**

**EDU-Snippets – A column that survives because you - the members - send in your Snippets**

by Roberta Meehan
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EDU-Snippets is a column designed to let you, the members of HAPS, share your “ways to make sure your students get it.” During these past few years of putting together your ideas into this EDU-Snippets column, our members have been continuously amazed at how many teaching and demonstration ideas pop up and are easily transferred from one instructor to another through Snippets. The following Snippets – with a PowerPoint theme – are certainly no exception. The members of HAPS always come through with flying colors! Please keep your wonderful ideas coming.

I. PowerPoint Controversy

A. Introduction

During recent months on the HAPS-L discussion list, the topic of PowerPoint presentations has come up more than once. The introduction of this topic led to the idea of making PowerPoint presentations the theme for this EDU-Snippets column.

B. Summary of the Controversy

It is certainly fair to say that the use of PowerPoints is quite controversial. It is also definitely valid to say that many people have had good and bad experiences with PowerPoints – both as students and as instructors. Let us first take a look at a few of the concerns and then we can examine how PowerPoint presentations can be used for the betterment of Anatomy and Physiology education.

Murray Jensen (University of Minnesota, msjensen@umn.edu) started our discussion with the following squib.

This is a great article on how to use and how not to use PowerPoint. Check it out at: http://www.slate.com/id/2253050/. My favorite quote in the article is from a military officer – “When I see moving text, I reach for my revolver.”

David Evans (Penn College, devans@pct.edu) added an interesting comment on this article.

I certainly agree with the underlying sentiment of the officer. No weapons please: For legal reasons, though, I must say I would just reach for my glasses and hearing aid and take them both off!

Murray Jensen (University of Minnesota, msjensen@umn.edu) summed up certain concerns with a tongue-in-cheek comment and stated that the sarcasm is intended.

If your students are tired and restless, but just can’t seem to fall asleep, Dr. Murray Jensen recommends using 200 PowerPoint slides in a one hour class session. Works every time.

C. Instructors’ Concerns

What the comments in the above section show is a real concern about the effectiveness of PowerPoints. EDU-Snippets had several anonymous statements and analyses on the use of PowerPoints. More than one instructor stated that he or she had simply stopped using PowerPoint presentations completely. These people used slides and specific diagrams, designed for given purposes, but they felt that the PowerPoints were a hindrance to actual learning.

One instructor stated that at her institution the use of PowerPoints was expected – almost required – for all topics in Anatomy and Physiology.

At this point it seems appropriate to turn away from the negative and the skeptical and to take a look at how PowerPoint presentations can be used in a positive and educationally sound way.

II. Examples

Pat Bowne (Alverno College, pat.bowne@alverno.edu) sent in a series of PowerPoint presentations. This column was only able to reproduce two but the idea is really good. Keep in mind that these are examples of what can be done when one adds a modicum of ingenuity. Pat says (referring to the totally functional model, which should be doable with relative ease or with only slight variations):

If you use these examples, program your PowerPoint so that when you click on the slides, the questions disappear and the answers are displayed. EDU-Snippets is not displaying the answers but the PowerPoint users should get the idea. Those who are not computer

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whizzes can always make two slides of each – one with the blanks and one with the answers – and from there can flip back and forth.

Example #1:

III. Breaking down the Point

This whole section is being turned over to Judith Gibber (Columbia University, jrg43@columbia.edu) because she sent in a whole series of point-by-point ideas for making and working with meaningful and learning-enhanced PowerPoint presentations.

A. Preparing the Slides

When introducing text on a slide, I animate with Wipe – from Left – Medium speed. This causes the words to appear naturally, that is, from left to right at about the same speed as the words would appear if a person were writing them on the board. This avoids the nausea caused by words that zip all over the place! Also, the slight movement helps attract students’ eyes to the particular words being added to the slide.

When preparing a slide with a complicated image, or a histological slide, I draw an arrow or circle (with no fill) to indicate the part of the slide I will be pointing to during lecture. I animate this image so that when I hit the space bar, it will appear as if I were drawing it (e.g., Wipe to Right, or Strip downwards to lower right). During lecture, it is much simpler to hit the space bar and have that arrow show up, than to have to fiddle with the mouse or a laser pointer to highlight something.

With PowerPoint, I can show the steps as a sequence of events or as a pathway, by creating a series of slides, each of which adds another step. (Those familiar with the software can also do this with a series of animations on a single slide.) I sometimes find it is simpler to create these sequences by working backwards. First, I create the complicated slide with its many images or words, and then I make a duplicate and delete parts to create the slides to be shown prior to that one. While working, I always make a duplicate of my initial complicated slide, lest I inadvertently delete the final, perfect version!

Example #2:

Case Study

He is put on low-flow Oxygen, but complains of shortness of breath. Somebody turns the O2 flow up. He is found in a coma with pCO2 of 59 mm Hg and blood pH of 7.2.

What was controlling his respiration?

How did the treatment affect respiration control?

What caused his acidosis and coma?

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**B. During the Presentation – Part I**

When you are working with a PowerPoint, do your students seem to look at the screen, glazed-eyed, while you are talking to them? Here is a very effective way to get their attention – simply hit the B key. This will turn the screen BLACK. This will temporarily remove the distraction and will return all eyes to you for a more natural discussion. When you are ready to continue with the slides, just hit any key, and you will be back on the last slide you showed.

**C. Active Learning**

For active learning, I suggest that you insert questions on your slides at the relevant parts of your lecture. For example, in a discussion of osmosis, I have a series of slides with solutions separated by semipermeable (selectively permeable) membranes, each having the question, “Which way will the water move?” After students have had a chance to think and offer their answers, I hit the space bar and an arrow appears, showing the direction of water movement. Of course, at this point I can ask, “Why?” The students become involved in the explanation.

**D. Helping the Students Take Notes**

I also provide advice on note-taking on the first day of class, emphasizing the ways I use slides and what I expect students to get out of them. I tell students to take advantage of the number on each slide, and to incorporate that into their note-taking. For example, “Slide #3. Huh???” or “Ask about Slide #5” or “Just woke up. Slide #11 is there. What did I miss?” I am certain you get the picture!

**E. During the Presentation – Part II**

This follows directly on the slide numbering system listed in the previous section. Is the linear nature of PowerPoint a problem in your interactive lectures? You can easily navigate in a nonlinear fashion by simply knowing the slide numbers. Say you are on Slide #12 when a student asks a question that requires a figure on Slide #3. Simply hit 3, then ENTER, and you will be on Slide #3. Of course, before going there, it is important to make a note to yourself as to what your current slide is, so that you can hit 12 ENTER to quickly zip back to where you were.

To facilitate this navigation, just before lecture I make a printout with 12 slides per page – too small to actually read, but big enough to see the slide numbers and the images on each.

One critical point for the Instructor seems to be mastering the tricks of the PowerPoint trade so that the presentation enhances learning rather than detracts from it.

**F. More Organizational Notes**

I avoid using the first slide of the PowerPoint template, where the title and author would go. Instead, I create a slide with an outline of the day’s lecture and let this sit on the screen as the students file into the classroom. This gives them a quick overview of what we will cover.

One critical point for the Instructor seems to be mastering the tricks of the PowerPoint trade so that the presentation enhances learning rather than detracts from it.

**IV. And We Hope You Will….**

Keep those cards and letters coming. Thank you all for your EDU-Snippet contributions. The influx of Snippets has been great! Please keep it up because more are always needed. Your ideas are tremendous! If you have thoughts or ideas, or any interesting ways to help our students understand anatomy and physiology, EDU-Snippets would love to hear from you.

For the next issue of the *HAPS-Educator*, send your EDU-Snippet experiences and ideas to biology@ctos.com as soon as possible. You will also find a reminder on the HAPS-L list. Plan ahead. You can even submit your ideas now and maybe next issue you too will see your EDU-Snippet in print!
In the anatomy lab, investigating a cadaver’s cause of death is a common exercise for students. At the beginning of each semester, most faculty inform students of their cadaver’s cause of death. However, disclosing the cause of death in advance of dissection generally limits students’ exploration to just the expected pathological signs. For example, if the cause of death was congestive heart failure, students will look to see if the heart is enlarged; rarely do they seek out additional pathological conditions. In reality, there are often other pathologies aside from the main cause of death listed. To illustrate this point, a cadaver that students and I dissected last semester was an 88 year old male who died from COPD. However, upon further inspection, I found that he also showed signs of having liver cancer and renal disease. Students who are focused on a pre-determined cause of death will pay special attention to the organs involved and overlook other important pathologies.

I recently tried an alternative approach to this exercise, only telling my students the age of their respective cadavers. As an assignment, students were asked to determine the cause of death and complete a one-page form describing the rationale for their decision. Students were given one point extra credit if they chose the correct cause of death or if their line of reasoning was appropriate for their hypothesized cause of death.

Over the course of the semester, I was impressed to hear students talking back and forth about potential causes of death. Each region of the body that we dissected provided a new opportunity to explore for tumors, plaques, ports, or stints. Students meticulously searched out every possible abnormality and discussed other potential comorbidities. It was a pleasure to hear them clinically analyzing what they saw and discussing whether the observations were part of a complex syndrome or disease process. One student stated, “It’s like putting the pieces of a puzzle together. The cause of death is a mystery, and the clues are within the cadaver; how exciting.” Another student reflected, “I am thinking like a forensic scientist; it’s thrilling.” Students also enjoyed this activity as it gave them an opportunity to combine their prior knowledge in other classes with the anatomy material presented. “It allowed me to apply my knowledge of anatomy with what I have learned in pathology,” said a student. Another discusses that “this helped me correlate anatomical knowledge with clinical knowledge.”

I was pleased with the level of interest that students exhibited during this exercise, and with their efforts at critical thinking. This exercise gave the students an opportunity for creative thinking that enhanced their experience in the lab. Students really seemed to welcome the opportunity for creative thinking which was a change of pace from the typical routine of the anatomy lab. One student stated, “I liked that this exercise added an element of critical analysis to the dissection,” while a classmate explained that the exercise “was helpful in critically thinking about various signs that were seen and linking them to a possible diagnosis.”

When asked if students would recommend this exercise for students in future semesters, all 78 students either agreed or strongly agreed with an average of 6.82 points out of 7 on the Likert scale. When students were asked what they didn’t like about the activity, there were no negative comments. One student responded, “What’s there not to like? We were making guesses all semester long. Every time we came across an abnormal finding, our speculation would either change or become more cemented.”

I would highly recommend this approach to teaching in the cadaver lab and advocate its use as a semester-long activity. As discussed, this exercise is an excellent mechanism to create an environment with enhanced levels of critical thinking, cross-disciplinary opportunities, and mysterious fun for students.

The author would like to acknowledge the contributions of Sarah Tomaka, Brittany Janssen, James Montante, and her students.
During the 2000 HAPS Annual Conference at Charlotte, interested HAPS members organized the Safety Committee to address issues of student and instructor welfare in the human anatomy and physiology laboratory. The primary goal of the Safety Committee is to promote an educational setting that is safe for both students and instructors. To that end, the Safety Committee created the Safety Guidelines (released in 2005 and updated regularly) as the standard for promoting safe practices in the human A&P laboratory. The Safety Committee continues to update and expand the Guidelines, publish Spotlight on Safety essays to the HAPS website, and serve as the authority on issues of safety for the HAPS membership. During the past year, the HAPS Safety Committee has written a series of five case studies to teach and promote safety in the laboratory. The Case Studies can be used as an interactive tool for students to recognize the pertinent safety issues before beginning a lab. “Too Hot to Handle” is based in part on an incident which happened in my own lab class. All of the Case Studies in Safety are available through the HAPS website.

Case Study: Too Hot to Handle

Brett was setting up the hot water bath in preparation for the chemical digestion exercise in the human anatomy & physiology laboratory. While his lab partner Beth was labeling the test tubes and adding the substrate, water, and enzymes according to the outline in the lab book, Brett plugged in the hot plate to the highest setting to speed up the reaction and hopefully get out of lab early.1

Next Brett got a beaker to make a water bath to hold the test tubes to be heated. He saw a crack on the side of the beaker but since it wasn’t on the bottom he used it anyway.2 While he waited for Beth to finish preparing the test tubes, Brett set out to do another exercise which demonstrated the solubility of lipids in a variety of solvents. Brett added 5 mL of various solvents (water, ether, carbon tetrachloride, benzene, and ethanol) and 1 mL of vegetable oil to each of five test tubes. After sealing each tube with parafilm™, he mixed each tube on the vortex™ mixer and returned the tubes to the test tube rack to observe solubility after 15 minutes. Brett placed the test tube rack right next to the hot plate.3

While the test tubes were being heated in the hot water bath on the hot plate, Brett decided to take a break and get a snack from the vending machine two floors down.5 Back in the lab, Brett noticed that the hot water bath had boiled down to dryness.6 Brett grabbed the tops of the test tubes from the bath to transfer them to the test tube rack.7 As Brett was removing the test tubes from the hot plate, his outer shirt billowed over and touched a corner of the hot plate. The shirt immediately burst into flames.8 Quick action by the instructor removed Brett’s outer shirt before he suffered any burns.

When lab was finally over, Brett turned off the hot plate and left somewhat shaken but no wiser from his experience today.9 After lab was dismissed, a teaching assistant came in to tear down the lab. She got a slight shock when she pulled the cord from the outlet.10 She made a mental note to get the cord replaced on the hotplate and proceeded to pick up Brett’s hot plate.11

(Continued on next page)
1. To boil water and most other liquids safely, use only a medium to medium high setting. The surface of a hot plate on the maximum setting can reach a dangerous temperature of 540°C.

2. Never use cracked glassware on a hot plate. Heating may cause any cracks to expand.

3. Hot plates should never be used in the presence of flammable liquids. Fire or explosion may result.

4. Boiling stones should be added to the water bath to prevent superheating and the violent release of steam and over boil at the surface.

5. Hot plates in use should never be left unattended, not even for a short break.

6. Never allow the solvent or mixture to boil away to dryness. A beaker may crack when heated directly on the hot plate.

7. Always use test tube clamps, silicone rubber hand protectors, or thermal resistant gloves to move heated items.

8. Make sure sleeves and other loose clothing are tucked in so they do not touch a hotplate or open flame. Never lean over or look into a container that is being heated. Always make sure that the opening of a heated test tube is not pointing at any one.

9. Always make sure that after use a hotplate is unplugged as well as turned off.

10. Electrical cords and plugs on hotplates should be checked regularly before use for frayed or damaged cords and plugs.

11. Hot objects don’t necessarily look hot. Hot plates will take some time before cooling down even after being unplugged. Make sure to carefully test a hot plate before handling. Or leave a warning sign for others that the hot plate is cooling.
Greetings from the Grants and Scholarship Committee!

This past year has been a challenging time for all of us in higher education with increased enrollment and decreased budgets; however, the Grants and Scholarship committee was able to provide funding for seven fortunate “seasoned” and “new” faculty members to attend the 2010 annual meeting in Denver. These recipients of the Robert Anthony Scholarship or the Adjunct Faculty Scholarship were rewarded with paid registration and banquet tickets. Following are reflections of the Denver meeting from some of the scholarship recipients.

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As a relatively new anatomy and physiology instructor (now in my second year), it is important for me to find people and resources who can help me develop into an excellent educator of these subjects. For this reason, I was very motivated to attend this year’s HAPS conference for the first time. Although the meeting is fairly large, the consolidated format and laid-back atmosphere made it seem much smaller. One of the best aspects of the HAPS meeting was how easy it was for me to meet people. I met many attendees who were eager to make connections and share ideas. As a new professor and one who is new to teaching anatomy, this was very reaffirming. I also found it encouraging that there were successful educators among the attendees who, like me, had come into anatomy and physiology education from outside fields. In addition, I found validation in the teaching approaches I have been using in my discussions with other attendees and was even able to offer the occasional bit of feedback myself.

On the other hand, I was also exposed to an incredible amount of expertise, which I tried to take full advantage of. It was very helpful for me to converse with educators at medical schools so I could think of approaches I can use to best prepare students for medical school. For example, I repeatedly heard about the need for medical students to be good problem solvers. I reinforce this through the problems I present through my anatomy course. I also appreciated Diane France’s talk about using comparative anatomy to teach the human skeletal system. I learned of a software program and acquired a database of radiological images that is used at the University of North Dakota in their anatomy courses. While I have yet to implement comparative anatomy into my skeletal unit, I have installed the imaging software onto the computers in my classroom and will use it for my dissection course in the spring. In addition, I learned of the growing number of on-line options for teaching anatomy and physiology as well as implementation of various technologies in the classroom to enhance student learning. Of particular interest to me were sessions discussing ways to use problem-based learning in anatomy and physiology classrooms.

Probably the most valuable experience for me, however, was the highly collaborative nature of the meeting and the large number of people I was able to meet. For this reason, my goal is to attend this meeting yearly or biennially so that connections I have established can be strengthened over the years. I am grateful for the support I was given through the Robert Anthony Scholarship to attend this year’s meeting.

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I was delighted to receive the Robert Anthony Scholarship which helped me attend the 2010 HAPS meeting in Denver. I traveled alone to Denver and did not know anyone else who was attending. As soon as I reached the HAPS check-in, I felt welcomed as part of the HAPS community. I was overwhelmed by the congeniality of all of the HAPS members, especially the boardmembers, during the conference.

The update seminars were interesting and the workshops were very beneficial. I was excited to incorporate some of what I learned into my fall classes. My students responded very well to the new techniques I brought to the classroom as a result of the workshops.

(Continued on next page)
I enjoyed the social aspect of the conference as well. It gave me an opportunity to meet and talk to many of the members and make connections with others teaching Anatomy and Physiology. I am looking forward to 2011 in Victoria!

Although the deadline has passed for the 2011 Robert Anthony and Adjunct Scholarships, maybe you have a project in mind? If so, check out the Call for Proposals for faculty grants and student grants on the HAPS website (www.hapsweb.org) or contact me, Michael Kopenits, Grants and Scholarship Chair at mskopenits@actx.edu. Be sure to check out the website for details and due dates.

The following is from last year’s student grant winner, Stephanie Biedleman:

Human physiology knows no language barriers. It knows no cultural or socioeconomical differences. The whooshing sound of a systolic murmur is no different in rural China than it is in the most developed of cities. Regardless of nationality, the compassion of a doctor to a patient in fear can be understood.

For two months this summer, I traveled around China’s rural Yunnan Province with a non-profit organization called China California Heart Watch (ChinaCal). As an American who knew very little of the Chinese language, this experience was about as out of the ordinary as I could have imagined. In this alien world, any water had to be boiled in order to be safe to drink, and mountaintop sunrises could be watched without the aid of Google.

Oddly enough, once I set foot into a hospital or clinic, nothing seemed foreign anymore. Patients were waiting, exams were performed, and diagnoses were made. Our group stayed in small villages in the mountains of southern Yunnan. Each morning, we would wake up to about fifty villagers (who had walked more than ten kilometers) waiting to be seen at our traveling clinic. Our team of interns and doctors was split into a hypertension research group and a clinical treatment group. I was able to see firsthand diseases and abnormalities most only read about in textbooks. It was amazing to see the curiosity of many of the patients when presented with the Western medicine we brought. At the end of the day, the interns traveled to local schools to screen children for congenital heart disease. ChinaCal helps those found in need of surgery apply for financial grants.

Thanks to the HAPS student grant, this summer I experienced life as the poorest of China’s villager do; I stayed in hotels costing less than my usual morning Starbucks. ChinaCal was able to conduct hypertension research in order to make a statement to China’s government. It seems as though the people with political power only push for a healthcare change when presented with startling data. China’s healthcare system will need many years and a stratospheric amount of money in order to reach the more than a billion citizens. However, with the help of organizations such as ChinaCal, many of the rural farmers are already receiving the medical attention they desperately need.

And finally, would you like to have financial assistance to be able to participate in the continuing opportunities offered by the HAPS-Institute? If so, go to the HAPS website and check out the call for HAPS-I applications!
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